Supplement to *HortScience*

Volume 49(9) September 2014

This supplement contains the abstracts of presentations from the following Regional and National Meetings of the American Society for Horticultural Science

**Northeast Region Annual Meeting**  
January 6-8, 2014, Philadelphia, Pennsylvania ............................S1

**Southern Region Annual Meeting**  
January 31–February 2, 2014, Dallas, Texas ...............................S17

**Annual Conference**  
July 28–31, 2014, Orlando, Florida .......................................S67
Abstracts of Presentations
from the
Annual Meeting
of the
American Society for Horticultural Science
—Northeast Region

6–8 January 2014
Philadelphia, Pennsylvania

Supplement to HortScience
Volume 49(9) September 2014

Contains abstracts of oral and poster presentations from the 2014 Annual Meeting of the Northeast Region of the American Society for Horticultural Science
Author index begins on p. S14

For citation purposes, abstracts should be cited as follows:

(Example)
POSTER PRESENTATIONS

As Seen Online: Using Webinar Technology to Reach Women Farmers

Jenn Matthews1*, Jenny Carleo2, Robin Brumfield3, April Lippet-Faczak4, Josh Heckman5, Steve Komar6, Meredith Melendez7, Robert Mickel8, Barbara O’Neill9, and Nicholas Polanin10

Program Coordinator in 1Cape May County and 7Mercer County; Agricultural Agents in 2Cape May County, 6Sussex County, 9Hunterdon County, 10Somerset County; Extension Specialists in 3Farm Management and 7Financial Risk Management; 4,5Social Media and Distance Education Coordinators, Rutgers NJAES Cooperative Extension, Rutgers University

In a time when Extension Educators are being asked to do more with less, using distance learning technology can broaden your reach while using fewer resources. Combining face-to-face interaction with remote broadcasting, a team-run, modified hybrid course has resulted in successful practice change among participants. Seventy-five women at three locations across the state were reached simultaneously through distance education. When working with a remote audience, the use of social media (such as Facebook or Twitter) is a necessity. This technology helped reduce the feeling of isolation frequently expressed in our often rural audience. It made the three separate locations feel like one large group. Evaluations of the 2012 course indicate that the Rutgers Annie’s Project Team discovered a method of education that saved both precious time and resources yet with minimal loss to participant satisfaction and networking. Surveys revealed that 93.5% of the women shared what they learned and 50% of the participants had completed their business plans six months after the course. On the last day of class, when asked “what has stuck with you the most?” evaluation comments include: “the power of networking;” “being motivated to actually make the business plan and networking with other women;” and “the diversity of presenters, networking and cooperative atmosphere.” In corroboration with evaluative data, these comments indicate success of the program and our primary goals have been met (networking and creating business plans).

Evaluating Switchgrass Cultivars for Bioenergy Production in New Jersey

Jessica Baculis1*, William T. Hlubik2, Zane Helsel3, and Stacy Bonos4

Switchgrass (Panicum virgatum) is a perennial crop native to North America that is being investigated as a possible source for bioenergy in the Northeast. There are many different switchgrass cultivars; which are adapted to different climates and regions. Identification of the highest performing cultivars for New Jersey would increase the economic viability of this crop and allow local farmers to maximize their production. A trial was established at the Rutgers Cooperative Extension of Middlesex County in North Brunswick, NJ. The trial evaluated 2 ecotypes and 5 distinct cultivars under low-input conditions for their seedling emergence rates, survival rates and dry matter yield. The plots were organized in a randomized complete-block design with four replications for each variety. Alamo and Carthage had significantly greater survival than Timber and High Tide in year one. The average dry matter yield was significantly greater in the second year for all cultivars. Carthage had significantly higher yields than Alamo, Timber and High Tide in the second year.

The Relative Rate of Change in Plant Cultivar Submissions in the Penn State University Landisville Plant Trials

Sinclair A. Adam Jr.1*, Alyssa A. Collins2, Robert Berghage3, and E. Jay Holcomb3

1Penn State Extension, 2120 Cornwall Rd. Suite 1, Lebanon, PA 17042; 2Southeast Agricultural Research & Education Center, The Penn State University SEAREC 1446 Auction Road, Manheim, PA 17545; 3The Penn State University, 318B Tyson Bldg., University Park, PA 16802

Annual plant trials are conducted at a number of institutions throughout the United States and Canada and a number of these test sites contribute to the collaborative National Trials Program. Penn State has a long history of conducting plant trials, starting in 1933, and was one of the early members in the National Trials Program, joining in 2012 when the national system was founded. Penn State maintains a website concerning the trials, making information on plant performance available to breeders, growers and consumers. Breeders utilize this information to improve and direct breeding programs. The Penn State Southeast Agricultural Research and Extension Center (SEAREC) at Landisville, PA, in Lancaster County, also hosts grower events and an open house for the public, conducts tours by appoint-
ment, and provides results of the annual trials to the National Plant Trials Program. Plants trialed in the Penn State program are grown in containers at the SEAREC. In 2013, 1167 selections were submitted to the trials, and 72 containerized plant combinations were also evaluated. Plants were evaluated four times in 2013, and the data was published on the Penn State Landisville Plant Trials web pages. Data was also supplied to the National Trials Program database. Changes in annual plant submissions to the trials have occurred over the 2009-2013 period. These changes reflect the industry response to market interest, environmental impacts and breeding focus. In 2009, 1196 selections were tested, as well as 13 containerized combinations. Over the five-year period, selections submitted to the trials fluctuated slightly in total number, and changed in species/cultivar significantly. Petunia submissions increased each year over the five-year period, while Pelargonium submissions (both Ivy and Zonal types) decreased. Double Impatiens decreased over the period, while Impatiens hybrids submitted increased. New Guinea Impatiens decreased from 2010 to 2011, and increased from 2011-2013. Single Impatiens selections submitted generally increased over the five-year period. Calibrachoa selections submitted decreased over the 2009-2011 period, but increased from 2011-2013, and Verbena increased from 2009-2010, and submissions have remained fairly constant since 2010. The changes in Impatiens submissions are likely due to the Downey Mildew concerns, while the other species changes are likely to reflect market considerations. Plant trial selection submissions are directed by the breeders, and are an important method of determining the market future for producers and consumers. Plant trials conducted at Penn State SEAREC contribute significantly to the industry nationally. Research conducted at this site is beneficial to farmers, industry professionals, consumers and lawmakers.

Evaluating Hispanic Community Exposure to Pb Found in New Brunswick’s Urban Garden Soils

Michele Bakacs1, Beth Ravit2, Carol Baillie3, and Brian Buckley4

1Rutgers Cooperative Extension Middlesex/Union Counties, North Brunswick, NJ, 08902; 2Rutgers Center for Urban Environmental Sustainability (CUES). Dept. of Environmental Sciences, New Brunswick, NJ 08901; 3Dept. Of Environmental Sciences, New Brunswick, NJ 08901; 4Environmental and Occupational Health Sciences Institute. Rutgers University, Piscataway, NJ, 08854

Urban soils often have high lead (Pb) levels due to contamination from Pb based paint, and emissions from leaded gasoline. The consumption of produce grown in Pb contaminated soil may pose a health risk to urban gardeners. In New Brunswick, New Jersey many Latino immigrants grow culturally important produce in their yards. Soil testing on these backyard gardens have shown significant Pb contamination. However, Pb bioavailability under local soil conditions is not known, nor is the rate that popular produce take up Pb. In light of the potential health risks associated with Pb, it is important to understand what chronic long-term dietary Pb exposure New Brunswick gardeners may be experiencing. In 2012, Rutgers researchers and local community groups began to investigate Pb uptake rates of popular garden produce and develop a human risk assessment based on a typical New Brunswick Latino diet. Utilizing contaminated soil from five New Brunswick backyards, three popular herbs and two popular vegetables were planted in Rutgers’ greenhouses. Three pots per species were planted using soil from the same yard. Two plants of each species were also planted in pots using control soil (yard soil with low lead concentrations). Plant tissue analysis was conducted to determine lead uptake by individual species. Results of the lead uptake analysis will be presented. Next steps include developing a dietary risk assessment based on typical consumption of the popular foods composed of the herbs and vegetables analyzed. The risk analysis will be used to develop best gardening practices that minimize potential Pb exposure through various ingestion pathways. The results will support programming focused on educating the Latino immigrant community on safe gardening practices.

Tree Size, Fruit Yield, Yield Efficiency, and Clements Tall Spindle Apple Suitability Index of Fourth Leaf ‘Honeycrisp’ Apple on 31 Rootstocks in Massachusetts and New Jersey As Part of the NC-140 Regional Rootstock Research Project

Jon Clements1, Win Cowgill2*, Wes Autio1, Rebecca Magron2, and J. Krupa1

1University of Massachusetts Amherst, 201 Natural Resources Rd., Amherst, MA 01003; 2New Jersey Agricultural Experiment Station–Rutgers Cooperative Extension of Hunterdon County, PO Box 2900, Flemington, NJ 08822

As part of the NC-140 Regional Rootstock Research Project (nc140.org), ‘Honeycrisp’ apple trees on 31 rootstocks with seven replications were planted in 2010 at the University of Massachusetts Cold Spring Orchard (MA) and Rutgers Snyder Farm (NJ). Included rootstocks are nine from Russia (Budagovsky), thirteen from the United States (Cornell–Geneva), several German rootstocks (Supporter, PiAu), and commercial standards M.9 and M.26. The primary objective(s) are to evaluate tree size, fruit yield, and yield efficiency of the rootstocks over a wide climatic range (plantings established across North America as part of NC-140) and determine suitability for modern, hi-density commercial apple orchards. The planting will be evaluated over a 10-year lifespan, but preliminary results in MA and NJ after the 4th leaf (2013) include: trees are overall larger as measured by trunk cross-sectional (TCSA) area in NJ (16.2 cm²) than in MA (9.8 cm²); TCSA ranged from 1.7 cm² (MA, B.71-7-22) to 40.6 cm² (NJ, B.70-20-20); fruit yield per tree in 2013 was greater in MA (16.0 kg) than in NJ (7.1 kg); fruit yield per tree ranged from 0.8 kg (NJ, B.9) to 40.9 kg (MA, CG.3001); overall yield efficiency (YE, kg fruit per cm² TCSA) in 2013 was higher in MA (1.65 kg/cm²) than in NJ (0.5 kg/cm²); YE ranged from a low
of 0.1 kg/cm² (NJ, B.9) to a high of 2.9 kg/cm² (MA, CG.3001) in 2013. Rootstocks were also numerically indexed during the 2013 harvest with the Clements Tall Spindle Apple suitability index, based on overall tree size and fruit yield (visual, subjective observation) in relationship to their suitability for the Tall Spindle Apple (TSA) production system. The numerically assigned index ranges from 0 = poor TSA suitability index to 3 = excellent suitability. Trees were only evaluated in MA in 2013, where five rootstocks (B.7-20-21, G.41N, G.202TC, CG.4003, and CG.5222) received the highest TSA index ranging from 2.3 to 2.5 (good to excellent suitability).

**Germination of Seeded and Seedless Watermelon Cultivars With and Without Heat Mats**

Michelle Infante-Casella¹* and Peter Nitzsche²

¹Agricultural Agent, Rutgers NJAES Gloucester County, 1200 N. Delsea Dr., Clayton, NJ 08312; ²Agricultural Agent, Rutgers NJAES Morris County, PO Box 900, Morristown, NJ 07963

Successfully germinating the seeds of seedless watermelon cultivars can be difficult. Cultural methods to improve germination rates can be economical and improve production efficiency. A study was conducted to determine if heat mats could improve germination of seeded and seedless watermelons. Seeds of twenty watermelon cultivars (seven seeded cultivars and thirteen seedless cultivars) were sown on April 10, 2010, in a greenhouse into Jiffy-7 peat pellets (30mm). Average greenhouse temperatures were kept at 85 degrees Fahrenheit. Peat pellets were soaked in water in 5-gallon buckets before seeding until saturated. Forty seeds were hand sown into forty peat pellets for each of the twenty cultivars and placed in shallow plastic trays and forty seeds of each of the twenty cultivars, placed in shallow plastic trays on top of heat mats. The heat mats kept the temperature in the peat plugs at 90 degrees Fahrenheit until germination occurred. Germination rates of seeded fruited and seedless fruited watermelon cultivars were recorded at 10 days after sowing. There were no differences in germination rates of seeded cultivars with or without heat mats. The seedless cultivars ‘E-104’, ‘Solitaire’, ‘Sunny Delight’, ‘Sharon’, ‘9156 WTC’, and ‘Wonder’ showed the greatest improvement in germination when using heat mats to warm the peat pellets. All seedless cultivars showed increased germination rates when seedling trays were placed on heat mats. The results of this study indicate that heat mats do not necessarily enhance germination of seeded watermelon cultivars while germination of seedless watermelon cultivars can be improved by utilizing heat mats.

**Strip-Tillage versus Plasticulture Field Preparation Techniques in Organic Muskmelon Production**

Jason Lilley* and Elsa Sánchez

Department of Plant Science, College of Agriculture, 102 Tyson Building, The Pennsylvania State University, University Park, PA 16802

Two methods of field preparation are being compared at Pennsylvania State University’s Russell E. Larson Research and Education Center in Rock Springs, PA, during the 2013–14 growing seasons. This research is investigating the productivity and soil characteristics of organically managed muskmelon (Cucumis melo) in a plasticulture system prepared with black polyethylene mulch and drip irrigation installed on 6 inch raised planting beds and a strip-tillage system prepared with 12 inch wide tilled strips for planting and also utilizing drip irrigation. Conservation tillage has been utilized in agronomic crop production for over 5 decades. It has been shown to decrease erosion, increase soil moisture retention and increase soil microbial communities. Conservation tillage methods are beginning to be utilized more in horticultural crop production such as for pumpkins (Cucurbita maxima) and tomatoes (Solanum lycopersicum). This research will quantify the suitability of organic muskmelon production in such a system in Pennsylvania. In this study, the fields for both treatments are planted with a winter rye (Secale cereal), hairy vetch (Vicia villosa) cover crop the fall before planting. In the plasticulture treatment the cover crop is fully incorporated into the soil prior to installation of black polyethylene mulch on raised beds. In the strip-tillage treatment the cover crop is killed with a roller crimper. A Hiniker™ strip-tiller is then used to create a loosened planting row while leaving the rest of the field undisturbed. These treatments are replicated four times. Data from the 2013 growing season has shown higher soil moisture in strip-tillage treatment plots and lower soil temperatures compared to the plasticulture treatment plots. During weekly scouting, insect pest pressure observed in plasticulture plots surpassed the set threshold twice throughout the season compared to none in the strip-tillage plots. Total pounds of fruit per treatment was 275% greater in plasticulture plots than in strip-tillage plots.

**Genetic Diversity Analysis of Rutgers Dogwood Selections**

Robert Mattera*, Josh Honig, Jennifer Vaiciunas, John Capik, and Thomas Molnar

Plant Biology and Pathology Department, Rutgers University, 59 Dudley Road. New Brunswick, NJ. 08901

The large-bracted dogwood (Cornus sp.) breeding program at Rutgers University, initiated in the early 1970s, has a long history. Fourteen cultivars have been released, including novel inter-specific hybrids that are popular throughout the United States, Europe, and Japan. In addition to the cultivar releases, a large germplasm collection of various dogwood species and advanced-generation, interspecific hybrids has also been developed. The purpose of this study was to examine the genetic diversity and relationships of a significant portion of the collection. In total, 95 accessions, consisting of named cultivars and breeding selections of C. kousa, C. florida, C. nuttallii, and C. angustata, were evaluated. Accessions representing various combinations of interspecific hybrids between these species were also included. Fourteen simple sequence repeat markers were amplified and used to fingerprint each of the accessions. The resulting peaks were scored using GeneMapper v5, with data...
Imbibition, Germination, and Dormancy of Amaranthus pumilus Raf. (Seabeach Amaranth) Seeds

Sasha W. Eisenman1*, I. Zeitzer2, and D. Snook3

1Temple University, Department of Landscape Architecture and Horticulture, 580 Meetinghouse Rd. Ambler, PA 19002; 2high school student; 3undergraduate student

Amaranthus pumilus Raf. is a federally threatened, annual plant species that grows on barrier island beaches of the eastern United States. In order to gain a better understanding of seed dormancy in A. pumilus, germination and imbibition experiments were conducted. An experiment was carried out to assess the influences of piercing and gibberellin A3 (GA3) solution on germination of A. pumilus seeds. Two lots of A. pumilus seeds (lot 1: stored at 4 °C for approximately 1 year and lot 2: stored at room temperature [21 °C] for approximately six months), were each subjected to four experimental treatments: 1) pierced+GA3, 2) pierced+H2O, 3) non-pierced+GA3, and, 4) non-pierced+H2O.

It was determined that the final germination percentages (FGP) of A. pumilus seeds in both lots were significantly increased by treatment with GA3 in combination with piercing of the seed coat. The pierced+GA3 treatment had the highest FGP, with 99% for both lot 1 and lot 2. Although treatment 2 (pierced+H2O) had some germination, it differed statistically from treatment 1, with a FGP of 9% and 35% for lot 1 and lot 2, respectively. Treatment 3 (non-pierced+GA3) caused 0% germination in lot 1, while lot 2 exhibited some germination with a FGP of 14%.

Treatment 4 had the lowest FGP with 0% for lot 1 and 1% for lot 2. Embryos, excised from unstratified seeds, failed to grow regardless of GA3 application. Imbibition and dye-tracking tests showed that the water-permeability of individual seeds was variable. Although groups of pierced and non-pierced seed both exhibited the greatest increase in mass within an initial twenty-four hour time period, dye-tracking revealed that only some individual seeds began imbibing within the first 24 hours, while others did not imbibe after 20 days. In seeds that showed imbibition, staining was restricted to the area between the inner and outer testa layers and did not reach the embryo or perisperm. Lack of imbibition due to the seed coat, is a characteristic of hard seed, which has not been documented in the Amaranthaceae.

Effect of Liquid and Gaseous 1-MCP Applications on Bud Retention of Semi-Hardwood Hazelnut Cuttings

*Megan F. Muehlbauer, Adam Morgan, and Thomas Molnar

Plant Biology and Pathology Department, Rutgers University, 59 Dudley Rd., New Brunswick, NJ. 08901

Hazelnuts are a low-input, high-value crop with great potential for commercial production in the northeastern United States. Historically, their production in this region has been limited due to the fungal disease eastern filbert blight (EFB). Today, EFB-resistant cultivars have been developed but other factors, such as inefficient propagation of hazelnuts, slow the establishment of a new industry. Rooting semi-hardwood cuttings has shown potential as a useful hazelnut propagation method, and previous studies have demonstrated high rooting success; however, many cuttings fail to develop into successful plants the following spring due to the loss of dormant buds over the winter period. In a recent study, the ethylene blocker 1-MCP (gaseous form) was shown to enhance bud retention in semi-hardwood hazelnut cuttings. However, this study included only one genotype and did not report on plant survival the following year. In our study, semi-hardwood cuttings from four EFB-resistant genotypes were taken on two dates in the early fall and treated with either gaseous 1-MCP or a foliar 1-MCP formulation. The goals were to confirm the previously published results, compare gaseous and foliar forms of 1-MCP, and assess plant survival in the spring. Preliminary results show that there was no treatment effect for either formulation of 1-MCP on bud retention (P > 0.0001). However, results did indicate that the genotype had a significant effect on bud retention, which confirms previous reports on genotype differences of rooting and may explain some of the differences between our study and other published results. While our results did not show that ethylene blockers had a significant effect on bud retention, they serve to guide our ongoing investigation into the usefulness of 1-MCP in more effectively propagating hazelnut stem cuttings.

Heritability of Fruit Rot Resistance in American Cranberry

Jennifer Johnson-Cicalese1*, Nicholi Vorsa1, James Polashock2, and Josh Honig3

1Department of Plant Biology and Pathology, P.E. Marucci Center for Blueberry & Cranberry Research & Extension, Rutgers University, Chatsworth, NJ 08019; 2USDA-ARS, P.E. Marucci Center, Chatsworth, NJ 08019

Cranberry fruit rot causes significant fruit loss in the Northeast and increasingly in other cranberry growing regions. This fungal disease complex is managed by multiple fungicide applications, increasing grower costs and environmental impact. Four distinct sources of resistance were identified in our breeding program and used in crosses; highly resistant Budds Blues and US89-3, and moderately resistant Holliston and Cumberland. Over 1600 progeny and their parents were established in 2.3 m² field plots and screened for resistance in 2011–13. Fungicide applications were withheld and severe disease pressure occurred. All plots were rated for fruit rot using a 1–5 scale (where 5 = 80% to 100% rotted fruit) and a subset of plots were harvested for yield and % rot evaluations. Good correlation was found between years (2011 vs. 2012: r = 0.59; 2012 vs. 2013: r = 0.62), and between ratings and counts (r = 0.75). Significant differences between and within families were found in rot ratings and % rotted fruit
counts. Resistance was moderately heritable (offspring/parent regression of rot ratings: $R^2 = 0.66$) and progeny with both good resistance and yield have been identified and selected for further testing in larger replicated plots. These will be evaluated under reduced fungicide regimes, for potential cultivar release.

Specialty Greens and Herb—Selections for the East Coast

William Sciarappa*, R. Govindsamy,
K.M. Kathleen, F. Mangan, J.E. Simon, S. Zhang,
A.O. Ayeni, P. Nitzsche, R.W. VanVranken,
G. McAvoy, S.J. Komar, and B. Shilling
Rutgers New Jersey Agriculture Experiment Station,
Rutgers University

Research teams at Rutgers University, University of Massachu-
setts, University of Florida and the University of Penn State assessed the demand for specialty greens and herbs sponsored by a USDA--SCRI grant. The project stresses the importance of locally grown produce, estimates east coast demand and then translates expected demands into local production possibilities towards the benefit of small and mid-size farms. The specific ethnic market segments are the Asian and Hispanic consumers, selected for their strong recent population growth and continued growth expectations. The top four sub-groups are Chinese, Asian Indian, Puerto Rican, and Mexican consumers representing an east coast population of 9.2 million citizens. Literature was collected on food habits, identified ethnic greens and herbs, a consumer survey was prepared and focus group bulletin board interviews were conducted. In 1117 completed surveys, over 100 crops of greens and herbs were identified as known foods from all four ethnicities. 40 crops were selected for the focus group bulletin board and telephone survey. A follow-up survey included the top 10 crops for each ethnicity to document consumer demand. This crop survey shows preferred Chinese crops are Shanghai bok choy, Chinese broccoli, spinach and sugar pea tops; Asian Indian crops are tumeric, radish greens, sorrel spinach and fenugreek; Mexican crops are purslane, roselle, vine vegetables and lambsquarter and Puerto Rican crops are lettuce, garlic chives, cilantro and Spanish oregano. Average quantity and purchase prices were determined for all four ethnic populations weekly. In University research farm trials, 40 specialty herbs and greens were chosen as leading crop candidates, 16 cultivars for replicated key crop trials and 9 cultivars for demonstrational crop trials. The majority of seeds had good germination in the greenhouse and produced good transplants. Ethnic greens and herbs grew well under standard American plasticulture, cultural practices and fertility recommendations. Thus, many of these ethnic specialty crops are adaptable to climatic conditions found in northeastern, mid-Atlantic and southeastern growing regions of the east coast of the United States. This information helps direct field production trials on the East Coast to assess the production feasibility of these selected high-market-potential greens and herbs.

ORAL PRESENTATIONS

ELISA Monitoring for Xylella Fastidiosa in Declining Residential/Street Trees in Philadelphia, Pennsylvania

Michael W. Olszewski*, J. Fine, and E. Monheim
Department of Landscape Architecture and Horticulture,
School of Environmental Design, Temple University, 580 Meetinghouse Rd., Ambler, PA 19002

Shade tree leaf scorch is caused by the xylem-limited bacterium Xylella fastidiosa. Typically, infection by this bacterium results in plant decline and, ultimately, death. The objective of this research was to determine disease presence in Philadelphia, Pennsylvania. Asymptomatic and symptomatic trees (N=118) were sampled for the presence of X. fastidiosa using enzyme-linked immunosorbent assay (ELISA: Agdia, Inc., Elkhart, IN) and positive determinations recorded with a microplate reader at 650 nm. Tree species, health rating (1 = tree is healthy; 2 = tree showing initial signs of decline/disease; 3 = tree showing low decline/disease severity; 4 = tree showing medium decline/disease severity; 5 = tree showing high decline/disease severity; 6 = tree dead) and visual symptomology also were recorded. All tree samples were from Temple University-Main Campus or from clippings made by the UC Green Pruning Club located in North and West Philadelphia regions. ELISA testing indicated that 69%, 18%, and 13% of sampled trees were negative, positive or inconclusive (weak positive), respectively, for X. fastidiosa. Most of the trees tested (92% of sampled trees) were London planetree (Platanus hybrid), red oak (Quercus rubra), pin oak (Q. palustris) and red maple (Acer rubrum). The health ratings for trees testing negative and positive for X. fastidiosa were 2.4 ± 1.3 and 3.6 ± 1.2 (mean±standard deviation), respectively, indicating that many trees were in a stage of decline likely resulting from multiple factors. Among those trees testing positive for bacteria, approximately 28%, 33%, 24%, 10% and 5%, respectively, were red oak, London planetree, pin oak, red maple and shingle oak (Q. imbricaria). Since a fairly rapid decline is expected in infected trees, there needs to be a management plan to address deteriorating trees in urban and suburban regions. Even after several decades of research, the full host range of X. fastidiosa and the epidemiology in urban centers remains unknown. In conclusion, the significant presence of X. fastidiosa in Philadelphia largely goes unnoticed as a bacterial infection; but, the costs to aesthetics, removal and the safety and damage issues that go along with declining trees are real costs to urban areas and should be included in real valuation of urban infrastructure.

Designing and constructing Natural Barriers for Stormwater Management and Coastal Lake Protection

William Sciarappa1*, Vivian Quinn1, and A. Modjeski 2
1Rutgers Cooperative Extension, New Jersey Agriculture Experiment Station, Rutgers University; 2Water Resource Director, AECOM

S6
Rain gardens are natural plant barriers designed to recharge polluted stormwater runoff back into the groundwater reserves and remediate pollutant problems to provide a clean and abundant supply of fresh water filtered through a beautiful landscape. PowerPoint presentations and hands-on training instructed clients and volunteers on how to construct a rain garden properly. This program was provided at over 100 conferences reaching a diverse group of community interests and certifying 100 Rain Garden Specialists. This county extension program initiated awareness and fostered the construction of 64 public rain garden demonstrations and over 450 private projects. Then, on October 29, 2012, “Superstorm” Sandy severely damaged the shoreline of New Jersey; including many of these existing coastal rain gardens, sandy berms, planted dunes and artificial barriers. Besides the severe human and housing toll, the oceanic storm breached beaches, eroded roadways and contaminated over a dozen coastal lakes on the Jerseyshore. An unforeseen problem was the immense sand surge that clogged weirs and piping infrastructure leading to rampant flooding. To mitigate this new problem, a demonstrational pilot project of a much larger natural barrier called a Maritime Forest was constructed on a one-acre oceanfront property. The protective design featured elevated terraces installed 50 meters from the ocean and in front of Fletcher Lake bordering Ocean Grove and Bradley Beach, NJ. This ocean coastal woodland is just beyond the beach dune area but within range of the salt spray. Native trees, shrubs and herbaceous perennials were planted into a sandy loam soil amended with humus to create an integrated wetland ecosystem. Tree specimens included the deciduous red maple (Acer rubrum), grey birch (Betula populifolia), black cherry (Prunus serotina), sassafras (Sassafras albidum) and blackjack oak (Quercus marilandica) as well as the evergreens American holly (Ilex opaca), eastern red cedar (Juniperus virginiana) and pitch pine (Pinus rigida). Additionally, 8 species of understory shrubs were utilized in this test along with 7000+ plugs of perennial grasses and herbaceous plants. Long-term assessments include measurement of establishment success, growth and durability of the diverse set of horticultural specimens and their effectiveness in mitigating salty storm-water and beach-sand intrusion.

Potential for Roselle (Hibiscus sabdariffa L.) as an Alternative Vegetable Crop for Mid-Atlantic Growers

Richard VanVranken1, V. Marbey2, and M. Gbolo3
1Professor-Agricultural Agent, Rutgers NJAES Cooperative Extension Atlantic County, 2Graduate Student, Biotechnology/Forensic Science, Stevenson University, MD, 3Owner, Gbolo’s World Crops Farm, Galloway, NJ

Roselle (Hibiscus sabdariffa L.) is cultivated for the bitter young leaves and shoots to cook as a potherb, and the fleshy calyx that can be added to soups or stews, or brewed for tea or dye. A staple vegetable in many tropical cuisines, new ethnic communities throughout the Mid-Atlantic have created demand opportunities. Imported Australian “Wild Hibiscus Flowers [calyces] in Syrup” is familiarizing the general public with this crop. Original observation plots at Rutgers indicated Roselle grows well on plastic mulch with drip irrigation, but the optimal production system for this crop has not been determined here. Typically, young Roselle shoots and leaves are picked from each plant which is allowed to re-sprout for multiple harvests, unlike leafy greens production in New Jersey which is normally a once over harvest of younger plants followed by immediate replanting. The Northeast’s short frost-free season also limits the potential to produce quality calyces. NE-SARE funded this study of yield potential of commercially available cultivars in response to three management systems (bare ground multi-harvest, plastic mulch multi-harvest, bare-ground single harvests of multiple plantings). Field trials were conducted at Gbolo’s World Crops Farm, Galloway, NJ, in 2011, 2012, and 2013. The 2011 plots were lost to root rots caused by heavy rains and poor drainage. In 2012, five 5-plant side-by-side (bare ground vs. plastic mulched) sub-plots were randomly selected for multiple harvesting from 200 feet long strip plantings on 5 feet centers. The 2013 trial included 6 planting x cultivar treatments in a split-plot (bare ground vs. plastic mulch), randomized block layout replicated five times. Plots 5 feet wide by 15 feet long were established by laying plastic mulch over the entire plot and then removing the mulch from half of each replicated plot. Leaves and shoots of all plants (5 plant subsamples in 2012, entire plots in 2013) were harvested beginning when the plants were approximately 18 inches tall. The main stems of all plants were left to regrow for multiple harvests. Despite multiple harvests, the cultivar Thai Red produced edible calyces in early October before frosts in both 2012 and 2013.

Mechanical Blossom Thinning of ‘GoldRush’ Apple Trees With Two String Types and Two Timings

Thomas M. Kon*, J.R. Schupp
Department of Plant Science, Fruit Research and Extension Center, Pennsylvania State University, Biglerville, PA 17307

Penn State researchers have conducted several mechanical blossom thinning trials on apple since 2007, but a practically significant increase in fruit size occurred in only one experiment. The purpose of this experiment was to evaluate the influence of two factors, string type and timing, on mechanical thinning efficacy. Trials were conducted in 2012 at Penn State’s Fruit Research and Extension Center in Biglerville, PA, on ‘GoldRush’/M. 9 NAKBT337 apple trees trained to tall spindle at 1.2 x 3.7 m spacing. All mechanical thinning treatments were applied with a Darwin 300 (Fruit-Tec, Deggenhauserertal, Germany) at 210 rpm spindle speed and 4.8 km h–1 ground speed. A total of 108 strings of either the original plastic strings, or the newer style injection-molded strings were mounted in two columns. Treatments were applied as follows: 1) control, 2) mechanically thinned at pink, with the original strings, 3) mechanically thinned at pink, with the new style strings, 4) mechanically thinned at full bloom, with the original strings, and 5) mechanically thinned at full bloom, with the new style strings. Thinning treatments removed
entire blossom clusters, reduced flower number on remaining spurs, removed 15% to 29% of the spur leaf area of persisting spurs, and reduced initial fruit set when compared to the control. Mechanical blossom thinning treatments reduced hand thinning time, crop load and yield per tree, but had no effect on mean fruit weight at harvest. Fruit size distribution was unaffected by thinning treatment. Fruit firmness from mechanically thinned trees increased when compared to the control. No differences were observed in soluble solids concentration or acidity between fruit from hand thinned control and mechanically blossom thinned trees. Thinning at pink increased 2013 return bloom when compared to the control and to treatments applied at full bloom. String type and timing were not significant factors to explain the differences in efficacy that have been observed in our previous trials.

Genetic Characterization of New Eastern Filbert Blight-resistant Hazelnut Seedlings from Turkey, Latvia, and Lithuania

Kaitlin Morey*, Megan F. Muehlbauer, John Capik, Josh Honig, and Thomas Molnar

Plant Biology and Pathology Department, Rutgers University, 59 Dudley Road. New Brunswick, NJ

The production of hazelnuts (Corylus avellana) in the eastern United States has been severely limited by eastern filbert blight (EFB), caused by the fungus Anisogramma anomala. To overcome this impediment, research efforts are ongoing at Rutgers University to identify resistant germplasm for use in breeding. From 2004–2006, nearly 1000 seedlings derived from open-pollinated (OP) seeds collected from Turkey, Latvia, and Lithuania were established at the Rutgers Fruit and Ornamental Research and Extension Center (Cream Ridge, NJ). They were exposed to A. anomala annually and evaluated for their response to EFB. In 2013, 46 of these trees were found to be highly resistant or tolerant to the disease (30 from Turkey, 13 from Latvia, and 3 from Lithuania). However, since they originated from open pollinated seed, little is known of their genetic background. The purpose of this study was to use simple sequence repeat (SSR) markers to characterize the relationships and genetic diversity of the new EFB-resistant plants in comparison to a wide panel of reference cultivars and control accessions. Seventeen SSR markers were amplified and used to fingerprint each accession. The resulting peaks were scored using GeneMapper v4.1 and a UPGMA cluster analysis was run and represented as a dendogram. The resulting data was also analyzed using Powermarker v3.25 to obtain marker summary statistics. The UPGMA tree shows that the Turkish and Latvian seedlings segregated into distinct clusters generally along with reference cultivars from similar origins. The other reference accessions tend to follow groupings corresponding to similar origins, similar to previous research. The average allele summary statistics for the 17 markers are: allele number = 11.5, average $H_e = 0.768$, average $H_o = 0.81$, and average PIC value = 0.741. The expected heterozygosity of 0.768 implies a high level of genetic diversity and is comparable to that seen in previous hazelnut research. In general, the SSR results show that most of the new accessions group into clusters devoid of any previous known sources of EFB resistance. Thus, they may represent new, diverse sources of resistance available for use in breeding.

Relationship of Phenological and Morphological Attributes of Interspecific F₁ Hybrid Processing Squash to Productivity

Whitaker Cole* and J. Brent Loy

Department of Biological Sciences, University of New Hampshire, Durham, NH 03824

Interspecific F₁ hybrid processing squash, produced by crossing bush breeding lines of Cucurbita maxima Duch., with processing cultigens of C. moschata Duch., were previously described. We have identified an especially productive interspecific processing hybrid, NH65 x SC936. However, pistillate flowers of this hybrid are often produced and set fruit within 10 nodes from the base of plants, and data from 2012 indicated that these crown set fruit were smaller and had lower dry matter content than fruit produced 12 nodes or more from the base of plants. In the summer of 2013, a field experiment was conducted to collect data on flowering, fruit set patterns, and productivity for determining the extent of precocious fruit set and its possible effect on productivity. A field experiment was conducted using a randomized complete-block design, with five replications, two treatments and 10 plants per plot. Plots were direct seeded into black mulch on raised beds (approximately 60 cm wide x 15 cm high) fitted with drip tape. Spacing was 2.4 m bed centers and 0.9 m between plants. Treatments were control (unpruned) versus plants in which pistillate flowers initiated from nodes on raised beds were pruned off. Mean node number for first pistillate flowers was 10.5, but only 20% of unpruned plants set fruit on nodes 12 or lower. The average node number for first fruit set on main stems was 13 for unpruned and 16 for pruned plants. Most well developed lateral branches were initiated along the main stem within 6 nodes from the base of plants. The percentage fruit set on lateral branches was similar for unpruned (19.3%) and pruned (17.8%) plants, but unpruned plants set most of the lateral fruit on the bed surface. Mean fruit size on laterals (6.6 kg) was significantly smaller than on primary stems (8.4 kg). Mean fruit size did not differ between unpruned (8.0 kg) and pruned (8.1) treatments, and mesocarp % DW was also not significantly different between unpruned (9.1) and pruned (9.6) treatments. Fruit FW yield did not differ between treatments and extrapolated to 67.8 mt·ha⁻¹ and 6.34 mt·ha⁻¹ of biomass DW.

2013 New Jersey Fungicide Efficacy Trial for Powdery Mildew of Cucurbita pepo ‘Solid Gold’

Nora Muehlbauer¹*, Win P. Cowgill Jr², C. Andrew Wyenandt², Kris Holmstrom², S. Sollner-Figler², Rebecca Magron² and Wes Autio³

¹ School of Environmental and Biological Sciences, Rutgers University; ² New Jersey Agricultural Experiment Station–Rutgers Cooperative Extension, PO Box 2900, Flemington, NJ 08822; ³ University of Massachusetts
An applied research trial screening fungicides for powdery mildew (Erysiphe cichoracearum) control in fresh market pumpkins (Cucurbita pepo var. ‘Solid Gold’) was conducted at the Rutgers Snyder Farm, Pittstown, NJ, in 2013. A completely randomized design field trial with ten treatments and four replications was established. The trial assessed efficacy and the status of powdery mildew resistance to systemic fungicides. On 26 September, on leaf bottoms, the best powdery mildew control was Fontelis® alternating with Quintec® at 1.8, Bravo®/Quintec® at 2.3, Bravo®/Quintec® alternated with Bravo®/Rally® at 2.5. The poorest powdery mildew control was the Untreated Control at 5, Bravo®/Cabrio® at 4.8, Bravo®/Torino™ at 4.5 and Bravo®/Inspire Super™ at 4.5. A relationship between canopy cover and weight of green fruit was observed; the lower the canopy cover rate (more green leaves), the higher the weight of green fruit, meaning maturity was delayed. The term, “Potential Marketable Yield” was used to represent the green fruit yield plus marketable fruit yield. Bravo/Quintec alternating with Bravo/Rally had the highest quality canopy rating at 2.5, followed by Bravo/Quintec at 3.0 and Fontelis® alternated with Quintec® at 3.5. Highest potential marketable yield was Bravo/Quintec alternated with Bravo/Rally at 182 lbs. per plot, followed by Bravo/Torino at 180 lbs. plot, Bravo/Rally at 174 lbs. plot. Lowest potential marketable yield was the untreated control at 59 lbs/plot followed by Bravo/Cabrio at 114 lbs. plot, Bravo/Inspire Super at 133 lbs. plot and Bravo/Pristine at 134 lbs. plot. All treatments showed a significant improvement in handle quality as compared to the untreated control at a $P = 0.05$ significance level. The results demonstrate that the most effective fungicide treatments keep the pumpkin canopy healthier longer, allowing fruit to fully mature with healthy handles, maximizing yield.


Peter Nitschke¹, William T. Hubik², Win Cowgill³, Jessica Baculis,⁴, Gokjo Jelenkovic⁵

¹Professor, Agricultural Agent Rutgers NJAES Cooperative Extension of Morris County; ²Professor, Agricultural Agent, Rutgers NJAES Cooperative Extension of Middlesex County; ³Professor, Agricultural Agent Rutgers NJAES Cooperative Extension of Hunterdon County; ⁴Agriculture Research Assistant, NJAES; ⁵Professor in Plant Breeding, Rutgers NJAES, Rutgers University and Cooperative Extension, Martin Hall, New Brunswick, NJ 08901

The Rutgers NJAES strawberry breeding program team has developed new genetic lines with excellent flavor and quality. University researchers and cooperative extension professionals have worked together with local farmers to select genetic lines with desired traits that consistently perform well under local environmental conditions. Two new strawberry cultivars are set to be released to local farmers and the general public by 2015 and are in the process of being patented. These cultivars have been bred for high quality fruit, aromatic flavors and competitive yields on plastic culture for the mid-Atlantic region. Grower surveys indicate that participants are satisfied with growth and production of the new NJAES cultivars and rated several NJAES cultivars as good as or better than Chandler for berry color, firmness, flavor, plant vigor and health. Current research is being funded by a grant from the Walmart Foundation, administered by the University of Arkansas, which has enabled researchers and extension personnel to greatly expand the project to both conventional and organic farmers. Trials are now located on 10 New Jersey farms as well as two university and extension research facilities in New Jersey. Additional research has been established at research facilities in North Carolina and Maryland. Five additional cultivars are currently in their second year of evaluation. Selected strawberry numbered cultivars are being propagated at a commercial nursery to allow for adequate availability of the plants for further distribution to growers throughout the region. The project will result in the release of high quality strawberry varieties adapted for utilization in the mid-Atlantic and Northeast regions of the United States.

Self-fruitfulness of Rutgers’ Advanced Blueberry Breeding Selections

Nicholi Vorsa¹,²* and Jennifer Johnson-Cicalese¹

¹PE Marucci Center, Rutgers University, NJAES, Chatsworth, NJ 08019; ²Plant Biology and Pathology Dept., SEBS, Rutgers University, New Brunswick, NJ 08901

The Rutgers’ highbush blueberry breeding program is focused on the development of machine-harvestable varieties for the fresh market. New Jersey growers have relied largely on available migrant hand-labor for harvest. Increasing restrictions on management options, e.g., labor availability, increased pesticide re-entry periods, etc., have placed additional burdens on farm sustainability, making machine-harvestable fresh fruit varieties highly desirable. Another required trait is self-fruitfulness for adequate productivity where plantings are large blocks of a single cultivar. Thus, most ovaries are self-fertilized resulting in high seed abortion. Thus, many if not most highbush blueberry cultivars do not achieve adequate production in large single cultivar plantings, where self-fertilization predominates. Unfortunately, due to the high varietal diversity in typical breeding blocks, virtually all blueberry breeding programs measure fruitfulness in a fairly cross-pollinated environment. In our breeding program we are evaluating the self-fruitfulness of progeny originally selected for their machine-harvestability in an open-pollinated environment. This study evaluated 30 progeny (selections), representing 15 crosses, for self-fruitfulness in controlled greenhouse crosses, as measured by fruit size, ripening period and fruit set. Respective flower clusters were pollinated with either the selections’ own pollen or pollen from the ‘Sierra’ or ‘Bluecrop’ cultivar. Cross-pollinated flowers typically yielded larger earlier ripening fruit for most selections. Relative to cross-pollinated clusters,
fruit ripening was delayed by an average of 3.4 days and fruit size reduced by an average of 18% in self-pollinated clusters. However, self-fruitfulness varied widely among the 30 selections, with some exhibiting only a small effect to others exhibiting a severe reduction in size, delayed ripening and reduced fruit set. Variation for self-fruitfulness between progeny of a given cross was observed; reduction in fruit size with self-pollination ranged from 7% to 59% and ripening was delayed from 2 to 23 days. Fruit set, fruit size, and ripening season under self-pollination in a number of selections appeared to be comparable to cross-pollinated flowers, suggesting they would have adequate productivity under a New Jersey cultural management environment. However, a number exhibiting severe self-unfruitfulness would likely not be suitable for the New Jersey commercial grower.

Comparing the Efficiency of Spring Frost Control Methods and their Effectiveness in Preventing Bud Damage for Selected Cranberry Cultivars

Faith Ndlovu1, 2, 3*, Peter Jeranyama1, 2, 3, Carolyn DeMoranville1, 2, Michelle DaCosta2, 1University of Massachusetts Amherst, Cranberry Station, P.O. Box 569, East Wareham, MA 02538; 2Stockbridge School of Agriculture, 121 Stockbridge Hall, 80 Campus Center Way, University of Massachusetts Amherst, Amherst, MA 01003; 3Plant Biology Program, 217 Morrill Science Center South, University of Massachusetts, 611 North Pleasant St., Amherst, MA 01003

Cranberry buds are susceptible to frost damage as they come out of dormancy. Different frost protection methods, which vary in application, are employed by cranberry growers. An experiment to compare the efficiency of the common methods used by cranberry growers was conducted in southeastern Massachusetts. The main objective was to understand the efficiency of these methods by evaluating cranberry buds, flowering density and fruit set under each method throughout the season. Sites were selected where conventional, automated and late water methods were used and had the cultivars Early Black, Howes and Stevens. Bud collection started prior to the beginning of the frost season to provide a benchmark on spring frost damage and continued after spring frost events throughout the season. Buds were dissected and assessed for damage under a microscope. The conventional method had the least amount of bud damage, with high percent bloom and fruit yield across all cultivars. Automated intermittent (AI) irrigation was associated with the highest bud damage in all cultivars and this was more visible in Stevens. This lead to the conclusion that Stevens is generally more susceptible to frost damage than either EB or Howes, which seemed to perform better under AI, while Stevens did better under LW. Howes and EB exhibited similar responses to frost protection throughout the frost events. The generally low bud damage across all events under LW can be explained by the slowing down vine and bud development while they are submerged in water, thus enhancing tolerance. There were no significant differences between method and cultivar for percent bloom (% bloom) and percent fruit (% fruit). Bloom was more than 50% for both EB and Howes across all methods and we observed the least % bloom for Stevens with 41% under AI and 35% under LW. Our conclusions are that while the conventional method may be more efficient in preventing bud damage, cultivar differences and other external factors play a role in determining yield.

The Role of Organic Acids in Suppression of Cranberry Fruit Rot Disease

Mariusz Tadych1*, James White1, Marshall Bergen1, James Polashock2, Jennifer Johnson-Cicalese3, Nicholi Vorsa1, 3

1Department of Plant Biology and Pathology, Rutgers University, New Brunswick, NJ; 2USDA-ARS, GIFVL, Chatsworth, NJ; 3P.E. Marucci Center for Blueberry and Cranberry Research and Extension, Rutgers University, Chatsworth, NJ

Cranberry fruit rot disease, caused by a complex of pathogenic fungi, is a major threat to the cranberry industry in the Northeastern United States and is increasing in other cranberry growing regions. Chemical methods currently used to control this disease may result in development of fungicide resistance in fungal rot pathogens. Therefore, developing cultivars with improved resistance to fruit rot should decrease dependence on fungicides and reduce fungicide residues. We currently have fruit rot resistant selections, however, the resistance mechanisms are unknown. Our experimental study using cultures of cranberry rot fungi showed that benzoic acid and quinic acid, both natural components of cranberry fruit, inhibit growth of cranberry fruit rot pathogens and reduce their ability to produce compounds, e.g. hydrogen peroxide, known to be involved in induction of cell death and fruit rot. Selections of cranberries that have fruit high in organic acids, e.g. benzoic and quinic acids, may be used in breeding programs to produce fruit resistant varieties. In addition, we are exploring the potential to control cranberry fruit rot disease using organic acids or close derivatives that naturally occur within cranberry plants.

Potential Water and Energy Savings in Cranberry Frost Cycling

Peter Jeranyama*, Faith Ndlovu, Casey Kennedy, and Carolyn DeMoranville

University of Massachusetts Amherst, Cranberry Experiment Station, 1 State Bog Rd., P.O. Box 569, East Wareham, MA 02538

Automated intermittent frost (AI) cycling offers an opportunity to reduce the amount of water usage during frost protection and at the same time saving energy because the irrigation pump will not be continuously running during a frost night. The objective of this study was to compare cranberry cultivar’s response conventional (CON) and AI approaches. In spring we collected 50 buds from each of the fourteen cranberry beds monitored from late March to early June following three frost events. Buds were
dissected under a microscope for visual assessment of the extent of damage from cranberry cultivars 'Early black', 'Howes' and 'Steven' from both conventional and AI methods of spring frost protection. Conventional comprise turning on irrigation sprinklers once a temperature threshold has been reached on a frost night and left to run throughout the night. Automated intermittent sprinkling involves cycling irrigation triggered by a temperature 2–4 degrees above the threshold. Water use in a frost night in AI was 60% relative to CON (2,800 x 10^-3 m^3·ha^-1). Assessments showed that buds in ‘Early black’ suffered the most damage (13%) under AI compared to ‘Howes’ (5%) and ‘Stevens’ (8%). All cultivar’s damage under CON was less than 5%. The bud damage under AI was mostly on one or two floral meristems which do not result in fruit yield loss.

Breeding for Improved Eating Quality in Acorn Squash

J. Brent Loy*

Department of Biological Sciences, University of New Hampshire, Durham, NH

In North America, acorn squash (Cucurbita pepo L.) is probably the least popular among the three major classes of squash because of variable eating quality. During the past two decades we have had a breeding program at University of New Hampshire directed towards improving eating quality in acorn squash and also introducing resistance to powdery mildew (PMR) into our acorn breeding lines. In this report, we summarize a three-year comparison of some of our new hybrids with some popular commercial acorn hybrids with PMR, and point out some of the problems inherent in attaining both acceptable and uniform eating quality in acorn squash. Experiments were conducted at the Kingman Research Farm in Madbury, NH, in 2011, 2012, and 2013. Squash were transplanted into raised beds mulched with black plastic and fitted with drip tubing. Row spacing was either 2.1 or 2.4 m, and plants were 0.6 m apart. In 2011 and 2012, the experimental designs were randomized, complete block with three or four replications, and 8 or 10 plants per plot for the five or six major hybrids being compared. In 2013, 16 hybrids were compared, but only two plot replications. In all three years there were significant differences in % DW among the hybrids. In 2011, DW values ranged from lows of 8.0% and 9.8% for two of the most popular commercial hybrids to 15.4% and 19.8% for ‘Honey Bear’ and NH1669. Likewise, soluble solids content (SSC) ranged from a low of 6.8 and 8.1%, respectively, for the same two commercial hybrids referred to above, to as high as 11.5 and 14.4% for ‘Honey Bear’ and NH1669. In general, hybrids with the highest % DW also had the lowest FW fruit yields per plot. Pruning plants to three fruit per plant significantly increased % DW in most hybrids. Overall, the ranking of hybrids according to % DW was similar from year to year, but there was appreciable year to year variability, noticeably among those hybrids with a mid-range of % DW (13 to 17%). Furthermore, all hybrids exhibited extensive variability in % DW, and thus eating quality, during a single season. For example, although % DW in NH1669 was 19.8% in 2011, 12% of the 34 fruit samples had DWs below 12%, a value associated with poor eating quality.

A Tri-State Study Evaluating Row Covers and the use of Plant Growth Promoting Rhizobacteria for Organic Muskmelon Production

Elsa Sánchez1*, E. Hernandez1, M. Gleason2, J. Batzer2, M. Williams3, T. Coolong3 and R. Bessin3.

1Pennsylvania State University Plant Sciences, University Park, PA 16802; 2Iowa State University Plant Pathology and Microbiology, Ames, IA 50011; 3University of Kentucky Horticulture, Lexington, KY 40546; 4University of Georgia Horticulture, Tifton, GA 31793; 5University of Kentucky Entomology, Lexington KY 40546

The goal of this study was to develop a strategy for organic muskmelon (Cucumis melo var. reticulatus) growers to manage the cucumber beetle (Acalymma vittataum and Diabrotica undecimpunctata)/bacterial wilt (caused by Erwinia tracheiphila) complex and increase early and marketable fruit yield by optimizing and integrating extended-duration row covers and the use of plant growth promoting rhizobacteria (PGPR). In 2009–12, we investigated various timings of removal of spun-bond polypropylene row cover and PGPR seed treatment in certified organic or organically managed production systems at Pennsylvania State University’s Russell E. Larson Agriculture Research Center in Pennsylvania Furnace, Iowa State University’s Horticulture Research Station in Ames, and the University of Kentucky’s Horticulture Research Farm in Lexington. In Pennsylvania, overall, removing row covers 10 days after anthesis (extended duration) resulted in early season management of cucumber beetles and a higher level of season long suppression of bacterial wilt compared to removing row covers at anthesis or not using row covers. In Iowa, low cucumber beetle populations were experienced and likely resulted in the lack of differences observed among row cover removal treatments for managing cucumber beetles. In Kentucky, using row covers (regardless of the timings of removal evaluated) resulted in less plant mortality due to bacterial wilt compared to not using row covers. PGPR seed treatment did not influence cucumber beetle populations or bacterial wilt incidence in any evaluation year or state. In Pennsylvania and Iowa, extended duration row covers resulted in the highest marketable yields and, in Pennsylvania, early yields. In Iowa, the highest early yields were observed when row covers were removed at anthesis. In Kentucky, removing row covers at anthesis combined with applying insecticides resulted in the highest marketable yields. Seed treatment with PGPR did not improve early or marketable yield in any evaluation year or state.

Documentation and Management of Linuron-Resistant Weeds in Processing Carrot Fields in New York

Julie R. Kikkert1* and R.R. Bellinder2

1Cornell University Cooperative Extension, Cornell University, Ithaca, NY 14850; 2USDA/ARS, Northeast Area Weed Science Research Unit, Cornell University, Ithaca, NY 14850

The goal of this study was to develop a strategy for organic muskmelon (Cucumis melo var. reticulatus) growers to manage the cucumber beetle (Acalymma vittatum and Diabrotica undecimpunctata)/bacterial wilt (caused by Erwinia tracheiphila) complex and increase early and marketable fruit yield by optimizing and integrating extended-duration row covers and the use of plant growth promoting rhizobacteria (PGPR). In 2009–12, we investigated various timings of removal of spun-bond polypropylene row cover and PGPR seed treatment in certified organic or organically managed production systems at Pennsylvania State University’s Russell E. Larson Agriculture Research Center in Pennsylvania Furnace, Iowa State University’s Horticulture Research Station in Ames, and the University of Kentucky’s Horticulture Research Farm in Lexington. In Pennsylvania, overall, removing row covers 10 days after anthesis (extended duration) resulted in early season management of cucumber beetles and a higher level of season long suppression of bacterial wilt compared to removing row covers at anthesis or not using row covers. In Iowa, low cucumber beetle populations were experienced and likely resulted in the lack of differences observed among row cover removal treatments for managing cucumber beetles. In Kentucky, using row covers (regardless of the timings of removal evaluated) resulted in less plant mortality due to bacterial wilt compared to not using row covers. PGPR seed treatment did not influence cucumber beetle populations or bacterial wilt incidence in any evaluation year or state. In Pennsylvania and Iowa, extended duration row covers resulted in the highest marketable yields and, in Pennsylvania, early yields. In Iowa, the highest early yields were observed when row covers were removed at anthesis. In Kentucky, removing row covers at anthesis combined with applying insecticides resulted in the highest marketable yields. Seed treatment with PGPR did not improve early or marketable yield in any evaluation year or state.
Roughly 3,000 acres of processing carrots are grown in New York with a value of $9 million. Weeds cost growers hundreds of thousands of dollars because of improper carrot root formation, reduced yields and harvest interference. Pigweed and ragweed have become particularly difficult to control in the Potter muck region of Yates County, where roughly 400 acres of carrots are grown. Growers rely on post-emergence applications of linuron (Lorox), using multiple low-rate applications starting at the 1 true-leaf stage. Linuron-resistant pigweed, ragweed and purslane have been previously documented in carrot production (http://www.weedscience.org/summary/home.aspx) with the problem escalating in Canada in recent years (www.omafra.on.ca). Seed collected from Powell Amaranth escapes on the Potter muckland were grown in the greenhouse and found to be resistant to sprays of 0.25 lb active ingredient/acre linuron and metribuzin. To find alternate products, field trials were conducted in 2012 and 2013 on mineral soils at the H.D. Thompson Research Farm in Freeville, NY, and in 2013 on muck soil in Potter, NY. Pre-emergence applications of Lorox, Dual Magnum, Nortron, Prowl H2O, Zidua, Harness/Warrant and Define, and post-emergence applications of Blazer, Reflex, GoalTender and Define were tested. There was no crop injury with the pre-emergence treatments on the muck, but significant stand reduction, stunting and reduced yields occurred with Zidua and Warrant on the mineral soil. In the muckland trial, the Zidua and Harness plots when followed by a single post-emergence application of 0.375 lb active ingredient/acre linuron were clean all season-long. All postemergence treatments in the muck trial resulted in severe necrosis to 2-leaf carrots, however this was outgrown. At the Thompson Research Farm, the post-emergence treatments were applied at the carrot 4- and 7-leaf stages, and while there was some chlorosis, necrosis and stunting in all treatments, it was only significant with GoalTender and Define. Yields were not impacted by the post-emergence treatments. Data from the trials will be used to obtain new product registrations for use on carrots in New York.

Synergistic Sweet Corn Variety Performance in Southeast Pennsylvania

Timothy Elkner, 1*, and S. Bogash 2
1Penn State Cooperative Extension, 1383 Arcadia Rd., Rm. 140, Lancaster, PA 17601; 2Penn State Cooperative Extension, 310 Allen Road, Suite 601, Carlisle, PA 17013

Sweet corn is the number one vegetable crop in acreage and value in Pennsylvania. New varieties are constantly being introduced and there have been numerous improvements in the genetics of this crop in recent years. The purpose of this study was to evaluate synergistic bicolor and white sweet corn varieties in SE Pennsylvania. Twenty four varieties of sweet corn were grown using commercial production practices in 2013. ‘Temptation’ was considered the standard; ears from 15 plants per plot were used for quality evaluations. Later maturing varieties tended to have greater ear height than ‘Temptation’ while earlier varieties tended to be lower. Most varieties were harder to harvest than ‘Temptation’ and while all had the same number of marketable ears, 16 of the varieties had greater yield in terms of weight; only ‘Paydirt’ was lower. All varieties had good tip cover and tip fill and were similar to ‘Temptation’ for number of rows and soluble solids. Most also had good husked and unhusked appearance. Most varieties were the same size as ‘Temptation’ for ear diameter; only ‘Temptation II’, ‘Profit’, ‘Paydirt’, and ‘Jackie’ were the same length while all others were longer.

Toward a Better Understanding of Hollow Heart Disorder in Watermelon

Gordon C. Johnson*, Emmalea G. Ernest, and Donald P. Seifrit Jr.
University of Delaware, Carvel REC, 16483 County Seat Highway, Georgetown, DE 19947

From 2010–2013, studies were conducted to investigate hollow heart disorder in triploid watermelon. In 2010 it was shown that there was a large increase in hollow heart frequency as triploid fruits approached and exceeded 1.5 m distance from a pollenizer crown. There was a significant logarithmic relationship between hollow heart incidence and distance from the nearest pollenizer plant ($r^2 = 0.83$). There was a significant linear relationship between hollow heart incidence with distance from the nearest pollenizer vine ($r^2 = 0.75$). There were no differences in hollow heart by weight class; however, highest hollow heart frequency was found with a length to width ratio of 1.26 suggesting that longer watermelons may be more susceptible to hollow heart. In 2011, there was <5% hollow heart incidence (hhi) in the beds with normal pollenizer spacing. Where pollenizers were spaced at a 1:10 ratio there was increased hhi in triploid fruits starting 1.5 m from a pollenizer crown: at 1.5 m, hhi was 12%; at 3.0 m, 28%. In a 2012 study, there was delayed fruit set and an increased hollow heart with increasing distance from pollenizer plants. This relationship was linear in the cultivar ‘Liberty’ but not in the cultivar ‘SS7187’. In 2013, it was shown that under pollen limited conditions, more dense fleshed watermelon varieties had less hollow heart in fruits than less dense varieties. Hand pollination studies in 2011 and 2013 showed reduced hhi with increased amounts of pollen. Growth regulator studies from 2011–13 showed that auxin applications increased hhi. The theory that pollination, hormone activity, and cell division in early watermelon fruit development determines hollow heart incidence and severity will be espoused upon.

Effects of Plant Population Density and Spacing on Processing Sweet Corn Yield

Emmalea G. Ernest
University of Delaware Cooperative Extension, Elbert N. & Ann V. Carvel Research and Education Center, 16483 County Seat Highway, Georgetown, DE 19947

Early plantings of processing sweet corn on the Delmarva Peninsula are prone to stand reduction due to unfavorable weather conditions or damage from pests. In contrast to fresh market
sweet corn, processing sweet corn offers some opportunity for yield compensation from plants producing a second ear or a larger first ear, because the final product is kernels cut from the ear. Research plots were established in 2012 and 2013 to determine the effects of plant population density and spacing on processing sweet corn yield both in terms of unhusked ears (tonnage) and cut corn. The results of these experiments have been useful in advising growers and processors deciding whether to keep or replant fields with reduced stand. In 2012 two plots were established to evaluate the yield of five sweet corn varieties (Overland, Protégé, GSS2259P, GSS1453, and SS Jubilee Plus) at populations of 27,900, 23,250, 18,600, 13,950 and 9,300 plants per acre (120%, 100%, 80%, 60%, and 40% of standard population density, respectively). Stand reduction had more of an effect on yield of unhusked ears than on the yield of cut corn. There was also an interaction between variety and population density -- some varieties were able to compensate for stand loss more than others. Overland and GSS1453, did not have significant reduction in yield for either unhusked ears or cut corn, even at 9,300 plants/acre. GSS2259P was the least able to compensate for stand loss and had significantly lower yield of unhusked ears at 18,600 plants/acre and a significantly lower yield of cut corn at 13,950 plants/acre. In 2013, varieties Overland and GSS2259P were tested at populations of 100, 80, 60 and 40 percent of standard planting density with reduced stands achieved by thinning plants evenly or adding random gaps of 1-plant, 2-plants, 4-plants or 8-plants (approximately 18, 24, 45, or 81 inches respectively). Gap size did not have a significant effect on yield in either planting. Population density had a significant effect on yield in terms of cut corn and tonnage, but the variety by population interaction that was observed in 2012 was not detectible in 2013.

Internal Fruit Abnormalities in Field Grown Colored Peppers

Wesley L. Kline*☐C. Andrew Wyenandt☐and Daniel Ward☐

Rutgers Cooperative Extension of Cumberland County, 291 Morton Ave., Millville, NJ 08332; ☐rutgers Agricultural Research and Extension Center, 121 Northville Rd., Bridgeton, NJ 08302

Twenty eight cultivars were planted on June 12, 2013 in a randomized complete block design with three replications. Single row plots were spaced 5 feet center to center on raised beds covered with black plastic with one drip tube down the center of the row. Plants were spaced 18 inches between plants in double rows 12 inches apart. Weekly applications of fertilizer through the drip and pesticides by airblast sprayer were made. Fruits with at least 50% color (red or yellow) were harvested weekly from August 23 to October 16 for a total of nine harvests. At harvest, all fruit was weighed, graded between marketable and unmarketable and cut horizontality the middle of each fruit to determine internal defects. There were no significant differences between marketable and unmarketable fruit with percent marketable ranging from 92% to 99%. When fruits were dissected for internal evaluations, two abnormalities were observed, fungal growth and premature seed germination. There were no apparent symptoms on the fruit exterior. Internal fruit rot ranged from 1% to 16%. The cultivars Red Knight, Vanguard, and Early Sunsatation had significantly more internal mold than the other cultivars. ’Red Start’ had the least amount of internal mold (1%), but did not differ significantly from thirteen other cultivars. The mold was tentatively identified as Fusarium lactis which has been reported in Canada and Belgium. Most of the internal mold was observed in the first four harvests which coincided with heavy rainfall periods. Internal growth was observed in between 3% and 47% of the fruit with the cultivar Revolution exhibiting 47%. The cultivars Touchdown, Patriot, Intrepid, and Enterprise did not differ from Revolution. Lantern and Red Start had 3% internal growth, which did not significantly differ from Yellow Gourmet, 6947B, Red Bull, Festos, or Classic. The internal growth was distributed over the full season for all cultivars.

An Evaluation of Soil Copper Levels Resulting from Copper Fungicide Applications

Meredith Melendez

Rutgers NJAES Cooperative Extension of Mercer County, 930 Spruce Street Trenton, NJ 08648

Vegetable producers rely on the use of copper compounds for the prevention and suppression of a number of plant diseases. Growers using organic methods rely more heavily on copper, particularly for late blight and downy mildew. During recent growing seasons a number of growers asked if the use of copper affected plant health and soil microbial activity. Research has shown that soil copper levels above 130ppm with 6.5 or higher pH can cause toxicity symptoms. This project set out to determine if New Jersey soil copper levels are high enough to cause toxicity symptoms in crops and cause a reduction of microbial activity. Fifteen New Jersey farms were sampled for soil copper levels, ten of the farms are certified organic and five use conventional growing methods. Soil samples were taken from the spayed and non-sprayed areas of each farm. Soil samples were analyzed at the Rutgers Soil Testing Laboratory for macro and micro nutrients (including soluble copper levels), soil pH, and organic matter content. The Rutgers Soil Testing Laboratory also assessed soil microbiological activity using the Solvita respiration test. NRCS evaluated soil samples for total copper levels utilizing the PXRF scanner. Soil copper levels were lower than the growers had expected with a high of 27.61ppm soluble copper and a low of 2.22ppm of soluble copper. Soil scanning indicated in sprayed areas a high of 153.00ppm total copper and a low of below detectable amounts. The high of 153.00ppm far exceeded all other total copper samples taken and a mean average of total copper in sprayed areas was 33.43ppm. Several farms participating in this project had historical use of copper fungicides in excess of 30+ years. There was no direct correlation to historical use and higher than average soil copper levels. All farms that used copper fungicides had an increase in soil copper levels. The Solvita test was used to evaluate microbiological activity in three farm soils. This test assessed soil carbon dioxide emissions, and showed that in the three farm soils copper was not a limiting factor in biological activity.
## Author Index

### A
- Adam Jr., Sinclair A................................................................. S2
- Autio, Wes ........................................................................... S3, S8
- Ayeni, A.O............................................................................... S6

### B
- Baculis, Jessica ....................................................................... S2
- Bailie, Carol ........................................................................... S3
- Bakacs, Michele ...................................................................... S3
- Batzer, J.................................................................................. S11
- Bellinder, R.R. ........................................................................ S11
- Bergen, Marshall ..................................................................... S10
- Berghage, Robert ................................................................... S2
- Bessin, R.................................................................................. S11
- Bogash, S................................................................................ S12
- Bonos, Stacy ........................................................................... S2
- Brumfield, Robin ..................................................................... S2
- Buckley, Brian ......................................................................... S3

### C
- Capik, John ............................................................................ S4, S8
- Carleo, Jenny .......................................................................... S2
- Clements, Jon .......................................................................... S3
- Cole, Whitaker ......................................................................... S8
- Collins, Alyssa A ..................................................................... S2
- Coolong, T. ............................................................................... S11
- Cowgill Jr, Win P. ................................................................... S8
- Cowgill, Win ........................................................................... S3, S9

### D
- DaCosta, Michelle .................................................................... S10
- DeMoranville, Carolyn .......................................................... S10

### E
- Eisenman, Sasha W .................................................................. S5
- Elkner, Timothy ...................................................................... S12
- Ernest, Emmalea G .................................................................. S12

### F
- Fine, J....................................................................................... S6

### G
- Gbolo, M.................................................................................. S7
- Gleason, M.............................................................................. S11
- Govindsamy, R......................................................................... S6

### H
- Heckman, Josh ......................................................................... S2
- Helsel, Zane ............................................................................. S2
- Hernandez, E........................................................................... S11
- Hlubik, William T....................................................................... S2, S9
- Holmstrom, Kris ....................................................................... S8
- Honig, Josh ............................................................................. S4, S5, S8
- Holcomb, E. Jay ....................................................................... S2

### I
- Infante-Casella, Michelle .......................................................... S4

### J
- Jelenkovic, Gokjo ..................................................................... S9
- Jeranyama, Peter ....................................................................... S10
- Johnson, Gordon C................................................................... S12
- Johnson-Cicales, Jennifer ......................................................... S5, S9, S10

### K
- Kathleen, K.M......................................................................... S6
- Kennedy, Casey ........................................................................ S10
- Kikkert, Julie R.......................................................................... S11
- Kline, Wesley L......................................................................... S13
- Komar, S.J................................................................................ S6
- Komar, Steve ........................................................................... S2
- Kon, Thomas M........................................................................ S7
- Krupa, J..................................................................................... S3

### L
- Lilley, Jason .............................................................................. S4
- Lippet-Faczak, April ................................................................ S2
- Loy, J. Brent ............................................................................ S8, S11

### M
- Magron, Rebecca ..................................................................... S3, S8
- Mangan, F................................................................................ S6
- Marbey, V................................................................................. S7
- Matthews, Jenn ......................................................................... S2
- McAvoy, G............................................................................... S6
- Melendez, Meredith .................................................................. S2, S13
- Mickel, Robert .......................................................................... S2
- Modjeski, A............................................................................... S6
- Molnar, Thomas ....................................................................... S4, S5, S8
- Monheim, E............................................................................... S6
- Morey, Kaitlin .......................................................................... S8
- Morgan, Adam .......................................................................... S5
- Muehlbauer, Megan F ............................................................... S5, S8
- Muehlbauer, Nora ..................................................................... S8

### N
- Ndlovu, Faith ........................................................................... S10
- Nitzsche, P................................................................................. S6
- Nitzsche, Peter ......................................................................... S4, S9
Abstracts of Presentations
from the

Annual Meeting
of the

American Society for Horticultural Science—Southern Region

31 Jan. – 2 Feb. 2014
Sheraton Dallas Hotel, Dallas, TX

Supplement to HortScience
Volume 49(9) September 2014

Contains abstracts of oral and poster presentations from the 2014 Annual Meeting of the Southern Region of the American Society for Horticultural Science
Author index begins on p. S62.

For citation purposes, abstracts should be cited as follows:

(Example)

American Society for Horticultural Science
1018 Duke Street, Alexandria, VA 22314
phone: 703.836.4606 • fax: 703.836.2024 • ash.org • ash@ashs.org
Social Media Marketing for Independent, Locally Owned Garden Centers

R. Bailey Swanson1*, Hikaru H. Peterson1, Cheryl R. Boyer2, and Lauri M. Baker3

1342 Waters Hall, Kansas State University, Manhattan, KS 66506; 2Throckmorton Hall, Kansas State University, Manhattan, KS 66506; 333301 Umberger Hall, Kansas State University, Manhattan, KS 66505

Online networks offer new advertising opportunities for businesses around the world. While large companies have developed elaborate online marketing strategies, its potential access to worldwide customers can be appealing to smaller businesses with little marketing budget. This study examined the impact of online marketing activities on daily retail sales of an independent, locally owned garden center, from August 2007 through December 2012. The garden center opened its Facebook account in July 2011. ‘Facebook Reach’ data were collected to track social traffic for an independent and locally owned garden center. Daily retail sales, adjusted for inflation, were regressed on various factors, including days of the week, temperature, sales events, and Facebook reach after the page was established. Before the Facebook introduction, Saturdays generated on average $2,361 more than other days of the week, warmer temperature (both the day’s high and low) generated higher sales, and among various events, non-plants features generated the highest sales. The same model used on the data after the company introduced a Facebook page supported the hypothesis that using Facebook as a marketing tool improved daily sales with $1.28 for each additional total reach over a 28-day period. As before, Saturdays generated highest sales, as did warmer temperature. But, among various events, general events generated the highest sales, suggesting that the garden center likely have changed how they run their events as they initiated outreach activities using Facebook.

Substrate Components and Drench Applied Paclobutrazol Effects Growth and Flowering of Poinsettia (Euphorbia pulcherrima)

Paul Bartley1*, Glenn B. Fain1, Raymond Kessler1, John Olive1, and Anthony L. Witcher2

1Dept. of Horticulture, Auburn University, Auburn, AL 36849; 2USDA–ARS Thad Cochran Southern Horticultural Lab, Poplarville, MS 39470.

Rooted cuttings of poinsettia (Euphorbia pulcherrima Willd. ex Koltz) ‘Prestige Red’ were potted into 1.5 liter (15 cm) azalea pots on 15 Aug. 2013; one rooted cutting per pot. The four substrate treatments were an industry standard peat:perlite mix (75:25, by vol.), a pine bark:peat mix (50:50, by vol.), a WholeTree:peat mix (50:50, by vol.), and a cedar:peat mix (50:50 by vol.). WholeTree was loblolly pine (Pinus taeda L.) trees (all above ground potions) that were chipped and reduced in a hammer mill to pass a 0.95 cm screen. Cedar was debarked cedar (Juniperus virginiana L.) logs that were shaved and processed in a hammer mill to pass a 1.27 cm screen. The milled cedar was then steam distilled removing a portion of the oil. Paclobutrazol (PGR) treatments were one substrate drench applied on 20 Sept. 2013 at 0, 2, or 4 ppm in 118 ml per pot when the axillary shoots after the pinch were 6 cm long. Data collected at first open cyathia on each plant were the date, plant height, growth index, bract size [(length+widest width)/2], flower stem length, and shoot dry weight. WholeTree substrates reduced growth index and shoot dry weight by 9% when compared to other substrates over all PGR rates. There were linear decreases in bract size, flower shoot length, growth index, and dry weight with increasing PGR rate over all substrates. At 0 ppm PGR, there were no differences in plant height among substrates. At 2 ppm, WholeTree substrate decreased plant height by 9% when compared to the other substrates. At 4 ppm, pine bark substrate increased height by 11% when compared to the other substrates. Height increase at 4 ppm PGR supports past studies which concluded that pine bark bound paclobutrazol and reduced drench efficacies.

Effects of Nitrogen Fertility on Yield and Nutritional Content of Basil (Ocimum basilicum) and Collard Greens (Brassica oleracea)

Raleigh Saperstein1*, David Berle1, George Boyhan1, and Ruthann Swanson2

1Dept. of Horticulture, University of Georgia, Athens, GA; 2Dept. of Foods and Nutrition, University of Georgia, Athens, GA

This study analyzed the effects of various organic fertilizers at varying rates on two leafy green crops, ‘Genovese’ basil (Ocimum basilicum) and ‘Champion’ collard green (Brassica oleracea). Crops were grown at 75%, 100%, 150%, and 200% of recommended nitrogen levels, sourced from three different OMRI-
approved organic fertilizer materials including: hydrolyzed chicken feathers; blood meal; and composted poultry manure. In addition to yield comparisons, total phenolic content was compared for each treatment according to the Folin-Ciocalteau reagent method. In the basil trial, there was no difference in yield or total phenolic content across all treatments. It is suggested that the lack of differences could be attributed to the tolerance of basil to a wide range of growing conditions. Results of the collard green trial show that for blood and symphony fertilizers, rate, chlorophyll content, yield, and total phenolic content in are significantly related. Results of this study add to current knowledge regarding the potential of organic fertilizers and fertilizer rates to promote the production of human health benefitting compounds in plants.

Effect of Pre- and Postharvest Treatments on Characteristics of ‘Pawnee’ Pecan Kernels

Zainab Mansur1*, Luis Cisneros-Zevallos1, Monte Nesbit2, and Leonardo Lombardini1

1Dept. of Horticultural Sciences, Texas A&M University, College Station, TX 77843-2133; 2Texas A&M AgriLife Extension, Texas A&M University, College Station, TX 77843-2134

The presence of speckling or dark spots on ‘Pawnee’ pecan [Carya illinoensis (Wangenh.) K. Koch] kernels has been reported as one of traits that may affect their marketability and usefulness for gift-pack. The Hunter Lab color system and a 3-class visual rating score system (class 1 = <2%, class 2 = 2% to 7%, class 3 = >7% speckling) were used to evaluate kernel color change and speckling incidence in ‘Pawnee’ kernels. Nuts were harvested at maturity directly from the trees and taken to the lab (Direct), left on the trees inside the shucks for an extended period of 3 weeks (Cluster), or harvested at maturity and kept on the ground of the orchard for 3 weeks (Ground). After harvest, four storage temperature combinations [oven at 80 °C for 48 h then ambient temperature (OA), continuous ambient temperature (AA), ambient temperature then refrigeration at 6 °C (AR), oven at 80 °C for 48 h followed by refrigeration (OR)] applied and two shelling dates were used. Results indicated that Direct followed by AR treatments in the first shelling date gave brighter kernel color (lightness = 27.9, Chroma = 13.4, and hue = 56.0) with higher number of class 1 kernels. In contrast, Ground and OA treatments in the second shelling date were darker (lightness = 23.6, Chroma = 12.0, and hue = 46.7) with more class 2 and class 3 kernels. In a separate experiment to understand the relationship between color changes and speckling appearance in kernels, ‘Pawnee’ nuts were subject to an interaction of four treatments: shelling (half of the nuts were either shelled and the other half kept in-sell), puncture (half of the nuts were subject to several punctures on the dorsal side using a small needle), temperature (half of the nuts placed in 40 °C and the other half placed in 25 °C), and storage time (0, 1, 2, and 3 weeks). Results indicated that lightness, Chroma, and hue values were greater for kernels in shelled, 25 °C, and 0 week treatments compared to in-shell, 40 °C, and 3 weeks of storage. The proportion of kernels attributed to class 2 and class 3 of visual rating scale increased with temperature increase and over the time of storage. No significant effect was found for puncture or shelling treatments on speckling in ‘Pawnee’ pecan kernels. In summary, data indicated that early harvest and cold storage may result in a better color quality and less speckling in ‘Pawnee’ pecans.

Effects of Cover Crops on Orchard Nutrition

J. Billig* and C.R. Rom

316 Plant Sciences, Dept. of Horticulture, University of Arkansas, Fayetteville, AR, 72701

Ground cover management systems affect orchard establishment, growth and productivity as well as soil quality and health. However, there have been few studies in the southern region of the US on the effects of managed drive-rows using cover crops as part of a sustainable orchard management system. A field study used main treatments of 1) seasonal legumes [cowpea (Vigna unguiculata) and crimson clover (Trifolium incarnatum)] , 2) seasonal grasses [millet (Setaria italica) and annual rye (Lolium multiflorum)] , or 3) unmanaged natural vegetation drive row plantings, with a mow/blow nested variable. After cover crop harvest, soil was sampled in both tree rows and drive alleys. The legume crop cycles produced more than twice as much cover crop tissue N than grasses or natural vegetation. Legume treatment soil labile C and N pools had lower C/N ratio in the tree row compared to drive row, and highest N for soils in the tree row with legumes as a mow/blow mulch compared to all other treatments. In June, 2013, after two seasonal plantings of cover crops, labile C/N ratio was lower for legumes than grass or weeds, and lower for all mulch treatments in both the total and labile pool. Legume mulches produced the highest labile soil N compared to other cover crop treatments, and the highest labile N where legumes were mulched to the tree-row with a mow/blow treatment. Apple tree foliage sampled in August, 2013, had highest N content for the legume treatments regardless of application. Long term continuation of the study will be needed to assess shifts in total C and N soil pools. Shifts in soil labile N pools and tree foliar nutrient content indicate that mow/blow management of legumes in orchard systems may offer a significant N benefit to apple trees and be a potential sustainable alternative for orchard management.

Effects of Five Container Sizes on Initial Landscape Establishment of Three Tree Species

Lauren Garcia1*, Michael A. Arnold1, Leonardo Lombardini1, W. Todd Watson2, Sean Carver4, and Andrew King1

1Dept. of Horticultural Sciences, Texas A&M University, College Station, TX 77843-2133; 2Dept. of Ecosystem Science and Management, Texas A&M University, College Station, TX 77843-2138

With container grown trees being offered to the public in an increasing array of sizes, it is important to determine the consequences of transplant shock on different size container stock. Transplant shock is a condition of physiological stress...
from injuries, depletion of nutrients, and impaired functions and a normal consequence of handling, moving, and planting plants into conditions less favorable than those in the nursery. Six replicates of *Vitis* agnus-castus, *Acer rubrum* var. *drummondii*, and *Taxodium distichum* were transplanted from each of five container sizes #1, 3, 7, 25, or 45 (3.5, 11.7, 23.3, 97.8, or 175.0L, respectively) to a sandy clay loam field in College Station, Texas. To determine the extent of transplant shock, physiological stress was assessed through data measurements utilizing mid-day and pre-dawn xylem water potentials and photosynthetic gas exchange rates for the first growing season. Changes in height and trunk diameter of each tree were calculated at the end of the first growing season along with root number and extension beyond the transplanted root ball. Across all measures, smaller container size trees responded more vigorously and recovered quicker than larger container sizes with the exception of tree number. Mean height increased by 55.9 cm (*A. rubrum*), 26.5 cm (*T. distichum*), and 63.0 cm (*V. agnus-castus*) in smaller container sizes (#1, 3, and 7) versus –5.0 cm (*A. rubrum*), 2.2 cm (*T. distichum*), and –12.1 cm (*V. agnus-castus*) in larger container sizes (#25 and 45). Mean trunk diameter of *A. rubrum* in #1, 3, and 7 containers increased 3.5 times that of #25 and #45 trunks. Similar responses were observed with *T. distichum* and *V. agnus-castus*, as smaller container size trunk diameters increased seven fold compared to that of larger container sizes. This could be due to a shorter duration of transplant stress in smaller trees. Data indicates all trees in #3 and #7 containers experienced less severe water stresses and required less time to return to a normal transpiration rates than trees grown in other containers. Also, *V. agnus-castus* in #3 and #7 containers had elevated photosynthetic rates. In comparison with trees from larger containers, trees from smaller size containers exhibited reduced transplant shock, potentially decreasing establishment time and increasing growth rates.

### Evaluation of Field Fungicide Application Effects on Nutraceutical Content of Muscadine Genotypes

Derek W. Barchenger¹*, John R. Clark¹, Renee T. Threlfall², and Luke R. Howard²

¹316 Plant Science, Dept. of Horticulture, University of Arkansas, Fayetteville, AR 72701; ²2650 N Young Avenue, Institute of Food Science and Engineering, University of Arkansas, Fayetteville, AR 72704

Muscadine (*Vitis rotundifolia* Michx.) grapes have some of the highest nutraceutical levels among fruit. Fungicide applications have been shown to influence nutraceutical concentrations of other functional foods, but little is known of their affect on muscadine grapes. The effect of field applications of fungicides on nutraceutical concentrations was evaluated on five muscadine cultivars (Nesbitt, Southern Jewel, Summit, Supreme, and Tara) and five breeding selections from the University of Arkansas Fruit Breeding Program in 2012. There were two field treatments (no fungicide and fungicide) for the fungicide treatment, alternating applications of two fungicides were applied at 14-d intervals during the growing season. Whole muscadine berries were analyzed for nutraceutical content. Nutraceutical content varied by genotypes; overall AM 20 and AM 27 had the highest nutraceutical content (sum of anthocyanins, total phenolics, flavonols, resveratrol, and ORAC), while ‘Supreme’ and AM 28 had the lowest. Total anthocyanins were only found in the black genotypes and total phenolics and resveratrol were unaffected by fungicide treatment. Total ellagitannins varied among the fungicide treatments. Total flavonols were generally greater in the no fungicide treatments, while ORAC was generally greater with fungicide treatments. Although field fungicide applications did not affect all nutraceuticals, differences among genotypes and fungicide treatments did occur.

### Exploring Methods to Enhance Rooting of *Vaccinium arboreum* Stem Cuttings

Andrew B. Baker¹*, James D. Spiers¹, Glenn B. Fain¹, and Eugene K. Blythe²

¹1101Funchess Hall, Dept. of Horticulture, Auburn University, Auburn, AL 36849, ²Mississippi State University, P.O. Box 193, Coastal Research and Extension Center, South Mississippi Branch Experiment Station, Poplarville, MS 39470.

Sparkleberry (*Vaccinium arboreum*) has great potential in the fruit and ornamental industries, but is very difficult to vegetatively propagate. A series of experiments were tested using juvenile cuttings from mature plants. The first study was designed to test the effects of environment and substrate on softwood cuttings. The second study tested the effects of substrate and wounding on hardwood cuttings. These factors were compared in two environments. The third study was designed to test the effects of a quick dip of ascorbic acid with varying concentrations of IBA [water (0), 100, 1000, 2500, 5000] on softwood cuttings. The fourth experiment tested the effects of a 2hr soak of ascorbic acid with varying concentrations of IBA [water (0), 100, 1000, 2500, 5000] on softwood cuttings. The fifth experiment was designed in a completely randomized design to test the effects of wounding on softwood cuttings. No ascorbic acid or hormone was applied. Rooting ranged from (0% to 23%). No positive effects were produced by environment, substrate, wounding, ascorbic acid, IBA concentrations, or interactions between these factors. No factors were found to affect rooting or callus percentages. Thus far, rooting hormone treatments, environment, and ascorbic acid applications have proven to be ineffective for enhancing adventitious root formation of sparkleberry softwood, semi-hardwood, and hardwood cuttings. Further research is needed to identify beneficial treatments.

### Exposure of *Canna flaccida* and Two *Canna* Hybrids to Five Species of *Phytophthora*

Kristin Van Kampen*, Sarah A. White, Steven N. Jeffers

School of Agricultural, Forest, and Environmental Sciences, Clemson University, E-143 P&AS, Clemson, SC 29634
Ornamental plant nurseries can reduce the overall volume of water used annually by collecting and reusing production runoff water for irrigation. Constructed wetlands and vegetative buffers have been shown to filter excess nutrients and contaminants from runoff water, but the occurrence of plant pathogens in runoff, particularly oomycetes like species of Phytophthora, is a potential problem and deterrent to water recycling. Previously, Canna flaccida was shown to be less susceptible to species of Phytophthora when compared with several other wetland plants. To determine the potential susceptibility of other types of Canna, C. flaccida and two hybrid cultivars—C. xgeneralis ‘Bird of Paradise’ and C. xgeneralis ‘Carolina Pink’—were exposed to zoospores of five species of Phytophthora (P. cinnamomi, P. citrophthora, P. cryptoeae, P. nicotianae, and P. palmivora) for 28 days. Each type of Canna was inoculated individually with each species of Phytophthora. Single plants in aquatic pots filled with water were exposed to zoospores from three isolates of each species of Phytophthora. During each experiment, rhododendron leaf baits were used to determine zoospore emergence rate. At the end of each experiment, levels of infestation and infection were determined by assaying the roots of plants before and after, respectively, surface disinfection. Infestation and infection levels on C. flaccida and C. xgeneralis ‘Bird of Paradise’ were lower than those on C. xgeneralis ‘Carolina Pink’. For all three types of Canna, infestation and infection levels were highest when plants were exposed to zoospores of P. cinnamomi. Based on these results, C. xgeneralis ‘Carolina Pink’ should not be used in constructed wetlands because of potential susceptibility to species of Phytophthora commonly found in irrigation runoff.

Herbicidal Activity of Mustard Seed Meal (Sinapis alba ‘IdaGold’ and Brassica juncea ‘Pacific Gold’) on Weed Emergence

Xi Wang1*, Mengmeng Gu2, Genhua Niu3, and Paul A. Baumann4

1Dept. of Horticultural Sciences, Texas A&M University, 2134 TAMU, College Station, TX 77843; 2Texas AgriLife Extension Service, College Station, TX 77843; 3Texas AgriLife Research at El Paso, 1380 A&M Circle, El Paso, TX 79927

Mustard seed meals (MSM) are byproducts resulting from crushing mustard seed to provide oil for biofuel productions. MSMs have been applied to soil as a bio-herbicide through the release of active glucosinolates hydrolysis products. Two experiments were conducted to determine the herbicidal activity of MSM (Sinapis alba ‘IdaGold’ and Brassica juncea ‘Pacific Gold’) on weed emergence. In expt. 1, in a petri dish, two types of MSM were applied at the bottom at 0 g/m² (control), 50 g/m², 100 g/m², 200 g/m², or 300 g/m², and then covered with germination mix moistened with same amount of water. Fifty large crabgrass (Digitaria sanguinalis) or pigweed (Amaranthus sp.) seeds were sowed in each petri dish. For each weed, there were 10 replications per MSM rate and weed type combination. 5 petri dishes were sealed with parafilm. In expt. 2, in 6-inch pots, 100 g soil was added at the bottom, then another 30 g soil, which incorporated with 1.5 g (5%), 3.0 g (10%) or 4.5 g (15%) of ‘IdaGold’ or 0.75 g (2.5%), 1.5 g (5%) or 3.0 g (10%) of ‘Pacific Gold’ was added. After all pots were moistened with same amount of water, 50 seeds of crabgrass and pigweed were sowed 1/2 inch deep. The number of emerged seed was recorded daily. In petri dishes, emergence rate of crabgrass with ‘IdaGold’ and ‘Pacific Gold’ was reduced from 2% to 52% more compared with the unsealed ones at 100 g/m², 200 g/m², and 300 g/m². Emergence rate of pigweed with ‘IdaGold’ in unsealed dishes reduced by 13.6% at 300 g/m² and reduced up to 47.2% at 100 g/m², 200 g/m² and 300 g/m² by ‘Pacific Gold’. ‘IdaGold’ in sealed dishes decreased emergence rate of pigweed by 40% and 44% at 200 g/m², and 300 g/m², and decreased from 22.8% to 54.4% at all rates of ‘Pacific Gold’. In pots, emergence rate of crabgrass was reduced by 18.4% and 22.8% at 10% and 15% ‘IdaGold’ and reduced by 40.4% at 10% ‘Pacific Gold (w/w)’ in pots. Emergence rate of pigweed was decreased by 33.6%, 37.6% and 42%, respectively, at 5%, 10% and 15% ‘IdaGold’ and reduced by 21.6% and 29.6% at 5% and 10% ‘Pacific Gold (w/w)’ in pots. In conclusion, MSM in sealed petri dishes greatly reduced emergence rate of large crabgrass and pigweed. Sealing maintained volatile ITCs released from MSM hydrolysis. Emergence rate of large crabgrass and pigweed was significantly decreased at high percentage (10% and 15%) of MSM and soil mixture. These results suggest that MSM is capable of suppressing weed emergence.

Methods to Enhance Marketable Yield of New Auburn Kiwifruit Varieties (Actinidia chinensis and A. deliciosa)

Andrew B. Thompson*, James D. Spiers, Elina Coneva, and J. Raymond Kessler Jr.

Dept. of Horticulture, Auburn University, Auburn, AL 36830

The objectives of this research were to determine the effective pollination period (EPP) of ‘AU Golden Sunshine’ (A. chinensis) and ‘AU Fitzgerald’ (A. deliciosa), and to determine effectiveness of bud or fruit removal on marketable yield of ‘AU Golden Sunshine’ (GS). For our first study we tested the EPP of GS and ‘AU Fitzgerald’. For each cultivar, approximately 30 isolated flowers (n = 30) were hand-pollinated using direct contact of male to female flowers each day at 1, 2, 3, 4, 5, and 6 days after anthesis (DAA) for ‘AU Fitzgerald’ and 1-5 DAA for GS. Anthesis is defined as the day the flower opens. Flowers were bagged and tagged using wax paper bags to prevent open pollination. Fruit set was relatively consistent throughout the 5 DAA for GS, so further testing will be performed extending the days tested. Fruit set, size, and weight were reduced for flowers pollinates 5 DAA for ‘AU Fitzgerald’, indicating that the EPP was 4 DAA. A second study was conducted to test the effects of lateral bud removal and fruit thinning on marketable yield of GS. Treatments included no thinning (control), lateral bud removal, and fruit thinning. Fruit thinning treatment resulted in yields similar to the control, indicating that fruit thinning was not effective for increasing fruit size or number of marketable

HortScience 49(9) (Supplement)—2014 SR—ASHS Annual Meeting—January 31–February 2014
fruit. Lateral bud removal did result in an increase in number of marketable fruit, without a decrease in total yield when compared to control. Lateral bud removal also provided the most fruit for size 30 and above (largest fruit) when compared to the other treatments. Open pollination for this study proved to be not very effective. Fruit size and marketable yield could have been further enhanced with more successful pollination.

**Overexpression of Celery Mannitol Dehydrogenase (MTD) in Tomato Increases Resistance to the Mannitol Secreting Fungal Pathogen Botrytis cinerea**

Takshay Patel*, J.D. Williamson, S.F. Krasnyanski, D.R Panthee, G.C. Allen, and A. Desai
Dept. of Horticultural Science, North Carolina State University, Raleigh, NC 27695

Plants have developed numerous strategies to overcome invading pathogens. Among those strategies the production of Reactive Oxygen Species (ROS) and the resultant signaling of the hypersensitive response has the potential of overcoming a wide range of biotrophic plant pathogens. The production of ROS is a crucial step in many aspects of plant immunity including synthesis of salicylic acid and resultant induction of Pathogenesis-Related (PR) genes. Mannitol is hypothesized to be an ROS scavenging agent that is secreted by pathogens like Alternaria solanae, A. alternata and Botrytis cinerea. When a plant is infected by such a pathogen, mannitol secreted by the fungus suppresses ROS signaling in the plant, thus suppressing a cascade of plant immune activities. Plants like celery that synthesize mannitol as a metabolite have an enzyme Mannitol Dehydrogenase (MTD) that catalyzes mannitol to mannose, a sugar that does not quench ROS. We hypothesize that overexpression of MTD might then provide increased resistance to mannitol secreting pathogens. Here we overexpressed a celery Mtd cDNA in tomato (cv. ‘Moneymaker’) and are testing transformed plants for resistance to Botrytis cinerea (grey mold). Preliminary results suggest that MTD overexpressing plants are substantially more resistant to grey mold compared to non-transformed plants. These plants will also be evaluated for early blight (Alternaria solani) resistance. If MTD provides general resistance against mannitol secreting pathogens, then breeding lines resistant to early blight and grey mold might be identified by screening for high MTD expression.

**Ploidy Levels and Relative Genome Sizes of Species, Hybrids, and Cultivars of Kalmia**

Dominic A. Gillooly* and Thomas G. Ranney
Dept. of Horticultural Science, North Carolina State University, Mountain Horticultural Crops REC, 455 Research Dr., Mills River, NC 28759

The genus Kalmia is a highly ornamental group of shrubs native to North America and Cuba and grown as a valuable landscape plant throughout much of the temperate world. Although most species of Kalmia have previously been found to be diploid with 2n = 2x = 24, one species, Kalmia polifolia, has been reported to be a tetraploid. However, sampling within the genus has been limited and information on the ploidy levels of specific cultivars is lacking. The objective of this survey was to determine relative genome sizes and ploidy levels of species, hybrids, and cultivars of Kalmia. Flow cytometry was used to determine the relative genome sizes and estimated ploidy levels of 65 accessions representing species, interspecific hybrids, forms, and cultivars. Traditional cytology was used to calibrate genome sizes with ploidy levels. Results showed that relative genome sizes were conserved with 1 Cx values ranging from 0.57 pg for K. carolina to 0.70 pg for K. latifolia. Most Kalmia species were predominately diploid including K. buxifolia, carolina, K. cuneata, K. hirsuta, K. latifolia, and K. microphylla. Although plants of Kalmia carolina were uniformly diploid, the closely related, but more northerly distributed, Kalmia angustifolia was primarily tetraploid, providing additional justification for treating these as separate species. An unusual triploid of Kalmia angustifolia f. candida was also documented. Kalmia polifolia included both tetraploid and pentaploid individuals, indicating a ploidy series within this species. Kalmia latifolia cultivars also included one triploid and two cytochimeras (2x + 4x and 3x + 6x). Overall, polyploidy was more prevalent in Kalmia than previously reported and varied both within and among species. This broader survey of relative genome sizes and ploidy levels in Kalmia provides valuable information for plant breeders and new insights into the cytogenetics of the genus.

**Poinsettia Growth Response to Container Substrate Amended With Biochar**

Yanjun Guo†, Mengmeng Gu², Genhua Niu³, Terri W. Starman¹
¹Dept. of Horticultural Sciences, Texas A&M University, College Station, TX 77843; ²Dept. of Horticultural Sciences, Texas A&M AgriLife Extension Service, Texas A&M University, College Station, TX 77843; ³Texas A&M AgriLife Research Center at El Paso, TX 79927

Biochar is a byproduct of bio-energy production. Using biochar in greenhouse production could substantially reduce the use of peatmoss and make greenhouse production more environmentally friendly. This experiment evaluated growth response of poinsettia ‘Prestige Red’ (Euphorbia pulcherrima) to a commercial potting mix (Sunshine Mix #1) amended with biochar at 0%, 20%, 40%, 60%, 80%, or 100% at four different fertilizer levels (100, 200, 300, or 400 ppm N). The experimental design was a split-plot with fertilizer level as the main plot and substrate treatment as the subplot with 10 replications. At 15 weeks after transplanting, a significant (P < 0.05) substrate treatment and fertilizer level interaction existed for poinsettia total number of leaves and shoot visual rating. The total number of leaves was not affected by the fertilizer level. For substrate treatments, only the 100% biochar treatment reduced the total number of leaves. Shoot visual rating was lower for plants irrigated with 400 ppm in 100% biochar treatment compared to the control. No differences in visual ratings were observed among the other three fertilizer levels regardless of substrate treatment. Plant
growth index (GI) measured biweekly was smaller at 100 ppm fertilizer and 100% biochar treatments compared to the control. No differences in plant GI were observed among the other five substrate treatments at fertilizer levels from 200 to 400 ppm. SPAD readings measured at weeks 12 and 14 were not affected by substrate treatment, and they increased with the fertilizer level. Poinsettia root rot caused by pythium was only observed in plants grown in 100% biochar treatment, and irrigated with 300 and 400 ppm. In summary, the commercial potting mix could be amended with biochar up to 80% for poinsettia greenhouse production without noticeably affecting plant quality.

Seedling Emergence of Oilseed Crops Subjected to Various Salinity Levels
Xi Wang1*, Genhua Niu2, and Mengmeng Gu3
1Dept. of Horticultural Sciences, Texas A&M University, 2134 TAMU, College Station, TX 77843; 2Texas AgriLife Research at El Paso, 1380 A&M Circle, El Paso, TX 79927; 3Texas AgriLife Extension Service, 2134 TAMU, College Station, TX 77843

Salinity affects plant growth and development causing water deficit, low uptake of essential nutrients, and accumulation of toxic ions. Production of biodiesel from oilseeds is potentially an effective way to mitigate greenhouse gas emissions and is more environmental friendly. Salt tolerant oilseed genotypes are needed in salt-affected areas in order to produce bioenergy crops without competing food production. This study evaluated the salt tolerance of three oilseed crops during seedling emergence stage under four salinity levels: control de-ionized (DI) water, three salt solutions: 75, 150, and 200 mM NaCl, corresponding to electrical conductivity (EC) of 7.80, 13.71, and 18.28 dS m⁻¹, respectively. The three oilseed crops are two genotypes of canola (DKW45-10 and DKW47-15), two safflower (CW1221 and CW99-OL), and two camelina (BSX-WG1 and ‘Cheyenne’). The experiment was a completely randomized design with four replications per treatment, with 6 subsamples per replication, and 4 or 6 seeds in each subsample. One 6-pack cells filled with same amount of germination mix served as one replication. Seeds were sowed 1/2 inch deep and sub-irrigated with treatment solutions. The treatment solutions were prepared by adding NaCl salt to DI water. The number of emerged seeds was counted daily for 10 days after sowing. Seedlings were cut for fresh weight at 14 days after sowing. Emergence rate of canola DKW45-10 was decreased 12.5% more and fresh weight was decreased 13.14% more than DKW47-15 at 150 mM NaCl. Emergence rate of canola DKW45-10 was decreased 5.63% more than DKW47-15 at 200 mM NaCl. Emergence rate of safflower CW99-OL was reduced 38.54% more and fresh weight was reduced 21.51% more than CW1221 at 200 mM NaCl. Salinity level at 150 mM reduced emergence rate and fresh weight of camelina BSX-WG1 by 54.67% and 91.7%, and reduced emergence rate and fresh weight of ‘Cheyenne’ by 34% and 90.2%. Salinity level at 200 mM NaCl reduced emergence rate of BSX-WG1 and ‘Cheyenne’ by 84.58% and 69.29%, and reduced fresh weight up to 99%. Results indicated that genotypes responded to salt stresses differently. For canola, DKW 47-15 had a slightly better performance than DKW 45-10. For safflower, CW1221 performed better than CW99-OL. Two camelina performed not as well as canola and safflower at high salinity level, indicating that camelina is less tolerant to salinity than canola and safflower.

Evaluation of Substrates in Constructed, Raised-Beds for Vegetable Culture
Jessica L. Cudnik1, David Berle1, George E. Boyhan1, Julia W. Gaskin2
11111 Plant Sciences Building, Dept. of Horticulture, University of Georgia, Athens, GA 30602-7273; 2USDA–ARS, 27 Japanese Beetle Ln, Wooster, OH, 44691; 3University of Georgia, Dept. of Horticulture, 1111 Miller Plant Sciences Building

With the increase interest in urban food production and interest in community gardens, many garden programs are utilizing a constructed raised bed production system in frames or boxes, particularly when existing site conditions do not permit in-ground production. Raised-bed vegetable culture offers the potential for better drainage, higher yields, expanded growing season, and production on difficult sites. Substrates for raised beds are often an afterthought, with little scientific basis for selecting materials and little consideration of long-term effects. This study evaluated the effects of eight substrates on yield of kale and basil, grown in constructed raised beds over three seasons. The substrates evaluated included common potting soil, compost, native soil, aged pine bark, wood chips and mixes of these materials with compost. The substrates were also evaluated for sustainability factors such as carbon mineralized over time, soil microbial biomass carbon and local availability. This study was conducted over three cropping seasons. There was a significant yield response to substrates, with compost/native soil, compost, compost/pine bark, and potting soil showing the greatest yield. There was however, evidence of low C-mineralization and release of CO₂ overtime with the native soil and compost/native soil substrates, while compost alone and compost/potting soil released the most. Results varied with time of year and crop, but yield and carbon mineralization indicators suggest that a substrate composed of native soil mixed with compost to be the best overall.

Warren S. Barham PhD Graduate Student Paper Competition
Comparison of Methodologies to Determine Hydrophysical Properties of Soilless Substrates
Jeb S. Fields1*, James S. Owen Jr.1, James Altland2, Marc van Iersel3, and William C. Fonteno4
1Virginia Polytechnic and State University, Dept. of Horticulture, Hamptons Road Agricultural Research and Education Center, 1444 Diamond Springs Rd. Virginia Beach, VA 23455; 2USDA–ARS, 27 Japanese Beetle Ln, Wooster, OH, 44691; 3University of Georgia, Dept. of Horticulture, 1111 Miller Plant Sciences Building,
The conventional method to obtain a moisture characteristic curve (MCC) for a soilless substrate is to apply increasing pressure to a substrate on a porous ceramic plate. Water is squeezed out of the substrate with increasing pressure, which can be used to determine volumetric water content. This allows inferences of hydrological and physical properties of a substrate at differing moisture contents and water potentials. This study was conducted to compare MCCs of pine bark and peat-based soilless substrate using the conventional method (pressure plate) and evaporative method utilizing the Hyprop© to evaluate repeatability of a given device and to compare MCCs generated using the two devices. The conventional and evaporative methods were consistent across repeated analyses for the peat-based substrate. However, greater variability occurred when generating MCCs using the evaporative as opposed to the conventional method when analyzing a pine bark based substrate. The authors hypothesize this was a result of the increased variability of particle size, and subsequent pore size distribution of pine-bark based substrates. Similar MCCs were generated for the peat-based substrate when comparing the two methodologies. The bark based substrate MCCs generated from the Hyprop differed from the pressure plate, most notably as a result of the increased detection of diminishing volumetric water content beyond ~100 cm H₂O, whereas the conventional method stabilized. This is hypothesized to be a result of the lack of connectivity between the plate and the water column in the pine bark, which resulted in the observed differences between the two methodologies. We conclude that due to the repeatability and similarity to more conventional methodology, the Hyprop is able to produce repeatable MCCs of porous soilless substrates. However, in this experiment, the evaporative method resulted in greater MCC variability when using a pine bark substrate. The authors hypothesize this was a result of the lack of contact between substrate particles and the tensiometers. In addition, the evaporative method was able to provide greater resolution, (100 versus 10 data points per analysis) and provide data over an extended range of tensions (~700 versus 300 cm H₂O) than the conventional pressure plate procedure.

**Effect of Nitrogen Rate, Irrigation Frequency, and Container Type on Plant Growth of Encore Azalea ‘Chiffon’**

Tongyi Li*, Guihong Bi, Richard L. Harkess, Geoffrey Denny, and Xiaojie Zhao

Dept. of Plant and Soil Sciences, Mississippi State University, Mississippi State, MS 39762

Encore azaleas are popular in the United States because of their multiple blooming seasons and good performance under full sun exposure in the southern region. This study was conducted to investigate the influence of irrigation frequency (once or twice per day with the same total amount of water) and nitrogen (N) rates (0, 5, 10, 15, 20 mM N from ammonium nitrate) on growth of Encore azalea plants grown in two types of containers (Plastic and Biocontainer from Western Pulp). Results indicated that plants grown in biocontainers had significantly greater daily water use than those grown in plastic containers. Plants treated with 10, 15, and 20 mM N and grown in biocontainers had higher plant growth indices, total leaf area, and total root length than those in other treatment combinations. The interaction of irrigation frequency and nitrogen rate had a significant influence on flower number. Plants treated with 10 and 20 mM N and irrigated once a day had a significantly greater flower number than those in other treatment combinations.

**Phenotypic Evaluations of Yield and Fruit Quality Traits in Segregating Black Raspberry (Rubus occidentalis L.) Populations in North Carolina**

Christine M. Bradish1*, Gina E. Fernandez1, Jill M. Bushakra2, Penelope Perkins-Veazie3, Michael Dossett4, Nahla V. Bassil2, and Chad E. Finn5

1Campus Box 7609, Dept. of Horticultural Science, North Carolina State University, Raleigh, NC 27695; 2USDA–ARS National Clonal Germplasm Repository, 33447 Peoria Rd., Corvallis, OR 97333; 3NC State University Plants for Human Health Institute, 600 Laureate Way, Kannapolis, NC 28081; 4Agriculture and Agri-Food Canada–Pacific Agri-Food Research Centre, 6947 Lougheed Hwy, Agassiz, BC V0M 1A2, Canada; 5USDA–ARS-Horticultural Crops Research Unit, 3420 NW Orchard Avenue, Corvallis, OR 97330

Over the last 75 years, the black raspberry industry in the United States has not grown, and breeding has been hindered due to a lack of elite germplasm and a lack of adapted, disease resistant cultivars. Despite this, recent research focused on the health benefits of a diet rich in polyphenolics, and black raspberries in particular, has led to a resurgence of interest in this fruit and a renewal of breeding efforts. In North Carolina, this study seeks to standardize phenotyping procedure and calculate yield parameters for black raspberry, and to define both the best phenotyping method and screening procedure to assess heat tolerance. Two half-sib populations, designated ORUS 4304 (192 progeny) and ORUS 4305 (115 progeny), were planted in 2012 at the Sandhills Research Station in Jackson Springs, NC, and evaluated for the first harvest season in 2013 for fruit traits, yield, and heat tolerance. Average fruit size ranged from 0.17–3.12 g/berry, with highest fruit weight found in ‘Jewel’ elite checks and two progeny in ORUS 4304. Average yields were 1.4 kg (3 lb) per plant, with no difference between populations. Yield was normally distributed, and positively correlated at P < 0.0001 with 11 plant and fruit traits. Heat tolerance was measured by chlorophyll fluorescence, and ranged from 0.015–0.940, where 0.7–0.8 is normal and >0.8 is heat tolerant, by convention. Several progeny had higher fluorescence scores than parents, indicating transgressive segregation for the trait. Our results showed that fluorescence was negatively correlated with florican vigor and lateral length at P < 0.0001. Further, fluorescence was normally distributed and these results were consistent with previous research done on red raspberry in the
same location. In 2014, a second year of phenotyping will take place, along with additional methods of phenotyping for heat tolerance and calculations of genotype x location x year interactions. Linkage map assembly of 4304 is underway in order to identify QTL for traits of interest. Validation with 4305 and comparative mapping between red and black raspberry will be used to further develop genetic tools for breeding black raspberry in the future.

Education Section

A Grading Alternative that Shifts Expectations and Refocuses Student Effort

William Klingeman*
The University of Tennessee, Plant Sciences Department, 2431 Joe Johnson Drive, 252 Ellington PSB, Knoxville, TN 37996

This talk highlighted a rationale and experiences in adapting conventional grading schemes, as informed by prospect theory, to integrate game dynamics and shift accomplishment expectations towards more proactive management by the student. A “leveling-up” grading format is introduced that, once explained to students and initiated, has helped to stimulate classroom discussion, critical thinking and inquiry. A planned book giveaway (Spring 2015) is expected to trigger healthy competition among students to achieve the highest mastery status. In practice, a subset of traditional homework assignments has been exchanged for the option to submit responses to Challenge Exercises designed to reward higher order learning efforts. These exercises may also take the place of former “extra credit” assignments. Challenges can be as simple as extending opportunity for receipt of partial credit gained by researching poorly understood content and self-correcting missed test questions. Creative outputs (a weblog, video, Extension fact sheet, or popular press article) can be rewarded with commensurately higher point accruals. To be effective, Challenge Exercises should be introduced early, made available throughout the semester but with a set deadline, and extend a range of opportunities by which grade-motivated and topic-enthusiastic students can assess, analyze, evaluate, and create novel outputs designed to demonstrate achievement and mastery of course-based content. If desired, challenges can be designed to reward individual or team-based accomplishments. Greatest student adoption has been observed when point accrual rewards are provided early enough in the term that students were introduced quickly to the courses’ “game” structure and sufficiently high to drive motivation for recognition of highest level attainment.

Program Assessment: Challenges Writing Effective Expected Outcomes and Assessment Criteria

Richard L. Harkess*
117 Dorman Hall, Dept. of Plant and Soil Sciences, Mississippi State University, Mississippi State, MS 39762

Program assessment is the systematic collection, review, and use of information for the purpose of continually improving student learning and overall program effectiveness. It is a cyclical process done to improve programs and is a scholarly endeavor. It is not an end goal nor is it the same as course grades or based on student satisfaction. While usually driven by university administration, when done well it can help measure success of a program, enhance student recruitment and provide program accountability. Program assessment is a four stage process: 1) determine program expected outcomes, 2) determine appropriate assessment criteria and procedures, 3) collect and analyze assessment results, 4) use results to improve the program and/or re-write expected outcomes. Challenges in developing an effective program assessment arise at each stage of the process. Effective expected outcomes should be actionable and measurable. Use of Bloom’s taxonomy of learning objectives may be useful in this process. Selecting assessment criteria and procedures should be a combination of direct (demonstration of knowledge, skills and abilities achieved) and indirect (stakeholder perceptions of how well students have mastered a learning outcome) measures with data collection and analysis requiring program faculty buy-in and participation. One of the most challenging aspects of program assessment is completing the circle or use of results. As goals are achieved, new expected outcomes or goals should be considered. If goals are not met, the fourth stage should reflect actions taken or to be taken to improve that part of the program so future student performance will meet or exceed program expectations. While developing and enforcing a successful assessment program with effective expected outcomes and assessment criteria is challenging, it is a useful endeavor. A good program assessment should improve educational programs and should be focused on student learning and development outcomes.

Successful Retention Efforts for Distributed Learning Students

Cynthia McKenney*, Thayne Montague, and Christi Chadwell
Dept. of Plant and Soil Science, Texas Tech University, Lubbock, TX 79409-2122

With over 30% of the nation’s college students accessing distributed learning courses each year, concerns regarding retention and completion of degree programs have arisen. Commodification of degrees, price sensitivity, delivery methods and components of a college experience have replaced apprehensions of the value and quality of distributed learning degrees. Exit interviews indicate positive and timely communication between advisors, faculty and students has become critical to student satisfaction with distributed learning. Streamlined paperwork along with a consistent and user friendly course portal have also reduced frustration and anxiety with online students. In addition, recognition of the varied backgrounds of the participating students helps to facilitate appropriate course components.
Food Gardening Classes in Horticulture Curricula at Major U.S. Universities

Curt R. Rom* and Olivia Suzanne Hines

316 Plant Sciences Building, Dept. of Horticulture, University of Arkansas, Fayetteville, AR

Food gardening is a growing household hobby and practiced in community, institutional and school gardens. Previous works indicate that food gardening provides a supplemental source of food, nutrition and income, is good exercise, and contributes to community resiliency. Also, previous work has indicated that students enrolling in horticulture degree programs have interest and/or experience in gardening. University-based educational programs on food gardening exist for children (Junior Master Gardeners) and adults (Master Gardeners). A study of major university horticulture and plant science department curricula was conducted to determine the frequency of food gardening courses or courses with major components of food gardening. The curricula course offerings of 80 public state and land grant universities including 59 1860 universities and 18 1890 universities were evaluated. Of those schools 26 (44%) of the 1860 and 4 (22%) of the 1890 schools offered a food gardening course or a course with major food gardening components. Based upon USDA regions, the Western Region had the highest percentage of programs (45%) with the Southern Region and North Central Region having the lowest (27% and 25%, respectively). The vast majority of all schools evaluated had industrial food crop production courses even in states with no identifiable crop industry segment. Of the schools evaluated, 71 out of 80 schools had student initiated and/or operated campus community gardens or farms regardless of the presence or absence of a food gardening course. It was hypothesized that increasing food gardening classes could increase food gardening home and community activity, improve food security and justice of communities, improve health and nutrition of citizens, increase sales and use of horticulture products and allied sales, service, increase community development and resilience, increase visibility of Horticulture programs within the university community, and increase Horticulture Department enrollments.

Don’t Try This at Home: Creating Videos to Improve On-campus Education in Nursery Production

J. Robbins*, M. Gu², A. Wright³

¹316 Plant Sciences, Dept. of Horticulture, University of Arkansas, Fayetteville, AR 72701; ²Dept. of Horticultural Sciences, Texas A&M University, 2134 TAMU 1 College Station, TX 77843; ³101 Funchess Hall, Dept. of Horticulture, Auburn University, Auburn, AL 36849

The objective of this project was to create virtual nursery field trips to improve on-campus and distance education in nursery production. From Oct. 2010 to Nov. 2011, digital HD video footage was captured at 42 nursery businesses in 22 states. Total travel included 65 days over 18 trips covering almost 43,000 miles. Almost 25GB or approximately 26 hours of video footage was collected in addition to over 5,700 photographs. Over 700 hours were required to organize the information into storyboard spreadsheets that would be used by the professional videographer. Following recording of professional narration, an additional 750 hours were required for the videographer to produce the final product using Adobe Premiere Pro. Videos were arranged in the final product by topic for a total of 20 ‘chapters’ encompassing nine general areas (container production, pot-in-pot, field production, liner production, propagation, nursery facilities/layout, labeling/inventory, innovation, and marketing). Video segments within each chapter or topic ranged from a few seconds to several minutes. The finished product has been transferred to a single USB drive and contains 444 individual topic videos (total time about 10.75 hours) and 28 company profiles for a finished project size of 29GB. USB drives containing videos and company profiles were provided in Spring 2013 to instructors of horticulture at land grant institutions (1862, 1890, and 1994) who submitted a request form. Product users will be surveyed to evaluate content, organization, accessibility, and ease of use and implementation of the product.

A Rationale and Methods Development for an Online Greenhouse Management Course

Michael R. Evans*

318 Plant Sciences Building, Dept. of Horticulture, University of Arkansas, Fayetteville, AR 72701

Methods for achieving four primary teaching goals were developed for an on-line Greenhouse Management course. The four goals were to develop a course with strong communication, provide content in multiple formats to enhance learning, provide structure to ensure that students progress through the course in a timely manner, and provide evaluation tools with learning value. Strong communication was achieved through the use of the Blackboard-based e-mail system, videos sent to students through a custom YouTube channel, Skype and Facetime. Content was provided through the custom-designed Greenhouse Management Online website that included text, images and videos. Recorded classroom lectures and YouTube-based videos supplemented the material provided in the website. Structure was provided to ensure that students progressed on schedule by providing information in multiple small learning units with specific beginning and completion dates and with self-exams due for each learning unit by the required completion date. Evaluation tools included learning tasks that were completed during the time allotted for each learning unit. Feedback was provided to students regarding their answers to learning tasks. Students were allowed to use the website and others resources to complete the self-exams at the end of each learning unit. Self-exams required students to find and provide correct answers for all questions before completing the self-exam. Midterm and final exams provided students with immediate feedback upon the completion of the exams. Students were able to see which questions were answered incorrectly and what the correct answers were for each question.
Shared Teaching Experiences with Distance Online Lectures and Labs in Greenhouse Management

Michael R. Evans*
318 Plant Sciences Building, Dept. of Horticulture, University of Arkansas, Fayetteville, AR 72701

Based on five years of experience teaching Greenhouse Management lecture and Greenhouse Management lab online to students at four universities, recommendations were made regarding the development of online courses. The need to maximize organization and communication using multiple formats such as e-mail, video, Skype and Facetime was discussed. The need for and methods to provide content in multiple formats including text, pictures, recorded lectures and video was discussed. Difficulties associated with having synchronous sessions as well as team activities were presented. Using new camera systems and Camtasia software makes creating high-quality teaching videos easy and economical. Video as a teaching tool has many advantages over traditional PowerPoint lectures. The creation and use of such videos in teaching online courses was discussed.

A Description of National Horticulture Curriculum for Food Crop Production in Controlled Environments

Mikel C. Lolley1,*, Catherine W. Shoulders1, Michael R. Evans2, and Christopher Currey3
1Dept. of Agricultural Education, Communications and Technology; 2Dept. of Horticulture, University of Arkansas, Fayetteville, AR 72701; 3Dept. of Horticulture, Iowa State University, Ames, IA 50011

In order to determine whether horticulture programs within higher education are mirroring industry trends for controlled environments food crop production (CEFP) within their curriculum, researchers set out to describe the presence of courses and topics within existing undergraduate horticulture programs devoted to CEFP currently offered at land-grant colleges and universities within the United States. To meet this purpose, the study’s objectives were: 1) to determine the number of controlled environment food crop production courses offered by land-grant institutions; 2) to determine the number of course objectives related to controlled environment food production; and 3) to determine the amount of course time allocated to topics related to controlled environment food production. Researchers identified 110 land-grant colleges and universities. From the 110 land-grant institutions recognized by the Association of Public and Land-grant Universities, researchers identified course curricula related to CEFP from course catalogues for the school years 2005, 2008 and 2013. Forty-one institutions had courses with potential for CEFP inclusion, while 69 institutions had no courses with potential for CEFP inclusion. Eighty-four courses were identified. Twenty-seven syllabi were received for a response rate of 32.1%. From those 27 syllabi, six included a total of eight CEFP-related objectives. Five syllabi included a total of 59 topics related to CEFP. Four of these syllabi included the number of hours devoted to each topic, yielding a total of 51.5 hours, or 3.97% of total course time devoted to CEFP. Researchers recommend that land-grant institutions provide more courses in CEFP to align with industry trends. Course syllabi should include course objectives related to CEFP. Course syllabi should include course time allocated to topics related to CEFP. Course syllabi should list all topics so students can make informed decisions about what is being offered.

Evaluating Students through Service Learning and Civic Engagement Projects

M’Randa R. Sandlin*, and Summer F. Odom
Dept. of Agricultural Leadership, Education, and Communications, Texas A&M University, College Station, TX 77843-2116

High-impact learning experiences allow students to learn, process, and retain information more effectively. These experiences that are purposefully linked with course content result in students’ deeper understanding of the holistic system. Three sections of a personal leadership education course (N = 166) were asked to spend a minimum of six documented hours completing a service project of their choice. Students were required to reflect on instructor-provided prompts about the course content in regards to their projects. The analysis of the reflections indicated content realization and application at the individual, group, and societal levels through the service-learning projects. Further, many students developed an individual desire to maintain long-term service engagement in their local communities. Although there were students involved in volunteerism efforts through philanthropic organizations, such as churches, sororities and fraternities, and other faith-based organizations, there was an indication that the freedom to choose a service outlet they were passionate about allowed for a higher level of commitment, passion, and enjoyment. It can be concluded service learning is a successful teaching and learning method; therefore, it is recommended that service learning projects be integrated into degree plans across disciplines to implement high-impact learning techniques. Horticulture programs that integrate service learning as part of the degree program could see an increase in student learning and content application and an increased interest in urban agriculture, community gardens, and local, small-scale food production.

Extension Section

A New Strategic Plan for the eXtension Grape Community of Practice

Eric T. Stafne1,*, Rhoda Burrows2, Matthew Fidelibus3, Lane Greer4, Paul Jenkins5, Kevin Ker6, Michelle Moyer7, Patty Skinkis8, and Hans Walter-Peterson9
1MSU Coastal Research and Extension Center, 810 Hwy 26 West, Poplarville, MS 39470; 2West River Agricultural Center–SDSU, 1905 Plaza Blvd., Rapid
In 2009, the Grape Community of Practice (GCoP) was formed with funding from a United States Department of Agriculture (USDA), National Institute for Food and Agriculture (NIFA), Specialty Crops Research Initiative (SCRI) grant. The GCoP is part of eXtension (www.extension.org), which is an online Extension presence where university specialists collaborate to generate new educational and informational resources for their specific stakeholders of interest (i.e. the commercial grape industry in the case of the GCoP). The USDA-NIFA-SCRI grant that established the GCoP will end on August 31, 2014. Although this creates a considerable challenge in the immediate future, it also allows the GCoP flexibility to explore new avenues to deliver information that meets clientele needs and fosters greater collaboration among the GCoP.During November 4–7, 2013, nine members of the GCoP met to develop a new vision for the project and initiate a strategic planning process. As a way to establish context for our future direction, the strategic planning committee engaged in a SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis exercise. Several new ideas for improving and expanding the group were discussed. One such discussed change is the need delivering a consistent message through our public brand, eViticulture. This change should help foster more consistency for marketing and promoting our work to the public. As the end of Federal funding comes closer (August 2014), eViticulture must move dynamically forward to further engage and serve all areas of the grape and wine industries.

Small Acreage Horticultural Crops: A Webinar-based Model Plan

Joseph G. Masabni*
2134 Texas A&M University, 221 Horticulture and Forestry Sciences Bldg., College Station, Texas 77843

Horticultural products are of high value and result in greater potential for per-acre returns and production costs. However, because of their high cost of production, perishable nature, and direct marketing, most horticultural producers in Texas face more challenges and many businesses fail due to lack of proper preparation. A webinar-based model plan was developed to assist small acreage vegetable producers in identifying and evaluating diversification strategies for risk mitigation and improved economic sustainability. In addition to online resources on site selection, marketing, crop guides and cultivar selection, ten webinars were held since inception in 2009 on various topics such as grapes, small fruits, pecans, vegetable production, high tunnels, and marketing. Attendees were asked to fill an evaluation form after each webinar with questions on the level of understanding, intent of adoption, and anticipated savings in dollars per acre. A total of 863 participants submitted evaluation forms. Based on an average of $601 in anticipated savings reported in the surveys, the webinars resulted in $334,745 in total savings to the participants. An additional $1,040 was saved in travel expense per speaker per webinar.

Overview of Recent New Crape Myrtle Cultivar Releases

Daniel Wells1, Allen Owings1, and David Creech2
1LSU AgCenter, Hammond Research Station, 21549 Old Covington Highway, Hammond, LA 70403; 2Stephen F. Austin State University Gardens, College of Agriculture, P.O. Box 13000, Nacogdoches, TX 75962

An evaluation trial of new crape myrtle cultivars was established at the LSU AgCenter’s Hammond Research Station in Hammond, Louisiana and at the Stephen F. Austin State University Gardens in Nacogdoches, Texas in Spring 2013 and will continue through 2015. The purposes of the ongoing trials are to evaluate cultivars for performance, incidence of disease, flowering, and size in differing geographical areas of the south. Recorded data include height, flowering initiation dates, flowering duration, flowering intensity, plant visual quality, and incidence and intensity of Cercospora leaf spot disease. These data will be utilized to inform the public on performance of new releases in the southern United States, as well as, plant selection and placement for such areas. Series being evaluated in the trials include ‘Barnyard’, ‘Black Diamond’, ‘Delta’, ‘Early Bird’, ‘Ebony’, ‘Enduring Summer’, ‘Magic’, and ‘Princess’.

Pathways2Possibilities: Introducing 8th Graders to Agricultural Careers

Christine E.H. Coker*
1815 Popps Ferry Road, Coastal Research and Extension Center, Mississippi State University, Biloxi, MS 39532

Pathways2Possibilities (P2P) is an interactive career expo designed for all 8th graders in private and public schools in the six lower counties of Mississippi. Each student has 120 minutes to experience 4-8 Pathways, which are aligned with the career clusters set forth by the Mississippi Department of Education. The Pathways also link to the Common Core state standards. The students were prepped during class before attending the event in order to familiarize them with the Pathways ahead of time. Each Pathway was led by a Pathfinder who coordinated the Pathway members to design and implement hands-on activities intended...
Marketing can be a challenging, though an important task in garden centers. Owners and employees often struggle to understand and use new social media tools to their fullest potential while also running the business. The objective of this study was to establish baseline data for a garden center marketing outreach event in December 2012. The garden center in this study was well established in a medium-sized community in Kansas with little social media marketing use. The event was a coordinated effort with a local family photographer (all marketing on social media platforms) with the hypothesis that new customers would be exposed to both businesses and make positive purchasing decisions. No intervention by the research team was offered, in order to establish reference points for future studies. Each business granted access to their Facebook analytics, in order to measure activity before and after the event. During the two days of the joint event, brief customer intercept surveys were used to collect data regarding demographics, purchasing history and Facebook familiarity. A total of 47 responses were collected: Most shoppers were female (79%, n = 37) and 25 to 34 years of age (23%). For 24% of the visitors, it was their first time to visit the garden center. Visitors who had primarily come for the photography event comprised 36% of the group, 49% came to look for something specific, and 15% came to browse. Of visitors with Facebook accounts (53%) only 19% had visited the garden center’s Facebook page and “liked” it. Slightly more of the visitors had visited and “liked” the photographer’s Facebook page (34%). Results of this study indicate a need for training of retail garden center’s on social media strategy and marketing. Implementing social media in a strategic way has the potential to enhance the financial sustainability of garden centers by enlarging their customer bases and bringing new customers into the store throughout the calendar year.

**Nursery Disease Crisis Management: A Case Study**

Ed Bush1*, Carla Herrera1, Jeff Kuehny1, and Raj Singh2
1 LSU AgCenter, School of Plant, Environmental, and Soil Sciences, 104 Sturgis Hall, Baton Rouge, LA 70803; 2 LSU AgCenter, Dept. of Plant Pathology and Crop Physiology, Life Sciences Building, Baton Rouge, LA 70803

Disease occurrence in the nurseries producing liriope has been steadily increasing over the past 5 years in retail and wholesale container nursery production and the landscape. *Liriope muscari* ‘Big Blue’ and ‘Evergreen Giant’ liriope cultivars have been especially prone to infection. Recent economic losses have compelled the industry to quantify the loss and determine the major factors increasing disease prevalence and quantify losses cause by disease. Cultural factors including: watering practices, nursery medium, propagation methods, sanitation practices and pest management were evaluated. A randomized complete block was established in a nursery block of newly planted two gallon squat pots with 10 blocks each having 10 plants was monitored for disease occurrence. Over a 6 month period disease infection was monitored and recorded. Disease samples were collected and identified in the LSU Diagnostic Lab. *Phytophthora palmivora* and *Fusarium oxysporum* (liriope leaf and crown rot) were isolated in infected plants and cultures were established for future research. Mortality rates for most blocks exceeded 40% within ‘Big Blue’ plots. Irrigation water was tested for disease and chemical characteristics. Both test were within acceptable levels for nursery BMP’s. Water distribution and practices resulted in less than acceptable practices. Below operational water pressure, volume and distribution was less than desirable. Corrective measures were taken to resolve these factors. Also, a review of pest control practices indicated a change in these practices as warranted by examining spray applications. Propagation methods lacked sufficient sanitation practices which caused cross contamination of bibs. Reuse of contaminated containers without proper sanitation was also recommended. Best management practices serve as a model during severe disease outbreaks. Although disease occurrence was not completely prevented, disease occurrence approached manageable levels when BMPs were followed.

**Short-Term Evaluation of Graywater Irrigation on Selected Ornamental Species**

Raul I. Cabrera*
Dept. of Horticultural Sciences, Texas A&M AgriLife Research, Uvalde, TX 78801

Graywater, identified as untreated water that comes from clothes washers, showers and bathtubs constitutes ≥50% of the total household wastewater, and has the potential for becoming a
Implementing Precision Irrigation Technology in a Commercial Nursery: A Case Study on Adoption and Expansion

Matthew R. Chappell* and Marc van Iersel

1111 Miller Plant Science Building, Horticulture Department, University of Georgia, Athens, GA 30602

Water quality and quantity are increasingly important concerns for agricultural producers and have been recognized by governmental and non-governmental agencies as focus areas for future regulatory efforts. In horticultural systems, and especially container production of ornamentals, irrigation management is challenging. This is primarily due to the limited volume of water available to container-grown plants after an irrigation event and the resultant need to frequently irrigate to maintain adequate soil moisture levels without causing excessive leaching. To prevent moisture stress, irrigation of container plants is often excessive, resulting in leaching and runoff of water and nutrients applied to the container substrate. For this reason, improving the application efficiency of irrigation is necessary and critical to the long-term sustainability of the commercial nursery industry. The use of soil moisture sensing technology is one method of increasing irrigation efficiency, with the on-farm studies described in this manuscript focusing on the use of capacitance-based soil moisture sensors to both monitor and control irrigation events. Since on-farm testing of these wireless sensor networks (WSNs) to monitor and control irrigation events began in 2010, WSNs have been deployed in a diverse assortment of commercial horticulture operations. In deploying these WSNs, a variety of challenges and successes have been observed. Overcoming specific challenges has fostered improved software and hardware development as well as improved grower confidence in WSNs. Growers are using WSNs in a variety of ways to fit specific needs, resulting in multiple commercial applications. Some growers use WSNs as fully functional irrigation controllers. Other growers utilize components of WSNs, specifically the web-based graphical user interface, to monitor grower-controlled irrigation schedules.

Effect of Cutless .33G on Six Landscape Shrubs Used as Hedge

Yan Chen*, Allen Owings, and Regina Bracy

LSU AgCenter, Hammond Research Station, 21549 Old Covington Highway, Hammond, LA 70403

Cutless.33G is a granular flurprimidol registered for managing growth of woody and perennial plants in established landscapes. As indicated by previous studies, its growth control efficacy varies among different plant species and might be affected by landscape irrigation methods. The objective of this study was to determine effects and possible interactions between irrigation methods (overhead micro-sprinkler, drip, and none) and 3 rates Cutless.33G (0, 14, and 21 lbs/1000 ft.2). Six plant species azalea, buford holly, elaeagnus, ligustrum, sweet viburnum, and wax myrtle were planted in fall 2012 and treated in spring 2013. Plant size index recorded monthly indicated that plant responses to Cutless were species specific with wax myrtle being the most responsive (31% size reduction at 21 lbs/1000 ft2 compared with untreated at 3 weeks after treatment) and sweet viburnum being the least responsive (no response). Irrigation methods had transient effects on plant size with overhead irrigation resulting in smaller plants in elaeagnus and wax myrtle at 4 WAT across Cutless rates, possibly because more PGR was delivered to roots. More treatments will be applied in the next two years and observations will be reported when available.

A Spatial Analysis of a Colony of Hibiscus dasycalyx, the Neches River Rose Mallow, Established in 1996 in Nacogdoches County, Texas

David L. Creech*, David L. Kulhavy, Daniel R. Unger, and Matthew A. Wade

Arthur Temple College of Forestry and Agriculture, Stephen F. Austin State University, Nacogdoches, TX 75962

Hibiscus dasycalyx, the Neches river rose mallow, received protection July 2013 as a threatened plant by the U.S. Fish and Wildlife. With four natural populations and seven successful reintroduction plots, a total of 11 critical habitats have been designated. In 1995, research plots were established in the full sun emergency spillway of an eight-acre lake on the property of the S.B. Hayter family, which is six miles west of Nacogdoches, TX. This study was the thesis work of Stacy Scott and involved 96 plants, four rates of slow release fertilizer, with and without
mulch, 3 blocks and four plants per replication. This study was the MS thesis work of Stacy Scott. Growth measurements (plant height, stem number, biomass) were taken for the first three years of establishment. The results significantly favored increasing rates of slow release fertilizer and mulch did not significantly improve growth. The initial high rates of fertilization applied only at planting resulted in bigger plants, and the benefits of that initial fertilizer application carried into the third year. Fifteen years passed with the colony receiving only minimal maintenance. In June, 2013, a “Hibiscus dasycalyx salvation team” comprised of forestry students was created by Kulhavy and Creech. The team mapped and collected data from all the Hibiscus dasycalyx plants in the habitat. The results indicate a healthy population of plants that have expanded their range with most downstream from the original plots. The number of plants grew from 96 to 476, almost a 500% increase in 19 years. Stem number (somewhat correlated with plant age), plant height measurements and GIS resultant maps indicate a population with a distribution of varied age plants and young plants representing about half the population.

Is Pictometry® a Useful Tool for Tree, Shrub and Landscape Evaluation?

David L. Creech*, David L. Kulhavy, Daniel R. Unger, and Matthew A. Wood
Arthur Temple College of Forestry and Agriculture, Stephen F. Austin State University, Nacogdoches, TX 75962

Actual tree height was measured using a height pole in .1 inch increments and compared to tree height measured on screen using Pictometry® hyperspatial 4-inch spatial digital imagery provided from a January 2013 flyover. The comparison utilized evenly spaced Taxodium distichum trees along LaNana creek, the stream that bisects the campus of Stephen F. Austin State University. Planted 2006 to present, the trees are part of SFA Gardens long term bald cypress evaluation program. Sixty trees were included in this study. Linear coefficients and coefficients of determination between actual tree height and Pictometry® estimated tree height for 1) all sixty trees, 2) the shortest trees, and 3) the tallest trees produced values over .99 on all three categories. Remotely sensed tree height using Pictometry® digital imagery was within 2.5 percent of actual height. Results indicate that hyperspatial digital imagery is an effective method to measure tree height and can replace field measurements. A few observations are warranted. The user friendly interface and a large high resolution monitor improve the process of data extraction. Large open public parks, campuses, green spaces with widely spaced woody trees produce the conditions for easier screen picks. Evergreen trees are easier to measure than deciduous. With imagery based on a mid-winter 2013 flyover, deciduous trees had already shed their foliage, making for more difficult screen picks. Each tree was located with GPS and entered into the GIS data base in the Arthur Temple College of Forestry and Agriculture, Stephen F. Austin State University.

Seed Germination in Green Roof Media

Cheng Chen and Derald A. Harp*
Dept. of Agricultural Sciences, Texas A&M University—Commerce, Commerce, TX 75429

Green roof (GR) media is designed to be very light while providing sufficient water, nutrients and support for plant growth. However, plant establishment from seed may not be effective in this media, due to its coarse nature. For this study, we tested the germination of four wildflower species: Leucanthemum vulgare, Chrysanthemum maximum, Achillea millefolium, Gailardia pulchella, and Phaseolus vulgaris, as a control, across five different GR media (peat/perlite/calcined clay, compost/sand/expanded shale, compost/black dirt/expanded shale, compost/expanded shale, and peat/perlite). A seed viability test was conducted prior to planting, resulting in the exclusion of L. vulgare. For the germination test, 25 seeds of each species were planted in each of the five media, with each combination appearing once per block. Germination was defined as seedling emergence from the media and monitored weekly for 28 days. Physical evaluation found that GR media had a higher percentage of particles 2.0 mm or larger (81.5%, 79.0%, 88.2%, and 53.0%), when compared to peat-lite (22.5%). Correspondingly, GR media had much lower WHC (39.6%, 34.3%, 35.1%, and 44.8%) and higher air-filled space (29.4%, 32.1%, 31.8%, and 18.4%) as compared to the peat-lite mix (71.8% and 13.6%). As expected, pinto beans had the highest germination percentage (76.2%) across all media, compared to 43.4% for Indian blanket, 23.0% for Shasta daisy, and 40.4% for yarrow. Further, seed germination was lower in the green roof media, across all species. In the peat/perlite mix, 68.5% of seeds germinated, as compared to 44%, 39.3%, 37.5%, and 39.5% for the various green roof media. These data confirm that seed germination in green roof media should be expected to be significantly lower than in traditional growing media.

Leaf Blackening—A New Physiological Disorder in Rose

Derald A. Harp*, Steve George‡, Greg Church‡, John Sloan‡, Dinesh Adhikary‡, Josephine Taylor‡, Dennis Gravat‡, and David Zlesak‡

1Dept. of Agricultural Sciences, Texas A&M University—Commerce, Commerce, TX 75429; 2Texas A&M Agrilife Extension, Dallas, TX 75252; 3National Great Rivers Research and Education Center, East Alton, IL 62024; 4Stephen F. Austin State University, Dept. of Biology, Nacogdoches, TX 75962; 5University of Wisconsin—River Falls, River Falls, WI 54022

In an evaluation of landscape roses under minimal input conditions, it was noted that the leaves of many varieties were turning black during the summer months. Experiments were conducted to determine whether the cause was cultural, pathological, or physiological in nature. In the first experiment, roughly 200 roses were evaluated under two different irrigation regimes. Roses in group one were irrigated weekly using drip irrigation, while the second received no supplemental irrigation. Symptoms
development was consistent across varieties. Symptomatic and asymptomatic leaves were collected from six cultivars, Brite eyes, KnockOut, Double KnockOut, Pink KnockOut, and Pink Double KnockOut and examined under a transmission electron microscope. Under the TEM, it became evident that severe damage had occurred to the vacuole in cells of the epidermis and mesophyll, including evidence of tonoplast rupture and accumulation of secondary metabolites. There was also significant damage to the cuticle in symptomatic cells and overall shrinkage of affected cells. All damage is consistent with UV damage, especially UV-B. However, the damage appears to be primarily cosmetic in nature and does not cause long-term damage to the plant. New leaves that form are asymptomatic, and there are no noted changes in growth rate or overall plant performance beyond what is typical during hot summers.

Factors Influencing Quality and Consistency of Pine Bark Substrates

Brian E. Jackson*

130 Kilgore Hall, Dept. of Horticultural Science, North Carolina State University, Raleigh, NC 27695

Pine bark has been the staple substrate for nursery crops for decades and much research has been dedicated over the years to best utilize this forestry by-product to grow horticultural crops in containers. Over the past decade pine bark is also being used more as a component in greenhouse substrates and in bagged retail potting mixes. Many variables can affect the quality and consistency of pine bark as has been noted over the years. Factors include variations in bark processing, handling, screening, aging, and amendments. A survey of aged pine bark supplies from five different suppliers was conducted to assess the variation in physical properties and white wood content of these materials. Differences in the processing and handling among the different sources were not evaluated, just the finished (saleable end-product). Physical properties including total porosity (TP), container capacity (CC), and air space (AS) were assessed in addition to the percent of white wood in the pine bark materials. Total porosity among the five sources ranged from 78% to 85%, CC ranged from 29% to 53% and AS ranged from 29% to 50%. The percentage of white wood of the five aged pine bark sources ranged from 4.5% to 17.4%. Four of the five bark materials had less than 10% white wood, which is considered to be acceptable within the industry, though no official guidelines exist as quality control standards in the horticulture industry. Many variables among the pine bark processors/suppliers could likely explain the differences discovered. Some of the variations include: time of year trees were harvested and debarked; machine type used to debark the logs; machine type used to initially process the pine bark; screening of different bark sizes prior to aging; and aging duration. Growers and substrate manufacturers need to consider the possibility of variations among pine bark materials prior to switching suppliers. Variations can also occur in the bark materials at the same supplier at different times of the year or from year-to-year.

Green Roofs: Water Recycling Effects on Water Quality and Soil Chemistry

Kirk Laminack1*, Astrid Volder1, Jacqueline Aitkenhead-Peterson2, and Anthony Camerino3

1Dept. of Horticultural Sciences Texas A&M University, College Station, TX 77843; 2Dept. of Soil and Crop Science, Texas A&M University College Station, TX 77843; 3Texas AgriLife Extension Service - Harris County, Texas A&M University System, Houston, TX 77084

Five intensive green roofs in the Houston, TX, area were investigated for their rainwater harvesting and recycling systems. One conventional roof was also included to compare runoff quality. Growing media, irrigation, and runoff samples were collected to determine if salt and nutrient concentrations were increasing with roof age and if there were differences in measured parameters across roofs. Electrical conductivity, pH, nitrate-N, ammonium-N, phosphate-P, K+, alkalinity, Na+, Mg++, Ca++, percent organic matter, and sodium adsorption ratio were analyzed. Runoff samples and irrigation samples had low concentrations for urban runoff and typical irrigation, respectively. The only difference in growing medium extracts between roofs was percent organic matter. Younger roofs had higher percent organic matter than older roofs, but all were within range (< 12%) suggested by most guidelines. Roof 1 had consistently higher concentrations in the water samples than the other green roofs likely due to it being the site of the aerobic septic treatment discharge spray. The unirrigated roof (2B) had similar concentrations in water and growing media samples than the other green roofs (Roofs 2–4) not receiving septic discharge spray. The conventional roof (C) had consistently lower concentrations in the runoff than all the green roofs. Concentrations declined through time rather than increased. This is likely due to the correlation of amount of precipitation with measured concentrations. As precipitation per day increased, concentrations in the growing media, irrigation, and runoff decreased. Precipitation likely dilutes the system causing the observed decrease in concentrations during time of higher precipitation. Rainwater harvesting systems in combination with green roofs can serve as a feasible option to reduce human impact on the environment while conserving potable water resources.

Effect of Flight Altitude (Spatial Resolution) of an Unmanned Aerial Vehicle and Canopy Separation on Plant Count Accuracy Using Black Fabric as Ground Cover

J.N. Leiva1*, J. Robbins1, D. Saraswat2

1316 Plant Sciences, Dept. of Horticulture, University of Arkansas, Fayetteville, AR 72701; 2Dept. of Biological & Agricultural Engineering

Collection of plant inventory data in nurseries is time consuming, expensive and inaccurate. Automating the plant inventory process would decrease labor inputs, increase precision and save
money. The objective of this research is to evaluate the effect of flight altitude and plant canopy separation on the counting accuracy of container-grown plants. Container-grown Fire Chief™ arborvitae (Thuja occidentalis L.), were established outdoors on a black polypropylene ground cover. Plants were spaced in staggered rows to achieve three canopy separation treatments: 5 cm between canopy edges, canopy edges touching, and 5 cm of canopy edge overlap. An Unmanned Aerial System (UAS) with an attached digital sensor was used to take the photographs at 6, 12, and 22 meters altitude. Images were analyzed using Feature Analyst to generate plant counts. Training sets, supervised learning, eroding, and aggregation procedures were part of the algorithm implemented in feature extraction process. There was no significant effect of canopy separation on plant count when images were taken at 12 or 22 m. When images were taken at 6 m, there was a significant difference in plant count between plants with canopies that were touching and overlapping. The highest plant count (122% of control) was observed when images were taken at 6 m for plants.

Gas Exchange Response to Leaf Excision of Field Grown Redbud Trees

Thayne Montague* and Cynthia McKenney
Dept. of Plant and Soil Science, Texas Tech University, Lubbock, TX 79409-2122

Gathering field leaf gas exchange data is essential for many research projects, and with current gas exchange systems available gathered data is accurate and precise. However, due to the length of time required to make each measurement, researchers are limited on the number of data samples they can gather. To help increase the number of samples collected, our research objective was to determine if gas exchange of excised redbud leaves is different when compared to gas exchange of redbud leaves remaining on the tree. Four redbud varieties were field planted in 2002 (Cercis canadensis var. texensis, C. canadensis var. texensis ‘Texas White’, C. canadensis var. texensis ‘Oklahoma’, and C. canadensis var. mexicana). Until 2012 all trees were irrigated weekly by drip irrigation. Mulch was placed around a select number of trees in 2010. Trees were not irrigated after January 2012. On two occasions during June 2013, auto program mode was used on two Li-6400 machines to simultaneously measure gas exchange on leaves from the same redbud tree (measurements were recorded every 30 seconds). After 180 seconds, one leaf was excised and auto program continued an additional 8 minutes. Gas exchange means for excised and non-excised leaves were graphed over time. In addition, gas exchange means at 120, 150, 180, 210, and 240 seconds after auto program began were exposed to ANOVA, and means were separated by Fisher’s Least Significance Difference procedure. Data indicate gas exchange for unexcised leaves of all varieties remained stable during the 11 minute measurement period. In contrast, gas exchange for excised leaves of each variety changed during the measurement period. However, data indicate there is approximately a 60 second “window” were excised leaf gas exchange is not different from gas exchange measured prior to leaf excision. Therefore, it appears leaf excision might be one means researchers have to increase sample size for gas exchange data collected in the field.

Gas Exchange and Growth of Two Field Grown Oak Species in Response to Post Establishment Applied Organic Mulch and Drought

Thayne Montague*, Cynthia McKenney, and Staci Parks
Dept. of Plant and Soil Science, Texas Tech University, Lubbock, TX 79409-2122

Organic mulch is thought to provide many benefits to urban landscapes. However, limited research has been conducted to determine if organic mulch placed below established landscape trees provides benefits. Under nonirrigated conditions, our research objective was to compare gas exchange and growth of established redbud trees which had, and which did not have organic mulch placed on the soil surface surrounding each tree. Containerized trees were planted in 2002. Two redbud varieties (Cercis canadensis var. texensis and C. canadensis var. mexicana) grew for 8 years prior to application of organic mulch. In Fall 2009 three trees of each species were randomly assigned a mulch treatment: no mulch (2.4 m diameter area around tree kept weed free), or mulch (2.4 m diameter area around each tree covered with 10 cm of cypress bark mulch). From Fall 2009 through Fall 2011 trees received weekly irrigation. Beginning 1 Jan. 2012, trees were not irrigated. Soil moisture and temperature sensors were placed below a mulched and below non-mulched tree. Throughout the 2012 and 2013 growing seasons budbreak data, and mid-day gas exchange data were measured. At the end of each growing season, shoot growth, and leaf area were measured. Data were exposed to ANOVA, and means were separated by Fisher’s Least Significance Difference procedure. Soil sensor data indicate soil under mulch was cooler, had greater soil moisture, and less extreme fluctuation extremes when compared to soil under non-mulched trees. Budbreak data indicates mulched trees broke bud earlier when compared to non-mulched trees. Gas exchange means indicate differences between mulch and non-mulched trees, and varieties. Shoot growth and leaf area were greater for Texas redbud trees when compared to Mexican redbud trees. For these redbud varieties, when grown under non-irrigated conditions our data suggest organic mulch placed below established trees can be beneficial to maintain tree growth.

Plants in the New Piney Woods Garden at LSU AgCenter Hammond Research Station

Allen Owings*, Regina Bracy, Daniel Wells, Gina Hebert, and Yan Chen
LSU AgCenter, Hammond Research Station, 21549 Old Covington Highway, Hammond, LA 70403

The LSU AgCenter’s Hammond Research Station, Hammond, LA has greatly expanded landscape horticulture efforts in the past 7 years. Research gardens are being planted and ornamental horticulture/landscape plant evaluations are being conducted on
annual bedding plants, trees, shrubs, roses, perennials and more. A new research garden—Pine Woods Garden—was started at the station in late 2012 is approximately 5 acres and is intended to be an complimentary garden addition to the existing Margie Jenkins Azalea Garden. The area includes 38 large landscape beds that are maintained with raised landscape bed soil areas, irrigation and pine straw mulch. The plant focus is woody ornamental trees and shrubs but a few native wildflowers, herbaceous perennials and marginally hardy semi-tropicals and tropics. Planting started in early 2013 and the majority of the garden is currently full. At the current time, approximately 92 genera containing 417 taxa are established in the garden. This includes a growing collection of Japanese maples and other Acer, Camellia hiemalis, Rhododendron, a Cornus collection that includes University of Tennessee and southern region unnamed selections, Hydrangea, althea, Taxodium, Iris, Gardenia, Vitex, Crateagus, Prunus, Ilex, Distylium, Illicium, Abelia, Liriope, Magnolia, Duetzia, Halesia, Gordonia, Kalanchoe, Trachelospermum, Cassia, Viburnum, Forsythia, Myrica, Quercus, Podocarpus, Photinia and much more. This effort to collect new cultivars and potential plants for entry into wholesale production and use in order to observe short term landscape performance is being done in cooperation with support from the Louisiana Nursery and Landscape Foundation for Scholarship and Research. In addition, industry grower partners include Panhandle Growers, Plant Development Services, Inc., Transcend Nursery, Jenkins Farm and Nursery, Bracy’s Nursery, Louisiana Growers, Windmill Nursery, Perino’s Garden Center, Greenleaf Nursery, GreenForest Nursery, Stephen F. Austin State University Gardens, Almost Eden Plants, Live Oak Gardens, Green Nurseries and Landscape, Garden Design Nursery, Nichols Nursery, USDA–ARS Poplarville, USDA–ARS McMinnville, Mississippi State University, Society of Louisiana Irises, Azalea Society of America, Willis Farms, Texas A&M Overton, Treesearch Farms, and more.

Horticulture and Pathology Observations in Landscape Planted Roses at the LSU AgCenter Hammond Research Station

Allen Owings1* and Mark Windham2

1LSU AgCenter, Hammond Research Station, 21549 Old Covington Highway, Hammond, LA 70403; 2University of Tennessee, Dept. of Entomology and Plant Pathology, 138 Biotechnology Building, Knoxville, TN 37996

The LSU AgCenter and the University of Tennessee are working cooperatively in evaluation of rose cultivars for the southeastern United States. New landscape plantings in 2013 at the LSU AgCenter Hammond Research Station, Hammond, LA, included cultivars previously proven to be less disease susceptible in Tennessee trials—Moje Hammarberg, Knock Out, Pink Knock Out, Double Knock Out, Pink Double Knock Out, Carefree Sunshine, My Girl, and Kashmir. Chicago Peace was used as a disease susceptible control in this replicated planting. An additional three cultivars from Weeks Roses will be added in 2014. In addition, two Kolorscape and seven Varanda cultivars from Kordes Roses / Greenheart Farms were landscape planted in 2013 for evaluations of horticultural characteristics and disease susceptibility in 2013–15. An existing planting of six cultivars in the Drift rose series continued to be evaluated in 2013. Blackspot and Cercospora leaf spot ratings were taken seasonally in 2013 using a scale from 0 to 5 with 0 = 0% foliage spotting, defoliation, 1 = less than 2% foliage spotting, defoliation, 2 = 2% to 10% foliage spotting, defoliation, 3 = 11% to 25% foliage spotting, defoliation, 4 = 26% to 50% foliage spotting, defoliation, and 5 = 50% to 100% foliage spotting, defoliation. The only Drift rose with blackspot in 2013 was Red Drift. However, Cercospora susceptibility was high with Peach Drift, Pink Drift, Sweet Drift and Apricot Drift being most problematic. Less Cercospora was observed on Coral Drift and Red Drift. Peach Drift and Apricot Drift were the most prone Drift rose cultivars prone to defoliation due to disease. Proven cultivars from Tennessee were also good in 2013 Hammond, LA, trials with the exception of Carefree Sunshine, which was moderately to highly Cercospora susceptible. Kolorscape and Veranda roses showed no to very low blackspot susceptibility but moderate to high Cercospora susceptibility. Kolorscape cultivars Cherri and Kardinal were more prone to defoliation than Veranda cultivars Brilliant, Blush, Cream, Chico, Lavender, Milano, and Sunbeam.

Salt Tolerance of Selected Texas Superstar Perennials

Youping Sun1, Genhua Niu1†, and Christina Perez2

11380 A&M Circle, El Paso, TX 79927, Texas Agrilife Research at El Paso, Texas A&M University; 2El Paso Community College RISE Program, El Paso, TX 79998

A greenhouse study was conducted to determine the responses of seven herbaceous perennials to irrigation water with elevated salinity. Rooted cuttings of the following species were received from a commercial company: Malavaviscus arboreus var. drummondii (turb’s cap), Phlox paniculata ‘John Fanick’ (garden phlox), Phlox paniculata ‘Texas Pink’ (texas pink phlox), Ruellia brittoniana ‘Katie Blue’ (dwarf mexican petunia), Verbena xhybrida ‘Blue Princess’ (blue princess verbena), Salvia farinacea ‘Henry Duelberg’ (mealy sage), and Salvia leucantha (mexican bush sage). Rooted cuttings were transplanted and grown in 2.6-L plastic containers filled with Metro-Mix 360 (SunGro Hort., Bellevue, WA) and irrigated with nutrient solution. One month after transplanting, treatments were initiated by irrigating plants with nutrient solution (control) or saline solutions at electrical conductivity (EC) of 5.0 (EC 5) or 10.0 (EC 10) dS m−1 with 10% to 20% leaching fraction. The two phlox plants were treated for six weeks before terminating due to poor performance under elevated salinity conditions, while other species were treated for eight weeks. The two phlox had salt damage such as leaf burn and death with visual scores of 2.6 and 0.0 (on a 0 to 5 scale) for garden phlox and 2.9 and 1.0 for texas pink phlox in EC 5 and EC 10, respectively. Turk’s cap had the highest visual score (5.0, 4.9), followed by verbena (5.0, 4.4), mealy sage (5.0, 4.4), and dwarf mexican petunia (4.3, 4.1) for the elevated treatments (EC 5, EC 10). Mexican bush sage had visual score of 5 in EC 5; however severe salt damage was observed in EC 10 with a visual score of 1.8. Shoot dry weight
Grower Priorities for Water Research: Results of a SCRI Planning Grant

Sarah A. White1*, James S. Owen2, John C. Majsztrik3, R. Tom Fernandez4, Paul Fisher5, Charles R. Hall6, Tracy Irani7, John D. Lea-Cox8, Julie P. Newman8, and Lorence R. Oki9

1Clemson University, School of Agricultural, Forest, and Environmental Sciences, E-143 P&AS, Clemson, SC 29634; 2Dept. of Horticulture, Hampton Roads Agricultural Research and Extension Center, 1444 Diamond Springs Road, Virginia Beach, VA 23455; 3Dept. of Plant Science and Landscape Architecture, 2120 Plant Sciences Building, University of Maryland, College Park, MD 20742-4452; 4Dept. of Horticulture, Michigan State University A288 Plant and Soil Science Building, East Lansing, MI 48824-1325; 5Environmental Horticulture Dept., University of Florida, 1533 Fifield Hall, PO Box 110670, Gainesville, FL 32607; 6Dept. of Horticultural Sciences, Texas A&M University, 2133 TAMU, HFSB Room 202, College Station, Texas 77843-2133; 7Agricultural Education and Communication Dept., 220 Rolfs Hall University of Florida Gainesville, FL 32611; 8University of California Cooperative Extension, 669 County Square Drive #100, Ventura, CA 93003-5401; 9Dept. of Plant Sciences, MS6, University of California, One Shields Avenue, Davis, CA 95616-8780

Access to high quality, fresh water sources is increasingly limited for irrigation of conventional and specialty crops. Nursery, floriculture, and propagation production accounted for 81% ($9.48 billion) of 2009 specialty crop production in the United States. The ornamental production industry is facing production, environmental, and economic issues associated with the use and release of water. These issues include use of recycled, reclaimed, surface, and ground water, and the movement of chemicals in water. To ensure the longevity and profitability of the industry, it is critical to correctly identify the needs of producers, to begin development of sustainable runoff, containment, and remediation technologies, and to identify alternative sources of water. To better understand water-related research needs as identified by grower stakeholders, five in-depth round-table discussion sessions were conducted at the Mid-Atlantic Nursery Trade Show, Gulf States Horticultural Expo, California Grown Show, OFA Short Course, and the Farwest Show with a total of 36 industry participants. Research and extension specialists, facilitated by a Specialty Crops Research Initiative Planning Grant (NIFA Project # 2011-51181-30633), analyzed the results from the round-table discussions inferring common needs and themes. Growers were most concerned with water quality, availability, and regulations in reference to their water supply. In terms of limitations of using alternative water sources or recycling irrigation water on site, grower adoption was limited by infrastructure concerns, cost of installation and treatment, and fear of contamination with biotic and abiotic pests that could damage crop health. These factors contributed to the grower identified research and extension related priorities that must be addressed before conservation-based water use and management practices would be widely adopted by the industry.

Greening Urban Spaces with Native Plants - the Clemson Sustainable Landscape Demonstration Garden

Sarah A. White*, Ellen A. Vincent, Dara M. Park
Clemson University, School of Agricultural, Forest, and Environmental Sciences, E-143 P&AS, Clemson, SC 29634

The sustainable landscape demonstration garden was created to address both consumer perception and the green industry marketing challenge related to native plants. Consumer perception of many native plant species is that of reduced aesthetics due to leggy, rambunctious growth habits, these attributes of many native species are perceived to reduce their commercial viability. This project is intended to increase awareness of the environmental benefits of biologically diverse gardens in public areas, facilitated mainly by incorporation of native plant selections in urban gardens. These benefits are communicated in a variety of manners to passersby including both participatory (such as in-person surveys) and passive (such as educational signage and QR codes) mechanisms to enhance access to garden information. Passersby were asked to rate the aesthetics, maintenance, and safety of the landscape on a scale of 1 (extremely poor) to 10 (extremely high), both pre-install (PRE) and post-install (POST). Perception of aesthetics increased from 4.3 PRE to 7.2 POST ($<0.0001$); perception of landscape maintenance increased from 4.8 PRE to 7.4 POST ($<0.0001$); and perception of safety within the landscape increased from 4.8 PRE to 7.2 POST to 8.7 POST ($<0.0001$). Also preference for trees (55% PRE, 25% POST) in the sustainable garden shifted to herbaceous perennials (8% PRE, 44% POST) two years after garden installation. Overall, passersby appreciated the increased biodiversity in the University landscape which they indicated enhanced the environmental benefits of the landscape (habitat), with increased knowledge about soil, plants, and water.

Contribution of Stored Nitrogen and Spring Fertilizer Nitrogen to Flowering and Growth Performances of Iris 'Immortality'

Xiaojie Zhao*, Guihong Bi, Richard L. Harkess, and Tongyin Li
Dept. of Plant and Soil Sciences, Mississippi State University, Mississippi State, MS 39762

(DW) was reduced by 23%, 18%, 12.5%, 10%, and 2.5% in mexican bush sage, dwarf mexican petunia, mealy sage, turk’s cap, and verbena in EC 5, compared to control. In EC 10, shoot DW was reduced by 56% (mexican bush sage), 44% (turk’s cap), 32% (dwarf mexican petunia), 30% (mealy sage), and 22% (verbena). In summary, verbena, turk’s cap, and mealy sage are more tolerant, followed by dwarf mexican petunia and mexican bush sage, while the two phlox were not tolerant to salt stress.
Many cultivars of tall bearded iris, Iris germanica, have potential to flower multiple times in one growing season which is called reblooming. Reliable reblooming could make tall bearded iris available as a cut iris over an extended season. Based on research, many factors influence consistent reblooming. The objective of this study was to determine the effects of nitrogen (N) source (e.g., stored or spring fertilizer application) on spring growth and blooming performances. Iris (I. germanica, ‘Immortality’) plants were fertigated with five N rates (0, 5, 10, 15, 20 mM) from April to September 2012. In early spring 2013, plants in each N rate treatment were supplied with either N-free modified Hoagland’s solution or a solution with 10 mM N fertigation for 8 weeks. During spring 2013, plant growth and blooming data were collected. Plants were harvested and analyzed for N concentration in May 2013. Both vegetative growth and flowering increased with increasing 2012 fertigation rates indicating storage N is an important source for the plant’s spring nutrient supply. Spring fertigation increased plant height. In addition, spring fertigation increased the number of flower stems for the plant that received 0 mM N fertigation rate in 2012. This result suggests that plants under 0 mM N treatment initiated flowers in the previous winter, but plants under N deficiency status could not support spring blooming without additional spring fertigation. Thus, for plants under N deficiency status, spring N fertilization improved spring blooming. Both stored N and spring fertigation had a positive relation with plant N content in spring which contributed to the reblooming performance. However, neither stored N nor spring fertigation had an effect on flower stem length or number of florets.

Fruit Section

Compensatory Yield Potential of ‘Neptune’ Grape

Eric T. Stafne1* and Becky Carroll2
1810 Hwy 26 West, Coastal Research and Extension Center, Mississippi State University, Poplarville, MS 39470; 2358 Agricultural Hall, Dept. of Horticulture and Landscape Architecture, Oklahoma State University, Stillwater, OK 74078

The Easter freeze of 2007 brought about dire crop loss estimates in grapes throughout the affected region. However, harvests that year were greater than expected, initiating a myriad of questions related to non-primary bud yield potential. For states in the Plains, late spring freezes and hail are just two potential events that could negatively affect vine productivity. For two years, 16 ‘Neptune’ vines were used to assess yield after a simulated destructive event. Each vine was pruned to 50 nodes in March prior to budbreak. All visible growth was removed on 8 vines on May 1 in 2009 and 2010, thus the vine would rely on secondary, tertiary, and latent buds to produce fruit. The remaining 8 vines were allowed to grow as normal. Harvest date was delayed 11 days in 2009 and 16 days in 2010 when initial growth was removed. Vines that did not receive the treatment produced an average of 8.4 kg per vine in 2009 and 12.5 kg per vine in 2010. Treated vines averaged 3.1 kg per vine in 2009 and 2.3 kg per vine in 2010. Individual average cluster weights were also greater on untreated vines vs. treated vines, but the treatment did not affect berry size. In this experiment, treated vines produced 37% of untreated vines in 2009 and just 18% in 2010. Using data from individual years, a standardized methodology could deliver essential information to grape growers who must make crucial economic management decisions after initial spring growth has been lost or damaged. More work must be done to determine effects of timing, location, cultivar, rootstock and other variables on compensatory yield potential.

Prime-Ark® Freedom Thornless Primocane-Fruiting Blackberry

John R. Clark
316 Plant Science, Dept. of Horticulture, University of Arkansas, Fayetteville, AR 72701

‘Prime-Ark® Freedom’ is world’s first primocane-fruiting thornless blackberry (Rubus L. subgenus Rubus Watson) commercial introduction. It is intended primarily as a home garden or local-market plant. This unique type of blackberry fruits on current-season canes (primocanes) and second-season canes (floricanes), potentially providing for two cropping seasons, both traditional summer fruits in addition to late summer to fall production. In addition to having thornless canes, this new introduction has very large fruits with good flavor, and is very early ripening on floricanes, the earliest of all Arkansas blackberries. Fruit does not exhibit exceptional postharvest storage potential however, and ‘Prime-Ark® Freedom’ is not recommended for the shipping market. ‘Prime-Ark® Freedom’ resulted from a 2004 cross made at the University of Arkansas Division of Agriculture Fruit Research Station, Clarksville. The original plant was selected in June, 2007 from a population of 309 plants and was tested as selection APF-153T. It was introduced in 2013.

Predicting Fruit Maturity Dates for South Carolina Peach Cultivars

Gregory L. Reighard1*, Leanne Kenealy1, Brad Rauh1, and William C. Bridges Jr.2
1School of Agricultural, Forest and Environmental Sciences, Clemson, SC 29634; 2Dept. of Mathematical Sciences, Clemson, SC 29634

Forecasting maturity date for weekly ripening fruit crops is important for retail marketing. A model based on growing degree days calculated from a base temperature of 70 °C has been used to predict peach harvest dates in California. The objective was to predict harvest dates for peach cultivars in South Carolina using a Growing Degree Day formula based on temperatures for the first 30 days after flowering. Three formulas were used to calculate Growing Degree Days so that a comparison could be made to find the model that best suited South Carolina. Two of these models, the BE method and the Averaging Method, require average daily temperatures, and the third (GDH method) requires hourly temperatures to complete a prediction. The method used
Efficacy of Foliar Calcium Applied to Rabbiteye Blueberry (Vaccinium ashei) and the Effect of Fruit Quality

Erick Smith*
Dept. of Horticulture Tifton Campus, The University of Georgia, Tifton, GA 31793-5766

In blueberry (Vaccinium sp.), fruit quality determines the marketability. Fresh blueberries return an average of two to three times more than processed fruit. Berry firmness is used as a quality index, where excessively soft fruit equates to poor quality. To alleviate fruit softening, producers use calcium in foliar sprays to improve fruit firmness with varying results. In this study, foliar calcium was applied to ‘Alapaha’ and ‘Powder Blue’ rabbiteye blueberry to determine the efficacy of calcium sprays. The materials evaluated were Cell Force Max™ (10% calcium nitrate), Calexin® (2% calcium carbonate) of Miller Chemical & Fertilizer Corp. (Hanover, PA), and KeyPlex® Calcium Plus (chelated calcium form calcium glucoheptonate) of KeyPlex, Winter Park, FL. All treated plants had two applications: one and two weeks preharvest at 2 pt/A (2336 ml/ha) at 20 gals of water per acre. These applications were compared to untreated fruit harvested at the same time as the treated material. Fruit were harvested twice, the first harvest at 40% ripe and the second one week later. Fruit firmness was measured on a BioWorks FirmTech 2 (BioWorks, Inc. Wamego, KS) at fifty fruit per replication and weight was measured at grams/100 fruit. The calcium application of Keyplex® Calcium Plus on ‘Alapaha’ was 2% firmer than the untreated fruit when comparing the fruit from second week of harvest, only. In addition, ‘Powder Blue’ treated with Calexin® was 5% firmer than the untreated fruit when comparing the fruit from harvest at 40% ripe, only. However, fruit weight of the Calexin® treatment was 7% less than the untreated fruit. Ultimately, fruit firmness was not positively affected by the foliar applications when compared with the untreated fruit. However, when considering fruit weight, two of the calcium products Cell Force™ and KeyPlex® Calcium Plus resulted in increased fruit weigh compared to the untreated fruit. In ‘Alapaha’, fruit treated with KeyPlex® Calcium Plus weighed an average, over both harvest dates, 9.5% more than the untreated fruit. In ‘Powder Blue’, Cell Force™ treated fruit weighed an average, over both harvests, of 5% more than the untreated fruit. Foliar calcium applications used in this study did not conclusively benefit fruit quality.

Yield and Fruit Quality Evaluations of Black Raspberry (Rubus occidentalis L.) in North Carolina

Christine M. Bradish*, Gina E. Fernandez¹, Jill M. Bushakra², Penelope Perkins-Yeazle³, Michael Dossett¹, Nahla V. Bassil², and Chad E. Finn²
¹Campus Box 7609, Dept. of Horticultural Science, North Carolina State University, Raleigh, NC 27695; ²USDA–ARS National Clonal Germplasm Repository, 33447 Peoria Rd., Corvallis, OR 97333; ³NC State University Plants for Human Health Institute, 600

Storage Retention of Stilbene, Ellagic Acid, Flavonol, and Phenolic Content of Muscadine Grape (Vitis rotundifolia Michx.) Cultivars

Donna A. Marshall¹, Stephen J. Stringer¹, and James D. Spiers²
¹USDA–ARS Thad Cochran Southern Horticultural Laboratory, Poplarville, MS 39470; ²Dept. of Horticulture, Auburn University, Auburn, AL 36849

The objective of this study was to determine the retention of some of the important phytochemical compounds such as anthocyanins, phenolics, flavonols, stilbenes and organic acids in post harvest storage period on different varieties of whole muscadine fruit and individual fruit parts. Stilbene, ellagic acid, flavonol, and phenolic compounds were analyzed in 11 muscadine cultivars. Analysis was carried out on muscadine fruit skin, pulp and juice partitions. The major phenolics in muscadine juice, pulp and skins were identified by their retention times and characteristic spectra. Quantification was made by calibration curves of external standards for each of the analyzed compounds: trans and cis resveratrol, trans and cis piceid, ellagic acid, myricetin, quercetin and kaempferol. The total phenolics decreased in 6 varieties and increased in 5 varieties, perhaps indicating differences in decay development and fruit deterioration in the different varieties. The anthocyanin content showed an overall decrease in the varieties tested with the exception of ‘Eudora’. The stilbenes showed an overall decrease as well. Flavonol content after cold storage was cultivar and compound specific. Free ellagic acid increased in most cultivars, with the exception of Pollyanna. Total ellagic acid also increased or remained constant in all cultivars. The presence of ellagic acid and other nutraceutical compounds in muscadine grape could add value and marketability to the crop due to the possible health benefits. This southern specialty crop could fast become the next “super fruit”.

Yield and Fruit Quality Evaluations of Black Raspberry (Rubus occidentalis L.) in North Carolina

Christine M. Bradish*, Gina E. Fernandez¹, Jill M. Bushakra², Penelope Perkins-Yeazle³, Michael Dossett¹, Nahla V. Bassil², and Chad E. Finn²
¹Campus Box 7609, Dept. of Horticultural Science, North Carolina State University, Raleigh, NC 27695; ²USDA–ARS National Clonal Germplasm Repository, 33447 Peoria Rd., Corvallis, OR 97333; ³NC State University Plants for Human Health Institute, 600
Laureate Way, Kannapolis, NC 28081; 4Agriculture and Agri-Food Canada–Pacific Agri-Food Research Centre, 6947 Lougheed Hwy, Agassiz, BC V0M 1A2, Canada; 5USDA–ARS-Horticultural Crops Research Unit, 3420 NW Orchard Avenue, Corvallis, OR, 97330

Over the last 75 years, the black raspberry industry in the United States has not grown despite the expansion of other small fruit crops. Breeding progress has been hindered due to the absence of elite germplasm and to the lack of adapted, disease resistant cultivars. However recent discoveries focused on the bioactive compounds of black raspberry has led to a growing interest in producing and consuming this fruit. As a result, there are collaborative national breeding efforts to develop new cultivars. In North Carolina, one of our goals is to standardize phenotyping procedure and calculate yield parameters for black raspberry. Two half-sib populations, designated ORUS 4304 (192 progeny) and ORUS 4305 (115 progeny), that segregate for aphid resistance were planted in 2012 at the Sandhills Research Station in Jackson Springs, North Carolina and evaluated for the first harvest season in 2013 for fruit traits and yield. Overall, quantitative versus qualitative field scoring methods were more accurate, and provided a broader range of information about seedlings for each trait measured. Average fruit size ranged from 0.17–3.12 g/berry, and positively correlated at \( P < 0.0001 \) with seed weight, seed number, and ‘seediness’ (mg seeds/g fruit). Average yields were 1.4kg (3 lb) per plant, with no difference between populations. Yield was normally distributed, and positively correlated at \( P < 0.0001 \) with 11 plant and fruit traits. In 2014, a second year of phenotyping will take place, along with additional calculations to look at interactions among genotype and environment. Linkage map assembly of both populations is underway in order to identify QTL for traits of interest, and comparative mapping techniques will be used in the future to align traits between red raspberry, black raspberry, and other Rosaceous fruits.

**Phenological Responses of Non-Cavendish Banana Cultivars to Central and Coastal Locations in Alabama**

Edgar L. Vinson1*, Elina D. Coneva1, Joseph M. Kemble1, Floyd M. Woods1, E. Greg Fonsah2, Penelope Perkins-Veazie3, and Jeff L. Sibley1

1101 Funchess Hall, Dept. of Horticulture, Auburn University, Auburn, AL, 36849; 2Dept. of Viticulture and Enology, University of California at Davis, One Shields Avenue, Davis, CA 95616; 3Chilton Research and Extension Center, 120 Co. Rd. 756, Clanton, AL, 35045

Three recently developed Pierce’s disease (PD) resistant 87.5% \( V. \) vinifera selections from the U.S.-Davis grape breeding program, namely ‘502-10’, ‘502-01’, and ‘501-12’, were planted at the Chilton Research and Extension Center (CREC) near Clanton, Alabama in 2010 to study their overall performance. The experimental vineyard is a RCBD with 6 blocks and 5 vines per block. Vines are trained to a vertical shoot positioning trellis system. The first commercial crop was produced in 2012, and data collection continued in 2013. Our second year results suggest selection ‘502-10’ had the lowest pruning weight of 2.1 kg/vine, while ‘501-12’ had the highest (2.3 kg). Selection ‘502-10’ matured early in the season, while ‘501-12’ ripened late. The selections differed in total yield per vine with the late maturing ‘501-12’ producing the largest crop of 8.1 kg/vine. ‘502-10’ and ‘501-01’ also produced very good yield. Selection ‘501-12’ had the largest number of clusters per vine – 89, while ‘502-10’ had 33 clusters. Early-season selection ‘502-10’ had the largest cluster weight of 210 g, while mid-season selection ‘502-01’ produced the largest berries. Late season selection ‘501-12’ had the sweetest berries with soluble solids content of 24.2%. The preliminary results of our study are very encouraging. The newly introduced grape selections have the potential to improve the grape production sustainability in the southeastern region and enhance the agriculture and food systems by advancing the environmental and economic sustainability through implementation of advanced technologies.

**Cultivation of Pierce’s Disease Resistant \( V. \) vinifera Selections in Alabama**

Elina D. Coneva1*, Andy Walker2, and J. Pitts3

1101 Funchess Hall, Dept. of Horticulture, Auburn University, AL 36849; 2Dept. of Viticulture and Enology, University of California at Davis, One Shields Avenue, Davis, CA 95616; 3Chilton Research and Extension Center, 120 Co. Rd. 756, Clanton, AL, 35045

Three recently developed Pierce’s disease (PD) resistant 87.5% \( V. \) vinifera selections from the U.C.-Davis grape breeding program, namely ‘502-10’, ‘502-01’, and ‘501-12’, were planted at the Chilton Research and Extension Center (CREC) near Clanton, Alabama in 2010 to study their overall performance. The experimental vineyard is a RCBD with 6 blocks and 5 vines per block. Vines are trained to a vertical shoot positioning trellis system. The first commercial crop was produced in 2012, and data collection continued in 2013. Our second year results suggest selection ‘502-10’ had the lowest pruning weight of 2.1 kg/vine, while ‘501-12’ had the highest (2.3 kg). Selection ‘502-10’ matured early in the season, while ‘501-12’ ripened late. The
for commercial banana fruit production. LER showed a steady increase during the warmest months and was similar to LER of banana plants produced in other regions of the subtropics. Preliminary data support potential to produce banana fruit commercially in coastal Alabama.

Observations of Frost Protection in High Tunnels for Season Extension of Berry Production

Curt R. Rom*, Jason McAfee, Luke Freeman, and Heather Friedrich
316 Plant Sciences Building, Dept. of Horticulture, University of Arkansas, Fayetteville, AR

High tunnels (HT) have the potential of extending the harvest season for berry crops both in the spring by advancing the bloom and harvest season, and in the fall by extending the harvest season. High tunnels also may provide environmental protection from frost, freezes, wind, rain and excessive sunlight, and may be used for pest exclusion. In preliminary studies, high tunnels extended the spring harvest season of blackberries and raspberries by 2 weeks and the fall harvest season by 4–6 weeks. However, tunnels did not provide much frost protection of spring blossoms or fall fruit without supplemental heat. A series of two studies has been initiated to study the use of tunnels-in-tunnels (TNT) to gain additional heat conservation to advance maturity of spring berries and extend the harvest season of fall berries. Temperature was monitored during a 30-day period in autumn 2013, October 25 through November 25, to evaluate heat accumulation and conservation, and to evaluate frost protection during 3 frost events during which two events supplemental heat was added and one event supplemental heat was not used. During the 30-day period, average daily temperature was greatest in the TNT compared to both HT and field conditions. The average daily temperature for HT was greater than the field. The average daily minimum temperature was significantly higher in the TNT compared to HT or field which was similar. The TNT approximately 2 °C over the ambient average daily low temperature. In combination with supplemental heating provided by methanol chafing dish burners during an overnight frost event, the TNT had significantly higher temperatures, more than 3–7 °C above ambient and no exposure to freezing temperatures within the plant canopy. Without supplemental heat, the TNT provided approximately 4 °C protection above ambient, even though while the HT and field were similar. During the freeze event the field was exposed to 14 hours of sub-freezing temperatures while the HT and TNT had 7 and 6 hours of sub-freezing temperatures, respectively. It is concluded that TNT have the potential to increase heat unit accumulation and provide additional freeze protection compared to HT alone.

Influence of Irrigation Regime on Gas Exchange, Growth, and Oil Quality of Field Grown Olea europaea L. ‘Arbequina’

Thayne Montague*, Cynthia McKenney, and Staci Parks
Dept. of Plant and Soil Science, Texas Tech University, Lubbock, TX 79409-2122

Production of olive oil in Texas is increasing each year. However, olive growers are concerned about limited water resources for this emerging crop. Therefore, this research was conducted to help determine irrigation regimes which help growers conserve water, maintain production, and preserve olive oil quality. This research was conducted in an established olive (Olea europaea L. ‘Arbequina’) orchard in Artesia Wells, TX. The experiment design was a randomized block design with 3 irrigation blocks and 5 trees within each block. Trees within each block were exposed to one of three irrigation treatments: high (3 emitters for each tree), medium (2 emitters for each tree), and low (1 emitter for each tree). Throughout the 2013 growing season, mid-day gas exchange measurements (Li-Cor 6400) were taken monthly. At the end of the growing season shoot growth was measured. In addition, fruit was collected from each tree and pressed into olive oil. Gas exchange (monthly data was pooled) and growth data were exposed to ANOVA.

James D. Spiers1*, William A. Dozier Jr.1, James A. Pitts2, and Bryan S. Wilkins3
1101 Funchess Hall, Dept. of Horticulture, Auburn University, Auburn, AL 36849; 2Chilton Research and Extension Center, 120 Co. Rd. 756, Clanton, AL 35045; 3Gulf Coast Research and Extension Center, Fairhope, AL 36532

These kiwifruit cultivars have been evaluated along with standard cultivars in central Alabama for over 20 years. Actinidia chinensis ‘AU Golden Dragon’ typically blooms a few days earlier than ‘Hort 16A’ kiwifruit. A. chinensis ‘AU Golden Sunshine’ typically blooms 10–14 days after ‘Hort 16A’. The harvest period for ‘AU Golden Dragon’ is late August to early September, and the harvest period for ‘AU Golden Sunshine’ is mid September. ‘Hort 16A’ typically is ready to be harvested in early October in central Alabama. A. delicosa ‘AU Fitzgerald’ is a lower chilling cultivar, compared to A. delicosa ‘Hayward’, that is typically harvested mid to late October. Bloom periods were monitored for three seasons to determine suitable pollinizers for these
Vegetable Crops Section

Assessing Virus Resistance and Quality in TAMU Tomato Breeding Lines

Kevin Crosby1*, Bhimu Patil1, John Jifon2, and Daniel Leskovar3

1Vegetable and Fruit Improvement Center, Texas A&M University, 1500 Research Pkwy, Ste 120, College Station, TX 77845; 2Texas AgriLife Research, 2415 E. Hwy 83, Weslaco, TX 78596; 3Texas AgriLife Research, 1619 Garner Field Rd., Uvalde, TX 78801

The Texas A&M AgriLife Research tomato improvement program has a 70 year history of heat-tolerant tomato breeding. The program has diversified to include a strong emphasis on virus resistance and fruit quality. Both beneficial phytochemical levels and flavor are being assessed in multiple vine-ripe, large fruited and processing types. Both traditional and marker assisted selection are being utilized to combine the Ty-2, Ty-3, Sw-5, Tm-2, I-2, I-3, Frl, and Mi-1 genes into heat tolerant, determinant breeding lines, adapted to south Texas. During 2013, roughly 500 breeding lines and experimental hybrids were evaluated for TYLCV, TSWV and Fusarium wilt race 2 resistance, along with fruit quality, yield and maturity. Dramatic improvements for early maturity and yield under high heat were observed in several lines and experimental hybrids at Weslaco, College Station and Uvalde Texas. Two hybrids, TAM 1204 and TAM 1203, matured 10 days before commercial checks, TY-coon and Charger, and had higher yields per plant. Though all four hybrids showed good TYLCV resistance, susceptibility to TSWV was evident in two of the trials. Another hybrid, TAM 214, demonstrated good TSWV resistance at College Station and high yields of large fruit, which matured 8 days before Christa and Red Line. Several joint TAMU-NCSU heirloom type hybrids with TYLCV resistance and heat tolerance also performed well in two organic production fields and merit further evaluation. At Edinburg, under intense whitefly and TYLCV pressure, we evaluated the efficacy of multiple TY genes against the begamovirus complex. Ty-2 provided the most resistant phenotype when deployed alone, while Ty-2 + Ty-3 hybrids had the best overall resistance. Ty-3 alone provided intermediate resistance, while ty-5 lines were slightly better. The best horticultural attributes were found in several Ty-2 lines and hybrids. Late maturity and modest yields were problems in most of the Ty-3 and ty-5 lines.

Evaluating Controlled Release Fertilizer for Vidalia Onion Transplant Production

Timothy Coolong1* and George Boyhan2

12360 Rainwater Road, Dept. of Horticulture, University of Georgia, Tifton, GA 31793; 21111 Miller Plant Sciences, Dept. of Horticulture, University of Georgia, Athens, GA 30602

Controlled-release fertilizers have been utilized for production of perennial crops for a number of years, but their use in vegetable cropping systems in Georgia is minimal. However, increased concerns about the environmental impact of nutrient leaching as well as improved controlled-release technologies have renewed interest in these fertilizer sources. A trial was conducted fall 2013 to evaluate the potential of two poly-coated urea (PCU) products for production of Vidalia onion transplants. Three treatments, all utilizing 146 kg·ha⁻¹ Nitrogen (N), were applied. A control treatment, where approximately 1/3 of the total N requirement as put out prior to seeding with a granular fertilizer, followed by two applications of calcium nitrate at 4 and 6 weeks after seeding, each containing 1/3 of total N applied. Two PCU products, ESN and Duration Short-Term (Agrium Advanced Technologies, Loveland, CO) were applied prior to seeding. Four varieties, Ringo, Sweet Uno, Sweet Jasper, and Golden Boy were grown. Plant total N levels were similar among all three treatments throughout growth, although there was a significant variety by fertilizer treatment by sampling time interaction. At 35 days after seeding the plants in the control treatment had less total N than the two PCU treatments. However, by harvest there were no differences among treatments for total N. Total plant N levels decreased in all varieties during growth. At harvest, average plant dry weight and diameter were significantly greater in the two PCU treatments. There were also significant differences among varieties, with Sweet Jasper and Sweet Uno being the largest, and Golden Boy and Ringo significantly smaller. The results of this trial suggest that PCU would be a suitable replacement for typical granular fertilizers used in Vidalia onion transplant production.

Weed Control in Watermelon with Reflex (fomesafen) in Oklahoma

James Shrefler1*, Merritt Taylor1, Lynn Brandenberger1, and Charles Webber III2

1Oklahoma State University, Division of Agriculture Sciences and Natural Resources, Stillwater, OK 74078; 2Sugarcane Research Unit, United States Dept. of Agriculture, Agricultural Research Service, 5883 USDA Road, Houma, LA 70360

More effective herbicides are needed for weed control in watermelon. Reflex was evaluated in watermelon ‘Delta’ in southeast Oklahoma in 2011 and 2012 using transplants, and in 2013 with direct-seeding. The soils were fine sandy loams and were fertilized each year based on Oklahoma Cooperative Extension recommendations. Transplants were set 10 days after making preplant surface herbicide applications in the 2011 and 2012 trials. In 2013, herbicides were applied to direct-seeded melons
2 days after seeding. All trials used treatments that included Reflex rates of 0.187, 0.25, 0.375, and 0.5 lbs. ai/a and these were applied with a hand boom using 15 to 20 gpa, depending on the trial. Conditions after herbicide application were extremely hot and dry in 2011 but favorable in 2012 and 2013. Minor early season crop stunting occurred with the highest rate of Reflex in 2012 and all rates in 2013. The stunting in 2013 was no longer detected at 6 weeks after planting. Reflex at all rates provided excellent control of cutleaf groundcherry, tumble pigweed, spiny amaranth, carpetweed and yellow nutsedge. Across trial years and Reflex application rates, the control of annual grasses ranged from 60% to 100%. The greatest watermelon yields (lbs. marketable fruit/acre) were 87,943 in 2011, 69,681 in 2012 and 45,628 in 2013. Yields of watermelon from Reflex treatments were either greater than, or not different from, those of hoed plots. Overall, these trials suggest that Reflex would be useful for weed control in direct-seeded or transplanted watermelon. The lowest rate evaluated provided good weed control and crop safety. Because detrimental effects of the highest rate were minor, there appears to be a good margin of crop safety.

**Comparison of Foliar and Root-dipped Crop Protectants for Strawberry Transplant Establishment**

Ixchel M. Hernandez-Ochoa* and Bielinski M. Santos
Gulf Coast Research and Education Center, IFAS, University of Florida, Wimauma, FL 33598

Florida is the major producer for winter strawberries. Production fields are surrounded by urbanization. Therefore, water use in agriculture is a major concern. The common practice during transplant establishment is the use of overhead sprinkler irrigation, which uses about 4500 m3/ha of water. Two studies were conducted to assess the effect of foliar and root-dip crop protectants as alternatives to reduce water volumes used during transplant establishment. For the first study, treatments were as follows: a) 10 days of sprinkler irrigation (DSI) as a control; b) 7 DSI alone; c) Kaolin clay at 28 kg/ha; d) Aluminum silicate at 11.2 kg/ha; and e) Calcium carbonate at 28 L/ha. Crop protectants were applied on the plant canopy after 7 DSI. The highest early marketable fruit weight and number were observed in plots with 10 DSI and 7 DSI plus foliar applications, averaging 14.8 t/ha and 558,220 fruit/ha. Using 7 DSI alone affected negatively early marketable fruit weight and number reducing yields to 11.6 t/ha and 464,187 fruit/ha, which were the lowest. For the second study, a water absorbent polymer and a biofungicide root-dip crop protectants were compared to 7 and 10 DSI. Crop protectants were applied at the moment of transplanting at the rate of 10 and 3.5 g/L of water, respectively. Sprinkler irrigation was turned on immediately after transplant for 7 days. The highest early marketable fruit weight was reported in plots treated with either 10 DSI or 7 DSI plus the root-dipped application, averaging 10.6 t/ha. Using 7 DSI alone decreased early marketable fruit weight to 8.9 t/ha, which was the lowest fruit weight value. Crop protectants are a suitable alternative to reduce the water usage during strawberry transplant establishment.

**Developing Technologies for Florida-produced Strawberry Plug Transplants**

Emmanuel A. Torres-Quezada* and Bielinski M. Santos
University of Florida, IFAS, Gulf Coast Research and Education Center 14625 CR 672 Wimauma, FL 33598

Most of the strawberry (*Fragaria xanassa*) production in Florida is planted with bare-root transplants, which is relatively inexpensive and provide high fruit yield. Due to the nature of bare-root production and the environmental conditions of Florida, high water volumes are needed for plant establishment. Approximately 600,000 gal/acre of water with 97% losses are utilized by growers during the first 10 days after planting. Plugs (containerized) transplants can be established with no overhead watering, being an alternative to traditional bare-root transplants. However, plug transplants used in Florida are imported from northern latitudes and cost twice as much as bare-root transplants. This project was conducted to evaluate the feasibility of producing strawberry plug transplants in Florida conditions. ‘Strawberry Festival’ plugs were produced in high tunnel conditions. Treatments consisted of: a) 4-week-old plug transplants; b) 4-week-old plug transplants dipped into indole-3-butyric acid (IBA at 0.10% v/v); c) 6-week-old plug transplants; d) 6-week-old plug transplants dipped into IBA; and e) bare-root transplants. Results showed no difference between bare-root transplants and Florida-produced 6-week-old plug transplants for total fruit weight. Results demonstrated that Florida growers could use locally-produced strawberry plugs, without affecting yield while reducing production costs and water usage.

**Determination of the Efficiency of a Mechanical Harvesting-aid Machine for Pepper Production**

Carlos A. Zambrano-Vaca*, Carlos J. Mendez-Urbaez, and Bielinski M. Santos
University of Florida, IFAS, Gulf Coast Research and Education Center 14625 CR 672 Wimauma, FL 33598

Bell pepper (*Capsicum annuum* L.) is one of the main vegetable crops in Florida. During 2012 about 18,000 acres were harvested, contributing $207 million to the state’s economy. One of the main concerns about Florida agriculture sustainability is high labor cost and availability for hand-harvesting vegetable and fruit crops. Alternatives to improve efficiency of hand labor harvesting are highly needed. One option to improve efficiency is a conveyor belt-based, self-propelled machine, which has a scope covering twelve beds on 1.52-m centers. A field study was conducted to determine the efficiency of a mechanical harvesting-aid machine compared to regular hand-harvesting for bell pepper production. Two treatments were evaluated: a) mechanical harvesting-aid machine and b) regular hand harvesting. Four harvests were made from November to December 2012, using a 10-person crew. The results showed that the harvesting efficiency of bell pepper increased by 38% using the machinery compared to regular hand harvesting. One hectare requires 9 hours 53 minutes
Genotypic and Environmental Variation for Total Soluble Solids and β-carotene Concentrations in Orange Fleshed Melons (Cucumis melo L.)

Sat Pal Sharma1*, Daniel Leskovar1, Kevin Crosby2, Amir Ibrahim3, and Astrid Volder2
1Texas A&M AgriLife Research, Texas A&M University System, Uvalde, TX 78801; 2Dept. of Horticultural Sciences, Texas A&M University, College Station, TX 77843; 3Dept. of Soil and Crop Sciences, Texas A&M University, College Station, TX 77843

Melon (Cucumis melo L.) fruit quality is very sensitive to environmental variations, thus understanding the nature and magnitude of genotype by environment (GxE) interactions for quality traits is very critical. Multi-environment melon trials were conducted to determine the stability of fruit quality traits.

Nine genotypes including four commercial hybrids were tested at three Texas locations (College Station, Uvalde and Weslaco) in three years (2010, 2011 and 2012). Fruit quality traits, total soluble solids (TSS), β-carotene and fruit firmness were recorded.

Data was subjected to the combined analysis of variance and trait stability by GGE bi-plot. Year, location, and genotype had significant effects on TSS and firmness, while β-carotene was significantly affected by year and genotype. Year x location interactions were significant for all the three quality traits; however, year x genotype interactions were significant only for TSS and β-carotene. Year x location x genotype interactions significantly affected β-carotene. Biplot analysis indicated that ‘Oro Duro’ was the highest mean performing genotype for TSS. The hybrid ‘Oro Duro’ ranked highest for the mean and stability of β-carotene but, it ranked lowest for fruit firmness.

Among the open pollinated breeding lines, TAMU 146 ranked second after ‘Oro Duro’ for β-carotene and also had higher stability of β-carotene but, it ranked lowest for fruit firmness. The hybrid ‘Oro Duro’ ranked highest for the mean and stability of β-carotene but, it ranked lowest for fruit firmness.

High Tunnel Cultivar Trials: Yield and Potential Returns for Three Spring Crops

William B. Evans*, S. Reynolds, and A. McCain
Mississippi Agriculture and Forestry Experiment Station
Truck Crops Branch, P.O. Box 231, Crystal Springs, MS 39059-0231

Growers in Mississippi have asked for crop and cultivar selection information for high tunnel production. As part of an effort to meet this need, a set of three spring cultivar trials was conducted at Crystal Springs in 2013. Seven or eight cultivars each of carrot (Daucus carota), lettuce (Lactuca sativa), and Asian greens (Brassica sp.) were tested for yield and potential economic return in amended raised beds with drip irrigation and published fertilizer recommendations based on crop and available soil nutrients. Greens tested included napa cabbage, pac choi, and mizuna. Lettuces included red and green romaine, leaf and butter head types. Carrots were direct sown at 15 seeds/ft., lettuce was transplanted in triple rows on 5 inch centers, greens in twin rows on 7 inch centers. Baby greens and lettuces were harvested at 21–28 DAT by taking every other plant in the plot. Fully mature plants were taken later as they matured, from 40 to 72 DAT. No differences in “baby”, mature, or total yield was seen among the crops tested. Mature lettuce yields differed, with ‘Magenta’, ‘Green Star’, and ‘Ridgeline’ making up the top performing group, and ‘Razes’, ‘Freckles’, and ‘Breen’ making up the lesser yielding group, with significant statistical overlap among performance groupings. All carrots yields were similar. Economic analysis of the yields indicated that carrots produced the least return per square foot and square foot per day, lettuce the most. Economics of the baby/mature system used here will depend on markets and grower choice.

Determination of Culturable Endophytic Bacteria Isolated from Field-grown Bell Pepper (Capsicum annuum L.) on Affecting Plant Growth by Measuring Physiological Indices

Zheng Wang1* and Timothy Coolong2
1N322-E Agricultural Science Building, Dept. of Horticulture, University of Kentucky, Lexington, KY 40546; 2Dept. of Horticulture, Tifton Campus, University of Georgia, Tifton, GA 31993

A total of 160 endophytic bacteria isolates were isolated from fruits, leaves, stems, and roots of seed surface-disinfected bell pepper plants which were grown under organic and conventional production systems applied with well-watered and drought stress treatments in 2011 and 2012. The BLAST results of 16S rRNA gene categorized these isolates (67 for 2011 and 93 for 2012) into 57 species and 3 phyla, Firmicutes, Proteobacteria, and Actinobacteria. These isolates, when re-inoculated into pepper plants in greenhouse conditions, were analyzed by their effects on promoting plant growth and resisting against water deficiency through evaluating 6 physiological indices, plant growth rate, leaf water potential, total leaf area, leaf dry weight, root and stem dry biomass. The final results indicated that there were 7 isolates from 2011 trial and 6 from 2012 that might promote or maintain plant growth under water deficit condition; whereas, there were 8 isolates from 2011 trial and 10 from 2012 that indicated promoting plant growth under well-watered treatment with the criteria of at least 2 out of 6 indices showing significantly greater than controls. The results suggested that the species isolated from the 2-year study were highly diverse, as well as having diversity when compared with different growing systems and irrigation regimes. In addition, endophytic bacteria may not only serve as a plant growth promotion bacteria that existed inside plants with adequate irrigation, but could also exist in abiotic-stressed plants which may potentially modulate plant growth to cope with adverse environments.
National Sweetpotato Collaborator Group

Optimizing Sweetpotato Production for Fresh and Processing Markets through Plant Spacing and Planting–Harvest Time

Ramón A. Arancibia1,*, Cody D. Smith2, Don R. LaBonte2, Jeffrey L. Main1, Tara Smith1, and Arthur Villordon3

1Pontotoc Ridge-Flatwoods Branch Experiment Station, Mississippi State University, Pontotoc, MS 38863; 2School of Plant, Environmental, and Soil Sciences, Louisiana State University Agricultural Center, Baton Rouge, LA 70803; 3Sweetpotato Research Station, Louisiana State University Agricultural Center, Chase, LA 71324

Consumption of sweetpotato (Ipomoea batatas) has increased in the past decade in part due to its nutritional and health attributes, and to the availability and convenience of processed products. The sweetpotato processing industry is expanding and supplying more sweetpotato products than ever before. Unlike the medium size roots (U.S. no.1) preferred for fresh market, large (jumbo) roots is accepted and in certain cases desired by the processing industry, and overall yield is preferred over strict sizing requirements and aesthetic appeal. Therefore, this study investigated the plant spacing and extension of the growing period to improve the economic benefit of the production system. Experiments with ‘Beauregard’ and ‘Evangeline’ sweetpotato were conducted in Mississippi and Louisiana during 2010 and 2011. Treatments consisted of a combination of early and late planting date and delay in harvest, in-row plant spacing and row width. Marketable yield was consistently greater in early plantings than late plantings. Delaying harvest in early plantings contributed to increase jumbo size roots and marketable yield. The yield of U.S. no.1 grade was not affected by delaying harvest regardless of planting date. The economic assessment of delaying harvest in early plantings indicated a gain in net benefit either when hand harvested for fresh market or field run bulk harvested for processing. The economic assessment of changing plant density indicated no gain in net benefit which indicates that choice of plant density can depend on other factors.

Developing Sweetpotatoes for Adaptability to Ontario Climates

Valerio Primomo

Vineland Research and Innovation Centre, Vineland Station, Ontario, Canada LOR2EO

Sweetpotato (Ipomoea batatas) consumption in Canada has nearly doubled in the past five years (1.5 kg per person per year) and continues to increase due to its nutritional value and increasing popularity of sweetpotato fries. To meet this demand, in 2011 Canada imported 125 million tonnes from the USA with an estimated value of $54 million. There are approximately 1300 acres of sweetpotato es currently grown in Ontario, Canada with Covington accounting for most of the acreage. Covington is a long season variety that is not highly adapted to Ontario’s short growing season and cooler climate resulting in up to 40% culls by growers as well as risk of chilling injury as temperatures decrease from late September into October. An opportunity exists to increase sweetpotato production in Canada that will 1) offset imports from the United States, 2) increase the profitability of sweetpotato growers, and 3) provide consumers with locally produced sweetpotatoes. This can be achieved by breeding sweetpotatoes adapted to Ontario’s short season and cooler environments. In 2012, 500 seedlings from Louisiana State University (LSU) were planted in Vineland, Ontario and selected for shape, size, and yield potential. In 2013, 85 selections were planted on three different planting dates (May 1, May 15, and May 30) using three replicates and five plants per plot. An additional 900 new seedlings were planted in 2013 consisting of ten plants per line where 210 were selected for further evaluation. Agronomic and analytical data was collected for each plot. Fourteen selections that survived the May 1, 2013, planting date suggested that they were tolerant to cooler temperatures. Preliminary data will be discussed which suggests that it should be possible to develop varieties that are better adapted to Ontario climates.

Testing the New Sweetpotato Cultivar L-06-52 (LSU52) in California

C. Scott Stoddard1,2* and Don R. LaBonte2

1UC Cooperative Extension, 2145 Wardrobe Ave, Merced, CA, 95310; 2School of Plant, Environmental, and Soil Sciences, LSU Agricultural Center, Baton Rouge, LA, 70803

In 2008, experimental sweetpotato cultivar L-06-52 from LSU was introduced in the California Advanced Line Trial (ALT) for field testing. The main purpose of the ALT is to evaluate new sweetpotato breeding lines that for various reasons have limited potential use in the Southeast United States, but may have a fit in the California market. The results from the first year with a small (~25 plants) non-replicated field trial were very favorable, with many attractive, well-shaped roots with orange skin and flesh. Roots were saved and evaluated again in 2009–10 with similar results. From 2011–13, L-06-52 was evaluated in numerous (10) replicated and non-replicated trials conducted in commercial fields around Livingston, CA. These trials were established to evaluate seed age, plant spacing, response to irrigation amount, and growth relative to the commercial standard cultivars Beauregard (Bx, LSU 1987) and Covington (NCSU 1998). Planting dates were from mid-May to early June, plant spacing varied from 9–18”, and all trials were drip irrigated. L-06-52 has deep purple foliage and produces attractive elliptic to ovoid shaped roots with orange skin color and uniform orange flesh with little to no yellow cortical ring. The skin color is less rosy than either Bx or Covington. Skin texture is very smooth, and the roots typically have very shallow eyes with no lenticels. Total yield potential is superior to Bx and Covington, though mainly because of jumbo root production. Averaged across all years and locations, total marketable yield was 1007 boxes per acre (range 268 to 1984), with 43% in the economically important #1 category (range 22% to 60%). By comparison, Bx and Covington had 822 and 844 boxes, 46% and 52%, for yield and #1’s, respectively. Cull production has
been similar to Covington, 7.0%, and far less than Bx (17%). The propensity to produce jumbo-sized roots was reduced by increasing the plant density by planting at 9”–10”. L-06-52 appears to be tolerant to feathery mottle virus complex, as the roots have shown no symptoms of Russet Crack and comparisons to virus-tested plants have not given significant yield differences. Long-term storage characteristics have been very favorable, but plant production in the hotbeds was poor—40% less than Bx. Though more work needs to be done, results to date suggest good potential for this cultivar for the California market, most likely as a replacement for Bx. Commercial release and patent protection will be sought.

**Root Architecture and Nitrate Signaling in Sweetpotato Storage Root Formation: A Conceptual Model and Preliminary Testing**

Arthur Villordon1* and Nurit Firon2

1Louisiana State University Agricultural Center
Sweetpotato Research Station, Chase, LA 71324;
2Institute of Plant Sciences, The Volcani Center,
Agricultural Research Organization, P.O. Box 6, Bet Dagan, 50250, Israel

We have developed a conceptual model for sweetpotato storage root formation that incorporates root system architecture as an integrator of internal cues and external signals during storage root formation. This model incorporates recent findings that the concentration and form of nitrogen in the growth substrate determines the extent of root architecture development and that storage root formation occurs only in competent adventitious roots that have undergone cortical tissue rearrangement through successful lateral root emergence and development. This conceptual model helps to explain how the sweetpotato plant modulates storage root formation among adventitious roots and directly addresses the question of how differential root carbon sink strength is determined within the root system. This model can be used as the basis for follow up work in further elucidating the intrinsic mechanism of storage root formation in sweetpotato, especially looking at the interaction of nitrate with signaling components associated with cambium formation, a necessary step in storage root formation.

**Evidence of Ammonium Sensitivity Response During the Storage Root Formation Period in ‘Georgia Jet’ Sweetpotato Grown in Israel**

Arthur Villordon1* and Nurit Firon2

1Louisiana State University Agricultural Center
Sweetpotato Research Station, Chase, LA 71324;
2Institute of Plant Sciences, The Volcani Center,
Agricultural Research Organization, P.O. Box 6, Bet Dagan, 50250, Israel

In an attempt to validate the influence of nitrogen rate on root architecture development in ‘Georgia Jet’ grown in Israel, it was determined in a preliminary experiment that nitrogen supplied as urea significantly reduced storage root formation. Based in part on findings about ammonium sensitivity in other crop species, it was hypothesized that the ammonium form of nitrogen interfered with storage root formation in a genotype-specific manner. Subsequently, experiments were conducted to investigate the influence of three common nitrogen fertilizers, i.e., urea, ammonium nitrate, and potassium nitrate, on storage root formation. Under the experimental conditions used in this study, plants supplied with potassium nitrate consistently showed evidence for root swelling at 30 days whereas plants supplied with an ammonium-containing fertilizer failed to show evidence for storage root formation. Follow up work with some varieties grown in the United States reveal that ‘Evangeline’ showed similar patterns of response to the presence of ammonium in a fertilizer source. These results represent the first report of genotype-specific ammonium sensitivity during the critical storage root formation stage in sweetpotato. The evidence also supports the possible role of nitrate signaling in storage root formation. These results have important implications for crop management and improvement.

**Insecticide Evaluations for Management of Sugarcane Beetle in Sweetpotato in Louisiana and Mississippi**

T.P. Smith1*, J. Beuzelin2, L. Adams3, R. Luttrell3, and T.F. Arnold1

1LSU Agricultural Center Sweetpotato Research Station, Chase, LA 71324; 2LSU Agricultural Center Dean Lee Research Station, Alexandria, LA; 3USDA: SIMRU, Stoneville, MS 38776

The sugarcane beetle, (**Eutheola humilis rugiceps** Burmeister) is a significant insect pest affecting sweetpotato in Louisiana. Adult sugarcane beetles feed on sweetpotato roots late during the production season. Sugarcane beetle feeding damage compromises the aesthetic quality of sweetpotato roots, often leaving them unsuitable for market. Producers currently rely on traditional labeled soil insecticides and planting date recommendations to manage this insect in commercial fields. More information is needed on monitoring techniques and chemical control options for this insect. Several insecticides currently labeled for use on sweetpotato in Louisiana and Mississippi were evaluated in 2011–13 in field trials and cage studies for their efficacy against sugarcane beetle. Cage studies were conducted in 2011 and 2013 at the USDA: Southern Insect Management Research Unit in Stoneville, MS. In these trials, sweetpotatoes were planted in screened cages and individual treatments were infested with sugarcane beetles prior to harvest (1 beetle/plant). Treatments were arranged in a RCB design and replicated four times in all trials. Preplant and layby insecticides were applied as a band along the row center to the 2 center rows. Foliar insecticide applications were applied weekly to select treatments. At harvest, roots from the two center rows of each plot were harvested and 25 roots per plot were chosen at random and evaluated for insect damage after washing. A separate cage study was conducted at Chase, LA in 2013. In this study, three replicate pipes (12 inches by 15 inches) were placed around individual sweetpotato plants following insecticide applications. Four sugarcane beetles were placed in each pipe and the pipes were secured with econet and a rubberband. Damage ratings were conducted 2 weeks following infestation. In 2011, 2012 and 2013 field trials, sugarcane
beetle damage ranged from 0% to 40%, 12% to 57% and 0% to 5%, respectively. Sugarcane beetle damage ranged from 1% to 33% and 0% to 17%, respectively, in the 2011 and 2013 Ston- eville, MS cage studies. In the 2013 Chase, LA cage study, no differences in sugarcane beetle damage were detected for any insecticide treatment evaluated, but the Lorsban 4E treatment did result in significantly higher beetle mortality.

**Influence of Variety and Days to Harvest on Sweetpotato Weevil Damage in the Virgin Islands**

Thomas W. Zimmerman*, Stafford M.A. Crossman, and Carlos Montilla
Agricultural Experiment Station, University of the Virgin Islands, Kingshill, St. Croix, VI, 00850

Sweetpotato weevil is the most serious pest of sweetpotato, not only in the Virgin Islands but throughout the Caribbean. It causes damage in the field to leaves, stems and most importantly the tuberous roots. The objective was to evaluate harvest date and weevil damage in 18 sweetpotato varieties. Twelve sweetpotato varieties were from in vitro virus-free material and six were Caribbean farmer varieties. The varieties were established from six node cuttings in a replicated trial at one foot in-row spacing and five feet between rows. Weevil traps with a male pheromone were distributed throughout sweetpotato plantings and monitored weekly. Harvest was conducted at 100 and 130 days. Weevils were found to increase during the initial four weeks and stabilized during the rest of the growing season. Through the course of the trial, nearly 2,000 male weevils were captured and destroyed. These numbers however indicate that sweetpotato weevils were at a high pressure throughout the growing period. All varieties had weevil damage at 100 days (4% to 15%), however by 130 days the weevil damage ranged from 4% to 75%. Overall, marketable production was reduced, due to weevil damage, the longer the sweetpotato remains in the field after 100 days.

**Weed Management with and Sweetpotato Tolerance to Fluridone**

Stephen L. Meyers* and Katie M. Jennings

1Pontotoc Ridge–Flatwoods Branch Experiment Station, Mississippi State University, Pontotoc, MS 38863; 2Dept. of Horticultural Science, North Carolina State University, Raleigh, NC 27695

Field studies were conducted at the Pontotoc Ridge–Flatwoods Branch Experiment Station in Pontotoc, MS, and the Horticultural Crops Research Station in Clinton, NC, to determine weed control and sweetpotato crop response to fluridone. At both locations fluridone was applied alone pretransplant at 0.2, 0.3, and 0.4 lb a.i./a and in tank-mixtures of 0.2 lb a.i./a fluridone plus either 0.6 or 1.5 oz a.i./a flumioxazin and 0.1 lb a.i./a fluridone plus 1.5 oz a.i./a flumioxazin. At Clinton, herbicide programs containing pre- and post-transplant herbicide applications were included and consisted of 1.5 oz a.i./a flumioxazin pre-transplant alone or followed by (fb) 0.2 lb a.i./a fluridone or 0.7 lb a.i./a S-metolachlor at 0, 2, or 4 WAP or a tank-mix of fluridone plus S-metolachlor 0 or 2 WAP. Additional programs consisted of no pre-transplant herbicide application fb 0.2 lb a.i./a fluridone or 0.7 lb a.i./a S-metolachlor at 0, 2, or 4 WAP. Hand-weeded and weed-free check plots were included for comparison. Experiment design was a randomized complete block with four replications. Plot size at Pontotoc was four rows on 40” centers and 30 ft. long. All rows were treated and rated for weed control and injury. The second (Beauregard) and third (Orleans) rows were harvested. At Clinton plots were two rows on 42” centers and 20 ft. long. The second row (Covington) of each plot was treated, rated, and harvested. Planting and harvest dates were July 18 and October 24, respectively at Pontotoc and July 16 and October 14, respectively at Clinton. Pre-transplant fluridone applications resulted in <6% transient interveinal chlorosis at both locations. Posttransplant applied fluridone resulted in up to 30% injury at Clinton. Redroot pigweed control at Pontotoc ranged from 95% to 100% at 2 WAP, and control decreased at 4 WAP (81...
to 96%) and 8 WAP (61 to 90%). Tank mixtures containing 1.5 oz/a flumioxazin and 0.4 lb/a fluridone alone resulted in the greatest season-long redroot pigweed control (88% to 95%). At Clinton, Palmer amaranth control was > 90% from fluridone applied pre-transplant, 0 WAP, or 2 WAP. S-metolachlor and fluridone applied alone 4 WAP resulted in only 25% control of Palmer amaranth. At Pontotoc, all fluridone treatments resulted in No. 1 and marketable yields equal to the hand-weeded check and greater than the weedy check. At Clinton, yields for No. 1 and marketable sweetpotato of all treatments were similar to both the hand-weeded and weed-free checks.

From Research Stations to Commercial Fields: Survey, Detection and Identification of Sweetpotato Viruses in North Carolina

Christie V. Almeyda1, Lydia C. Neal1, Tamara Abernethy1, Jorge A. Abad2, and Zvezdana Pesic-VanEsbroeck1*

1Dept. of Plant Pathology, North Carolina State University, Raleigh, NC27695; 2USDA, APHIS PPQ FO PGQP, Beltsville, MD20705

Limited information on the status of sweetpotato viruses in North Carolina led us to conduct field surveys in research stations and commercial fields using biological, serological and molecular detection methods. Experiments were carried out at research stations in 2012 and at commercial fields in 2013 growing seasons. Susceptible indicator plants (Ipomoea setosa) were evenly distributed in sweetpotato experimental plots at two research stations in North Carolina. Naturally infected indicator plants (n = 129) showing virus-like symptoms were collected and tested for the presence of viruses by NCM-ELISA, multiplex PCR, multiplex and quantitative RT-PCR. Single and mixed viral infections were found in 34% and 66% of the samples, respectively; with potyviruses mixed infections being the most common. Sweetpotato feathery mottle virus (SPFMV) was the most frequent followed by Sweetpotato virus G (SPVg), Sweetpotato virus C (SPVC), Sweetpotato leaf curl virus (SPLCV), Sweetpotato chlorotic stunt virus (SPCSV) and Sweetpotato virus 2 (SPV2). Additionally, naturally infected sweetpotato samples (n = 122) were collected in the same experimental plots and they were virus tested using the same procedures. Results showed a similar trend of viral infections as in indicator plants. The same experimental layout for indicator plants was repeated in 2013 at two commercial fields. Most of the indicator plants (n = 135) were symptomless and virus testing data showed potyvirus infections ranging from 0.7% to 13%. Sweetpotato samples (n = 330) were collected from fifteen commercial fields based on viral symptoms. Virus testing results demonstrated that mixed potyvirus infections were predominant and no presence of SPLCV was observed. Testing for SPCSV is underway. This study showed evidence of the wide occurrence of potyviruses affecting sweetpotatoes in North Carolina in research stations and commercial fields. The incidence of the begomovirus SPLCV seems to be cyclical depending on whitefly populations. Detection methods used in this study demonstrated the applicability of standardized protocols to investigate virus infection in sweetpotato production areas.

Application of Biochar to Reduce Skinning in Sweetpotato

B.H. Hayes1, J.K. Ward1*, J.W. Lowe1, J.D. Davis1, M.W. Shankle2, and R.A. Arancibia2

1Agicultural and Biological Engineering, Mississippi State University, Mississippi State, MS 39762; 2Pontotoc Ridge–Flatwoods Branch Experiment Station, North Mississippi Research and Extension Center, Mississippi State University, Pontotoc, MS 38863

Biochar (charcoal produced by pyrolysis of biomass feedstock) has been shown, in pot and small scale studies, to improve soil physical properties. Sweetpotato skinning instances occur from not only machine interaction at harvest and handling but from the soil in which the roots are harvested. Soil clods and soils abrasive in texture cause damage to tender fresh harvested storage roots. The objectives of this study were to assess the influence of biochar as an amendment to improve soil characteristics and to assess its effects on sweetpotatoes over two years. Biochar was applied at rates of 2.2, 4.4, 6.6, and 8.8 t/acre, in combination with organic (poultry litter) or inorganic fertilizers. Plots were sampled for soil bulk density and percent organic matter. Yield, grade, and sweetpotato skin strength were also measured. Organic matter increased, but the soil bulk density did not improve due to the effects of tillage. The addition of biochar did not influence yield or grade, but did result in mixed effects on skin strength.

Measuring Resistance to Skin Shear and Tensile Fracture in Sweetpotato Storage Roots

Ramón A. Arancibia*, Xiang Wang, Nestor Bonilla, Jeffrey L. Main, and Lori B. Grelen

Pontotoc Ridge–Flatwoods Branch Experiment Station, Mississippi State University, Pontotoc, MS 38863

Skinning or surface abrasion of sweetpotato at harvest causes a substantial loss of marketable storage roots due to rots, loss of moisture and simply to unattractive marketable appearance. The storage root periderm is composed of three layers: phellem (skin), phellogen (meristematic cell layer) and phelloderm (inner cell layers). Two instruments and methods to measure the force required to breaking the phellem across (tensile fracture) and to separate the phellem along the phellogen (shear fracture) were evaluated. The instruments were a digital force gauge (DS2-11; Imada Inc., Northbrook, IL) with a slanted bar 4 mm wide and the Halderson shear tester attached to an analog torque meter (TQSO50FUA, Snap-On Tools, Kenosha, WI). Both instruments were suitable to measure shear force directly and the combined tensile and shear forces required to fracture and peel the skin off when measured with the force gauge and the torque meter, respectively. The force gauge with a clamp attachment was also suitable to measure tensile force directly by pulling and was estimated to be 27% of the total force. Differentiating the forces required for skin shear and tensile fractures will assist in breeding for tougher skin as well
as to develop effective preharvest treatments to improve skin set and reduce skinning at harvest.

**Physiological Responses to Preharvest Conditioning Associated with Skinning Resistance in Sweetpotato**

Xiang Wang*, Jeffrey L. Main, Lori B. Grelen, and Ramón A. Arancibia
Pontotoc Ridge-Flatwoods Branch Experiment Station, Mississippi State University, Pontotoc, MS 38863

Preharvest conditioning, namely devining and ethephon foliar applications have been reported to reduce sweetpotato skinning at harvest. Skinning or surface abrasion causes a substantial loss of marketable storage roots due to rots, loss of moisture and simply to unattractive marketable appearance. We previously reported that preharvest conditioning increases the force required to fracture and peel the skin, maintain or reduces skin phenolic content, and increases skin lignification/suberization suggesting changes in the phenylpropanoid pathway. In this study, changes in the activity of phenylalanine ammonia lyase (PAL), peroxidase (POD), and polyphenol oxidase (PPO) in response to preharvest conditioning were investigated to associate them with chemical changes in the skin. There were no changes detected in skin PAL activity suggesting that conditioning does not influence the initial step in the phenylpropanoid pathway. Although changes in skin POD activity were not detected, cortex POD increased significantly with ethephon application. Skin PPO also increased with devining and ethephon application. These results as well as the reduction in skin phenolics and increase in skin lignin/suberin suggest that ethephon induced stress influences the last step of lignin/suberin synthesis.

**Rhizopus Soft Rot: Can We Ever Get Away from Prophylactic Use of Fungicides to Control This Disease?**

Christopher A. Clark*, David H. Picha, and Rebecca R. Sweany
Dept. of Plant Pathology and Crop Physiology, Louisiana State University Agricultural Center, Baton Rouge, LA 70803

Rhizopus soft rot, caused primarily by *Rhizopus stolonifer*, can result in significant loss of sweetpotatoes after storage, washing, and packing. Prophylactic use of fungicides has been relied on for soft rot prevention since the mid-1960’s. Interest in finding alternative control procedures began in the early 1990’s, when the continued availability of diconlar (Botran) was uncertain. This interest intensified with increasing interest in reducing pesticide use and exposure. While prophylactic application of fungicides has been a very effective and easy to use control method, finding effective alternatives for reducing the incidence of soft rot has proved daunting. Chemicals categorized as “generally recognized as safe (GRAS)” are available, but have been ineffective in controlled trials. Available biologicals provide some reduction in soft rot incidence, but the level of control is less compared to diconlar or fludioxonil (Scholar). There are levels of resistance to *R. stolonifer* in the available sweetpotato germplasm that might allow reliance on resistance as the primary control strategy. However, development of resistant cultivars is hampered by the strong effects on expression of resistance by environment, both pre- and postharvest and the wound treatment used in screening. Efficient screening for resistance is further complicated by the number of storage roots required to reliably screen for resistance. Hot water treatments have provided some soft rot reduction, and when combined with subsequent treatment with biologicals the effect may be enhanced. However, in some tests hot water treatments increased soft rot incidence. Many factors have been correlated with *Rhizopus* soft rot resistance in sweetpotato storage roots, including skin color, phenolic content, sugar content, and various edaphic and cultural practices. The efforts to develop alternative controls for *Rhizopus* soft rot will be reviewed and possible future courses of action will be discussed.

**Effect of Oil Temperature and Frying Time on Sugar Composition in French Fry Style Sweetpotatoes**

David H. Picha* and Mary S. Bowen
School of Plant, Environmental and Soil Sciences, Louisiana State University Agricultural Center, Baton Rouge, LA 70803

Individual sugar content was determined in French fry style sweetpotatoes of four cultivars after frying in canola oil at two different temperatures (149 °C and 182 °C) and three different durations (120, 165, and 210 seconds). Sucrose was the dominant sugar in the French fries of all cultivars, followed by glucose, maltose, and fructose. All sugars, except maltose, increased in concentration with increasing frying time and temperature. Significant increases in French fry darkening also occurred with increasing oil temperature and longer frying durations. French fry darkening was correlated to reducing sugar content, with the lighter-colored Evangeline fries containing the lowest amount of reducing sugars. Among cultivars, French fries from Evangeline and 07-146 contained the highest amounts of sucrose (10% to 12%) and total sugar content (12% to 17%). French fries from Beauregard and Orleans contained between 4% to 5.5% sucrose and 9% to 11% total sugar. Reducing sugars (glucose, maltose, fructose) comprised approximately half of the total sugar content in the French fries of all cultivars, followed by glucose, maltose, and fructose. All sugars, except maltose, increased in concentration with increasing frying time and temperature. Significant increases in French fry darkening also occurred with increasing oil temperature and longer frying durations. French fry darkening was correlated to reducing sugar content, with the lighter-colored Evangeline fries containing the lowest amount of reducing sugars. Among cultivars, French fries from Evangeline and 07-146 contained the highest amounts of sucrose (10% to 12%) and total sugar content (12% to 17%). French fries from Beauregard and Orleans contained between 4% to 5.5% sucrose and 9% to 11% total sugar. Reducing sugars (glucose, maltose, fructose) comprised approximately half of the total sugar content in the French fries of all cultivars, followed by glucose, maltose, and fructose. All sugars, except maltose, increased in concentration with increasing frying time and temperature. Significant increases in French fry darkening also occurred with increasing oil temperature and longer frying durations. French fry darkening was correlated to reducing sugar content, with the lighter-colored Evangeline fries containing the lowest amount of reducing sugars. Among cultivars, French fries from Evangeline and 07-146 contained the highest amounts of sucrose (10% to 12%) and total sugar content (12% to 17%). French fries from Beauregard and Orleans contained between 4% to 5.5% sucrose and 9% to 11% total sugar. Reducing sugars (glucose, maltose, fructose) comprised approximately half of the total sugar content in the French fries of all cultivars, followed by glucose, maltose, and fructose. All sugars, except maltose, increased in concentration with increasing frying time and temperature. Significant increases in French fry darkening also occurred with increasing oil temperature and longer frying durations. French fry darkening was correlated to reducing sugar content, with the lighter-colored Evangeline fries containing the lowest amount of reducing sugars. Among cultivars, French fries from Evangeline and 07-146 contained the highest amounts of sucrose (10% to 12%) and total sugar content (12% to 17%). French fries from Beauregard and Orleans contained between 4% to 5.5% sucrose and 9% to 11% total sugar. Reducing sugars (glucose, maltose, fructose) comprised approximately half of the total sugar content in the French fries of all cultivars, followed by glucose, maltose, and fructose. All sugars, except maltose, increased in concentration with increasing frying time and temperature. Significant increases in French fry darkening also occurred with increasing oil temperature and longer frying durations. French fry darkening was correlated to reducing sugar content, with the lighter-colored Evangeline fries containing the lowest amount of reducing sugars. Among cultivars, French fries from Evangeline and 07-146 contained the highest amounts of sucrose (10% to 12%) and total sugar content (12% to 17%). French fries from Beauregard and Orleans contained between 4% to 5.5% sucrose and 9% to 11% total sugar. Reducing sugars (glucose, maltose, fructose) comprised approximately half of the total sugar content in the French fries of all cultivars, followed by glucose, maltose, and fructose. All sugars, except maltose, increased in concentration with increasing frying time and temperature. Significant increases in French fry darkening also occurred with increasing oil temperature and longer frying durations.

**Reduction of Acrylamide Formation in Sweetpotato French Fries by Common Processing Treatments**

V.D. Truong1*, Y.T. Pascua1, R. Reynolds1, R.L. Thompson1, T.K. Palazoğlu2, B.A. Mogol3, and V. Gökmen4

**HortScience 49(9) (Supplement)—2014 SR—ASHS Annual Meeting—January 31—February 2014**

S47
Our previous studies demonstrated that sweetpotato French fries (SPFF) with consistent quality can be produced year round from sweetpotatoes (SP) stored under appropriate conditions. However, aside from quality, acrylamide formation in SPFF could be a potential health concern, and limited information is available. We report hereto the application of processing treatments that have been commonly used in the food industry as acrylamide mitigation strategies in SPFF. Covington SP roots were peeled, cut into strips and subjected to a processing scheme including water blanching, soaking in 0.5% sodium acid pyrophosphate before par-frying for 1 min and finish-frying in canola oil at 165 °C. Samples were taken at each step for analyses on sugar profiles and asparagine by HPLC, and acrylamide by LC-MS. Acrylamide level in the par-frying samples was 4.5 μg/kg which linearly increased to 16.37, and 58 μg/kg in the final SPFF fried for 2, 3, and 5 min, respectively. These acrylamide levels were reduced by 85% from 124.9, 255.5, and 452.0 μg/kg, respectively in the untreated SP strips, the cut-fry procedure for the home cooked French fries. Leaching out of the acrylamide precursors, reducing sugars and asparagines, during blanching and soaking SP strips contributed to the acrylamide reduction in SPFF. Therefore, SPFF with acrylamide level of several times lower than that of regular white potato French fries can be obtained by integrating processing treatments commonly used in the food industry. Unlike potatoes, the total reducing sugar content in raw SP (18.5 m/g) was 25 times more than asparagine content (0.7 mg/g) suggesting that asparagine is likely a limiting factor in SPFF acrylamide formation.

Process for Pigmented Juice Extraction and Co-Product Recovery from Sweetpotatoes

An N. Truong1, Yiwen Thor1, Josip Simunovic1, Keith Harris1, and Van-Den Truong1,2,*

1Dept. of Food, Bioprocessing and Nutrition Sciences; 2USDA–ARS Food Science Research Unit, North Carolina State University, Raleigh, NC 27695

With high phytochemical and starch contents, sweetpotatoes (SP) are processed into various food products including beverages and natural colorants. For juice processing, SP are usually subjected to heat treatment for inactivation of pigment-degrading enzymes. However, heating gelatinizes starch and produces thick slurry with cooked flavor, which are drawbacks in SP juice processing. Development of alternative processes to overcome the stated problems in extracting pigmented juices from raw SP and recover starch and high fiber residue as co-products will be beneficial to SP processors. This study demonstrated that acidified water was effective in inhibiting polyphenol oxidase and peroxidase activities in raw purple-fleshed SP (PFSP, cv. Stokes Purple) during processing resulting in an attractive reddish juice. About 93% total phenolics (TP) and 83% total monomeric anthocyanins (TMA) in PFSP were extracted by the first and second extraction. The combined PFSP juice of the two extracts had high levels of TP (1.850 mg/L) and TMA (475 mg/L). With the developed process, 18 kg dried starch, and 6 kg dried high-fiber residue were obtained besides the highly pigmented-juice, for each 100 kg PFSP. High temperature short time (HTST) pasteurization of the PFSP juice samples (pH 3.2) at 80 °C for 12 seconds in an oil bath resulted in 15% loss in TMA and had no effect on TP. For the orange-fleshed SP (cv. Covington), acidified juice had all-trans-β-carotene content of 39 mg/L, which was not significantly affected by the HTST pasteurization (P ≥ 0.05). The results indicate an efficient process to produce pasteurized SP juice with high bioactive compounds and provide an alternative for the SP industry in producing natural colorants and functional beverages from SP with varying flesh colors.

Improving Sweetpotato Production Efficiency in Louisiana: Observations from On-Farm Validation Plots

T.F. Arnold*, T.P. Smith, and A.Q. Villordon

LSU Agricultural Center Sweetpotato Research Station, Chase, LA 71324

On-farm validation studies of a sweetpotato production model were conducted from 2010–12 on several sweetpotato farms throughout Louisiana. The validations studies were participatory in design, in that cooperating producers were involved with site selection and contributed to production and pest management decisions in each evaluation year. The goals of these studies were to validate the accuracy of the model and use the findings in assisting producers with making informed production decisions about the sweetpotato crop. In all cases, with the exception of the north Louisiana field in 2012, the predicted yield exceeded the actual yield realized, for total yield and U.S. No. 1 yield categories. Actual yields increased in each year for the north Louisiana location. The north Louisiana site did have irrigation capabilities and as such, soil moisture was maintained as close to an optimum level (15% to 20% VWC) as possible. Yields realized in the south Louisiana were reduced compared to the north Louisiana site. The south Louisiana location was not irrigated and yields were lower and more variable as a result. Producers, who participated as case studies on this project, are not only aware of the model based decisions concerning sweetpotato production, but they implemented these practices on their farms, made informed decisions and subsequently optimized results, thereby demonstrating that our research has impacted early adopters.

Environmental Factors on the Incidence of End Rot on Sweetpotato

Ratchanee Pattararavayo1*, Don R. LaBonte1, Tara Smith2, Arthur Villordon2 and Chris Clark3

1School of Plant, Environmental and Soil Sciences, LSU AgCenter; 2Sweetpotato Research Station, LSU AgCenter; 3Dept. of Plant Pathology and Crop Physiology, LSU AgCenter

Decay in storage represents a significant economic loss to producers. Ethylene treatments used to kill vines have been implicated as contributing to internal necrosis and the incidence
of endrots. However, endrots, which have a complex etiology occur in stored roots with no history of an ethylene harvest aid. The objective of this research is to evaluate the influence of flooding, harvest method (skinning), curing, and storage conditions on the incidence of endrots in storage roots. Beauregard was planted in a randomized complete block with three replications. Factorial combinations consisted of flooding/non-flooding; skinned/non-skinned; cured/non-cured; recommended storage (15.5 °C)/ambient (15.2 °C; 6.8 °C to 28.7 °C). Storage roots were in all possible combinations and were recorded every month for six months. The combination of non-flooding/skinned/non-cured/ambient storage and the combination of flooding/skinned/non-cured/ambient storage had the lowest percentage of weight loss (17%). Moreover, the treatments that consisted of non-cured and ambient storage had higher weight loss percentage than the treatments that consisted of cured and recommended storage. The highest incidence of endrots was found in the combination of flooding/skinned/non-cured/ambient storage and the combination of non-flooding/skinned/cured/recommended storage had the lowest percentage of weight loss (1%) compared with the lowest of endrots was found in the combination of flooding/skinned/non-cured/ambient storage. Curing and recommended storage were the most important factors in the study mitigating endrot.

Water-Soluble Vitamin Content in Different Sweetpotato Tissue Types
Wilmer A. Barrera* and David H. Picha
School of Plant, Environmental and Soil Science,
Louisiana State University, Baton Rouge, LA 70803
Sweetpotato is considered a good source of ascorbic acid (vitamin C) and certain B vitamins. These water-soluble vitamins (WSV) play essential roles in sustaining human health. Besides the root, sweetpotato vegetative tissues are also edible and considered high in nutritional value. Despite the availability of general reference values for sweetpotato WSV content in the root and leaves, little is known about the distribution of these vitamins in specific sweetpotato root and vegetative tissues. The objective of this study was to determine the ascorbic acid, thiamin (B1), riboflavin (B2), and vitamin B6 content in a wide range of edible sweetpotato tissues. Ascorbic acid content was highest in young leaves and lowest in old petioles. In root tissues, the ascorbic acid content was similar in the cortex, proximal, distal, and central pith; and lower in the skin. Thiamin content was highest in the cortex tissue. No thiamin was detected in foliar tissues. Old leaves contained the highest riboflavin and vitamin B6 content among all tissue types; whereas, the skin contained the highest riboflavin and the lowest vitamin B6 content among root tissues. The results of this study expanded the current knowledge of WSV content in edible sweetpotato tissues and confirmed earlier reports suggesting that sweetpotato leaves can be a good source of multiple WSV in the human diet.

Plant Establishment Considerations in Sweetpotato—Yield Response and Root Quality

Due to Various Transplant Sizes and Planting Depths
W. Bradford Thompson*, Jonathan R. Schultheis,
David Monks, and Katherine M. Jennings
Dept. of Horticultural Science, N.C. State University,
Raleigh, NC 27965
Transplant production and quality are key for North Carolina growers to continue to lead the nation in sweetpotato production and to produce high quality yields that support the demand for sweetpotatoes. The transplant component of production may be one of the most overlooked practices when growing sweetpotatoes. Growers do their best to ensure that only the best transplants are used for planting in the field. However, plants will often have size variability and can range from 3 inches to 12 inches in length. ‘Covington’, unlike ‘Beauregard’, produces plants where the growing point is often lower than the top of the foliage canopy in the plant bed. This growth habit makes it even more difficult for laborers to harvest plants that are consistent in length and quality that are best suited for planting. Having plants of varying size can lead to planting difficulties such as burying of the plant which could result in plant death, reduced yields, and root size variation due to lack of proper plant competition across a field. Weather conditions can also play a role in transplant survival. It is not uncommon in North Carolina to experience periods of drought throughout the growing season. Untimely drought conditions can be experienced during planting resulting in plant stand reduction, or during the season, which can inhibit storage root enlargement and result in reduced yields. Recent research that has been conducted over the past few years has shown that root yields, quality, and plant stand are impacted by transplant size and transplant planting depth. Efforts were focused on evaluating different size transplant categories that ranged from 3.0–4.5", 5.5–7.0", 8.0–9.0", and 9.5–12" in length and planted at two different depths of 2 inches and 6 inches beneath the soil surface. Consideration of transplant size and planting depth are important planting considerations and may play a critical role in how well plants tolerate and survive periods of moisture stress. Improved plant selection and proper planting depth could translate into improved yields, both under stress or under more favorable growing conditions.

The Short Term Impact of Fish Fertilizer on Sweetpotato [Ipomoea batatas (L.) Lam] Rhizosphere Microbial Communities in South Central Alabama
Lauren A. Lindsey*, Desmond G. Mortley,
Rambo O. Ankumah, and Raymon Shange
Dept. of Agricultural & Environmental Sciences, College Of Agriculture, Environment and Nutrition Sciences (CAENS), Tuskegee University, Tuskegee Institute, Al 36088 (llindsey4473@mytu.tuskegee.edu)
Agricultural practices impact many important properties of soil ecosystems. Organic farming has become an attractive alternative to conventional production but there is limited information on its impact on soil rhizosphere microbial community. Field experiments were conducted to evaluate the impact of NPK,
Effect of Organic and Inorganic Fertilizers on Yield and Biochemical Attributes of Sweetpotato (Ipomoea batatas L.) Varieties of Different Flesh Colors

M. Maksud Hossain*, ASM. H. Sorker, O. Njue, and S. Islam
Dept. of Agriculture, University of Arkansas at Pine Bluff, 1200 North University Drive, Pine Bluff, AR 71601

The yield stability and nutritional qualities of ten sweetpotato (Ipomoea batatas L.) varieties were studied at the agricultural research farm of University of Arkansas at Pine Bluff (UAPB). The varieties were Beauregard B14, Beauregard B63, Evangeline, Bonita, Stokes purple (purple color roots), Covington, Travis, O8-21P (purple color roots), Hernandez, and Porto Rico. The objective of this study was to evaluate the effect of different fertilizers on yield, nutritional quality and physiological functions of the varieties. The experiment was conducted on a split-plot design with three treatments, replicated 4 times. The treatments were organic fertilizers, inorganic fertilizers and control. Results revealed that ‘Travis’, which has reniform leaf-shape and purple vine base but with orange flesh color, produced the highest marketable yield (66.67 tons/ha) followed by ‘Porto Rico’ (50.36 tons/ha) of marketable tubers. ‘Evangeline’ produced the lowest marketable yield (26.23 tons/ha). The results showed that the organic fertilizer gave better marketable yield as compared to other treatments. Significant differences were found among the treatments in case of polyphenolics, antioxidant, and total soluble solids. Furthermore, the purple colored varieties exhibited significantly higher antioxidant activities and polyphenolic contents than orange and white varieties.

Development of an In-Vitro Screening Method for Development of Herbicide Tolerance in Sweetpotato (Ipomoea batatas (Lam) L.)

Michael F. Polozola*, Don R. LaBonte, and Niranjan Baisakh
School of Plant, Environmental, and Soil Sciences, Louisiana State University Agricultural Center, Baton Rouge, LA 70803

Sweetpotato is an important commodity to the Louisiana agriculture industry. Its importance is increasing with the development of value-added sweetpotato products and the growing demand of the world population seeking alternate food sources. Weed management is a problem in sweetpotato because of its prostrate growth habit, which poses hindrance to cultural methods, and limited choice of herbicides. Also, different cultivars vary in their sensitivity to the herbicide of choice and its dosage. The present research focuses on development of an in-vitro screening method to identify Louisiana sweetpotato cultivars that can tolerate concentration at or more than the field rate of application of Sandea. To this end, an optimal tissue culture system was developed for efficient callus induction and plant regeneration of three local sweetpotato cultivars, Beauregard, Orleans and 07-146. Out of several phytohormonal combinations tested, 0.05 mg/L 2, 4-D was found ideal for Beauregard and Orleans callus induction and 0.1 mg/L 2, 4-D for callus induction in 07-146. Orleans had the quickest response in terms of callus induction whereas 07-146 produced the most embryogenic callus. Callus tissues were selected and regenerated under various concentrations of halosulfuron methyl (active ingredient of Sandea). Promising results were obtained for 07-146 with several plantlets being produced that showed in vitro resistance to halosulfuron methyl. The results will be presented and discussed in detail.

Evaluating Skinning Resistance in Sweetpotato

Reeve Legendre1*, Ramón A. Arancibia2, Tara Smith3, and Don R. LaBonte1
1School of Plant, Environmental, and Soil Sciences, Louisiana State University Agricultural Center, Baton Rouge, LA 70803; 2Pontotoc Ridge-Flatwoods Branch Experiment Station, Mississippi State University, Pontotoc, MS 38863; 3Sweetpotato Research Station, Louisiana State University Agricultural Center, Chase, LA 71324

Sweetpotato (Ipomoea batatas) is experiencing burgeoning demand; however, high production costs continue to limit farmer income. More mechanized approaches to harvest are needed to save on labor expenses. Many of the popular varieties of sweetpotatoes are highly susceptible to skinning damage and the problems that are associated with such damage such as rotting and weight loss. A more durable skin would greatly facilitate transition to more mechanization. However, it is unknown if we can breed for a more durable skin. The objective of the present study is to develop a suitable assessment tool for skinning resistance and determine heritability. A modified torque wrench device used in potato was found superior to other techniques in measuring skinning resistance. The torque wrench was used in a 2-year study of multiple varieties of undamaged sweetpotato roots in order to analyze the amount of skinning resistance. Heritability is being estimated over two growing seasons and initial findings will be presented.
USDA–ARS, Southern Insect Management Research Unit Sweetpotato Demonstration Study 2012–13

Larry Adams1,*, Chris P. Johnson1, and Salliana R. Stetina2

1USDA–ARS, SIMRU, Stoneville, MS 38776; 2USDA–ARS, CGPRU, Stoneville, MS 38776

During the 2012–13 growing seasons USDA–ARS, Southern Insect Management Research Unit transplanted sweetpotato demonstration plots to illustrate the value in taking soil samples for nematode populations and applying a preplant incorporated insecticide to control soil insects attacking the developing sweet-potato roots. In 2012, three Mississippi Delta locations—Sanders Farm, Mound Bayou, MS, Alcorn State University Research Farm, Mound Bayou, MS, and Livingston Farm, Elizabeth, MS—were transplanted with ‘Beauregard 14’ slips in mid-May and in 2013, two Mississippi Delta locations—Sanders Farm, Mound Bayou, MS, and Alcorn State University Research Farm, Mound Bayou, MS—were transplanted with ‘Beauregard 14’ slips in late May. Treatments were applied approximately two weeks prior to transplanting and included Lorsban, K-Pam, Lorsban plus K-Pam, untreated control and a grower field. Soil samples were taken preplant, mid-season and preharvest during 2012 to determine nematode populations. In 2013 soil samples were taken preplant only due to very low populations of nematodes. Plots were harvested at ~115 days in 2012 and 135 days in 2013. Yield, quality and insect damage were recorded and analyzed. All locations in the study illustrated a total insect damage and yield response to the SIMRU managed K-Pam/ Lorsban and Lorsban treatments. Economic threshold levels of reniform nematode from seasonal soil samples were a factor only at the Stoneville location during the 2012 growing season. Weed control at all test locations appeared to be a factor that may have influenced insect populations and yield.

Effect of Prohexadione-Ca on Yield and Insect Damage to Sweetpotatoes

Tahir Rashid1,*, Victor Njiti1, Randy Luttrell2, and Larry Adams2

1Alcorn State University, Alcorn State, MS 39096; 2USDA–ARS, Stoneville, MS 38776.(trashid@alcorn.edu)

Four sweetpotato cultivars, Beauregard, Covington, O’Henry, and Puerto Rican were planted in a split plot, randomized complete-block design with 4 replications in ASU Extension/Research Demonstration Farm and Technology Transfer Center, Mound Bayou, MS. Prohexadione-Ca treatments (0 and 810 mg·L−1 a.i.) were the main plots and cultivars were the subplots. Each plot consisted of two rows. Preplant application of glyphosate (24 oz./acre) was made to burn down all weeds. Sweetpotato was transplanted to conventionally prepared raised beds at a rate of 10 plants per row, with 1.5 ft. between plants within the row and 3.5 ft. between rows. The control and treated plots were separated by 10 ft. buffer. Drip irrigation was used as needed until the plants were established. Post-transplant weed control was accomplished by hoeing and gas powered push til-lers. Prohexadione-Ca treatments were applied with a 5-gallon backpack sprayer at 810 mg·L−1 (140 g·ha−1 a.i.) mixed with 1 mL·L−1 of crop oil concentrate and 1 mL·L−1 urea ammonium nitrate. Plants were sprayed until run off. Control plots were sprayed with water mixed with 1 mL·L−1 of crop oil concentrate and 1 mL·L−1 urea ammonium nitrate. Treatments were applied twice during the season, 2 weeks and 6 weeks after transplanting. All treatment plots were harvested. Random sweetpotato samples were evaluated for insect damage. Overall insect damage to the roots differed significantly among different sweetpotato cultivars. Individual white grub damage and multiple insect-damage also significantly differed among different cultivars. ‘O’Henry’ had the least insect damage. Wireworm larval feeding damage was significantly higher in non-treated plots. Further experiments will determine if selection of a resistant sweetpotato variety and manipulation of the vegetative growth of sweetpotato plant can reduce the insect feeding damage.

Effect of Low Temperature Exposure on Water-Soluble Vitamin Content of Sweetpotato

Wilmer A. Barrera and David H. Picha

School of Plant, Environmental, and Soil Science, Louisiana State University Agricultural Center, Baton Rouge, LA 70803 (wbarre1@tigers.lsu.edu)

Sweetpotato is considered a good source of ascorbic acid (vitamin C) and certain B vitamins. These water-soluble vitamins (WSV) play essential roles in multiple metabolic reactions that sustain human health. Storage temperature abuses are common during postharvest handling of sweetpotato and may effect nutrient composition, including WSV contents. Although previous reports have indicated a negative effect of chilling injury on the ascorbic acid content of sweetpotato and other fruits and vegetables, no information is available on the relationship between low temperature exposure and other WSV contents in sweetpotato. The objective of this study was to determine the effect of short-term low temperature storage on ascorbic acid, thiamin, and riboflavin contents of sweetpotato root tissue. Low temperature exposure of sweetpotatoes to 1 °C and 6 °C for two or four weeks generally did not result in a significant change in ascorbic acid content. However, ascorbic acid generally decreased during a subsequent holding period for 1 week at 14 °C. Exposure to low temperatures and subsequently holding of the roots at 14 °C for 1 week did not result in a significant change in thiamin and riboflavin content.

Vegetable Crops Section—Watermelon

Pollination, Fruit Development, and Hollow Heart Disorder in Watermelon

Gordon C. Johnson* and Donald Seifrit

University of Delaware, Carvel REC, 16483 County Seat Highway, Georgetown, DE 19947

A framework for understanding factors affecting fruit set, fruit development, fruit retention, and fruit disorders in triploid...
watermelons was presented consisting of the following phases: 1) flowering of triploids and diploid pollenizers; 2) pollen production by diploid pollenizers; 3) pollen transfer; 4) pollen germination and pollen tube growth; 5) fertilization-like event; 6) hormone release; 7) cell division; 8) photosynthetic production and movement to developing fruits; and 9) cell expansion and fruit enlargement. Inadequate pollen, pollen viability reduction, or pollen germination reduction leads to fruit abortion. It was theorized that reduction in pollen that germinates and successfully produces pollen tubes will cause reduction in hormones released during the fertilization-like event and limit initial cell division leading to smaller fruits and hollow heart disorder. Lack of available photosynthates reduces fruit carrying capacity of plants. Experiments were conducted from 2011–13 where pollenizers were spaced at a 1:10 ratio with selected triploids. In 2011 there was increased hollow heart incidence (hhi) in triploid fruits starting 1.5 m from a pollenizer crown: at 1.5 m hhi was 12%; at 3.0 m, 28%. In a 2012 study, there was delayed fruit set and increased hhi with increasing distance from pollenizer plants. This relationship was linear in the cultivar ‘Liberty’ but not in the cultivar ‘SS7187’. In 2013, it was shown that under pollen limited conditions, less dense fleshed varieties (Liberty, SS7187) had 312% to 432% more hollow heart than more dense fleshed watermelon varieties (Crunchy Red and AC9651). Hand pollination studies in 2011 and 2013 showed reduced hhi with increased amounts of pollen. Pollen transfer studies showed that ~500 pollen grains are necessary for triploid watermelon fruit set but ~1000 pollen grains were necessary for full fruit size and reduced hhi. Growth regulator studies from 2011-2013 showed that auxin (2,4-D, IBA) and cytokinin (6BA, CPPU) applications improved early fruit set. The theory that pollination, hormone activity, and cell division in early watermelon fruit development determines hollow heart incidence and severity was presented.

Identification and Development of Multiple Disease Resistant (Phytophthora Fruit Rot and Powdery Mildew) Watermelon Germplasm

United States Dept. of Agriculture, Agricultural Research Service, (USDA–ARS), U.S. Vegetable Laboratory, 2700 Savannah Highway, Charleston, SC 29414

Phytophthora fruit rot (PFR) and powdery mildew (PM) on watermelon can be devastating under favorable conditions and significantly reduce fruit yield. In recent years these two diseases have become more common in southeastern United States. Based on previous literature we selected 35 watermelon plant introductions (PI) with varying levels of resistance to PM (Podosphaera xanthii, melon race 1 and 2). These PIs were evaluated for resistance to PM in the greenhouse from 2011–13. Because of variability in resistance to PM, highly resistant plants were selected each year to develop multiple disease resistant watermelon germplasm. Mature watermelon fruit from PM resistant lines were inoculated with a local isolate of Phytophthora capsici and evaluated for resistance to PFR in a humid chamber (> 96% RH, 26 ± 2 °C). The PI were also evaluated in the field (summer and fall 2012, 2013) against a PM melon race 1 (1W) strain prevalent in Charleston, SC. PI 269677 and Mickey Lee were used as PM and PFR susceptible checks. Mature fruit harvested from the field were also evaluated for PFR resistance. After three cycles of screening and selections we have developed several watermelon germplasm lines from PIs by pure line selection with uniform PM and/or PFR resistance (e.g. PI 560020, PI 189225, PI 186489, PI 532738). The PM resistance is expressed in hypocotyls, cotyledons and true leaves of young watermelon seedlings in the greenhouse and adult plants in the field. Some of the PIs were also resistant to anthracnose in two field evaluations. The PM and PFR resistant germplasm lines that are being developed may be used for developing resistant varieties and rootstocks for grafting watermelon.

Texas Statewide Watermelon Trials for 2013

Joseph G. Masabni*, Juan Anciso, Larry Stein, and Russell Wallace
Dept. of Horticultural Sciences, Texas A&M University–College Station, Weslaco, Uvalde, and Lubbock
(jmasabni@ag.tamu.edu)

Texas usually ranks 3rd or 4th in U.S. production of watermelons with 27,000 to 38,000 acres. Large scale watermelon producers usually rely on plastic mulch and drip irrigation, while small acreage producers tend to adopt dryland production. With increasing popularity of seedless watermelons, Texas now ranks 2nd and over 90% of total acreage planted with seedless watermelon. Pollenizers are needed and producers often use diploid varieties for pollination. Specialized varieties, such as ‘SP-5’, can also be used as pollenizers as they provide pollen but have no marketable value themselves. In 2013, the statewide watermelon variety trial included 21 triploid varieties. Trials were set up in Weslaco, Uvalde, Overton, and Lubbock. Plastic mulch and drip irrigation were used for production in all sites, except for Lubbock. Fertility and pest management needs were based on local disease and insect pressure. General trends in yield performance were noted in this trial. Some varieties were top performers at all four locations, such as ‘SV 0010 WA’ and ‘SV 0258 WA’. ‘Maxima’ appeared to perform best and ‘Yuval’ worst in northern Texas. Most cultivars evaluated in this study (17 out of 21) performed better than the standard ‘Tri-X 313’. Finally, varieties that ranked in the lowest 1/3 in terms of yield also ranked lowest at all four locations.

Synchronized Flowering of Triploid Watermelon Cultivars and Diploid Pollinizers

Cecilia E. McGregor* and Vickie Waters
Dept. of Horticulture, University of Georgia, 1111 Miller Plant Science Bldg., Athens, GA 30602

The past 10 years has seen a steep increase in production of seedless watermelon (Citrullus lanatus) in the United States. Seedless fruit is produced on triploid plants that require pollination from diploid pollenizers for fruit set. Synchronization of the male flowers on the pollenizers with the appearance of
female flowers on the triploids is a fundamental requirement for this production system. We compared the flowering patterns of 29 triploid cultivars and 20 pollenizers, including 10 harvested pollenizers, during the first 6 weeks after transplanting over two years. The K-means clustering of the weekly percentage of plants with male and female flowers for the different cultivars shows that different triploid and pollenizer cultivars have different flowering patterns and that some combinations have better synchronized flowering than others. Growers should take particular care when choosing pollenizers for early flowering triploid cultivars and should choose triploid and pollenizer cultivar combinations with flowering patterns that best satisfy their specific production goals.

Grafted Watermelon Root Length Density and Distribution under Different Soil Moisture Treatments

Gilbert Miller1,2, Ahmad Khalilian1, Jeffrey L. Adelberg2, Hamid J. Farahani3, Richard L. Hassell4, and Christina E. Wells5

1Clemson University, Edisto Research and Education Center, 64 Research Road, Blackville, SC 29817; 2School of Agriculture, Forest, and Environmental Sciences, Clemson University, E-143 Poole Agricultural Center, Box 340319, Clemson, SC 29634; 3Water Management Engineer, USDA-NRCS East National Technology Support Center, 2901 E. Lee Street, Suite 2100, Greensboro, NC 27401-4901; 4School of Agriculture, Forest, and Environmental Sciences, Coastal REC, 2700 Savannah Highway, Charleston, SC 29414; 5Dept. of Biological Sciences, Clemson University, 150 Long Hall, Clemson, SC 29634

The objective of this 3-year field study was to measure root distribution and root length density of watermelon (cv. Wrigley) grafted on two different rootstocks (Lagenaria siceraria cv. ‘FR Strong’ and Cucurbita moschata 3 Cucurbita maxima cv. Chilsung Shintoha) and grown under three soil moisture treatments. Irrigation treatments tested were: no irrigation (NI), briefly irrigated for fertigation and early-season plant establishment; minimally irrigated (MI), irrigated when soil moisture in top 0.30 m of soil fell below 50% available water capacity (AWC); well irrigated (WI), irrigated when soil moisture in top 0.30 m of soil fell below 15% (AWC). Root length density (RLD) was measured from 75-cm-deep soil cores at two locations three times per growing season and a third location at the end of the season. Cores 1 and 2 sample locations were 15 cm to the side of each plant: Core 1 on the same side as the drip tape and Core 2 on the opposite side. At the end of the season, Core 3 was taken 15 cm outside of the bed in bare ground. RLD was significantly greater in the 0- to 30-cm soil depth and dropped dramatically below 30 cm; it was not significantly affected by irrigation treatment or rootstock. Core 1, next to the drip tape, had greater RLD than Core 2, 30 cm from drip tape, but only at the later sampling dates. Roots were found in Core 3 at all depths, but the RLD was significantly less than that measured in Cores 1 and 2. These findings suggest that the effective root zone depth for watermelon is 0 to 30 cm and that the particular scion/rootstock combinations tested in this study do not differ in root system size or location.

2013 Watermelon Cultigen Yield and Quality Trial Results in North Carolina

Jonathan R. Schultheis* and W. Bradfred Thompson
Dept. of Horticultural Science, Kilgore Hall, Box 7609, North Carolina State University, Raleigh, NC 27695-7609

Thirty-nine standard size triploid advanced lines or cultivars (cultigens) were evaluated in 2013 at the Central Crops Research Station, Clayton, North Carolina to determine their adaptation in the southeastern United States. A randomized complete design was utilized using four replications per treatment. Seeding was mid-April, while transplanting in the field was 14 May, 2013. Watermelons were grown on black polyethylene mulch with drip irrigation. Transplants were set in-row 2.5 ft. apart while row centers were 10 ft., and four pollenizer plants were established per plot. Two ‘Ace’ pollenizer plants were planted at each end of the plot while two ‘SP-6’ plants were established in the middle of each plot. Five harvests were made 18 and 25 July, and 1, 14, and 29 August. Each fruit was harvested and weighed. Fruits were considered marketable when fruit were at least 10 pounds. Fruit number and mass were determined on a per acre basis. Key fruit quality characteristics measured included average fruit weight, percentage and severity hollow heart, and flesh firmness. Hollow heart was not severe such that fruit were unmarketable. Greater occurrence of hollow heart (20% to 35%), even though not severe in this growing season, occurred mainly in fruits that had a softer flesh. These cultigens included, ‘Bold Ruler’, ‘Affirmed’, ‘Cut Master’, ‘Tri-X-313’, ‘Cut Above’, ‘Liberty’, ‘Sugar Red’, ‘Citation’, and ‘Sugar Coat’. Several cultigens had extremely firm flesh; ‘SV0051WA’, ‘SV0010WA’, ‘LaJuya’, ‘SV2757WA’, and ‘Maxima’, and would be better suited than many other cultigens for the fresh cut processing industry. All cultigens with the firmest flesh originated from Seminis Vegetable Seeds and Origen Seed Company. The cultigens that produced the largest average fruit size across all five harvests were ‘Exclamation’, ‘Premont’, ‘Declaration’, ‘SV 0051WA’, ‘Yuval’, ‘WDL 9409’, ‘Crunchy Red’, ‘Sugar Coat’, and ‘WM 8317’, while the smallest average fruit size was produced by ‘UG 711’, ‘LaJuya’, and ‘Citation’. The top 8 yielding cultigens in terms of both number of fruit per acre and tonnage were: ‘Exclamation’, ‘Yuval’, ‘Crunchy Red’, ‘11051’, ‘Cut Above’, ‘Sugar Red’, ‘SV 0010WA’, and ‘Sugar Coat’. This production season should be noted as extremely wet which resulted in loss of a replication due to flooding, stunted plant growth due to water stress that was more obvious in one of the replications included in the analysis, and occurrence of hard core/spot (light brown-yellow, 1–3 inch regions that are hard and unsightly and were scattered within the flesh) in several cultigens. Yields were generally low ranging from 12,500 to 44,000 pounds per acre.
Evaluation of Pollenizer Varieties for Triploid Watermelon (Citrullus lanatus) Production in Southwestern Indiana, 2013

Shubin K. Saha1* and Dan Eggel2
1Dept. of Horticulture, University of Kentucky, Ag Science Building North, N-322C, Lexington, KY 40546-0091; 2Botany and Plant Pathology Department, Purdue University, 4369 N. Purdue Rd., Vincennes, IN 47591.
(Shubin.saha@uky.edu).

Triploid watermelon production requires the use of pollenizer plants in the field to provide male flowers to allow for fruit production. In the past and to some extent currently, producers have used traditional edible diploid melons. There is now also widespread use of special pollenizers which generally produce a smaller more delicate vine to avoid competition with the triploid plants. Fifteen pollenizer varieties were evaluated for male flower production and susceptibility to a common foliar disease in watermelon, anthracnose (Colletotriuchium obiculare). The experiment was established 16 May 2013, when all varieties were transplanted into the appropriate plots based on a randomized complete-block design with 4 replicates. The site was located at the Southwest Purdue Ag Center in Vincennes, IN. Prior to crop establishment; the field was prepared by tillage and bed formation using a plasticulture system with drip tape. Preplant fertilizer included 350 pounds of urea, 100 pounds of potassium chloride, and 200 pounds of pelletized lime. Irrigation was applied in season as needed. Management of insects was based on weekly scouting reports and using recommended insecticides. Diseases were managed also with scouting and the use of Melcast, disease forecasting system. There were four harvests where yield data was collected and nine fruits from each variety were evaluated for quality characteristics including percentage of soluble solids, size, rind thickness, and firmness. The 2013 yields ranged from 28,400 to 45,300 pounds/acre and average fruit weight ranged from 13.5 to 16.9 pounds. ‘Sweet Gem’ and ‘Cut Above’ had higher soluble solids (> 12%) than 15 other varieties, however yields were relatively low. ACX 6166 had the highest numerical yield and had acceptable soluble solids (11 %). SVO258WA had high yield and high soluble solids as well. Other varieties with higher yields and high soluble solids were ‘Sugar Red’ and NUN 01009. The varieties which had greater yield in the first harvest were: ‘Maxima’, ‘Sugar Coat’, ‘Sweet Gem’, and ‘Fascination’.

Nitrogen Uptake Efficiency in Grafted Watermelon

David H. Suchoff, Jonathan R. Schultheis*, and Christopher C. Gunter
Dept. of Horticultural Science, Kilgore Hall, North Carolina State University, Raleigh, NC 27695-7609

The use of grafted watermelon in the United States has gained interest due to the phasing out of methyl bromide and the resistance to soilborne pathogens imparted by the grafted rootstock. Some studies have shown that certain rootstock-scion combinations result in increased vigor as well as changes in fruit quality. The objective of this study was to determine the nitrogen uptake efficiency of grafted watermelon compared to a nongrafted control. The seedless watermelon ‘Melody’ was grafted onto three commercially available rootstocks: ‘Shintosa’, ‘Macis’, and ‘Carnivor’. All grafting was conducted on North Carolina State University campus via the one-cotyledon method. Nongrafted ‘Melody’ was used as the control. Plants were grown in the field using a plasticulture production system in the Sandhills Research Station in Jackson Springs, NC. The field was arranged in a split-block design with four replications. Each replication contained five fertilizer treatment rows: 0, 84, 126, 168, and 252 kg·ha⁻¹. Treatment rows consisted of the four rootstock plots containing eight plants with three pollenizers per plot (‘MickyLee’). Fertilization occurred biweekly through a ‘Chemilizer’ HN55 chemical injector. Vine length, leaf count, stomatal conductance, petiole sap nitrate levels, and leaf nitrate...
levels were collected throughout the season. Three weekly harvests were conducted and fruits were analyzed for weight per area, size, flesh firmness, and soluble solids. Nongrafted plants yielded more fruit per plant than all grafted treatments. Fruit from nongrafted plants also weighed significantly more than fruit from the grafted treatment plants. Fruit from ‘Carnivor’ grafted treatment had significantly higher soluble sugar content than the nongrafted control, but not the other grafted treatments. Flesh from ‘Shintosa’ grafted plants was significantly firmer than both ‘Macis’ grafted plants and the nongrafted plants. The nongrafted treatment resulted in higher tissue nitrogen content compared to the ‘Carnivor’ grafted treatment but not the other grafted treatments.

Poster Section

Greywater Irrigation of Two Herbaceous Landscape Plant Species
Richard Sluznis¹, Amy Wright²*, and Charlene LeBleu1

¹Dept. of Landscape Architecture; ²Dept. of Horticulture, Auburn University, AL 36849

Research was conducted to determine the chemical properties of greywater samples collected on-campus and to evaluate the effect of greywater irrigation on growth of two herbaceous landscape plant species. Portulaca oleracea received daily irrigation with collected greywater in concentrations of 0% (tap water, no greywater), 25%, 50%, 75%, or 100% greywater. Echinacea purpurea received daily irrigation with solutions of anionic surfactant in concentrations of 0 mg·L⁻¹ (tap water, no surfactant), 50 mg·L⁻¹, 100 mg·L⁻¹, 150 mg·L⁻¹, 200 mg·L⁻¹, or 250 mg·L⁻¹. For P. oleracea, there were no effects of greywater treatments on root or shoot dry weights and no symptoms of stress or toxicity. There were also no effects of greywater treatments on substrate leachate pH or EC. For E. purpurea, there was no effect of surfactant on growth. In collected greywater, the surfactant concentration ranged from 25–90 mg·L⁻¹, the Na concentration ranged from 22–24 mg·L⁻¹, and the Cl concentration ranged from 12–25 mg·L⁻¹. P. oleracea and E. purpurea were tolerant of treatments and could potentially be used in landscapes irrigated with greywater. Additional research to identify landscape species that are tolerant of surfactants will allow for greater utilization of greywater for landscape irrigation.

Evaluation and Economics of an Organic Nitrogen Source in a Yellow Squash–Collard Rotation
C.Z. Ogles, J.M. Kemble, A.N. Wright, and E.A. Guertal

Dept. of Horticulture, 101 Funchess Hall, Auburn, AL 36849; Dept. of Agronomy & Soils, Auburn, AL; 36849

In-season nitrogen (N) management is a common challenge in organic vegetable production. Especially when using polyethylene mulch combined with fertigation. There is a need for a highly soluble quick release N source that is suitable for fertilization in organic vegetable production. Yield with organic N supplied by hydrolyzed fish fertilizer (HFF) was compared to that of inorganic N. A crop rotation of yellow squash (Cucurbita pepo) and collards (Brassica oleracea var. acephala) was used. Three N sources were used in the experiment; HFF, Inorganic N source with secondary and micronutrients (INORGWM), and Inorganic N without secondary or micronutrients (INORGWO). The experiment was arranged as a randomized complete-block design consisting of 10 treatments with 4 replicates. The yellow squash was seeded on 7/6/12 and was harvested 3 times weekly. Yellow squash had a 30% higher yield with the inorganic N source treatments compared to the HFF. The collard crop was transplanted on 10/2/12 and harvested 12/12/12. Collards had 21% higher yield with INORGWM compared to the HFF. The second collard crop was planted on 3/22/13 and harvested on 5/17/13. Yield was significantly reduced across all N treatments. The highest yields were produced in the INORGWM treatments followed by those grown in the HFF treatments. Overall yield was reduced by 50% from those in the 2012 crop. The final summer squash was transplanted on 8/13/13. The squash grown in the inorganic N treatments produced the highest yields. Those grown in the HFF yielded 16% lower than the two inorganic N sources. Overall yield was reduced by 60% from the yield produced in the 2012 crop. Though yields were reduced in the HFF treatments, the premium price associated with organic products was enough to offset the reduced yield. Total profit from the HFF treatment was 230% greater than the INORGWM treatment and 328% higher than the INORGWO. If growers can obtain the price premiums associated with organic produce, the use of HFF can be an economically feasible option in organic vegetable production.

Effects of High Tunnel and Shade on Blackberry Yield and Incidence of White Drupelets
James D. Spiers, Robert T. Boozer, and James A. Pitts

¹101 Funchess Hall, Dept. of Horticulture, Auburn University, Auburn, AL 36849; ²Alabama Agricultural Experiment Station, Chilton Research and Extension Center, 120 Co. Rd. 756, Clanton, AL 35045

This 2-year study was arranged in a split-split-plot design to determine effects of shade (40%) and/or high tunnel on yield and incidence of white drupelets on ‘Kiowa’, a floricane-fruiting blackberry, and ‘Prime-Jan’, a primocane-fruiting blackberry. Yield, berry weight, and the number of fruit with white drupelets per 25-berry sample was recorded. Total yield was variable in 2012, but was much greater inside high tunnel in 2013. Berry size was not influenced by high tunnel or shade. ‘Kiowa’ berry weight was approximately twice that of ‘Prime-Jan’ in both years. The incidence of white drupelets on blackberries was reduced under shade in both years, and did not affect yield inside or outside of high tunnel.

The Effects of Sulfuric Acid Scarification and Seed Coat Removal in the Germination of Miracle Berries (Synsepalum dulcificum Daniell)

Carly Schall1*, Eric Limbird2, and Nate Phillips1
1School of Agribusiness and Agriscience; 2Dept. of Biology, Middle Tennessee State University, Murfreesboro, TN 37132

Synsepalum dulcificum (Miracle Berry), a species endemic to the Sub-Saharan West Africa region, is a species of horticultural, economical, and medical importance. In the wild, it is commonly found in rainforests and has been used to make unpalatable foods taste better for West Africans. Since its discovery by Chevalier des Marchais in 1725, more people are becoming aware of its benefits as a horticultural, health, and trade and industry product. The miracle berry fruit contains the homodimeric glycoprotein miraculin contained within the pulp which is responsible for binding to the taste receptors causing anything that tastes sour to become sweet. Little research has been conducted on seed germination behavior and characteristics due to its current lack of popularity as a horticultural crop. However, the medical and economical potential impact for the horticultural community makes the study of seed germination beneficial. Therefore, this experiment was initiated to evaluate germination behavior. Manipulation of the seed by removal of the seed coat and two sulfuric acid soak durations were conducted to determine if the seed coat contributes to its recalcitrance. Tetrazolium testing was conducted to evaluate staining patterns related to seed viability. The germination percentages (88.9%) were equal between the de-coated seeds and the intact seeds not exposed to the sulfuric acid soak. Seeds scarified with sulfuric acid for 1 minute achieved (57.4%) germination compared to no germination in seeds subjected to the 5 minute sulfuric acid scarification. Despite achieving equal germination percentages, the de-coated seeds germinated at a faster and more uniform rate than the intact seeds (T1 = 16.7, T50 = 18.6, and T10-90 = 9.4). Our findings demonstrate that varying germination percentages occurred in response to the treatments. Uniformity and rate were significantly better in the de-coated seeds. Absent existing protocols for S. dulcificum, our initial tetrazolium testing provided a range of staining patterns that presented no apparent correlation with viability. Our assumption, based on the proven viability of other species (T1 = 16.7, T50 = 18.6, and T10-90 = 9.4). Our findings demonstrate that varying germination percentages occurred in response to the treatments. Uniformity and rate were significantly better in the de-coated seeds. Absent existing protocols for S. dulcificum, our initial tetrazolium testing provided a range of staining patterns that presented no apparent correlation with viability. Our assumption, based on the proven viability of other

North Carolina’s Role in a Nationwide Effort to Improve Black Raspberry

Christine M. Bradishi1, Gina E. Fernandez1, Jill M. Bushakra2, Penelope Perkins-Veazie3, Michael Dossett4, Nahla V. Bassil2, and Chad E. Finn5
1Campus Box 7609, Dept. of Horticultural Science, North Carolina State University, Raleigh, NC 27695; 2USDA–ARS National Clonal Germplasm Repository, 33447 Peoria Rd., Corvallis, OR 97333; 3NC State University Plants for Human Health Institute, 600 Laureate Way, Kannapolis, NC 28081; 4Agriculture and Agri-Food Canada–Pacific Agri-Food Research Centre, 6947 Lougheed Hwy, Agassiz, BC V0M 1A2, Canada; 5USDA–ARS-Horticultural Crops Research Unit, 3420 NW Orchard Avenue, Corvallis, OR 97330

In recent years there has been a significant expansion in both the production and consumption of many small fruit crops, yet the black raspberry industry has not expanded beyond a limited commercial acreage in Oregon and a scattered small scale acreage across the country. However, recent research about the health benefits of a diet rich in polyphenolics, and black raspberries in particular, has led to a resurgence of interest in
this fruit and a renewal of breeding efforts. In North Carolina, this study seeks to standardize phenotyping procedure, calculate yield parameters for black raspberry, and to define both the best screening method and selection protocol for heat tolerance. Two half-sib populations, designated ORUS 4304 (192 progeny) and ORUS 4305 (115 progeny) were planted in 2012 at the Sandhills Research Station in Jackson Springs, NC, and evaluated for the first harvest season in 2013 for fruit traits, yield, and heat tolerance. Average fruit size ranged from 0.17–3.12 g/berry, and positively correlated at P < 0.0001 with seed weight, seed number, and ‘seediness’ (mg seeds/g fruit). Average yields were 1.4 kg (3 lb) per plant, with no difference between populations. Yield was normally distributed, and positively correlated at P < 0.0001 with 11 plant and fruit traits. Heat tolerance was measured by chlorophyll fluorescence, and negatively correlated with floricanse vigor and lateral length at P < 0.0001. Several progeny had higher fluorescence scores than parents, indicating transgressive segregation for heat adaptation. Heat tolerance trait was normally distributed and consistent with previous research done on red raspberry in the same location. Based on 2013 scoring and trait distribution data, a proposed phenotyping and selection criteria was composed for breeding black raspberries that can be tailored to meet varying grower and consumer demands. In 2014, a second year of phenotyping will take place, along with additional methods of phenotyping for heat tolerance and calculations of genotype x location x year interactions. Linkage map assembly of 4304 is underway in order to identify QTL for traits of interest. Validation with 4305 and comparative mapping between red and black raspberry will be used to further develop genetic tools for breeding black raspberry in the future.

Center for Crop Diversification

Miranda Hileman1*, Tim Woods1, and Christy Cassady2
1400 C.E. Barnhart Building, Dept. of Agricultural Economics, University of Kentucky, Lexington, KY 40546; 2N-318 Ag Sciences Center, Dept. of Horticulture, University of Kentucky, Lexington, KY 40546

The Center for Crop Diversification at the University of Kentucky is a virtual resource center that offers printed and electronic resources on a variety of crops and marketing channels. This information is free and always accessible. Our resources are used in decision-making and planning for small farmers across the nation. Funding in 2013 from The Kentucky Agricultural Development Fund has allowed us to expand the Center’s Web-based marketing and production resources. These funds will be used to develop online podcasts, webinars, video training, expanded price reports and new publications to meet the high demand for crop diversification information. Producers and Extension educators from surrounding states utilize many of our crop and marketing profiles, fillable crop budgets, and price reports. We work with Extension personnel in surrounding states to offer better educational programming and want to grow this program over the next several years. Formerly known as the Crop Diversification & Biofuel Research & Education Center (CDBREC), we coordinated multi-disciplinary teams of faculty, staff and students to establish research and set guidelines for producing and marketing selected crops at a profit. CDBREC was funded by a Special Research Grant from the USDA from July 1, 2000, to June 30, 2013.

Influence of Substrates and Controlled-release Fertilizer on Growth Characteristics of Select Native Texas Species

Andrew R. King1*, Michael A. Arnold1, Charles R. Hall1, H. Brent Pemberton2, Marco A. Palma3, and Sean T. Carver1
1Texas A&M University, Dept. Horticultural Sciences, College Station, TX 77843-2133; 2Texas A&M AgriLife Research, Overton, TX 75684; 3Texas A&M University, Dept. Agricultural Economics, College Station, TX 77843-2124

In previous selection, three promising native groundcovers were identified; [Borrichia frutescens (L.) DC], [Erigeron procumbens (Hout. ex Mill.) G.L. Nesom], and [Phyla nodiflora (L.) Greene]. Studies were designed to determine which combination of substrate and controlled-release fertilizer (CRF) concentration yielded optimum growth and ornamental characteristics. Substrates included 100% pine bark, 100% peat moss, 100% perlite, 1:1 mixes of all substrates and 1:1:1 pine bark : peat moss : perlite. Fertilizer treatments were applied by topdress and included 6, 12 and 18 g of Osmocote® Classic (19–2.6–9.9, 3–4 month) per container. Height, width, flower count, and ornamental rating were measured periodically throughout the experiments while root and shoot dry masses were included at the cessation of the experiment. Interactions among substrate and fertilizer concentration were found to be significant (P ≤ 0.05) for almost all growth parameters for each species. Significant main effects of substrate and CRF were observed for all species while two-way interactions were observed for B. frutescens and P. nodiflora. In each experiment, the heavier substrates (i.e. peat moss) produced plants with growth characteristics and ornamental ratings among the highest observed. Significant interactions were observed among substrate and CRF concentrations for all root and shoot mass measurements.

The Effects of Different Levels of Fertilizer on Yield and Nutritional Qualities of Kangkong (Ipomoea aquatica): A Potential Leafy Vegetable

Asm H. Sorker*, Z. Adam, and Shahidul Islam
Dept. of Agriculture, University of Arkansas at Pine Bluff, 153 Woodard Hall, Mail Slot 4913, 1200 North University Drive, Pine Bluff, AR 71601

Kangkong (Ipomoea aquatica), within the family convolvulaceae, is one of the favorite leafy vegetables grown in Asia and parts of Africa. Kangkong, also known as water spinach, is very nutritious and rich in vitamins A and C, minerals such as calcium and iron, and is also rich in dietary fiber and protein. All parts of the young plant are edible with the shoot tips...
and young leaves being the most preferred. Apart from human consumption, Kangkong leaves and stems also serve as fodder for domesticated animals and fish when grown in lakes, including higher concentration of vitamins, minerals, and polyphenols. Thus, Kangkong offer the possibility of adding greatly to the available food supply as well as bioactive compounds for human health. Kangkong has many uses in addition to food and fodder crop with great potential as leafy vegetables in the United States. To exploit this potential further, large-scale studies should be promoted on all related spheres from horticulture, genetic resources to processing techniques. The objective of this study was to examine and compare the yield and nutritional qualities of Kangkong grown under different levels of fertilizer. The study showed that four gram of urea fertilizer treatment had the highest yields and nutritional qualities compared to other treatments.

Seed Morphology and Germination of the Medicinal Plant *Artemisia annua* (Asteraceae)

Hazel Y. Wetzstein1*, Justin Porter1, Ming Li2, Everett Souza3, and Adriana Martinelli3

1Dept. of Horticulture, University of Georgia, Athens, GA 30602; 2Dept. of Traditional Chinese Medicine Resources, Guangdong Pharmaceutical University, Guangzhou, Guang Dong 51006, PRC; 3CENA, University of São Paulo, Piracicaba, SP, 13416, Brazil

*Artemisia annua*, ‘Sweet Annie’, is a critical medicinal plant because it produces artemisinin, a potent compound effective against drug resistant malaria. Recent studies show that *A. annua* also possesses anti-cancer, anti-inflammatory, antibacterial, antiviral, and anti-parasitic activities. Despite the importance of *A. annua* as a medicinal crop, fundamental features of reproductive biology including details of seed maturation and germination are poorly understood. Problematic is that seed form within small capitula that shatter at maturity. Unclear is how early seed can be harvested and when seed achieve viability. Studies examining morphological changes in seed development are needed to define a maturity index. Selection of genotypes producing high numbers of viable seed can assist seed production efforts.

Phosphorus Uptake and Flooding Tolerance of Three Native Landscape Plant Species

Amanda Meder and Amy Wright*

Dept. of Horticulture, Auburn University, AL 36849

Bioretention gardens restore hydrologic function of urban landscapes and capture stormwater runoff pollutants, such as phosphorus, a main pollutant in urban cities and residential neighborhoods. The objective of this study was to evaluate three native landscape plant species for phosphorus uptake and tolerance of bioretention garden conditions. Plant species included *C. verticillata* ‘Zagreb’, *A. ternarius*, and *I. vomitoria* ‘Schilling’s Dwarf’. Plants (3.8 L) were planted into 94 L nursery containers in a substrate of a 50:50 sand:organic matter. Containers were irrigated (non-flooded) or flooded with 1.6 mg L⁻¹ P solution. At experiment termination, root and shoot dry weight were recorded, and leachate, substrate, and plant tissue were analyzed for P concentrations. The experiment was conducted in fall and repeated in spring. SDW and RDW of *A. ternarius* were higher than that of other species in fall. RDW of *A. ternarius* was also higher than that of other species in the spring. Flooding did not affect SDW or RDW of any species in the fall or RDW of any species in the spring. In the spring, SDW of *C. verticillata* was higher in non-flooded conditions than flooded; flooding did not affect SDW of *I. vomitoria* or *A. ternarius*. Substrate P and leachate P were higher in flooded than non-flooded treatments. Tissue P was higher in *C. verticillata* than other species. Plants were more effective in the removal of P than substrate. Including a variety of plants in a rain garden can improve P uptake and reduce vegetation gaps caused by seasonal growth variations among species.

Muscadine Grapes: Evaluation of Genotypes and Field Fungicide Applications on Composition and Postharvest Storage Attributes

Derek W. Barchenger1*, John R. Clark1, and Renee T. Threlfall2

1316 Plant Science, Dept. of Horticulture, University of Arkansas, Fayetteville, AR 72704; 22650 N Young Avenue, Institute of Food Science and Engineering, University of Arkansas, Fayetteville, AR 72704

A major limiting factor in muscadine grape (*Vitis rotundifolia* Michx.) commercialization is deterioration during storage. Research on table grapes has shown that field fungicide applications increase storability, but little is known of their affect on muscadines. The effect of field applications of fungicides on composition attributes during postharvest storage was evaluated on five muscadine cultivars (Nesbitt, Southern Jewel, Summit, Supreme, and Tara) and four breeding selections from the University of Arkansas Fruit Breeding Program in 2012 and 2013. There were two field treatments (no fungicide and fungicide). For the fungicide treatment, alternating applications of two fungicides were applied at 14-d intervals during berry maturaion. Fruit was harvested and composition attributes including berry volume, titratable acidity (TA), pH, soluble solids (%),
color (L, Chroma, and hue), firmness (force to penetrate berry skins), storage weight loss (%), and unmarketable fruit (%) were evaluated every 7 d for 3 weeks. Due to less decay, less weight loss, and greater firmness during storage, AM 27, ‘Southern Jewel’, and ‘Supreme’ had the highest potential for postharvest storage, while AM 01, AM 15, and ‘Tara’ had the least potential. Although field fungicide applications did not affect all postharvest attributes, differences among genotypes and fungicide treatments did occur during the three weeks of storage.

Performance of Fall Planted Broccoli Varieties in Georgia
Timothy Coolong*
2360 Rainwater Road, Dept. of Horticulture, University of Georgia, Tifton, GA 31793

Broccoli (Brassica oleracea var. italica) production in Georgia has increased in recent years due to market windows in the fall and early spring. Varieties developed under more uniform climate conditions often perform poorly when grown in southwest Georgia. Thus routine variety evaluation is essential. Fourteen varieties of broccoli were planted on 5 Sept. 2013, into a bare-ground production system. Harvests were initiated on 1 Nov. 2013, and terminated on 9 Dec. 2013. Weighted averages were used to determine the harvest dates for the 14 varieties trialed. Varieties having the fewest days-to-harvest were generally more uniform. Green Magic was the earliest harvested variety, while Alborada and Malibu were latest. Luna and Gypsy were the highest yielding varieties, but they were not statistically different from the top six yielding varieties. Yield was a function of average head weight and number of marketable heads. ‘Green Magic’ had the highest average head weight, but it was not significantly different than Luna or Imperial. Average crown height and a crown:head ratio were determined as well. ‘Belstar’ and ‘Alborada’ had the most compact crowns, but overall head weights were low. ‘BC 1691’ had a compact crown, but still produced yields that were no different from the highest yielding varieties. Emerald Crown is the most widely grown variety in Georgia, as it generally does not exhibit the purpling associated with anthocyanin production in cold weather. However, harvests for this variety were variable, requiring several picks over a long period of time. Two newer varieties that yielded well and displayed high quality characteristics were Luna and BC 1691. Both had compact, tight heads with small beads. Although most heads were harvested prior to the freeze event at 83 days after planting, those that remained did demonstrate purple coloring. Thus, they would only be recommended for early fall or spring production in Georgia.

Fall Planted Cabbage Variety Trials in Southwest Georgia
Timothy Coolong1* and Matt Roberts2
12360 Rainwater Road, Dept. of Horticulture, University of Georgia, Tifton, GA 31793; 2350 Bldg. 1 Room 132, Veteran’s Parkway N, Colquitt County Cooperative Extension, Moultrie, GA 31788

More than 6000 acres of Cabbage (Brassica oleracea var. capitata) are grown in Georgia annually. Routine cabbage evaluations have not been conducted in Georgia in recent years, despite the introduction of several new and promising varieties. This trial was conducted to determine the suitability of several of these varieties for fresh market production in the fall in southwest Georgia. Fifteen varieties (13 green and 2 red) were transplanted on 15 Sept. 2013, into a bare-ground production system. Plants were grown according to standard commercial practices for Georgia and were sprayed weekly with fungicides or insecticides. Harvests were initiated on 2 Dec. 2013, and continued until 15 Jan. 2014. Plots were rated for disease on 20 Dec. 2013. A weighted average was used to determine days to harvest. Checkmate was the earliest variety harvested, while Garnet was the latest to mature. Varieties were also evaluated for disease. ‘Checkmate’ had the highest incidence of disease, with ‘Stonehead’ and ‘Primo Vantage’ also having significant levels of disease. Disease symptoms appeared primarily on the heads making them unmarketable. Yields ranged from 25,540 to 87,950 kg·ha⁻¹. The variety SCB6334R had the highest marketable yield, but it was not significantly different from 7 additional varieties. SCB6334R is a flattened variety that also had the largest average head weight at harvest. ‘Excalibur’ and ‘Expat’ were both part of the highest yielding group and tended to have very tightly packed leaves. The two lowest yielding green varieties, Stonehead and Checkmate, displayed significant disease symptoms resulting in large numbers of unmarketable heads. The two red varieties trialed had smaller average head weights, leading to lower yields as well. Garnet, the latest maturing variety, had the smallest head diameter.

Molecular Breeding in Spinach
Ainong Shi1*, Beiquan Mou2, Zhangjun Fei1, Jim Correll1, Dennis Motes1, Jianbing Ma1, and Chunda Feng1
1University of Arkansas, Fayetteville, AR, 2USDA–ARS, Salinas, CA, 3Carnell University, Ithaca, NY

Spinach (Spinacia oleracea L.) is an economically important leafy vegetable crop mainly growing in China, East Asia, and the United States, and it is also grown in many other regions and countries. Molecular breeding has become part of the breeding program to speed up breeding progress and obtain genetic gain in breeding. Molecular breeding covers molecular marker discovery, genetic mapping, QTL identification, genetic diversity, association analysis, marker-assisted selection (MAS) and genome-wide selection (GWS). Genotyping by sequencing (GBS) is one of the next-generation sequencing platforms and it can be used in genome sequencing and SNP discovery for trait QTL mapping and association in any germplasm or species with and without prior knowledge of the genome in the species. The objectives of this study are to discover genome-wide SNPs, construct genetic maps, conduct QTL mapping and association, and analyze genetic diversity in spinach. So far, 96 spinach lines including 20 inbreeding lines and other commercial varieties, F₁ hybrids, and germplasm and a Zebu hybrid F₁ sister-crossing derived population with 95 individuals are conducted by GBS.
An averaged around 1 million read with 80-90 bp length for each sample were observed and 250 thousand variant (SNP and Insert/Deletion) were detected. A total of 322 SNPs were mapped to six linkage groups in spinach based on the Zebus population.

Development of Technology for Sustainable Banana Production in Coastal Alabama

Edgar L. Vinson1*, Elina D. Coneva1, Joseph M. Kemble1, Floyd M. Woods1, E. Greg Fonsah2, Penelope Perkins-Veazie3, and Jeff L. Sibley1

101 Funchess Hall, Dept. of Horticulture, Auburn University, Auburn, AL, 36849; 215 RDC Road, Dept. of Agricultural and Applied Economics, University of Georgia–Tifton, Tifton, GA 31793; 3Plants for Human Health Institute, 600 Laureate Way, Suite 1329, North Carolina State Research Campus, Kannapolis, NC 28081

Banana fruit may be offered as an alternative commodity to help improve sustainability of farm operations. Cold tolerant banana cultivars have been developed for the subtropics; however, fluctuations in environmental conditions occur regularly in the subtropics and impose several constraints on banana production. The objective of this project was to evaluate several key phenological responses of bananas to the climate of coastal Alabama in order to determine the potential for production of specialty banana fruit. Thirteen banana cultivars were evaluated: ‘Grand Nain’, ‘Dwarf Cavendish’, ‘Dwarf Red’, ‘Dwarf Green’, and ‘Double’ (dwarf); ‘Gold Finger’, ‘Viente Cohol’, ‘Raja Puri’, ‘Ice Cream’, and ‘Cordoba’ (medium); and ‘Pisang Ceylon’, ‘Sweetheart’, and ‘Saba’ (tall). Phenological data collected consisted of leaf emergence rate (LER), total leaf production (TLP), number of healthy, photosynthesizing leaves present (NLP), and height: diameter ratio (HDR). Preliminary findings were encouraging. The range of leaf emergence rate (an important indicator of growth rate and flowering potential) among medium height bananas was 5.0–5.5, 5.7–7.0, and 6.0–7.2 leaves/month in July, August and September, respectively. The emergence rates showed a steady increase and were similar to emergence rates of banana plants cultivated in other regions of the subtropics according to the literature. TLP ranged from 30–35 in 2013. A maximum TLP of 50 is required for flower initiation. These preliminary findings support the potential to produce banana fruit commercially in coastal Alabama.

Potential New Rabbiteye and Southern Highbush Blueberry Cultivars for the Southeastern United States

USDA–ARS Thad Cochran Southern Horticultural Laboratory, Poplarville, MS 39466.

Development of new small fruit germplasm and cultivars, in particular blueberries, has been among the major objectives of the USDA–ARS Thad Cochran Southern Horticultural Laboratory, Poplarville since the early 1970s. Three elite blueberry strains including two rabbiteye (Vaccinium ashei) and one southern highbush (V. corymbosum) are among those currently being increased in completion of development for release as new cultivars. A rabbiteye blueberry selection (MS 794) has been identified as a candidate for release and has desirable characteristics including plants having a semi-dwarf growth habit that drastically reduces the need for yearly pruning, a very early berry ripening period, and large light blue berries with high quality. In the pipeline is MS 1230, also a rabbiteye blueberry that has an upright growth habit with narrow crowns, high production potential, an early-mid season ripening period, and also has high berry quality. The MS 1425 is a late season southern highbush blueberry that has exceptionally large high quality berries, many of which exceed 4 g in weight. Upon release, these new cultivars will provide growers with rabbiteye blueberry cultivars suitable for the fresh berry market and a southern highbush blueberry that provides growers with opportunities to develop a specialty market for exceptionally sized fruit.

The Effects of Cover Crops on Apple Trees: A Model Greenhouse Study

J. Billig* and C.R. Rom
316 Plant Sciences, Dept. of Horticulture, University of Arkansas, Fayetteville, AR, 72701

While sustainable orchard management practices have gained popularity, the research on the use of cover crops in perennial cropping systems is insufficient. Most research on the subject has been conducted at Northern latitudes and there is limited work in the Southern United States. This project examines the effects of two cover crop species on apple tree growth and nutrition in a controlled environment. A greenhouse study of potted M26 apple trees (Malus domestica) grown in neutral media (sand, vermiculite, perlite; 1:1:1) utilized five treatments with 11 replications and repeated across two years. Treatments were: 1) cowpeas (Vigna unguiculata) in competition with apple trees (CPC); 2) millet (Setaria italica) in competition with apple trees (MC), 3) cowpea mulch added to trees grown without competition (CPM); 4) millet mulch added to trees grown without competition (MM); and 5) an untreated control. Trees were measured for growth, dry weight, and tissue C and N content during the 161 (2012) and 120 (2013) day study. Both cover crop species were assessed for C, N, and total biomass. The legume cover crops generated more biomass per plant, higher % N, total N, and total C. Cowpeas contained over 10 times the total N per pot compared to millet (1.67 g : 0.16 g). Apple trees grown in competition with cover crops (CPC, MC) had reduced growth compared to mulch treatments (CPM, MM, or control), and did not recover after cover crop harvest within the duration of the study. Trees with mulches but no competition (CPM, MM) had greater shoot growth than other treatments while tree caliper was similar for CPM, MM, and control treatments. The CPM and MM had higher C and N content, and CPM had the highest total N content of all treatments. Trees with mulches but no competition were larger and had higher N and C content, and those with legume mulches had the highest total N content. Results of this
study corroborate previous studies on the inability of apple to compete with vegetation sharing rhizosphere space and imply benefits of leguminous mulches.

**Pumpkin Cultivar Evaluations for Central Mississippi**

William B. Evans and Anna H. McCain*

Truck Crops Branch Experiment Station, Mississippi State University, Crystal Springs, MS 39059

Pumpkin (Cucurbita pepo/Cucurbita maxima) is not a major Mississippi crop in part because it can be a difficult and costly crop to produce. This is due to pressure from insects and diseases, as well as difficulties growers face in supplying enough water to sustain the crop during hot summer months. Cultivar selection is an important disease management and marketing strategy. On July 1, 2013, six medium-to-large sized Jack-o-lantern type pumpkins and two small decorative pumpkin cultivars were direct seeded in a randomized complete-block design with 4 replications, with ten hills seeded per plot. Weather conditions were such that the trial did not require any sprays for insects or disease. At harvest, each cultivar was evaluated for their marketable fruit number, yield per acre and average weight to determine if these cultivars are suitable for production in Central Mississippi. All entries performed well. The two smaller pumpkins, ‘Touch of Autumn’ and ‘Mischief’, produced the greatest number of fruit per acre. ‘Gold Medal’ had the greatest average fruit weight and was a high yielding pumpkin. If Mississippi growers wish to move into the wholesale market, ‘Gold Medal’ could be a good selection. The cultivar Hannibal had the lowest yield per acre because it produced fewer fruit than other entries of similar size. We conclude that many pumpkin cultivars can produce good yield and quality for local sales, and that cultivar selection for Central Mississippi will greatly depend on the grower and market needs.

**Germination Techniques in Ipomopsis rubra and Melampodium leucanthum**

Amanda Gunter*, Cynthia McKenney, and Thayne Montague

Dept. of Plant and Soil Sciences, Texas Tech University, MS 2122, Lubbock, TX 79409

Wildflowers are generally more difficult to germinate, without having a definite step-by-step germination strategy. This experiment was conducted in order to find effective germination techniques for two Texas native wildflowers. Various pre-treatments were performed for germination in standing cypress (Ipomopsis rubra) and blackfoot daisy (Melampodium leucanthum).

**Assessing Advanced Rabbiteye Blueberry (Vaccinium ashei) Selections**

Elina D. Coneva†*, Scott NeSmith‡, and Arnold Caylor§

†Dept. of Horticulture, Auburn University, 101 Funchess Hall, Auburn, AL 36849; ‡Dept. of Horticulture, University of Georgia, 1109 Experiment Street, Griffin, GA 30223; §765 County Road 1466, North Alabama Horticulture Research Center, Cullman, AL 35055

Alabama’s blueberry farm gate value has increased by approximately 13% in the last decade. Proper cultivar selection is one of the first and perhaps the most important decision a grower can make when planting blueberries. The University of Georgia Blueberry Breeding Program has accelerated development of blueberry varieties in the past 15 years to facilitate commercial and home garden demands for new varieties. A new large-fruited rabbiteye blueberry cultivar named ‘Titan’ was developed and released in 2010. Rooted plants from ‘Titan’ and other selections were introduced to Alabama in 2011 to study the plant response to the specific growing conditions. Blueberries were planted at the North Alabama Horticulture Research Center (NAHRC), Cullman, in 2011 in a RCBD. Cultivars and selections studied include ‘Alapaha’, ‘Brightwell’, ‘03-06’, ‘Titan’, ‘T-611’, ‘T-743’, ‘T-957’, and ‘Vernon’, each represented by 5 plants. Our results suggest selection ‘03-06’ had the highest total yield of 1.6 kg/plant, whereas ‘T-611’ had the smallest. Selections ‘T-965’ and ‘Titan’ had the largest fruit size of 2.7 and 2.5 g respectively. Berries of ‘T-965’ had the largest fruit width and length. ‘Alapaha’ and ‘T-611’ had the sweetest berries in 2013, while ‘Vernon’ berries had the lowest sugar content.

**Asian Pear Cultivar Evaluation**

Elina Coneva1 and James Pitts2

1101 Funchess Hall, Dept. of Horticulture, Auburn University, AL 36849; 2Chilton Research and Extension Center, 120 Co. Rd. 756, Clanton, AL, 35045

Asian pear trees are quite precocious and productive. Nine Asian pear cultivars (Hosui, Isilwase, Kosui, Olympic, Shinko, Ya Li, Yoinashi, Atago, and Shinsui), and two European pear cultivars (Golden Russett and Bartlett), were planted at the Chilton Research and Extension Center near Clanton in Spring 2010 to field test currently available fire blight tolerant Asian pear cultivars for their adaptation to Alabama conditions. The experiment is part of a multi-state replicated trial set in eight locations across the eastern United States to assess Asian pear cultivars potential for growers focused on producing sustainable fruit crops for local and regional markets. Trees began flowering and fruiting in their second leaf and measurements of fruit quality began in the third leaf. Tree survival varied considerably among cultivars. ‘Bartlett’ had lost all 5 trees planted, while 60% of ‘Golden Russett’ trees had survived. The Asian pear cultivars with better tree survival (80%) were ‘Kosui’, ‘Olympic’, and ‘Shinko’, while only 40% of ‘Ya Li’, ‘Yoinashi’, and ‘Atago’ trees survived. ‘Ya Li’ and ‘Olympic’ had the highest yield of 11.4 and 7.00 kg/tree, respectively. ‘Kosui’ had the largest mean fruit size of 211 g. These results indicate that selected Asian pear cultivars could be grown sustainably for local markets.
Author Index

A
Abad, Jorge A.........................................................S46
Abernethy, Tamara ..................................................S46
Adamczyk Jr., J.J ......................................................S60
Adams, L. ..................................................................S44
Adams, Larry ................................................................S1
Adam, Z. ......................................................................S57
Adelberg, Jeffrey W ....................................................S53
Adhikary, Dinesh ..........................................................S31
Aitkenhead-Peterson, Jacqueline ..................S32
Allen, G.C. .................................................................S22
Almeyda, Christie V ......................................................S46
Altland, James .............................................................S23
Anciso, Juan ..................................................................S52
Ankumah, Ramble O. ....................................................S49
Arancibia, R.A. ............................................................S46
Arancibia, Ramón A ..................................................S43, S46, S47, S50
Armitage, Anna R. ..........................................................S56
Arnold, Michael A. ..........................................................S19, S56, S57
Arnold, T.F. .................................................................S44, S48

B
Baisakh, Niranjan.........................................................S50
Baker, Andrew B ..........................................................S20
Baker, Lauri M .............................................................S18, S29
Barchenger, Derek W ....................................................S20, S58
Barrera, Wilmer A ......................................................S49, S51
Bartley, Paul .................................................................S18
Bassil, Nahla V .............................................................S24, S37, S56
Baumann, Paul A ............................................................S21
Berle, David .................................................................S18, S23
Beuzelin, J. .................................................................S44
Bi, Guihong .................................................................S24, S35
Billig, J. ......................................................................S19, S60
Blythe, Eugene K ..........................................................S20
Bonilla, Nestor .............................................................S46
Boozer, Robert T ..............................................................S55
Bowen, Mary S .............................................................S47
Boyer, Cheryl R .............................................................S18, S29
Boyhan, George ..........................................................S18, S40
Boyhan, George E ..........................................................S23
Bracy, Regina ...............................................................S30, S33
Bradish, Christine M ..................................................S24, S37, S56
Bridges Jr., William C ................................................S36
Burrows, Rhoda ............................................................S27
Bushakra, Jill M ..........................................................S24, S37, S56
Bush, Ed..................................................................S29
Byrne, David H ............................................................S56

C
Cabrera, Raul I .............................................................S29
Camerino, Anthony .....................................................S32
Carroll, Becky ..................................................................S36
Carver, Sean .................................................................S19
Carver, Sean T ............................................................S56, S57
Cassady, Christy ..........................................................S57
Caylor, Arnold ..............................................................S61
Chadwell, Christi ..........................................................S25
Chappell, Matthew R ....................................................S30
Chen, Cheng .................................................................S31
Chen, Yan ....................................................................S30, S33
Church, Greg .................................................................S31
Cisneros-Zevallos, Luis ..................................................S19
Clark, Chris .................................................................S48
Clark, Christopher A ....................................................S47
Clark, John R ...............................................................S20, S36, S58
Coker, Christine E.H. ..................................................S28
Coneva, Elina .................................................................S21, S61
Coneva, Elina D .............................................................S38, S60, S61
Coolong, Timothy ..........................................................S40, S42, S59
Correll, Jim .................................................................S59
Creech, David L ..........................................................S28, S30, S31
Crosby, Kevin .............................................................S40, S42
Crossman, Stafford M.A ..............................................S45
Cudnik, Jessica L ..........................................................S23
Currey, Christopher .....................................................S27

D
Davis, J.D. .................................................................S46
Denny, Geoffrey ..........................................................S24
Desai, A .................................................................S22
Dossett, Michael .........................................................S24, S37, S56
Dozier Jr., William A ..................................................S39

E
Egel, Dan .................................................................S54
Evans, Michael R ..........................................................S26, S27
Evans, William B .........................................................S42, S61

F
Fain, Glenn B .............................................................S18, S20
Mansur, Zainab ........................................... S19
Marshall, D.A. ................................................. S60
Marshall, Donna A. .......................................... S37
Martinei, Adriana .............................................. S58
Masabni, Joseph G. ........................................... S28, S52
McAfee, Jason .................................................. S39
McCain, A. ....................................................... S42
McCain, Anna H. ............................................... S61
McGregor, Cecilia E. ......................................... S52
McKenney, Cynthia ......................................... S25, S33, S39, S61
Meder, Amanda ................................................ S58
Mendez-Urbaez, Carlos J. .................................... S41
Meyers, Stephen L. ........................................... S45
Miller, Gilbert .................................................... S53
Mogol, B.A. ....................................................... S47
Monks, David ................................................. S49
Montague, Thayne ........................................... S25, S33, S39, S61
Montilla, Carlos ............................................... S45
Mortley, Desmond G. ........................................ S49
Motes, Dennis ................................................... S59
Mou, Beiquan .................................................... S59
Moyer, Michelle ................................................ S27
N
Neal, Lydia C. .................................................. S46
Nesbitt, Monte .................................................. S19
NeSmith, Scott .................................................. S61
Newman, Julie P. ............................................... S35
Niu, Genhua ..................................................... S21, S22, S23, S34
Njiti, Victor ........................................................ S51
Njue, O. ............................................................. S50
O
Odom, Summer F. ............................................... S27
Ogles, C.Z. ......................................................... S55
Oki, Lorence R. .................................................. S35
Olive, John ........................................................ S18
Owen, James S. ................................................ S35
Owen Jr., James S. ............................................ S23
Owings, Allen ................................................... S28, S30, S33, S34
P
Palazoğlu, T.K. .................................................. S47
Palma, Marco A. ............................................... S57
Panthee, D.R ...................................................... S22
Park, Dara M. .................................................... S35
Parks, Staci ..................................................... S33, S39
Pascua, V.T. ........................................................ S47
Patel, Takshay .................................................... S22
Patil, Bhimu ..................................................... S40
Pattaravayo, Rachanee ....................................... S48
Pemberton, H. Brent ......................................... S57
Perez, Christina ............................................... S34
Perkins-Veazie, Penelope .................................... S24, S37, S38, S56, S60
Pesic-VanEsbroeck, Zvezdana ............................. S46
Peterson, Hikaru H. .......................................... S18, S29
Phillips, Nate .................................................... S56
Picha, David H. ................................................ S47, S49, S51
Pitts, J. ............................................................... S38
Pitts, James ...................................................... S61
Pitts, James A ................................................... S39, S55
Polozola, Michael F. ........................................... S50
Porter, Justin ..................................................... S58
Pounders, C.T. .................................................. S60
Primomo, Valerio ............................................. S43
R
Ranney, Thomas G. .......................................... S22
Rashid, Tahir .................................................... S51
Rauh, Brad ....................................................... S36
Reighard, Gregory L. ......................................... S36
Reynolds, R. ..................................................... S47
Reynolds, S. ..................................................... S42
Rinehart, T.A. ................................................... S60
Robbins, J. ....................................................... S26, S32
Roberts, Matt ................................................... S59
Rom, C.R. ........................................................ S19, S60
Rom, Curt R. .................................................... S26, S39
S
Saha, Shubin K. ............................................... S54
Sakhanoko, H.F. ................................................ S60
Sandlin, M’Randa R. .......................................... S27
Santos, Bielinski M. ........................................... S41
Saperstein, Raleigh ........................................... S18
Saraswat, D. ..................................................... S32
Schall, Carly .................................................... S56
Schultheis, Jonathan R. ...................................... S49, S53, S54
Seifrit, Donald ............................................... S51
Shange, Raymon .............................................. S49
Shankle, Mark W .............................................. S45
Shankle, M.W. .................................................. S46
Sharma, Sat Pal ............................................... S42
Shi, Ainong ..................................................... S59
Shoulders, Catherine W. .................................... S27
Sibley, Jeff L. .................................................... S38, S60
Simunovic, Josip .............................................. S48
Singh, Raj ......................................................... S29
Skinkis, Patty ................................................... S27
Sloan, John ....................................................... S31
Sluznis, Richard ............................................... S55
Smith, Cody D. ................................................ S43
<table>
<thead>
<tr>
<th>Name</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smith, Erick</td>
<td>S37</td>
</tr>
<tr>
<td>Smith, Tara</td>
<td>S43, S48, S50</td>
</tr>
<tr>
<td>Smith, T.P.</td>
<td>S44, S48</td>
</tr>
<tr>
<td>Sorker, Asm H.</td>
<td>S57</td>
</tr>
<tr>
<td>Sorker, ASM. H.</td>
<td>S50</td>
</tr>
<tr>
<td>Souza, Everton</td>
<td>S58</td>
</tr>
<tr>
<td>Spiers, James D.</td>
<td>S20, S21, S37, S39, S55</td>
</tr>
<tr>
<td>Stafne, Eric T.</td>
<td>S27, S36</td>
</tr>
<tr>
<td>Starman, Terri W.</td>
<td>S22</td>
</tr>
<tr>
<td>Stein, Larry</td>
<td>S52</td>
</tr>
<tr>
<td>Stetina, Salliana R.</td>
<td>S51</td>
</tr>
<tr>
<td>Stoddard, C. Scott</td>
<td>S43</td>
</tr>
<tr>
<td>Stringer, S.J.</td>
<td>S60</td>
</tr>
<tr>
<td>Stringer, Stephen J.</td>
<td>S37</td>
</tr>
<tr>
<td>Suchoff, David H.</td>
<td>S54</td>
</tr>
<tr>
<td>Sun, Youping</td>
<td>S34</td>
</tr>
<tr>
<td>Sutterer, Larry</td>
<td>S54</td>
</tr>
<tr>
<td>Swanson, R. Bailey</td>
<td>S18</td>
</tr>
<tr>
<td>Swanson, Ruthann</td>
<td>S18</td>
</tr>
<tr>
<td>Sweany, Rebecca R.</td>
<td>S47</td>
</tr>
<tr>
<td>Taylor, Josephine</td>
<td>S31</td>
</tr>
<tr>
<td>Thompson, Andrew B.</td>
<td>S21</td>
</tr>
<tr>
<td>Thompson, R.L.</td>
<td>S47</td>
</tr>
<tr>
<td>Thompson, W. Bradfred</td>
<td>S49, S53</td>
</tr>
<tr>
<td>Thor, Yiwen</td>
<td>S48</td>
</tr>
<tr>
<td>Threlfall, Renee T.</td>
<td>S20, S58</td>
</tr>
<tr>
<td>Torres-Quezada, Emmanuel A.</td>
<td>S41</td>
</tr>
<tr>
<td>Truong, An N.</td>
<td>S48</td>
</tr>
<tr>
<td>Truong, Van-Den</td>
<td>S48</td>
</tr>
<tr>
<td>Truong, V.D.</td>
<td>S47</td>
</tr>
<tr>
<td>Unger, Daniel R.</td>
<td>S30, S31</td>
</tr>
<tr>
<td>V</td>
<td></td>
</tr>
<tr>
<td>van Iersel, Marc</td>
<td>S30</td>
</tr>
<tr>
<td>Van Kampen, Kristin</td>
<td>S20</td>
</tr>
<tr>
<td>Villordon, A.Q.</td>
<td>S48</td>
</tr>
<tr>
<td>Villordon, Arthur</td>
<td>S43, S44, S48</td>
</tr>
<tr>
<td>Vincent, Ellen A.</td>
<td>S35</td>
</tr>
<tr>
<td>Vinson, Edgar L.</td>
<td>S38, S60</td>
</tr>
<tr>
<td>Volder, Astrid</td>
<td>S32, S42</td>
</tr>
<tr>
<td>Walker, Andy</td>
<td>S38</td>
</tr>
<tr>
<td>Wallace, Russell</td>
<td>S52</td>
</tr>
<tr>
<td>Walter-Peterson, Hans</td>
<td>S27</td>
</tr>
<tr>
<td>Wang, Xi</td>
<td>S21, S23</td>
</tr>
<tr>
<td>Wang, Xiang</td>
<td>S46, S47</td>
</tr>
<tr>
<td>Wang, Zheng</td>
<td>S42</td>
</tr>
<tr>
<td>Ward, J.K.</td>
<td>S46</td>
</tr>
<tr>
<td>Waters, Vickie</td>
<td>S52</td>
</tr>
<tr>
<td>Watson, W. Todd</td>
<td>S19</td>
</tr>
<tr>
<td>Weechte, W.P.</td>
<td>S52</td>
</tr>
<tr>
<td>Wells, Christina E.</td>
<td>S53</td>
</tr>
<tr>
<td>Wells, Daniel</td>
<td>S28, S33</td>
</tr>
<tr>
<td>Wetzstein, Hazel Y.</td>
<td>S58</td>
</tr>
<tr>
<td>White, Sarah A.</td>
<td>S20, S35</td>
</tr>
<tr>
<td>Wilkins, Bryan S.</td>
<td>S39</td>
</tr>
<tr>
<td>Williamson, J.D.</td>
<td>S22</td>
</tr>
<tr>
<td>Windham, Mark</td>
<td>S34</td>
</tr>
<tr>
<td>Witcher, Anthony L.</td>
<td>S18</td>
</tr>
<tr>
<td>Wood, Matthew A.</td>
<td>S31</td>
</tr>
<tr>
<td>Woods, Floyd M.</td>
<td>S38, S60</td>
</tr>
<tr>
<td>Woods, Tim</td>
<td>S57</td>
</tr>
<tr>
<td>Wright, A.</td>
<td>S26</td>
</tr>
<tr>
<td>Wright, Amy</td>
<td>S55, S58</td>
</tr>
<tr>
<td>Wright, A.N.</td>
<td>S55</td>
</tr>
<tr>
<td>Z</td>
<td></td>
</tr>
<tr>
<td>Zambrano-Vaca, Carlos A.</td>
<td>S41</td>
</tr>
<tr>
<td>Zhao, Xiaojie</td>
<td>S24, S35</td>
</tr>
<tr>
<td>Zimmerman, Thomas W.</td>
<td>S45</td>
</tr>
<tr>
<td>Zlesak, David</td>
<td>S31</td>
</tr>
</tbody>
</table>
Abstracts of Presentations
from the
Annual Conference
of the
American Society for Horticultural Science
July 8–31, 2014, Orlando, Florida

Supplement to HortScience
Volume 49(9) September 2014

Contains abstracts of colloquia and workshops, plus oral and poster presentations from the 2014 ASHS Annual Conference.

Part 1:
Colloquia .................................................................S68
Workshops ...............................................................S76
Index of Authors, Coordinators, and Moderators ..................S112

Part 2:
Oral Presentations ..................................................S115
Poster Presentations ..................................................S246
Index of Authors and Moderators .................................S407

Appendix:
Presentations Listed by Title (includes Colloquia, Workshops,
Oral, and Poster Presentations) ..................................S423

For citation purposes, abstracts should be cited as follows:

(Example)

American Society for Horticultural Science
1018 Duke Street, Alexandria, VA 22314
phone: 703.836.4606 • fax: 703.836.2024 • ashs.org • ashs@ashs.org
Recent Advances in Perennial Berry Crop Nutrition and Directions for Future Research

Sponsor: Viticulture and Small Fruits (VSF) Working Group
Moderator/Coordinator: David R. Bryla, brylad@onid.orst.edu
Coordinator: Bernadine C. Strik, bernadine.strik@oregonstate.edu

The objective of the colloquium is to bring together leaders in the field of berry crop nutrition to discuss recent research on the topic and provide guidance for future investigations required to address new industry challenges, such as expanding production into non-traditional growing regions and to increase protection of water sheds and natural resources.

Many advances in research have been made recently on plant and soil nutrition of berry crops. The information is essential for developing new or improved nutrient management practices for these crops and plays a vital role in enhancing fruit production and quality, protecting soil and water resources, reducing fertilizer usage, and maintaining or improving competitiveness of the small fruit industry in the marketplace. Speakers specializing in nutrition of blueberry, blackberry, cranberry, raspberry, and strawberry will present their recent research findings, offer advice on nutrient management, and provide new ideas for future research. The covered topics will include dynamics of soil nutrient supply and loss; uptake, assimilation, and partitioning of plant nutrients; soil and plant tissue standards for accurate assessment of nutrient requirements; new and efficient methods of fertilizer application; and soil amendments to enhance crop nutrition. The colloquium will offer attendees an opportunity to learn more about the physiology and management of nutrients in these important horticultural crops and a chance to participate at the end of the presentations in a panel discussion on directions and plans for new research. The outcomes should be particularly useful to new faculty and students interested in research and consulting work in crop nutrition.

2:00–2:15 PM
An Introduction to Regional Nutrient Management of Berry Crops
*David R. Bryla
USDA–ARS, HCR; Corvallis, OR

2:15–2:45 PM
Understanding the Physiological Response of Perennial Strawberry to Nitrogen Limitations and Developing Nutrient Management Practices to Improve Plant Growth and Productivity
*Marvin P. Pritts
Cornell University, Ithaca, NY

Strawberry plants have many physiological characteristics in common with perennial trees and shrubs, despite their small size. Over the last 50 years, strawberries increasingly have been grown as annuals in warmer climates where cold weather does not interrupt the growth cycle. However, in many temperate regions of the world, strawberries are still grown as perennials. So while the basic physiology between annual and perennial strawberries is the same, the nutritional management is quite different. With perennial strawberries, the plant establishes a vegetative structure, initiates flower primordia, prepares for winter, regrows the vegetative structure quite rapidly after winter, produces flowers and fruits, produces stolons, and then repeats the process for another year. To understand the management of key nutrients in perennial systems, growth, carbon acquisition and metabolism must be understood, because these influence the demand for essential nutrients, particularly nitrogen. As with most other perennial crops, soil tests are used to determine macronutrient needs. If the recommendations are correct, then adequate nutrients (e.g. Ca, Mg, K) are applied to ensure that the plant can meet demand for most nutrients for several years after planting, without supplemental additions or further pH adjustment. Nitrogen is the exception in that most soils do not provide adequate amounts to optimize growth and fruiting, so periodic additions are required. Several principles apply to the application of N in perennial strawberries: 1) during establishment, excessive N fertilizer in spring can damage root systems and create too much vegetative growth and running, 2) excessive N in the fall can reduce C reserves and potentially reduce yield the following spring, 3) if C reserves are adequate, supplemental fall N can increase yields, 4) spring N applications have only a small effect on subsequent yield, but stimulate vegetative growth and may cause increased Botrytis on fruit. Many soil testing labs routinely recommend P incorporation during strawberry plant establishment, yet there is little evidence that additional P is helpful when levels are above a minimum level. In fact, excessive P can suppress availability of some micronutrients (e.g. Zn) and cause deficiency symptoms under certain conditions.
circumstances. Perennial strawberry roots are active during colder times of the year, so are able to acquire and accumulate nutrients like P when the plant is not actively growing above ground. Inadequate B can trigger deficiencies in K and P, despite adequate levels in soil.

2:45–3:15 PM

Uptake and Partitioning of Nutrients in Blackberry and Raspberry and Evaluating Plant Nutrient Status for Accurate Assessment of Fertilizer Requirements

*Bernadine C. Strik
Oregon State University, Corvallis

David R. Bryla
USDA–ARS, HCR; Corvallis, OR

Knowledge of annual accumulation of nutrients and periods of rapid uptake allows for better management of fertilization programs. Raspberry and blackberry (Rubus sp.) plantings have relatively low nutrient requirements compared to many other perennial fruit crops. Annual total N accumulation in the aboveground plant ranged from 69–122 kg·ha⁻¹ and 37–44 kg·ha⁻¹ in field-grown red raspberry and blackberry, respectively. Research on the fate of applied ¹⁵N has shown that primocanes rely primarily on fertilizer N for growth, whereas florican growth is highly dependent upon stored N in the over-wintering primocanes, crown, and roots; 30% to 40% of stored N was allocated to new growth. Plants receiving higher rates of N fertilizer took up more N, often leading to higher N concentrations in the tissues, including the fruit. Reallocation of N from senescing floricanes and primocane leaves to canes, crown, and roots has been documented. Accumulation of other macro- and micronutrients in plant parts usually preceded growth. Primocanes generally contained the highest concentration of most nutrients during the growing season, except Ca, Cu, and Zn, which often were more concentrated below ground in roots. Roots typically contained the highest concentration of all nutrients during winter dormancy. Nutrient partitioning varied considerably among elements due to different nutrient concentrations and requirements in each raspberry and blackberry plant part. This difference not only affected the proportion of each nutrient allocated to plant parts, but also the relative amount of each nutrient lost or removed during harvest, leaf senescence, and pruning. Macro- and micronutrient concentrations are similar for raspberry and blackberry fruit, resulting in a similar quantity of nutrient removed per ton of fruit harvested; however, yield may differ among cultivars and production systems. Nutrient removal in harvested red raspberry and blackberry fruit ranged from 12–20 kg·ha⁻¹ N, 2–4 kg·ha⁻¹ P, 11–21 kg·ha⁻¹ K, 1–2 kg·ha⁻¹ Ca, and 1–4 kg·ha⁻¹ Mg. Pruning senescing floricanes in August led to greater plant nutrient losses than pruning in autumn. Primocane leaf nutrient concentrations are used in nutrient management programs, but concentrations often differ among cultivars and with leaf sampling time. Development of tissue standards that are specific to the type of caneberry grown (e.g., primocane- and florican-fruiting raspberry or blackberry, and erect vs. trailing blackberry) would be an important tool for nutrient management programs.

3:15–3:45 PM

Nutrient Assimilation in Southern Highbush Blueberry and Implications for the Field

*Rebecca L. Darnell
University of Florida, Gainesville

Jeffrey G. Williamson
University of Florida, Gainesville

Blueberries (Vaccinium spp.) are adapted to a narrow range of soils that have low pH, high organic matter, and nitrogen in the ammonium form. Under more typical agricultural soil conditions of higher pH, lower organic matter, and nitrogen in the nitrate form, blueberry growth is sub-optimal. This is likely due, in part, to a limitation in the uptake and assimilation of nitrate-N. Studies indicate that nitrate uptake and assimilation are limited in highbush blueberry compared with ammonium uptake/assimilation. Increased dry weight accumulation under ammonium vs nitrate-N fertilization supports this. Iron uptake and assimilation also appear to be reduced under high soil pH conditions, also contributing to decreased growth of blueberry in these soils. V. arboresum (sparkleberry) is a wild tree-like species that is native to the southeastern U.S. and is found on low organic matter, higher pH (~6.0–6.5) soils. Sparkleberry is better able to assimilate nitrate-N and iron, especially under higher pH conditions, compared with highbush blueberry. These characteristics of sparkleberry may be exploited by using it as a rootstock for southern highbush blueberry (SHB). We currently have two plantings of grafted vs own-rooted SHB growing on amended vs non-amended soils with or without pH control. Canopy growth of grafted plants initially lagged behind that of own-rooted plants, but by the end of the second growing season (2013), canopy growth rate of grafted plants increased such that canopy volumes of grafted plants were similar to or greater than own-rooted plants, especially on non-amended, higher pH plots. In general, N, P, K, and Fe leaf concentrations were higher in SHB grafted onto sparkleberry rootstocks compared with own-rooted SHB, while leaf Ca and B were lower. Grafted plants generally had higher leaf chlorophyll concentrations throughout the season compared with own-rooted plants. Yields of grafted plants the first fruiting season (2013) were lower compared with own-rooted plants on amended soil, but similar to yields of own-rooted plants on non-amended soil. Since yields are highly correlated with canopy volume, we predict there will be very little yield difference between grafted and own-rooted plants in the second fruiting season, even on amended soils. Preliminary results suggest that limitations in nitrogen and iron uptake/assimilation may limit blueberry growth in non-amended, high pH soils; however, more research is needed in order to determine the ability of grafted blueberry to overcome nutrient deficiencies and maintain growth under these soil conditions.
Fertilizer and Soil Management Practices for Improving the Efficiency of Nutrient Uptake and Use in Northern Highbush Blueberry

*David R. Bryla  
USDA–ARS, HCRL, Corvallis, OR

Bernadine C. Strik  
Oregon State University, Corvallis

Northern highbush blueberry (Vaccinium corymbosum L.) is a long-lived perennial crop (30+ years) well-adapted to acidic soil conditions (pH 4.5–5.5). Plants acquire primarily NH₄⁺ over NO₃⁻N and tolerate relatively low concentrations of P, K, Ca, and Mg in the soil and high concentrations of plant available metals such as Al and Mn. Leaf and soil nutrient standards are available for blueberry, but the standards are mostly derived from research on one or two cultivars or from anecdotal evidence collected from commercial plantings. Recently, we found that optimal leaf nutrient concentrations may vary in blueberry, depending on the age of the planting, the cultivar, or the method in which the fertilizer is applied. For example, in a new planting, we found that leaf concentrations of many nutrients were within or above the range considered normal for fully-productive mature plants. Plant uptake of most of the nutrients increased throughout the growing season, indicating that it would be best to apply the majority of fertilizers in the split application in the spring. However, uptake of K, Mg, Mn, and Zn was greater later in the season, and therefore, it may be better to apply these nutrients, if needed, in early or midsummer. Leaf nutrient concentrations are also higher, in many cases, in early- than in late-season cultivars, or when the plants are fertilized with granular fertilizers than by fertigation in new plantings. We also found that young blueberry plants were sensitive to high soil salinity levels associated with the use of granular N fertilizers and demonstrated that growth and yields were greater when the fertilizer was applied by fertigation. With granular ammonium sulfate, electrical conductivity of the soil solution (ECw) reached levels as high as 13 dS·m⁻¹ following the first split application in the spring, 10 dS·m⁻¹ following the second application, and 8 dS·m⁻¹ following the third application in early summer, which is 5-fold higher, on average, than the level considered safe for blueberry. In comparison, ECw remained < 2 dS·m⁻¹ when the fertilizer was applied weekly from mid April to late July by fertigation. Fertigation is becoming a common practice for highbush blueberry, but much more research is needed to identify the best fertilizer sources of each nutrient to use, determine precisely how much of each nutrient to apply, and to decide exactly when to apply them to a given cultivar.

Target Compost Analytical Values for Application to Highbush Blueberry

*Dan M. Sullivan  
Oregon State University, Corvallis

Recent development of markets for blueberry (Vaccinium corymbosum L.) produced under Organic certification has stimulated interest in production of composts specifically tailored to its edaphic requirements. Blueberry is a calcifuge (acid-loving) plant that responds favorably to mulching and incorporation of organic matter into soil. Many composts are high in pH and soluble nutrients and may not be suited to blueberry. This presentation will review the chemical criteria for “custom” blueberry compost, based on plant growth in recent mulch and soil amendment trials. Acidic pH (< 5.5) is the most important compost characteristic for blueberry. Chemical analyses of compost can be used to identify potential compost suitability for blueberry. Composts with pH < 6 are rare, so a testing protocol to quantify the pH buffering capacity of compost (CBC) and the quantity of acidity needed to reduce compost pH to 5.0 was developed. Composts that require > 8 g·kg⁻¹ so for acidification (to pH 5) and contain total K > 10 g·kg⁻¹ (by acid digestion and ICP determination), total cations (sum of Ca, Mg, K, Na) > 1.5 mol (+)/kg, and have electrical conductivity (EC) > 4 dS·m⁻¹ (by SME) may damage transplants when applied at high rates (> 5 cm depth) to blueberry beds. Even when applied as mulch, composts with high EC can kill transplants. Composts that meet all of the target chemical analysis criteria are rare. Therefore, composts that meet “most” of the analytical criteria should be considered for trial use. To meet target compost analysis values, compost N usually should be limited to low analysis values (< 20 g·kg⁻¹ N) because high pH and EC and excess K are often present in composts with higher N analyses. Typical municipal yard debris composts in western Oregon usually meet the suggested target compost analytical criteria for pH and EC. However, they often contain K concentrations near the suggested limit, which could be a potential long-term soil problem (K⁺ leaches slowly). An ongoing field trial (2006 to present) in western Oregon has demonstrated that yard debris has a positive effect on yield but a negative effect in terms of weed control costs relative to alternative mulches such as sawdust or weed mat. In the future, blueberry production systems that combine geotextile weed mat and compost show promise and may help growers realize the benefits of compost use without incurring additional weed control costs.

Craberry Nutrient Management in Southeastern Massachusetts: Balancing Crop Production Needs and Water Quality

*Carolyn J. DeMoranville  
University of Massachusetts, Amherst

Cranberry (Vaccinium macrocarpon), native to North America, is a low growing plant that produces stolons that cover the soil, root at intervals along their length, and produce upright shoots that bear the crop. The plant is acid-loving and adapted to sandy, nutrient-poor soils and thus, like blueberry, its nutritional requirements are low compared to many other perennial crops. Research conducted over the past 30 years has defined the annual requirements for N (20–60 kg·ha⁻¹), P (< 20 kg·ha⁻¹), and K (40–120 kg·ha⁻¹) based on tissue testing, plant growth demands,
potential for remobilization, and determination of removal in the crop. However, much of this work was conducted on native cultivars and there is an expectation that requirements of newer hybrid cultivars are greater. In Massachusetts, cranberries are grown in coastal watersheds and often depend on small lakes as their water source for irrigation and harvest and winter flooding. As a result, cranberry farmers are faced with regulatory demands including TMDL (total maximum daily load) limits as mandated in the Federal Clean Water Act. Since cranberry production is heavily dependent on water use, the interaction of nutrient management, particularly for N and P, and water management has become a primary focus area for research and extension. A study of N output from a single cranberry farm identified annual output in the range of 20 kg·ha⁻¹. That number has since been used in models of watershed-wide N contributions to coastal estuaries in Southeastern Massachusetts. However, the farm in that study was a “flow-through” style cranberry system with a constantly flowing stream running through the beds. That configuration represents >15% of cranberry farms in the region. Recent preliminary research examining cranberry farms with other configurations has indicated that the cranberry bogs may act as either source or sink for N depending on configuration and management activities. In a study of cranberry farms where P use was reduced to an average of <10 kg·ha⁻¹, P concentration in harvest flood water declined by as much as 85% while crop production was sustained. However, results were variable leading to the need for further research to define how soil types and site hydrology interact with P loss in harvest floods.

5:15–6:00 PM
Panel Discussion, Q&A

Tuesday, July 29 8:00–12:00 PM

The Importance of Light Quality for High Value Plant Products
Sponsors: Controlled Environments (CE) Working Group*, Floriculture (FLOR), Quality, Safety, and Health Properties (QUAL), and Vegetable Crops Management (VCM) Working Groups
Moderator/Coordinator: Gioia D. Massa, gioia.massa@nasa.gov
Objectives: The light environment is one of the most influential abiotic factors impacting quality of specialty crops. This colloquium will cover recent advancements in the applications of advanced lighting technologies in specialty crop production systems. Speakers will focus on impacts in specialty production systems including vegetables, floriculture and ornamentals, and bio-pharmaceuticals. Attendees will be introduced to the benefits of using color-selected phosphor fluorescent lamps, narrow-band light emitting diodes (LEDs), wavelength filters, and reflective technologies and how they can be applied to horticultural research and commercial production. This colloquium will follow on from a very successful workshop on LED lighting held in 2007.

Light is one of the most important environmental stimuli affecting plant growth and development; moreover, growers can now easily manipulate light quality in controlled growing environments. Opportunities now exist to apply different lighting technologies to increase the value of specialty crops. Technologies such as advancements in color-selected phosphor fluorescent lamps, narrow-band light emitting diodes, wavelength filters, and reflective materials allow for the specific control of light quality to eliminate spectra outside the photosynthetic action spectrum or provide unique wavelengths to maximizing efficiency or increase desired qualities. Optimizing and customizing the light spectrum and intensity may have dramatic impacts on plant growth and development, physiology, and energy fluxes within metabolic pathways, all impacting crop quality. Topics will cover increasing yield, quality, and specialized plant characteristics.

8:00–8:05 AM
Introduction to the Colloquium
*Tessa H. Pocock
NASA, Kennedy Space Center, FL

8:05–8:35 AM
Light Control of Consumer-desired Traits in High-value Produce
*Kevin M. Folta
University of Florida, Gainesville
Sofia D. Carvalho
University of Florida, Gainesville
Thomas A. Colquhoun
University of Florida, Gainesville

Plants possess a set of sensors that monitor the ambient light environment. These photoreceptors are sensitive to wavelengths from UV-C to near-infra red, and each sensor controls discrete physiological, developmental and metabolic processes. We have exploited activation of specific light sensors in changing and dynamic lighting programs to tailor biological outcomes, particularly in regard to consumer-desired traits in high-value crops. The appearance and nutrient content of sprouts has been manipulated with light. We have demonstrated that we can change the accumulation of important aroma/flavor volatiles in herbs and fruits, both pre- and postharvest. Current efforts seek to identify genotypes with wavelength dependent phenotypic plasticity with the goal of breeding for selections most amenable to light manipulation and presentation of desirable or novel traits. Our interest is not to design light conditions to simply support plant growth and development. Instead the goal is to design a vocabulary of light treatments that command specific aspects of plant growth, development and metabolite accumulation/retention. These findings advance opportunities to produce improved plant products with non-chemical, non-invasive, and inexpensive treatments.

8:35–9:05 AM
LED Light Impacts on Specialty Crops
*Tessa H. Pocock
Rensselaer Polytechnic Institute, Troy, NY

LEDs have been in existence for a long time now, but the wide range of adjustable narrow-band LEDs in horticulturally relevant wavelengths is relatively new. It is now possible to work toward understanding how to achieve precision lighting in production facilities while controlling plant attributes including morphology, development and biochemistry. Light is the energy source for plants but it also provides information that can shape the plants development. There are five different families of photoreceptors that sense the information carried in light but the chloroplast can also act as a sensor that can elicit similar responses. Research performed on crop and model organisms grown under different spectral compositions will be presented.

How this fits into context with what is being published today and the challenges of interpreting these complex systems will be discussed.

9:05–9:35 AM

**LEDs Create a Less Stressful Light Environment and Increases in Higher-energy Blue Wavelengths will Increase Production of Nutritionally Important Metabolites in Specialty Vegetable Crops**

*Dean A. Kopsell*
The University of Tennessee, Knoxville

Carl E. Sams
The University of Tennessee, Knoxville

Robert C. Morrow
ORBITEC, Madison, WI

Light is one of the most important environmental stimuli impacting plant growth and development. Plants have evolved specialized pigments to capture light energy to drive photosynthetic processes, as well as respond to changes in light quality and quantity. Blue light can act as a powerful environmental signal regulating phototropisms, suppression of stem elongation, chloroplast movements, stomatal regulation, and cell membrane transport activity. An emerging application of light-emitting diode (LED) technology is for horticultural plant production in controlled environments. Work by our research group is measuring important plant responses to different wavelengths of light from LEDs. Using brassica species as model crop systems, we have demonstrated dramatic impacts of primary and secondary metabolism in microgreen and baby leafy green crops. Results show significantly increases in shoot tissue pigments following exposure to higher percentages of blue LED wavelengths. Significant positive correlations among NPQ and leaf tissue zeaxanthin concentrations also demonstrate LEDs provided a less stressful light environment. LED lighting with higher percentages of blue wavelengths will also significantly increase shoot and root tissue essential mineral element concentrations. Working with brassicas, we have also shown blue LED wavelengths to significantly increase nutritionally important glucosinolate compounds. The perception of energy-rich blue light by specialized plant photoreceptors will trigger a cascade of metabolic responses. Results from our research clearly show stimulation of primary and secondary metabolite biosynthesis following exposure to blue LED wavelengths. Management of the light environment may be a viable means to improve the nutritional contributions of specialty vegetable crops.

9:35–10:05 AM

**Developing Photosynthetic, Photomorphogenic, and Photoperiodic LED Lighting Applications for Floriculture Crop Production**

*Roberto G. Lopez*
Purdue University, West Lafayette, IN

Erik S. Runkle
Michigan State University, East Lansing

Light-emitting diodes (LEDs) offer numerous possibilities to manipulate growth, development, and morphology of ornamental crops grown in traditional controlled environment greenhouses and indoor production facilities. The Purdue and Michigan State University floriculture research and Extension programs are quantifying floriculture crop responses to LED lighting technologies in comparison to traditional horticultural lighting sources. We will highlight our work investigating plant responses to light quantity, quality, and duration to produce high-quality young and finished crops.

10:05–10:25 AM

**Break**

10:25–10:55 AM

**The Potential of LEDs in Plant-based Biopharmaceutical Production**

*Joey Norikane*
Fraunhofer USA, Newark, DE

Fraunhofer USA, Inc. Center for Molecular Biotechnology (FhCMB) has pioneered a transient plant-based bio-pharmaceutical platform to produce vaccines and therapeutics quickly and cost-effectively. Using this platform, plants are grown in a controlled environment using a hydroponic system. The plants are vacuum infiltrated with a recombinant Agrobacteria carrying a plant viral based-launch vector and returned to a controlled environment for the target protein to be produced in infiltrated plant tissue. When target protein levels peak in leaf tissue, the infiltrated plants are harvested and homogenized, extract is clarified and the target protein is purified. There are multiple opportunities in this system for LED’s to be applied to optimize biomass accumulation and the production of target proteins. There is potential to develop specific lighting recipes to optimize plant growth and target protein production.

10:55–11:15 AM


*Esther Hogeveen van Echtelt*
Philips Lighting, Eindhoven, Netherlands

The action spectrum of photosynthesis in plants is the ability of light of different wavelengths to support photosynthesis. Based on this fundamental process of plants, light sources were developed in the past mostly on efficiency (μmol/J). Now with LEDs we have next to energy savings many more opportunities to develop light recipes that are optimized to crop, geographical location and to grower’s business targets. Plant specialists from Philips are globally active to develop together with researchers and growers new insights and practical light recipes based on LEDs (sometimes together with traditional HPS). In these recipes the characteristics of LEDs like: choice of spectrum, intensity, lack of heat radiation, freedom of positioning and ease of switching are being balanced to reach the best result for the crop/grower. Application of these LED recipes are versatile as we have realized the past years many projects globally for high wire crops like tomato and cucumber, tissue culture propagation labs, cut flower production and many others. But also new growing concepts are now becoming possible by using LED recipes: growing on commercial scale in controlled multilayer environments for city farming, using LED light to improve secondary metabolite production of pharmaceutical crops, enhance nutrient content or taste and influencing disease resistance with light. Plants being bio-dynamic in nature respond to many factors like temperature, Carbon dioxide concentration, humidity, nutrition management, media, growing technique and light. Working toward achieving a practical, complete and customized solution with emphasis on energy savings and quality of the product with the efficient use of LEDs is the new fast track to growth.

11:15–11:35 AM

*Abhay Thosar
Philips Lighting Horticulture, Rosemont, IL

The action spectrum of photosynthesis in plants is the ability of light of different wavelengths to support photosynthesis. Based on this fundamental process of plants, light sources were developed in the past mostly on efficiency (μmol/J). Now with LEDs we have next to energy savings many more opportunities to develop light recipes that are optimized to crop, geographical location and to grower’s business targets. Plant specialists from Philips are globally active to develop together with researchers and growers new insights and practical light recipes based on LEDs (sometimes together with traditional HPS). In these recipes the characteristics of LEDs like: choice of spectrum, intensity, lack of heat radiation, freedom of positioning and ease of switching are being balanced to reach the best result for the crop/grower. Application of these LED recipes are versatile as we have realized the past years many projects globally for high wire crops like tomato and cucumber, tissue culture propagation labs, cut flower production and many others. But also new growing concepts are now becoming possible by using LED recipes: growing on commercial scale in controlled multilayer environments for city farming, using LED light to improve secondary metabolite production of pharmaceutical crops, enhance nutrient content or taste and influencing disease resistance with light. Plants being bio-dynamic in nature respond to many factors like temperature, Carbon dioxide concentration, humidity, nutrition management, media, growing technique and light. Working toward achieving a practical, complete and customized solution with emphasis on energy savings and quality of the product with the efficient use of LEDs is the new fast track to growth.
Reports suggest that the US demand for fresh tropical fruits and vegetables has increased greatly since the early 1970s. It is estimated that the imports of tropical fruits and vegetables between 1990–92 and 2004–06, increased from $2.7 billion to $7.9 billion. Fruits such as mango, pineapple, papaya, avocados, grapes, and plums increased consistently through the past decade. With an expected increase of 24% in the volume of demand for tropical fruits the estimated import of tropical fruits will account for 2.6 million tons. Although these trends seem lucrative and promising, it has its share of concerns. The major factors limiting the increase are health issues. The critical compliance requirements by the health and safety requirements although helps in preventing any untoward incident, recent large-scale food borne disease outbreaks renews the need for a better traceability and postharvest techniques to maintain the quality. Furthermore, exploring understudied fruits and vegetables pose food safety and quality concerns. These challenges are daunting but also provide opportunities for integrating different fields of sciences such as economics, microbiology, nutrition, and pre-and postharvest sciences.

8:00–8:05 AM
**Introduction to Globalized Tropical Horticulture**
*Ram M. Uckoo*  
Texas A&M University, College Station  
Tropical horticulture is the largest contributor of fruits and vegetables. In the current generation of ‘globalization’, it is imperative that this field of science needs to be researched, discussed and recognized. A brief introduction on the topics to be presented in the colloquium will be presented.

8:05–8:40 AM
**Global Challenges and Opportunities for Tropical Fruits and Vegetables as Functional Foods**
*Bhimanagouda S. Patil*  
Vegetable and Fruit Improvement Center, College Station, TX  
Peace and national security require efforts to reduce the burden of nutritional insecurity. Recent efforts by different stakeholders to increase the consumption of fruits and vegetables have not yielded the expected favorable outcomes. The current poor nutritional dietary regimen of certain sectors of the population, in both developed and developing nations worldwide, has led to an alarming increase in chronic diseases. These circumstances require a renewed focus and constructive action plan involving education, research, and promotion of healthy eating. Accumulating evidence suggests that maintaining a healthy lifestyle, including optimum daily intake of fruits and vegetables, can prevent chronic diseases. Tropical fruits and vegetables, with their high nutritional values and excellent flavor, offer an excellent means to achieve this goal. Exploring under-studied and unexplored tropical fruits and vegetables will enable us to unravel the potential benefits of nutritional components that may help to reduce the risk of certain chronic diseases. Consequently, the research community must provide valid scientific evidence on the role of these fruits and vegetables in maintaining health. Additionally, providing the consumers with knowledge and easy access to these fruits and vegetables, as functional foods, needs to be addressed. Research at the Vegetable and Fruit Improvement Center has focused on using a system-wide approach to explore tropical fruits and vegetables with functional properties. Our current research exploring the potential health benefits of tropical and subtropical species, such as certain types of citrus, carrot, pepper and turmeric, have provided a valid justification of their wide range of biological properties. Case studies of tropical fruits and vegetables will be presented, to demonstrate their potential uses to maintain health, and thus promote human well-being, decrease health care costs, and improve national security.

8:40–9:15 AM
**Tropical Medicine: Combatting the Global Epidemic of Chronic Diseases**
*Jay Morris*  
The University of Texas Health Science Center at San Antonio  
Cancer is now considered on the constellation of diseases known as non-communicable chronic diseases. Included in this group are many diseases that are generated by chronic inflammation. They include not only cancer, but diabetes, obesity, Alzheimer’s, asthma, and cardiovascular disease to name a few. By all estimates the global burden of cancer will overwhelm developing nations in the next half century. One explanation for the rise in chronic inflammatory disease is the process of acculturation, where populations drift away from traditional plant-based diets in favor of the high calorie, easy access, and phytochemically-depleted diets of developed nations. Tropical plants provide an extensive source of anti-inflammatory compounds with proven anti-cancer capability. These include compounds from green tea, and from an array of spices and herbs including turmeric, ginger, cloves, cinnamon, garlic, lemongrass, and black pepper. The evidence for anti-inflammatory action of culinary herbs and spices will be presented. Given that many phytochemicals are poorly absorbed in humans, strategies to enhance their bioavailability are the center of current research. Lastly, the new frontier of cancer epigenetics has revealed that many plant-based chemicals have the capacity to de-silence regulatory genes that are often turned off in cancer cells; the latest research suggests that judicial use of certain compounds in herbs and spices can reverse epigenetic changes in cancer cells, offering a potential promise of their use in cancer prevention and therapy.

9:15–9:50 AM
**Tropical Horticulture—Trade and Investment Opportunities for U.S. Growers**
*John VanSickle*  
University of Florida, Gainesville  
Tropical horticulture is important for both commercial and subsistence agriculture. The globalization of the economy and the increased demand for healthy and more diverse food products have opened large markets for many of these crops. Despite this
fact, increased production of many tropical crops is hindered by a lack of understanding of the basic comparative advantages in production and marketing. An understanding of the resource requirements for producing these crops and the integrated role that production and marketing have in determining trade and investment opportunities is important. This work identifies critical elements for competitive production and marketing and identifies some key products that hold promise for U.S. growers. It also discusses key policies that could influence future trade and investment opportunities.

9:50–10:25 AM

Challenges in Postharvest Procedures for Maintenance of Quality of Tropical Fruits and Vegetables

*Jeffrey K. Brecht
University of Florida/IFAS

Tropical fruits and vegetables marketed in the United States are produced primarily in other countries and exported to the United States using marine transport. Challenges involved in exporting tropical fruits and vegetables to the United States are interrelated and include those related to the production environment and to the postharvest physiology of tropical crops. Many tropical fruits and vegetables are quite sensitive to physical injury during harvesting and postharvest handling. Postharvest decays are an issue since there are no labeled pesticides available for most tropical crops. An inherent problem in international trade of tropical fruits and vegetables is that long transit durations of 2 to 4 weeks, or even longer, may exceed the limits of the products’ potential postharvest life. This is particularly problematic for fruits, because it may lead exporters to ship immature fruit with consequent poor sensory quality at the consumer level in the United States. The average daily temperatures during harvest seasons in tropical production regions are typically quite high—commonly in the range of 30 °C to 40 °C. In addition, many tropical products are subject to quarantine for insect pests and the most common treatments required to address potential infestation involve heating the products with high temperature (in excess of 40 °C) water or air. This makes rapid cooling and excellent temperature management essential for successful export operations, but the required infrastructure for proper postharvest temperature management is often lacking. On the contrary, tropical fruits and vegetables can be injured by exposure for sufficient duration to low temperatures that are below a threshold unique to each product. This chilling injury is an issue in exporting tropical products because exporters may address transit durations that test the limits of their products’ postharvest life by using lower than recommended set point temperatures in the marine containers during shipping. Since the sensitivity of tropical products to chilling injury is greater for lower maturity stages, the combination of immature products and lower than recommended transit temperatures can be devastating to product quality. These practices often result in produce that, while it has acceptable appearance upon arrival in the United States, is very likely to later develop chilling injury in stores or in consumers’ homes.

10:25–11:00 AM

Opportunities for Farmers to Grow Tropical Vegetables in the Northeastern United States

*Francis X. Mangan
Stockbridge School of Agriculture, University of Massachusetts
R. Orellana Barros
Stockbridge School of Agriculture, University of Massachusetts
A. Marchese
Stockbridge School of Agriculture, University of Massachusetts
V. Barros
Stockbridge School of Agriculture, University of Massachusetts

The demographics of the United States are changing rapidly as immigrant populations have increased at rates not seen since the early 20th century. The majority of these recent immigrants, unlike the majority who arrived from Europe in the 18th,19th and early 20th centuries, are coming from tropical and sub-tropical regions of the world. The dominant groups are Spanish and Portuguese-speaking ethnicities from Latin America; there are also growing numbers of ethnicities from Asian countries and to a lesser extent from African countries. Researchers at the University of Massachusetts, in collaboration with Rutgers University and University of Florida, have been evaluating crops popular among these new and growing immigrant groups to the northeastern United States that can be viably grown and marketed by U.S. farmers. A large percentage of vegetables grown in the Northeastern United States are from tropical and sub-tropical regions of the world. For example, more than 70% of the 15,000 hectares of vegetables that are grown in Massachusetts have their center of origin in tropical or sub-tropical regions, such as sweet corn (Zea mays), peppers (Capsicum sp.), tomatoes (Solanum lycopersicum) and species in the family Cucurbitaceae. A system has been created that involves several intergraded components to evaluate and introduce new tropical vegetables to commercial growers and markets in the northeastern United States that are desired by these new immigrants. Key components of this integrated system include: 1. Informal and formal surveys of members of the target immigrant groups and markets where they shop to learn more about specific vegetables used in their respective cuisines. 2. Trials at research facilities and on cooperating farms to establish yields, pest and fertility management, postharvest requirements, among other production and packing requirements. 3. Establish the market size and demand for specific crops, including price points and seasonal demand. 4. Assist commercial farmers to promote the target crops in order to ensure viability of the production and marketing. A critical element in all aspects of the above components is the participation of members of the target immigrant group; working with people who speak the language and know the culture of the target groups has been essential to the success of this work. This research has led to sales of more than five million dollars in retail sales since 2004 of crops never before grown in Massachusetts.
Examples introduced include calabaza (*Cucurbita moschata*), jiló (*Solanum gilo*), and water spinach (*Ipomoea aquatica*).

**11:00–11:30 AM**

**Partial Rootzone Drying as a Water Conservation Strategy for Tropical Citrus Production**

*Beatriz A. Contreras-Barragan*  
Texas A&M University, Kingsville  
Ayako Kusakabe  
Texas A&M University, Kingsville  
Juan Carlos Melgar  
Texas A&M University, Kingsville  
Shad D. Nelson  
Texas A&M University, Kingsville  
Juan Enciso  
Texas AgriLife Research, Weslaco, TX

Partial rootzone drying (PRD) is an irrigation strategy that consists in keeping half of the rootzone well-irrigated while the other half is allowed to dry in order to trigger root-to-shoot signaling to increase water use efficiency. A field experiment was conducted to evaluate the effect of PRD on growth and fruit production in mature grapefruit (*Citrus paradisi* Macf.) trees. Three different irrigation treatments were applied to 22-year-old ‘Rio Red’ grapefruit trees grown in a one acre plot: 1) Control: both sides of the rootzone were irrigated with drip irrigation (double line); 2) PRD: one part of the rootzone was irrigated with a single drip line; and 3) MS: microsprinklers. After the first year, PRD saved 41% water compared to the control without affecting fruit quality; no differences were found in fruit diameter, fruit firmness, juice percentage, total soluble solids, acidity, maturity index or yield. PRD did not cause any negative effect on tree overall condition during the first year. Second and third year still need to be evaluated but if data follow the same trend, this could be suggested as an effective water conservation approach.

**11:30–11:55 AM**

**Panel Discussion: Addressing the Challenges and Identifying the Opportunities for Advancement of Tropical Horticulture in the United States**

*Ram M. Uckoo*  
Texas A&M University, College Station  
Bhimanagouda S. Patil  
Vegetable and Fruit Improvement Center, College Station, TX  
Shad D. Nelson  
Texas A&M University, Kingsville  
Juan Enciso  
Texas AgriLife Research, Weslaco, TX

A round table panel discussion will be conducted to identify the key challenges and opportunities for the current and future of tropical horticulture globally.

---

**WORKSHOPS**

### Monday, July 28

**9:00–10:00 AM**

**Peer Review of Non-journal Article Teaching or Extension Tools: Should We, Shouldn’t We, Could We?**

Sponsor: ASHS Board of Directors  
Moderator/Coordinator: Michael A. Arnold, ma-arnold@tamu.edu

The purpose of this workshop is to discuss the development of a peer review system for non-journal article teaching or extension instruments or tools. ASHS is currently conducting surveys of members and targeted non-members in teaching, extension, and outreach positions to determine their interest in using and value associated with the development of a peer review system for the tools and instruments they develop that are not conventional journal-article types of scholarly activities. The American Society for Horticultural Science (ASHS) Board of Directors has formed an exploratory committee tasked with investigating the potential interest from the membership in submitting non-journal article teaching, extension or outreach instruments for peer review, determine if members or non-members are interested in access to and would use such peer reviewed materials in their programs, and if so what would be the perceived value of such a peer reviewed validation of non-journal article scholarly activities. One of the first steps undertaken to this end was to conduct a survey of targeted ASHS members and non-members regarding these questions. A conceptual framework of the proposed peer review system and results of the survey will be presented to the membership. The committee for this project represents a wide diversity of career backgrounds within horticulture. Following the presentation of the general framework and survey results, the committee will serve as a panel discussion group with questions and comments regarding the development of the proposed peer review of teaching and extension instruments provided from the general membership in attendance.

### Monday, July 28

**1:45–3:45 PM**

**Indigenous Herbal Medicine of Florida and Recent Developments in Cannabis Regulation and Cultivation**

Sponsor: Herbs, Spices, and Medicinal Plants (HSMP) Working Group  
Moderator/Coordinator: Hideka Kobayashi, hideka.kobayashi@kysu.edu

---

An asterisk (*) in front of a name indicates the presenting author.
Consumers increasingly continue to pursue healthy lifestyles as they become more informed about health and environment. Nearly 40% of Americans use contemporary and alternative medicine in their everyday lives for various ailments or overall well-being, and herbal medicine is once again gaining in popularity. Nowadays, many consumers opt for self-medication, including medical marijuana and native plant species. While cultivation of cannabis (Cannabis sativa L.) for recreation and self-medication are still illegal in most states in the United States, researchers at government and academic institutions in authorized states now can grow hemp, opening the door to research opportunities. The aim of this workshop is to inform participants of herbal professionalism in Florida and recent developments in cannabis regulation and research.

1:45–2:05 PM  
**A Dozen Native Medicinal Plants of the Deep South**  
*Susan Marynowski*  
Herbalist, Gainesville, FL

This fast-paced presentation will delve into a dozen important medicinal plants of the Deep South, exploring the energetics and indications —both historic and modern— for how a practitioner would use these plants in the healing clinic. We will explore some of the common “weeds” that grow all around us and under our feet, such as Solidago, Monarda, and Sambucus, as well as some lesser-known medicinal plants.

2:05–2:25 PM  
**The Movement to Medicinal Cannabis**  
*Lyle Craker*  
University of Massachussets, Amherst

While the classification of marijuana as a Schedule 1 drug has inhibited any horticultural or medicinal research for the past several years, recent acceptance by state laws may offer some opportunities to investigate horticultural practices. The ability of federal law enforcement to override state laws, however, places state universities and research centers under severe restrictions with the threat of cancelling all federal grants if federal law is violated. While the illegal production of marijuana plants has produced a number of cultivars and production techniques, scientific evidence is lacking. The failure to classify plant types according to cannabinoid levels and types may limit the ability of medical personnel to prescribe the most effective plant material and the correct dose. Thus, the question on whether cannabis can effectively treat human ailments remains unanswered.

2:25–2:45 PM  
**Organic Hemp Research at Kentucky State University**  
*Micahel K. Bomford*  
Kentucky State University, Frankfort

Kirk William Pomper  
Kentucky State University, Frankfort

Industrial hemp is a fiber, oil and seed crop with a 5,000 year history of cultivation. It was first planted in Kentucky in 1775, and Kentucky’s Bluegrass region was the center of the U.S. hemp industry through much of the 1800s. Kentucky’s hemp industry declined rapidly in the late 1800s, recovered briefly during the two world wars, and virtually disappeared by the late 1940s. Contributing factors to the decline included competition from cheaper imported fibers like jute, manila, and sisal; falling costs of domestic cotton production; and increased regulation. Hemp production was restricted by the federal Marihuana Tax Act of 1937, which required hemp growers, importers, and processors to be registered and taxed. The Controlled Substance Act of 1970 made hemp a controlled substance under Federal Law, with production regulated by the U.S. Drug Enforcement Administration. Kentucky is one of several states to have legalized the cultivation and research of industrial hemp. The 2014 Farm Bill allows State Agriculture Departments, colleges, and universities to grow hemp for academic or agricultural research purposes in states, where it is legal under state law. Kentucky State University (KSU) is evaluating hemp variety trials on certified organic land, to determine yield and competitiveness of hemp varieties that show promise for certified organic production on small farms in Kentucky. The objectives of the current hemp research at KSU are to: 1) compare yield and quality parameters of four hemp varieties grown on certified organic land and 2) evaluate hemp’s ability to compete with johnsongrass (Sorghum halepense).

2:45–3:05 PM  
**Hemp Construction in the United States and Efforts to Grow the Raw Material Here**  
*Jeanine M. Davis*  
North Carolina State University, Mills River

The nation’s first house to be constructed primarily with hemp is located in Asheville, NC. It was built with blocks of hempcrete (a composite of hemp fibers and a lime mixture). One of the companies involved in its construction, Hemp Technologies, is a leader in promoting the use of hemp for a wide range of purposes including construction, clothing, landscaping, lubrication, art, and bedding. Currently, the hemp used in these products is imported from other countries, but many individuals, organizations, and companies are working to change that. This presentation plus a short video will provide a brief overview of hemp construction, farming of industrial hemp, and efforts to bring hemp production to the United States.

Monday, July 28, 2014  
1:45–3:45 PM  
**Technological Innovations in Smart Device and Computer Usage for Extension and Teaching**  
Sponsor: Computer Applications in Horticulture (COMP) Working Group  
Moderator/Coordinator: Kent D. Kobayashi, kentko@hawaii.edu

Objectives: The goal of this workshop is to familiarize the attendees with technological innovations in the field of smart device and computer usage for extension and teaching in horticulture.
audience with leading-edge applications of smart devices and computers for extension and teaching.

With ever-changing developments in smart devices, computers, software, and high technology, one’s professional development calls for keeping abreast of advanced horticultural applications. In this workshop, four speakers will share their experiences involving innovative applications that use smart devices and computers for extension and teaching. The audience will learn about a customizable mobile website for floriculture training information, a website on greenhouse production and management for greenhouse operators, software tools for developing and delivering online courses and high quality images, and assignments involving students creating websites to develop their web technology skills.

1:45–2:05 PM
Back Pocket Grower—A Customizable Training Website for Mobile Devices
*Paul R. Fisher
University of Florida, Gainesville
Rosanna Freyre
University of Florida, Gainesville
Bruce MacKay
ThomasBaine Ltd., Palmerston North, New Zealand

Widespread use of mobile devices means that technology is no longer a critical barrier to information access by horticulture professionals in the field. The objective was to develop a website (“Back Pocket Grower™”, backpocketgrower.com), which is formatted for use on smart phones and tablets and delivers floriculture training information in the greenhouse work environment. Content includes both public and protected information, with “accounts” that allow customized access to training resources for a particular company, organization, or event such as a workshop. The website has three main components. A crop planning component presents a database of scheduled management activities such as planting, pinching, and agrichemical applications by crop type and crop stage, based on published or confidential in-house plans. A tools component includes calculator apps related to fertilizers, water quality, growing substrate testing, and crop costing. The training component includes videos and text providing background education and detailed standard operating procedures. Many of the training topics are targeted toward temporary and production staff, with English/Spanish access. The main advantage of using a mobile website rather than standalone apps is greater compatibility across devices and easier maintenance. As the horticulture extension community develops an increasing number of online training options, the biggest challenges probably now relate to marketing, funding, collaboration, and adoption of training resources rather than technical issues.

2:35–2:55 PM
Tools for Enhancing the Development and Delivery of Online Courses
*James McConnell
University of Guam, Mangilao

The Tropical Agricultural Science Program at the University of Guam currently has one course delivered fully online (including the lab which utilizes a lab kit) and numerous courses delivered as hybrid courses. Several tools are used to help enrich the online learning experience. The courses are currently managed using Moodle. SoftChalk (www.softchalk.com) is used to produce lessons that included interactive activities not available within Moodle. SoftChalk lessons are stored externally to Moodle, but can be accessed by links in Moodle. Lessons can include activities that are graded and the scores automatically posted into the Moodle Gradebook. Lessons can also be exported to disk for situations where web access is unavailable. The current generation of cameras produces images that contain great detail, but because of the high resolution, are generally too large to download and display at typical bandwidth speeds available to students. In order to utilize the detail of full resolution images, Zoomify (www.zoomify.com) is used. Zoomify makes it possible to deliver high-resolution images that can be zoomed and panned with reduced loading lag on the web. Zoomify images can be incorporated into online lessons making detailed images more usable. Images can also include interactive labeling. Producing images continues to become easier as
camera technologies advance. While full frame DSLRs offer the highest quality images, smaller format cameras are much easier to carry and produce high quality images. A brief summary of the strengths and weaknesses of some recent camera formats will be compared.

3:00–3:20 PM
Using Web-based Assignments to Enhance Student Learning and Productivity
*Hye-Ji Kim
University of Hawaii at Manoa

The use of the Internet has become an integral part of higher education for teaching and learning. To enhance students’ learning experiences, undergraduate students in the Department of Tropical Plant and Soil Sciences at University of Hawaii at Manoa were asked to submit web-based assignments as their course requirements. The type and format of web-based assignments were constructed based on the level and requirement of the course: i) TPSS 120E Plants for People, Ornamental Plants: a web-based report on ornamental plants, ii) TPSS 364 Horticultural Practices: a web-based report on their weekly gardening activities, and iii) TPSS 420 Plant Propagation: a web-based report on propagation of selected plant material. Students were asked to create a website on a public domain, design their own webpages, and post pictures and information relevant to the topic of their assignment. The premises were that through constant interaction with information technology, students will be familiarized with web technologies and resources, develop web technology skills, create and utilize their own website as information delivery tool, and/or be better prepared for their career goal with their published website. Their feedback was solicited after the courses were completed. Results showed that students were positive toward the incorporation of web-based assignments, and found the assignment to be very relevant to their learning and to promote a positive attitude to learning and achievement with a high level of motivation. These results show that the use of web-based assignment can serve as an effective teaching and learning tool in a technology-infused classroom.

Monday, July 28
1:45–3:45 PM
USDA–ARS: Highlights on Citrus Research in Florida
Sponsor: Federal Partners Working Group
Coordinator: Penelope Perkins-Veazie, penelope_perkins@ncsu.edu

The purpose of this workshop is to highlight the type of work done in federally funded U.S. laboratories. An important component of United States agriculture is the U.S. Department of Agriculture (USDA), which is made up of 66 agencies. The Agricultural Research Service (ARS) is one of these agencies, and its role is to do long-term fundamental work that addresses agricultural problems of current priority and maintain continuity for further problems (such as germplasm maintenance, long-term production practices, etc.) that cannot be addressed by public or private universities. In this workshop, research done at the USDA–ARS Horticulture Research laboratory in Fort Pierce, Florida, is highlighted to demonstrate the coordination and collaboration needed to address the citrus commodity, including greening disease and products from citrus waste.

1:45–2:10 PM
Effect of Greening or Huanglongbing (HLB) Disease on Orange Fruit and Juice Flavor
*Elizabeth Baldwin
USDA–ARS, USHRL, Ft. Pierce, FL

Greening or Huanglongbing (HLB) disease of citrus was discovered in Florida in 2005. It can kill a citrus tree in 5 years and imparts off-flavor to the fruit and subsequent juice. The disease is thought to be caused by a bacteria (Liberibacter asiaticus), vectored by a psyllid and is now found in all citrus growing areas in Florida, drastically reducing yields. Our laboratory is working on both ends of the problem, keeping the trees alive and productive, and for my unit, identifying the off-flavors and the chemical compounds responsible as well as developing strategies to manage the disease-induced off-flavor.

2:10–2:35 PM
Estimation of Relative Abundance of 16S rDNA of Candidatus Liberibacter asiaticus by Comparison to Host Cytochrome Oxidase DNA in Orange Juice
*Jinhe Bai
Elizabet Baldwin
Wei Zhao
USDA–ARS, USHRL, Ft. Pierce, FL

A protocol was developed to isolate DNA from orange juice and detect titer of Candidatus Liberibacter asiaticus (CLas), the presumed pathogen associated with citrus Huanglongbing (HLB) disease by real-time PCR. To obtain quality DNA, new methods were used to remove pectin and unidentified inhibitors.

2:35–3:00 PM
The Pharmacokinetics and Health Benefits of Orange Peel Compounds
*John A. Manthey
Elizabeth Baldwin
Jinhe Bai
USDA–ARS, USHRL, Ft. Pierce, FL

Orange peel is a resource rich in phenolic antioxidants, including several classes of flavonoids and hydroxycinnamates. These compounds have been extensively studied for their biological actions particularly against chronic diseases in humans. Yet, full development of these materials as new, commercial products has yet to be achieved, as important gaps still exist in our understanding of the pharmacokinetics and modes of actions
An asterisk (*) in front of a name indicates the presenting author.

Monday, July 28, 2014

Gateways to International Horticulture—Potentials and Challenges

Sponsor: Working Group of Asian Horticulture
Moderator: Hye-Ji Kim, hkim2@hawaii.edu
Coordinators: Shengrui Yao, yaoa@nmsu.edu and Mengmeng Gu, mgu@tamu.edu

Increasing trends in transcontinental travels, commerce, and trade; an easier access and availability to digital information; and a greater level of cooperation among governments and institutions in agriculture have lead to increased opportunities in international horticulture in the past few decades. Today, opportunities in international horticulture are abound and varied, ranging from access to plant germplasm for crop improvement, human nutrition, or medicinal purposes; adoption of cultural practices for best crop production and pest management practices followed elsewhere; access to new and automated technologies available for horticulture crop production and postharvest; and the exchange of knowledge and information in research and education as well as international employment opportunities. The eagerness and willingness to work and collaborate at an international platform involves either relocating to a different country or indirectly working with people and institutions from a different country. These opportunities then come with their challenges that can range from those being scientific in nature, unintentionally introducing a potentially invasive plant species or a potential pest problem, monetary challenges (such as lack of adequate funding or inadequate knowledge on sources of funding), or socio-cultural challenges that could involve language barriers, dealing with regulations and strategies different from ones’ home country or targeting a different market population. The workshop will highlight some of the potentials and challenges of international horticulture research, teaching and outreach.

4:00–4:25 PM

How to Find an International Horticulture Opportunity That Fits Your Experience

*John L. Griffis Jr.
Florida Gulf Coast University, Ft. Myers

Many horticulturists, from home gardeners to students to professors to researchers, dream of traveling internationally, meeting exotic people and working on projects in far away lands. Certainly there exists a wealth of opportunities, but some of the more familiar ones, such as the USAID-funded farmer-to-farmer program require more than a bit of professional experience and are not available to non-U.S. citizens. Other longer-term consulting opportunities are often very difficult to qualify for without a lot of prior experience and a specific degree may be required. So, how does anyone get a start in international horticulture? There are actually a lot of ways to gain valuable experience and there are a lot of websites where anyone can find out much more. We’ll briefly look over several programs and portals that will help guide you along the path to the “right” international horticulture opportunity.

4:25–4:50 PM

The Role of the Horticulture Lab in International Horticulture

*Robert E. Paull
University of Hawaii at Manoa

Investment in horticulture is important because of the close link between poverty and hunger and malnutrition. Horticultural development offers the opportunity to meet food needs and improve nutrition and health in the developing world, while providing prospects for income diversification and economic advancement of the rural poor. In addition, women are, in many regions, the main producers and marketers of horticultural crops, so increasing horticultural production often leads to an improved income stream for women and their children. Typically, horticultural crops are both highly nutritious and economically valuable. Horticultural research is crucial to enable small-scale producers to overcome agronomic market barriers and realize the benefits offered by horticultural development. For the past five years, a collaborative team lead by the University of California, Davis, has managed the Horticulture Innovation Lab (formerly Horticulture CRSP), with the mission of building international partnerships for fruit and vegetable research to improve livelihoods in developing countries. The Horticulture Innovation
Lab is about to enter its second five years (Phase II). We have reflected on the unique opportunities and challenges presented by horticultural development, and enter Phase II committed to building international research partnerships to sustainably reduce global poverty and hunger. In order to achieve this goal, we will focus on horticultural value chain research, innovation and scaling, capacity building, nutrition-sensitive horticulture, empowering women and the most vulnerable, and sharing information. The Horticulture Innovation Lab partner universities are the University of Hawaii, Manoa, North Carolina State University, the University of Florida, and Cornell University. We will share our work and results from the past five years, reflect on some of the opportunities and challenges that we have encountered while working in horticultural development, and discuss our plans for the next five years.

4:50–5:15 PM
*International Collaboration on Teaching, Research, and Extension
*Donglin Zhang
University of Georgia, Athens

5:15–PM
*Benefits of Studying Abroad from Global Perspective
*Hye-Ji Kim
University of Hawaii at Manoa
Mengmeng Gu
Texas AgriLife Center, College Station

Monday, July 28

4:00–6:00 PM
*Nickolai Ivanovich Vavilov: Plant Genetic Resources Pioneer and Hero
Sponsor: History of Horticultural Science (HIST) Working Group
Moderator/Coordinator: Jules Janick, janick@purdue.edu
Objectives: The objective of this workshop is to celebrate the life and career of N.I. Vavilov and to bring into focus the enduring impact of Vavilov on Genetics, Plant Breeding, and Horticulture.

Nicolai Ivanovich Vavilov (1873–1943), one of the pioneers of 20th century plant breeding, is best known for seminal work in identifying centers of origins and diversity for cultivated plants. Vavilov studied genetics with William Bateson from 1913–14 at the John Innes Horticultural Institute. In 1921, he was chosen by Vladimir Lenin to head the Branch of Applied Botany in Petrograd (St. Petersburg) and rose to be the Director of the All-Union Institute of Agriculture in Leningrad, where he oversaw agricultural research for the entire country. By 1934, Vavilov established more than 400 research institutes and experiment stations with a staff of 20,000. His efforts established the Soviet Union as a world leader in genetics and plant breeding in the 1920s and early 1930s. Vavilov studied genetics with William Bateson from 1913–14 at the John Innes Horticultural Institute. In 1921, he was chosen by Vladimir Lenin to head the Branch of Applied Botany in Petrograd (St. Petersburg) and rose to be the Director of the All-Union Institute of Agriculture in Leningrad, where he oversaw agricultural research for the entire country. By 1934, Vavilov established more than 400 research institutes and experiment stations with a staff of 20,000. His efforts established the Soviet Union as a world leader in genetics and plant breeding in the 1920s and early 1930s. Vavilov carried out an extensive series of expeditions worldwide, including the United States, to collect germplasm; and he created the world’s largest repository, over 250,000 seed accessions.

An asterisk (*) in front of a name indicates the presenting author.
4:00–4:30 PM  
**Nicolai Ivanovich Vavilov: Plant Geographer, Geneticist, Martyr of Science**  
*Jules Janick  
Purdue University, West Lafayette, IN  
Nicolai Ivanovich Vavilov (1873-1943), one of the pioneers of 20th century plant breeding, is best known for seminal work in identifying centers of origins and diversity for cultivated plants. Vavilov studied genetics with William Bateson from 1913-1914 at the John Innes Horticultural Institute. In 1921, he was chosen by Vladimir Lenin to head the Branch of Applied Botany in Petrograd (St. Petersburg) and rose to be the Director of the All-Union Institute of Agriculture in Leningrad, where he oversaw agricultural research for the entire country. By 1934, Vavilov established more than 400 research institutes and experiment stations with a staff of 20,000. His efforts established the Soviet Union as a world leader in genetics and plant breeding in the 1920s and early 1930s. Vavilov carried out an extensive series of expeditions worldwide, including the United States, to collect germplasm; and he created the world’s largest repository, over 250,000 seed accessions. However, as a result of famine in the Soviet Union in the late 1920s, partly as a result of forced collectivization of peasants, Vavilov came in conflict with an ambitious agronomist, Trofim Lysenko, who came to prominence with an agricultural technique proposed in 1928, of exposing chilled, soaked seeds of wheat (dubbed vernalization) to extend production in northern areas of Russia. Lysenko’s rejection of Mendelian genetics won the support of Joseph Stalin, leading to the arrest and death sentence of Vavilov, although this was later commuted to 20 years imprisonment. Vavilov died of starvation in prison in 1943, thus entering the select group martyrs of science along with Gordiano Bruno, Galileo Galilei, Antoine Lavoisier, and Georgii Karpechenko.

4:30–5:00 PM  
**Molecular Mechanisms and the Laws of Homologous Variation**  
*Kevin Folta  
University of Florida, Gainesville  
Vavilov’s Law of Homologous Series in Variation is built upon the concept that similar traits selected during domestication would share a common genetic basis. There is predictive value in understanding these traits because of likely shared mechanisms. Modern genomics tools can be implemented to test this concept. Important plant traits such as flowering, disease resistance and abiotic stress tolerance share remarkably similar mechanisms and support Vavilov’s contention. On the other hand, some traits do not obey this principle. For instance, seed shattering was domesticated multiple independent times in parallel. In these cases, molecular resolution shows that the different domestica- tion events were based on separate molecular mechanisms. In a broader view, colinearity and synteny are conserved within the genes underlying these functions. An analysis of larger genome structure is consistent with Vavilov’s Law, whereas selection of specific traits frequently can be attributed to gene-level alterations that fit into the existing syntenic relationships. Directed breeders, to the continued improvement and economic development of plants for humanity. Inherent genetic plant variability is the basis of domestication and breeding into crops of economic importance with food, fuel, fiber, and industrial uses. The objective of this manuscript is to summarize Vavilov’s revised centers of origin of cultivated crops and discuss how these have been further modified by other scientists including, most notably, Jack Harlan. Examples of major crop species, including cereals, protein plants, starch crops, fruits, and vegetables, will be discussed in relation to their origins. Conservation of their genetic resources and potential for future development will be presented.

5:00–5:30 PM  
**Vavilovian Centers of Diversity: Implications and Impacts**  
*Kim E. Hummer  
USDA–ARS, NCGR, Corvallis, OR  
Nikolai I. Vavilov, Academician of the V. I. Lenin All-Union Academy of Agricultural Sciences, takes his place as a found- ing pillar of knowledge in the cathedral of the origin and development of cultivated plants. Relying on the theories of his revered predecessors Charles Darwin and Alphonse de Candolle, Vavilov developed the concept of centers of origin for agronomic crops. Vavilov’s astute hypotheses set the stage for the modern use of exotic germplasm in plant breeding. Vavilov, a life-long scientist, used additional plant collections and data evaluation to continually revise and refine his theory of the centers of crop origins. Though he initially proposed three centers in 1924, his final papers of 1940 discussed seven major centers. His concept of specific centers of origin for crop plants was not an isolated aphorism but has directed breeders, to the continued improvement and economic development of plants for humanity. Inherent genetic plant variability is the basis of domestication and breeding into crops of economic importance with food, fuel, fiber, and industrial uses. The objective of this manuscript is to summarize Vavilov’s revised centers of origin of cultivated crops and discuss how these have been further modified by other scientists including, most notably, Jack Harlan. Examples of major crop species, including cereals, protein plants, starch crops, fruits, and vegetables, will be discussed in relation to their origins. Conservation of their genetic resources and potential for future development will be presented.

5:30–6:00 PM  
**Vavilov’s Centers of Crop Origins versus Centers of Diversity: Why Does That Distinction Matter?**  
*Gary Paul Nabhan  
Kellogg Endowed Chair in Sustainable food Systems, University of Arizona, Tucson  
Building on deCandolle and even Darwin, Nicolai Vavilov developed the first testable theories regarding bio-geographic discernment of areas of crop origins. His maps have then been
An asterisk (*) in front of a name indicates the presenting author.

HortScience 49(9) Supplement—2014 ASHS Annual Conference

used as the basis for discussing the biogeography of centers of crop land race diversity and diversity of wild crop relatives, if not mega enters of wild biodiversity in general. Jack Harlan cautioned against confusing and conflating these different geographies, but his center vs. non-centers counter proposal was less than satisfactory. New advances in genetics, historic linguistics, archaeology and paleoclimatic habitat suitability modeling have now been used by an interdisciplinary team of us to advance a new integrative method for determining the geographic origins of particular crops, but it can also help determine whether several crop domestications were culturally or ecologically related in space and time. However, the issues of determining land rice diversity hotspots, wild crop relative hotspots, and overall biodiversity hotspots are only marginally useful in determining crop origins. What’s more, current hotspots for wild and cultivated plant diversity may be artifacts of prehistoric and historic land use changes associated with periods of colonization, conflict and landscape degradation that confound our sense of where diversity was situated at Thor immediately after the re of domestication. Examples from chile peppers, beans and what will bring these points home.

Monday, July 28

**Promoting Horticulture: A New National Initiative to Recruit the Next Generation of Horticulture Professionals**

Sponsor: ASHS Board of Directors
Moderator/Coordinator: Mary H. Meyer, meyer023@umn.edu

Horticulture offers one of the most satisfying and rewarding careers, with an increasing number of people needed in the future, yet young people today are often unaware of the opportunities and diversity in this engaging field. The National Initiative plans to change this. ASHS, along with Longwood Gardens, AmericanHort, American Horticultural Society, National Junior Horticultural Association, and American Public Gardens Association have announced a National Initiative to promote horticulture. Over 150 industry, academic, public gardens and horticultural associations have agreed with the proposal to increase the awareness and advocacy of horticulture. This workshop will discuss the initiative, the firm selected for the work being done this year along with practical ideas of what academia, public gardens, and industry can do to recruit the next generation of horticulture professionals. Discussion will allow time for all participants to share thoughts and ideas.

4:00–4:15 PM
**Discussion with all the speakers**

4:15–4:30 PM
**The Need for a National Promotion of Horticulture**

*Mary H. Meyer
University of Minnesota, Chaska

The National Initiative to Promote Horticulture plans to change the perception of horticulture. Launched in 2013, an update and status of this project will be given along with a brief presentation by the company selected to complete the initiative.

4:30–4:45 PM
**Ideas from Academia**

*John M. Dole
North Carolina State University, Raleigh

What you can do today to increase the visibility of horticulture to new university students.

4:45–5:00 PM
**Ideas from Public Gardens**

*Paul Redman
Longwood Gardens, Kennett Square, PA

Public gardens are a natural place for anyone, young or old, to learn about plants. Longwood has a wide variety of educational programs, many of which are models for other gardens.

5:00–5:15 PM
**Ideas from Industry**

*Craig Campbell
Valent Biosciences, Libertyville, IL

Horticulture graduates often have a choice of employment opportunities; many hort industries face labor shortages; hear from industry how to attract horticulture students and future employees.

5:15–6:00 PM
**Discussion with all the speakers**

Tuesday, July 29, 8:00–10:00 AM

**Climate Change and the Role of Plasticulture to Help Mitigate the Impact on the Production of Vegetables and Berries**

Sponsor: Plasticulture Working Group
Coordinator: Juan Carlos Diaz-Perez, jcdiaz@uga.edu

Plasticulture technologies have allowed significant increases in yield and quality of fruits and vegetables all over the world. Benefits of plasticulture technologies can be attributed in part to their ability to modify the crop microenvironment. Increased temperatures and irregular temperatures patterns due to climate change may result in reduced crop yields and quality, increased utilization of irrigation water, and augmented incidences of insects and plant diseases. This workshop will discuss research and current and potential applications of plasticulture technologies intended to maximize yield and quality, as well as to mitigate the impact of climate change, particularly the effects of increased temperatures on the production of vegetables and berries.

4:00–4:15 PM
**Discussion with all the speakers**

4:15–4:30 PM
**The Need for a National Promotion of Horticulture**

*Mary H. Meyer
University of Minnesota, Chaska

The National Initiative to Promote Horticulture plans to change
Row Covers are a Weather Risk Management Tool in Plasticulture Strawberries

*Barclay Poling  
North Carolina State University, Raleigh

The 2014 winter season in the Mid-South proved to be one of the most challenging winters for management of cold weather extremes since strawberry plasticulture was introduced in this region in the early 1980s. Though temperatures below –20 °C were not experienced this past winter (as occurred in January 1985), many strawberry growing areas in North Carolina experienced temperatures of just below –17.7 °C on 7 January 2014. Despite plants being fully dormant at the time of this arctic clipper in early January, significant crown injury occurred in both Chandler and Camarosa plants that did not have winter row cover protection. The freeze-injured plantings were about 10 days later in crop ripening in spring 2014 than plantings that had row cover protection. A second “arctic clipper” occurred in the Mid-South over the period of 26 February to 1 March 2014, and minimums were as low as –10 °C in the NC piedmont. At this juncture, the crop had broken dormancy and was in the pre-bloom period. With row cover protection during this second arctic clipper in late February, growers were able to save nonemerged flower buds that were still inside crown, but a high percentage of newly emerged ‘tight’ buds were killed at –10 °C. Under the windborne freeze conditions of 26–27 February, a small number of growers attempted a relatively new technique of using sprinkling in conjunction with row covers, and this approach proved to be very successful for saving all flower buds stages (nonemerged and emerged) as well as the so-called “popcorn” stage (just before open blossom). The author will describe a relatively new weather tool called the ‘Row Cover Optimizer’ that provides generally accurate two week weather forecasts for strawberry growers in a 4-state region (VA-NC-SC-TN). With this tool, growers can better anticipate when their row covers may need to be “ON” for freezes, and they are also advised of mid-winter “warm up” periods when covers need to be ‘OFF.’ Whenever average daily temperatures in January are 4 °C to 5 °C above normal, and this happens over a consecutive 2–3 day period, there is greater risk of the crop breaking dormancy underneath the cover. Smaller strawberry plasticulture growers (< 4 ha) with access to family and/or local labor are generally more successful in making timely adjustments in winter row cover usage according to changing weather conditions than are larger growers who depend on a migrant labor force that is unavailable until early spring.

High Tunnel Production of Organic Strawberry in Northern Florida: Opportunities and Challenges

*Xin Zhao  
University of Florida, Gainesville

High temperatures during late spring and early summer cause flower drop, fruit abortion, and fruit physiological disorders such as sunscald, resulting in substantial fruit yield loss to bell pepper (Capsicum annuum L.) in the southeast U.S. Shade nets are used to modify the microenvironment with the goal of improving crop production. The objectives were to evaluate effects of shade level on plant disease and fruit yield. Experiments were conducted in Tifton, GA, during the spring and summer 2009 and 2010, with cvs. Camelot, Lafayette, Sirius, and Stiletto. Bell pepper plants were grown on plastic film mulch under shade levels of: 0% (unshaded, as a control), 30%, 47%, 63%, and 80%. Incidence of Phytophthora blight (caused by Phytophthora capsici Leon.) and fruit sunscald decreased with shade level by 2009 and 2010. Total and marketable (Fancy and US1) fruit yield, and individual fruit weight increased with shade level to a maximum and then de-
creased with further increases in shade level. The US2 and cull (sunscaled) fruit declined with increasing shade level. Based on regression analysis, optimal shade level for marketable yield was 34% and 35% for mature green and ripe fruit, respectively. Among cultivars, ‘Camelot’ had among the highest marketable fruit number and fruit yields and ‘Sirius’ the greatest number of cull fruit. ‘Sirius’ produced the heaviest fruit, followed by ‘Camelot’, ‘Lafayette’ and ‘Stiletto’.

Tuesday, July 29 8:00–10:00 AM

**Two-minute Teaching Tips**

**Sponsor:** Teaching Methods (TCHG) Working Group  
**Coordinator:** Cynthia Haynes, chaynes@iastate.edu  
**Objectives:** Provide innovative ideas on improving teaching to interested ASHS members. Discuss teaching tips with attendees. Want some ideas on how to improve your teaching? Watch the members of the Teaching Methods Working Group briefly present some of their favorite teaching tips. Each presenter will have 2–3 minutes to share their favorite tip and how it has worked with their students. At the end of the session, attendees can ask questions and discuss these teaching tips and others with the group.

Tuesday, July 29 10:15 AM–12:15 PM

**Hot Topic Workshop**

**Advancing Worldwide Research, Education, and Outreach with Massive Open Online Courses—How Does It Work?**

**Sponsor:** ASHS Education Division  
**Moderator/Coordinator:** Sandra B. Wilson, sbwilson@ufl.edu  
**Objectives:** 1) To provide insight in creating and managing MOOCs that can be used worldwide to disseminate research, teaching and extension expertise. 2) To address acceptance of MOOCs for degree credit, institutional and instructional benefits, and the overall educational quality of a MOOC learning experience.

Online technology is transforming the way top universities teach and how we can interact with the world in the same virtual classroom. As an educational technology company that partners with leading universities and organizations to offer massive open online courses (MOOCs) for free, Coursera’s mission is to connect the world to a great education to foster learning without boundaries. Based on sound pedagogical foundations, their technology enables student’s to master new concepts quickly and effectively in a global community of thousands rather than hundreds. The Coursera platform currently supports over 21 million student enrollments in 571 courses representing 190 countries (www.coursera.org). In this workshop, speakers will provide insight from their personal experiences in creating and managing certified MOOCs in economic food issues, sustainable energy, and agricultural land management with enrollment ranging from 10,000 to 22,000 initial students in a single session.

10:15–10:55 AM

**A Mooc Point: Collision or Collaboration**

*Rebecca Miles  
University of Arkansas  
Curt R. Rom  
University of Arkansas

The past two decades brought an explosion of new teaching technologies with a resulting proliferation of on-line courses, virtual degree programs, and internet-based colleges. One example gaining attention in both academic and public domains is the Massive Open On-line Course (MOOC). In this session, the authors will present and lead a discussion on the development of MOOCs and their role in and impact on educational programs. There have always been means of self-education and self-improvement — ways to learn independently and blaze an individual trail for a career or increased education. MOOCs are a new tool for individuals pursuing personal goals; however, the presence of MOOCs in the existing, traditional educational environment creates interesting questions. Are MOOCs a new and novel educational approach or simply an old idea dressed differently? Who is the audience for MOOCs and whose needs do these courses meet? Do MOOCs fit into our traditional agricultural curricula and outreach programs or do MOOCs pose a threat? Should our universities and/or our faculty develop MOOCs or participate in commercial MOOC consortia (such as Coursera) and what would be incentives or disincentives to produce and share a MOOC? Should a MOOC be a part of the teaching methodology and curricula portfolio or an academic resource for enhancement? The presenters will explore these ideas and lead an open “crowd-sourcing” discussion as an opening to the workshop.

10:55–11:35 AM

**“Me and My MOOC” — An Online University of Florida Class in Global Sustainable Energy**

*Wendell Porter  
University of Florida

The advent of new media types allow for the development of new delivery systems and just as a movie is different from a book of the same title, the delivery of educational material is different online than it would be in a traditional classroom. This presentation will explore the transition of a typical university class into an asynchronous online learning experience. Developmental methods will be discussed as will typical problem areas. The multi-faceted approach for each learning topic, or module, will be outlined and examples given. The necessity of the pairing of the Instructional Designer and the content expert faculty will be explained and discussed in detail. The seven year history of this class will be summarized and used as a lead in to discuss the conversion of this methodology into a new learning delivery methodology titled: massive, open, online course, or
MOOC. The interaction of the instructor in the original online course is a key part of the student experience while as a matter of course, this capability is entirely removed for the MOOC. With 10,000 to 100,000 students, interaction with the instructor is quite limited. Course construction and differences will be presented along with examples of how this method can be useful for extension activities.

11:35–12:15 PM

**Sustainable Agricultural Land Management, an Agricultural Course Offering with Coursera.org**

*George J. Hochmuth
University of Florida

Shay Potts
University of Florida

In 2012, the University of Florida (UF) joined a consortium of worldwide universities with the educational technology company, Coursera, offering massive open online courses (MOOCs). Among the first four courses offered by UF was Sustainable Agricultural Land Management. This course, first offered in 2013, was the first agricultural course offered through Coursera. Sustainable Agricultural Land Management, modeled after a course taught on campus at the graduate level, introduced agricultural nutrient and water best management practices to an international audience. The course begins with discussions about world-wide challenges with nutrient pollution and water scarcity and presents the history of environmental regulations in the USA. We discuss many of the farming practices used by farmers today that conserve soil and improve crop nutrient and irrigation management, making farming more sustainable. A basic theme of the course is the “triple bottom line” that emphasizes consideration of social, environmental, and economical aspects of farming practices. We focus on science-based solutions and practices that farmers around the world are using - or could use - to produce food in an environmentally protective and economically sustainable fashion. The course has three lectures each week, for 8 weeks, with weekly quizzes and weekly discussion topics. There is a major peer-assessed optional project dealing with a major agricultural or environmental issue where the students live and work. The issue should be one that they would like to address with ideas learned in the course. The students develop solutions that they may propose to decision-makers. There are four levels of completion in the course Statements of Accomplishment. Two of these statements involve the “Signature Track” which is a Coursera verified certificate with a minimal cost. The course has been offered twice, averaging 12,000 students from all over the world. It has been interesting to see the similarity of the environmental problems and food production issues in the countries of the world. This MOOC has provided an opportunity to take a university course on agricultural sustainability to a worldwide audience and to receive feedback from that audience that will strengthen the MOOC in future offerings as well as improve the campus-based course.

Tuesday, July 29

10:15 AM–12:15 PM

**ASHS meets SWD: A New Pest of Small and Stone Fruits**

Sponsor: Viticulture and Small Fruits Working Group
Moderator/Coordinator: Jimmy Klick, klickj@hort.oregon-state.edu

Objectives: 1) Educate students, technicians, extension agents and faculty about this new invasive pest, Spotted Wing Drosophila (SWD), to facilitate their communications with the industry and public. 2) Provide hands-on experience to learn identification and detection of SWD. 3) Provide management options for SWD.

A new invasive pest of small and stone fruit crops has been causing economic damage in North America and Europe. The spotted wing drosophila (SWD), *Drosophila suzukii*, is a vinegar fly that infests ripe fruit. The biology, life cycle, global impact, management, and current and future research will be discussed. A hands-on education session on adult and larval identification and monitoring will facilitate communication to the audience. This workshop will provide crucial knowledge to students, technicians, extension agents, and faculty that do research, consult, and work in any aspect related to small and stone fruit crops.

10:15–10:45 AM

**Spotted Wing Drosophila: A Major Threat to Small and Stone Fruit Production in the United States**

*Ash Sial
University of Georgia

Spotted wing drosophila (SWD), *Drosophila suzukii* (Matsumura) (Diptera: Drosophilidae), a native of Eastern and Southeastern Asia, has recently emerged as a devastating pest of small and stone fruits in the United States. Since its first detection in California in 2008, SWD has spread throughout the United States causing significant losses in crop yield (as high as 100%) and quality, which have been estimated at $850 to $900 million annually. The SWD is a highly polyphagous insect and presents a major threat to soft- and thin-skinned fruit industries including blueberries, caneberries (blackberries and raspberries), cherries, strawberries, peaches, and grapes in the United States. Management of SWD is further complicated by the lack of reliable traps and lures that can be used to determine fly density and infestation risk. While this aspect of SWD monitoring is actively being researched, SWD management is currently achieved primarily through preventative insecticide applications. The zero tolerance policy for SWD by marketers has led growers to make weekly insecticide applications, which may be reapplied in the event of rain. With applications occurring once or twice a week throughout the growing season, the selection pressure is extreme and likely to lead to resistance development in SWD, which threatens the sustainability of SWD management programs. Results from the recent investigations to optimize the use of currently available tools in SWD monitoring and management programs will be discussed.
Workshops

10:45–11:05 AM

SWD in Florida: Monitoring, Alternative Hosts, Management, and Outreach
*Lindsay Iglesias
University of Florida
Teresia Nyoike
University of Florida
Oscar Liburd
University of Florida

The spotted wing drosophila (SWD), Drosophila suzukii, is an invasive pest threatening Florida’s small fruit industry. Female flies lay eggs in ripe fruit, where larvae develop, resulting in unmarketable fruit. Since its introduction into Hillsborough County in 2009, SWD has been trapped in all major blueberry producing counties except DeSoto in the south. A strict monitoring program using a simple and effective trap-and-lure system is necessary to anticipate SWD outbreaks and guide control actions. Results from field studies comparing different trap designs showed little difference between designs baited with commonly used apple cider vinegar (ACV). The same designs baited with a yeast mixture captured more SWD in the field. Studies evaluating the attractiveness of different recommended baits for SWD in the field showed that yeast-based baits captured more SWD than ACV and a rice vinegar-red wine mixture. Trapping studies in blueberry fields also showed that fields adjacent to stands of wild blackberry (Prunus spp.) were more infested with SWD. Wild blackberry has been shown to be a viable SWD host and its prevalence in surrounding areas is an important consideration when developing management programs. Current management recommendations include sanitation and short harvest intervals to remove host material from the field. Multiple chemical control tools have shown to be effective when used in rotation to prevent pesticide resistance. Due to SWD’s increasing threat to Florida’s small fruit industry, research is occurring rapidly. Outreach workshops disseminate up-to-date research to growers, extension, and researchers and provide training on identification, monitoring, and control options.

11:05–11:25 AM

Hands-on Teaching: Identifying and Monitoring SWD Adults and Larvae
*Jimmy Klick
Oregon State University
Lindsay Iglesias
University of Florida

The larvae and adults of the small vinegar fly, Spotted Wing Drosophila (SWD), Drosophila suzukii, can be difficult to identify and distinguish from other insects. Correct identification is necessary for estimating prevalence of this important pest in fruit crops and for making management decisions. A hands-on education session will facilitate communication to the audience and provide essential skills in adult and larval identification and monitoring of SWD. Work stations will teach the audience about recognizing symptoms on fruit, extracting larvae from infested fruit and identifying male and female adults. These skills are crucial to students, technicians, extension agents, and faculty that do research, consult and work in any aspect related to small and stone fruit crops.

11:25–11:40 AM

Managing SWD Using Reduced Spray Strategies
*Jimmy Klick
Oregon State University
Denny Bruck
USDA–ARS
Wei Qiang Yang
Oregon State University

Since the invasion of Spotted Wing Drosophila (SWD), Drosophila suzukii, blanket applications of broad-spectrum pesticides are made between 2 and 8 times per season to protect susceptible fruit from infestation. As a consequence, growers are faced with the challenges of managing harvest around pesticide preharvest and restricted entry intervals; disruption of current IPM programs; increased secondary pest outbreaks; increased production costs; fruit knockdown from sprayers traveling down rows; and greater risks to environmental and human health. Reduced pesticide application strategies may mitigate some of these challenges. Field studies were conducted from 2011 to 2013 to determine (1) if reduced spray programs manage SWD as well as conventional blanket sprays and (2) the economics of the reduced spray programs. Three raspberry sites and one blueberry site were alternate-row middle sprayed and border sprayed, respectively, and compared to blanket sprays during the harvest season. SWD adults and larvae, non-target arthropods and fruit knockdown were quantified. Reduced pesticide strategies such as alternate-row middle and border sprays show promise as a replacement to blanket sprays for SWD management while reducing spray area, application time and production costs.

11:40–11:55 AM

Comparing Pesticide Delivery Methods for SWD Control
*Wei Qiang Yang
Oregon State University
Lynell Tanigoshi
Washington State University
Vincent Hebert
Washington State University

Three pesticide delivery methods were compared for efficacy in controlling spotted wing drosophila (SWD) – a new invasive pest in the United States. Airblast had the best field coverage, followed by helicopter and micro-spray chemigation. Foliage bioassays indicated that SWD mortalities were mostly similar between airblast and non-invasive micro-spray chemigation of Mustang Maxx®. However, airblast provided a better coverage than micro-spray chemigation at harvest despite airblast’s eco-
The results showed that all of the fruit juices are attractive to SWD; however, those from raspberry and strawberry were most attractive. The headspace volatiles from these juices were tested in GC-EAD experiments using antennae from both male and female SWD. Strong electrophysiological antennal responses were observed. The EAG active volatile compounds from raspberries have been identified and their attractiveness will be evaluated under field conditions. SWD attractants could be used in baits for early detection of fruit infestation as well as in the development of attract-and-kill strategies to manage SWD in small fruit farms.
Southeastern United States

An asterisk (*) in front of a name indicates the presenting author.

The primary focus of the USDA-ARS stone fruit rootstock program at Byron, Georgia has been the development of disease resistant rootstocks for peach. Historically peach tree short life (PTSL), aka “Bacterial Canker Complex”, and Armillaria root rot (ARR) have been the two most important causes of premature mortality of commercial peach trees in the southeastern United States. Several root-knot nematode species are of concern in this region as well. In addition to these disease issues the horticultural performance of trees on the new materials developed in this program is also of paramount importance.

Watermelon rootstocks were used with scions to determine effects on field holding quality, fresh cut quality, and composition. Watermelon fruit could be held a week in the field (attached to the vine) without loss of quality (firmness, lycopene, sugars) if grafted to interspecific squash hybrid rootstocks. Lycopene content was enhanced by 10% to 20% with rootstock, but citrulline content was slightly lower in grafted fruit. Fresh cut watermelon from fruit field-stored up to 7 days and held at 4 °C for 10 days had little drip loss although juice pH increased compared to 0 day field stored fruit. Watermelons field-stored 14 days had loss of firmness, loss of lycopene, and high pH when fresh cut. Our results show that grafted watermelons can be held attached to the vine in the field under high temperatures after full ripeness to 7 days without negative effects on fruit flesh characteristics or fresh cut life.

Effect of Different Tomato Mosaic Virus Resistance in Grafted Tomato Scions and Rootstocks

*Penelope Perkins-Veazie
North Carolina State University, Kannapolis

Richard L. Hassell
Clemson University, Coastal Research & Education Center, Charleston, SC

Watermelon rootstocks were used with scions to determine effects on field holding quality, fresh cut quality, and composition. Watermelon fruit could be held a week in the field (attached to the vine) without loss of quality (firmness, lycopene, sugars) if grafted to interspecific squash hybrid rootstocks. Lycopene content was enhanced by 10% to 20% with rootstock, but citrulline content was slightly lower in grafted fruit. Fresh cut watermelon from fruit field-stored up to 7 days and held at 4 °C for 10 days had little drip loss although juice pH increased compared to 0 day field stored fruit. Watermelons field-stored 14 days had loss of firmness, loss of lycopene, and high pH when fresh cut. Our results show that grafted watermelons can be held attached to the vine in the field under high temperatures after full ripeness to 7 days without negative effects on fruit flesh characteristics or fresh cut life.

Effects of Different Tomato Mosaic Virus Resistance in Grafted Tomato Scions and Rootstocks

*Erin Rosskopf
USDA–ARS

Jason Hong
USDA–ARS

Nancy Kokalis-Burelle
USDA–ARS

Chieri Kubota
University of Arizona

Scott Adkins
USDA–ARS

During the 2011–12 production season, ‘heirloom’ tomato scions grafted onto Tomato yellow leaf curl virus (TYLCV)-resistant tomato rootstocks were observed to undergo a rapid and severe wilt, and necrosis. No soilborne plant pathogens were detected, but several of the necrotic plants were infected with Tomato mosaic virus (ToMV). During the 1970s, a rapid wilt resulting from mechanical damage to the rootstock bark, called rootstock blight, was prevalent. Rootstock blight has been observed on several other rootstocks and is known to cause a rapid decline in scion productivity and fruit quality.

The primary focus of the USDA-ARS stone fruit rootstock program at Byron, Georgia has been the development of disease resistant rootstocks for peach. Historically peach tree short life (PTSL), aka “Bacterial Canker Complex”, and Armillaria root rot (ARR) have been the two most important causes of premature mortality of commercial peach trees in the southeastern United States. Several root-knot nematode species are of concern in this region as well. In addition to these disease issues the horticultural performance of trees on the new materials developed in this program is also of paramount importance.

The primary focus of the USDA-ARS stone fruit rootstock program at Byron, Georgia has been the development of disease resistant rootstocks for peach. Historically peach tree short life (PTSL), aka “Bacterial Canker Complex”, and Armillaria root rot (ARR) have been the two most important causes of premature mortality of commercial peach trees in the southeastern United States. Several root-knot nematode species are of concern in this region as well. In addition to these disease issues the horticultural performance of trees on the new materials developed in this program is also of paramount importance.
from differential virus resistance in tomato rootstocks and scions was reported in Japan. This has not been of significant concern in the US where interest in grafting is relatively new. In most cases, commercial tomato scions are resistant hybrids and have ToMV resistance. The problem has arisen when ToMV-resistant rootstocks (having allele combinations of Tm-2/Tm-2 and Tm-2a/Tm-2a) are grafted with susceptible (Tm-1 or tm) scions. In the case of the field trial using grafted ‘heirloom’ tomatoes where the rapid wilt occurred, scions were homozygous susceptible and the rootstocks were homozygous resistant with Tm-2/Tm-2 genotype. Recent work has confirmed that, particularly with grafting of ‘heirloom’ tomato scions to commercially-available tomato rootstocks, it is important to select a rootstock that has the same resistance alleles as the scion, or has the Tm-1 gene, which appears to prevent the wilt regardless of the scion resistance status. The wilt only occurs when plants become infected with the virus. It has become standard practice in the Japanese market to provide ToMV compatibility information, but this has not been the case in the United States, where the grafted tomato market is just beginning to grow.

3:05–3:25 PM

Toward More Effective Selection of Tomato Rootstock and Scion Varieties for Use in U.S. Soil-Based Production, Including Organic

Bizhen Hu
The Ohio State University

Jennifer B. Moyseenko
The Ohio State University

Stephanie Short
The Ohio State University

Sonia D. Walker
The Ohio State University

*Matthew D. Kleinhenz
The Ohio State University

North American propagators and fruit growers look ever more often to preparing and using grafted tomato plants to enhance income potential. Selecting rootstock (RS) and scion (Sc) variety combinations is the first step in that process. Scientists also gain from choosing varieties reliably. The technical and lay literature, however, currently satisfy neither community. Our goal has been to develop decision aids through rigorous documentation beginning at seeding and concluding with post-harvest fruit quality assessment. Our most recent effort involves 18 RS and 5 Sc varieties (90 combinations). Seedling growth rate, graft success, grafted plant vigor and fruit yield are being recorded at OARDC and by grower-cooperators in thirteen states. Varieties were chosen based on grower input, market type and reported traits. Seedling growth and grafted plant vigor are monitored directly and indirectly using destructive and non-destructive measures. Graft success and grafted plant yield are assessed using standard protocols. Data are analyzed to account for variation assigned to variety combination, grafted date and location of yield test and other sources. Narrowly, the data will help identify combinations among the ninety tested that: a) can be grafted most effectively, b) resume growth most quickly after grafting and c) maximize fruit yield. More widely, the effort will also help establish protocols for high-throughput assessment of the large and growing number of possible RS-Sc variety combinations on farms and within research-extension programs.

3:25–3:45 PM

Grafted Tomato Production Under Different Planting Densities

*Xin Zhao
University of Florida

Zack Black
University of Florida

Jason Neumann
University of Florida

Given the improved vigor of grafted vegetable plants, reducing plant population in field production has been proposed to lower the cost of using grafted plants. In this study, grafted tomato trials were performed during Fall 2013 and Spring 2014 in certified organic field in Citra, FL, under five in-row spacing treatments including 0.46, 0.61, 0.76, 0.91, and 1.07 m, with a constant between-row spacing of 1.83 m. Determinate tomato scion ‘Tribute’ was grafted onto two commercial tomato rootstocks ‘Multifort’ and ‘RST-04-106-T’, respectively. Non-grafted ‘Tribute’ was included as the control. The experiments were arranged in a split-plot design with plant spacing as the whole-plot factor and grafting as the subplot factor. In addition to fruit yields, root-knot nematode (RKN) galling was evaluated due to the natural RKN infestation in the field. Results from this two-season study will be discussed to explore the feasibility of modifying the planting density in field production of grafted tomatoes for improving economic returns.

Tuesday, July 29

1:45–3:45 PM

Nuts and Bolts of Postharvest Shipping Around the World

Sponsor: Postharvest (PH) Working Group
Moderator/Coordinator: John C. Beaulieu, John.Beaulieu@ars.usda.gov

Today, consumers demand fresh, local, regional, national, tropical, and exotic produce to be on the grocer’s shelf, 365 days a year. Local and national sourcing of “in-season” produce is often simple and uncomplicated in comparison to importation of peak production of high quality produce, aligned with low domestic production. There are several important aspects regarding the successful acquisition of imported perishables arriving safely and in optimum quality to the grocer’s display case. In this workshop we will present a logistical overview of the intricacies and postharvest problems often encountered with international cargo shipments of fresh produce. Focus will be on ship and air freight of containers routinely moved in/out and through international ports. Four speakers will discuss strategies and
fundamental concepts required to facilitate meaningful research and technologies needed to ensure safe and expedient delivery of fresh produce to and from international ports to the marketplace. In addition to important postharvest and engineering aspects for proper cooling and shipping, key regulatory issues and logistical/legal aspects will also be addressed. The workshop will include both university and corporate level in-depth analysis and real-world research with international corporate cases used to illustrate the nuts and bolts required for successful, timely produce delivery, and satisfied consumers.

1:55–1:55 PM
Introductory Remarks
*John C. Beaulieu
USDA–ARS

1:55–2:20 PM
Harvesting, Shipping & Handling Concerns in International Perishable Shipping
*Mary Lu Arpaia
University of California, Riverside

2:20–2:45 PM
Conducting Transportation Research
*Jeffrey K. Brecht
University of Florida/IFAS, Gainesville

2:45–3:10 PM
International Shipping & Container Technologies—Latin America/United States
*Mark Girardin
North Bay Produce, Inc., Traverse City

3:10–3:45 PM
Interaction of the Custom and Border Protection, Quarantine Treatments and APHIS Requirements, and Food Safety Modernization Act in International Shipping
*Jean Pierre Emond
Cold Chain Research, Georgia Tech Research Institute, Atlanta

Tuesday, July 29 1:45–3:45 PM
Production Water Impact on Produce Safety and Ways to Reduce Risks
Sponsor: Produce Quality, Safety, and Health Properties (QUAL) Working Group
Moderator/Coordinator: Annette L. Wszelaki, annettew@utk.edu

Water is a critical part of fruit and vegetable production, but it can also introduce microbial food safety risks to the crops. Since maintaining the safety of produce is critical to the survival of the produce industry, it is important to understand the risks associated water used during production as well as ways to minimize these risks on the farm. This workshop will highlight both research that helps us define produce safety risks as well as research and extension focused on how to minimize risks. Understanding how to prioritize the implementation of produce safety practices that reduce the most significant risks is important to farm viability and consumer health.

1:45–2:10 PM
Microbial Risk Assessment During Flooding Events: Focus on LGMA Metrics and the Presence/Absence of Indicator Microorganisms and Human Pathogens
*Eduardo Gutierrez-Rodriguez
North Carolina State University, Raleigh

2:10–2:35 PM
Transfer and Survival of Organisms to Cantaloupe and Lettuce from Surface Irrigation Water in the Southeast
*Annette L. Wszelaki
University of Tennessee, Knoxville

2:35–3:00 PM
Survey of Mid-Atlantic Farms for Foodborne Pathogens in Tomatoes, Leafy Greens, Irrigation, Water, and Soil
*Wesley L. Kline
Rutgers University, Millville, NJ

3:00–3:25 PM
Irrigation Water Remediation: Treatment Options
*Chris Gunter
North Carolina State University, Raleigh

3:25–3:45 PM
Resources for Growers: Decision Trees for Prioritizing Produce Safety Risk Reduction Strategies on the Farm
*Gretchen Wall
Cornell University, Ithaca, NY

Tuesday, July 29 4:00–6:00 PM
Advances in Commercial-ready LED Technologies for Horticulture
Sponsor: ASHS Industry Division
Coordinator: Jeffrey Norrie, jnorrie@acadian.ca

LED technology is advancing well, at “lightspeed.” With developments in spectral quality, intensity and the myriad of plant-specific interactions on growth and active ingredients, opportunities to commercialize these technologies have never been more focused. This workshop brings together several critical thinker-researchers to discuss the state of the art as far as commercial-ready or almost-ready LED technologies...
are concerned. We will explore advances in research as well as those technologies which are expected to see commercial success in the short to medium term.

**Tuesday, July 29**

4:00–6:00 PM

**Impact of Utilizing Biodegradable Containers in Ornamental Crop Production Systems**

Sponsor: Nursery Crops Working Groups  
Moderator/Coordinator: Amy F. Fulcher, afulcher@utk.edu  
Coordinators: Andrew Koeser, akoeser@ufl.edu and Diana Cochran, dcochra1@utk.edu

The horticulture industry relies heavily on plastic-derived products, such as nursery pots, trays, flats, chemical containers, greenhouse covers, and irrigation tubing for its production efforts. While the widespread use of plastic has led to many production efficiencies, it is also the source of an estimated 350 million pounds of plastic waste annually. Though recycling in general is on the rise in the United States, only about 1% of horticulture plastics are recycled. This waste has generated significant interest from consumer and commercial markets for more sustainable production alternatives. Biocontainers have emerged as potential substitutes for standard plastic containers. Research has shown that plants marketed in biodegradable containers increase buyer interest—more so than most other efforts to increase production sustainability. Biocontainers can be plantable or compostable with plantable containers offering the additional benefit of reduced installation time. However, there are many unanswered questions regarding whether biocontainers are able be integrated into existing commercial production systems effectively. This workshop will highlight the latest biocontainer research findings, including: plant performance during production; irrigation requirements; appropriateness for long-term crop production, container durability during production and shipping; and container biodegradability and plant establishment in the landscape. These presentations discuss current research-based information on the use of biocontainers during commercial production (including greenhouse, above ground nursery, and pot-in-pot nursery production) and landscape performance of plants produced in plantable containers. All of these applied trials are used to guide holistic economic and carbon footprint accountings of biocontainer use. This information is applicable to growers, extension personnel, educators, and landscapers.

**4:15–4:30 PM**

**Impact of Alternative Materials on Container Physical Properties and Substrate Temperature**

Susmitha Nambuthiri  
University of Kentucky, Lexington  
* Robert L. Geneve  
University of Kentucky, Lexington  
Youping Sun  
Hunan Academy of Forestry, changsha, China  
Xueni Wang  
Michigan State University, East Lansing  
Guihong Bi  
Michigan State University, East Lansing  
Rodney Thomas Fernandez  
Michigan State University, East Lansing

An asterisk (*) in front of a name indicates the presenting author.
Studies were conducted at the University of Kentucky to evaluate side wall water loss and substrate temperature of quart size alternative containers derived from paper, cardboard, peat, cow’s manure, rice hull or coir, bio degradable plastic, and plastic (control). An environmental chamber controlled for temperature and relative humidity was used to obtain a VPD of 2.6 kPa. The containers were filled to their rim with saturated Fafard potting mix. Top part of each container was sealed using plastic sheet to prevent evaporation through the open surface. Five replicates of containers were moved to the chamber and hourly substrate water loss was measured. Another five replicates were used to determine light reflectance, wall temperature and substrate temperature in room temperature at 20 °C and relative humidity 50%. Two 100 watts incandescent bulbs were installed 6 inches away from pots to provide heating for 90 minutes to warm up the substrate. After 90 minutes, radiation flux density of pot side wall was measured using a pyranometer (Licor-LI200). After measuring the radiation, the light was turned off, the temperature of pot wall was determined using an Infra-Red thermometer. Substrate temperature was obtained at one inch depth of the substrate at the center of pot and between the pot side wall and center of pot. It was found that on an average plastic and bio-plastic containers lost 2.5 ml water whereas containers manufactured using rice hull, coir and straw containers lost 10 to 20 ml and peat, wood pulp and cow manure containers lost 25 to 30 ml in an eight hour period in the chamber. Light reflectance was lowest for black containers (20Wm-2) and it was higher for all alternative containers and it varied around 70 to 120 Wm-2 for rice, coir and straw containers. Container wall temperature was highest for plastic and bio-plastic containers (40 °C) followed by rice hull, coir and straw containers (30 °C) and peat, wood pulp and cow manure based containers showed lowest wall temperature of around 24 °C. Substrate temperature near to sidewall was highest for plastic and bio-plastic (28 °C), followed by all other alternative containers (22 °C), same trend was noticed for temperature at the center of the container with plastic showing the highest (25 °C) and all alternative containers showing lower values (21 °C). Light reflectance and porous nature of container walls prevented higher substrate temperature buildup of some of the alternative containers.

4:30–4:45 PM

Water Use of Nursery Plants Grown in Alternative Containers: Implications for Sustainability
*Rodney Thomas Fernandez
Michigan State University, East Lansing
Xueni Wang
Michigan State University, East Lansing

4:45–5:00 PM

Economics of Utilizing Biodegradable Containers in Ornamental Crop Production Systems
*Robin G. Brumfield
Rutgers University, New Brunswick, NJ
Guihong Bi
Mississippi State University, Mississippi State
Diana Cochran
University of Tennessee, Knoxville
Rodney Thomas Fernandez
Michigan State University, East Lansing
Amy F. Fulcher
University of Tennessee, Knoxville
Robert L. Geneve
University of Kentucky, Lexington
Andrew Koeser
University of Florida, GREC, Wimauma
Genhua Niu
Texas A&M AgriLife Research Center at El Paso
J. Ryan Stewart
Brigham Young University, Provo, UT
Xueni Wang
Michigan State University, East Lansing
Alyssa DeVincentis
Rutgers University, New Brunswick, NJ

Plant production facilities for perennial plug and container plants are high input systems using large quantities of water, fertilizers, chemical pesticides, plastics, and labor. The use of renewable and biodegradable inputs while growing an aesthetically pleasing and healthy plant will improve the economic, environmental, and social sustainability of current production systems. However, costs, such as poor integration of sustainable
practices into established systems, increased carbon footprints, increased product shrinkage, and reduced plant health, which may be associated with sustainable production practices, have been ill defined. Our objectives are to determine the environmental and economic costs of commercial production systems using biocontainers (including greenhouse, above ground nursery, and pot-in-pot nursery production). The costs of all of the production inputs including water, fertilizers, chemical pesticides, disinfectants, and containers were collected for each system in each participating state. Labor inputs of potting, watering, applying chemicals, inspecting plants, harvesting, and cleaning pots and production area were also recorded. Use of “Green” processes based upon quantitative data will result in improved farm incomes while sustaining environmental quality by reducing the carbon, water, and chemical foot prints used in nurseries and greenhouses. Any strategy that can reduce expense and benefit the environment is a priority for the long-term sustainability of the industry.

5:00–5:15 PM

Biocontainer Use in Petunia x hybrida Greenhouse Production—A Cradle-to-Gate Carbon Footprint Assessment of Secondary Impacts

*Andrew Koeser
University of Florida, GREC, Wimauma
Sarah T. Lovell
University of Illinois, Urbana
Aaron C. Petri
University of Illinois-Champaign
Robin G. Brumfield
Rutgers University, New Brunswick, NJ
J. Ryan Stewart
Brigham Young University, Provo, UT

While biocontainers (i.e., biodegradable, plant-based containers) are marketed as being more sustainable than conventional plastic pots, little scientific literature exists to substantiate these claims. Life cycle assessment (LCA) serves as a holistic accounting of all the material/energy inputs and waste/pollution outflows associated with a given product. This presentation draws on LCA methods to assess how secondary production impacts (e.g., irrigation demand) differ as container type changes for the production of a common annual ornamental plant (e.g., Petunia x hybrida). Results show that the container itself accounts for approximately 17% of overall CO₂e (i.e., carbon dioxide equivalent) emissions during petunia production using a conventional plastic pot. Though container was a significant contributor to GWP, electrical consumption for supplemental lighting during plug production and irrigation throughout the production process proved to be the leading sources of CO₂e emissions (over 44%). Differences in GWP were only minor in comparing the use of various biocontainers with standard plastic containers for secondary production impacts. Results demonstrate that biocontainers compete with plastic pots for secondary impacts, suggesting they could potentially be more sustainable than plastic pots once pot manufacturing data are considered. Use of more efficient supplemental lighting sources, however, may ultimately have the greatest impact on overall GWP.

5:15–5:30 PM

Use of Fiber Containers in Pot-in-Pot System for a Two-year Nursery Production of Birch

*Tongyin Li
Mississippi State University, Mississippi State
Guihong Bi
Mississippi State University, Mississippi State
Genhua Niu
Texas A&M AgriLife Research Center at El Paso
Susmitha Nambuthiri
University of Kentucky, Lexington
Robert L. Geneve
University of Kentucky, Lexington
Xuexi Wang
Michigan State University, East Lansing
Rodney Thomas Fernandez
Michigan State University, East Lansing
Amy F. Fulcher
University of Tennessee, Knoxville
Youping Sun
Texas A&M AgriLife Research Center at El Paso
Xiaojie Zhao
Mississippi State University, Mississippi State

Birch (Betula nigra) bare root liners were planted into two types of fiber containers (seven gallon, Kord® Fiber Grow, Western Pulp) and one plastic container (seven gallon, GL 2800, Nursery Supplies® Inc.), which were used as the production pots in a pot-in-pot production system (PIP). Production pots were inserted into a GL 6900 (15 gallon) socket pot. The study was initiated in mid-June 2011 at four locations, Kentucky, Michigan, Mississippi, and Texas, and lasted through October 2012. Plant height, widths (Plant growth index (PGI) = (height+ width + perpendicular width)/3), and plant caliper (20 cm above ground) were measured at all locations at monthly intervals. Substrate moisture was determined with a calibrated theta probe (ML2, Dynamax Inc.) in Kentucky with daily irrigation applied to replace 100% of daily water use (DWU). At the end of each growing season, a visual and tactile evaluation of the fiber containers was conducted to assess container strength. Birch plants were destructively harvested in October 2012. Above ground dry weight, root dry weight, and total dry weight were determined. There was no significant difference in plant height, plant dry weight, plant caliper or PGI among plants grown in different container types in Mississippi, Kentucky, or Texas. Data from Kentucky showed that there was no significant difference of DWU of plants grown in all three container types. At the end of the 2011 growing season fiber containers were still intact but by the end of the experiment roots had penetrated the bottom
of the containers. In Mississippi, the bottom of fiber containers were severely penetrated by birch roots by October 2012 due to vigorous root growth; whereas, in Kentucky, plant growth was less vigorous with only a few roots found penetrating the bottom of the pots.

Tuesday, July 29

4:00–6:00 PM

Invasive Plant Management and Restoration: Florida Regulations and Experiences

Sponsor: Invasive Plants Research Working Group
Moderator/Coordinator: Gary W. Knox, gwknox@ufl.edu

Objectives of this workshop are to present approaches to invasive plant management as developed by Florida agencies and researchers to 1) identify and characterize invasive plants; 2) indicate strategies for regulation of plants considered invasive; and 3) present strategies for invasive plant management and natural area restoration.

As the fastest growing segment of US Agriculture, ornamental horticulture has been recognized as a primary source of plant invasions worldwide. Considerable controversy still surrounds invasive plant identification, impacts, regulation, and strategies for management and natural areas restoration. Differences in regional invasivity, regional impacts, ease of management, and cultivar fruitfulness only adds to public confusion, governmental hesitance, and Green Industry frustration. Florida’s sensitive ecosystems, extensive urban areas and large Green Industry have been particularly prone to invasive plant impacts and controversies.

4:00–4:30 PM

Evaluating the Invasion Risk of Non-native Plants in Florida’s Natural Areas

*Deah Lieurance
University of Florida, Gainesville

S. Luke Flory
University of Florida, Gainesville

The detrimental effects of biological invasions, including reduced biodiversity and altered ecosystem functions are costly both ecologically and economically. Preventing high-risk species from being released into natural areas and managing invasive species early in the invasion process can reduce ecological and economic impacts. The effects of invasions are especially evident in the natural areas of Florida, where detection, monitoring, and management of invasions cost the state millions of dollars per year. To identify species most likely to invade and cause damage in Florida’s natural areas, The IFAS Assessment of Non-Native Plants in Florida’s Natural Areas was developed by the University of Florida’s Institute of Food and Agricultural Sciences (IFAS). The purpose of the IFAS Assessment is to provide UF faculty and staff with consistent recommendations for the use and management of non-native plant species in Florida. The IFAS Assessment consists of three components: the Status Assessment to evaluate resident species already present in the state of Florida, the Predictive Tool to evaluate species new to the state or proposed for a new purpose (e.g., biofuels), and the Infraspecific Taxon Protocol (ITP) to evaluate cultivars, varieties, and subspecies independently from resident species. To date, approximately 800 species have been evaluated including Lantana, Nandina, and Ruellia cultivars that were developed as alternatives to problematic resident species. The success of the IFAS Assessment is largely dependent on information that is queried from the land management and scientific communities who are willing to donate their time to assist in the evaluation process. In return, the synthesis of our efforts benefits the natural areas of Florida and provides a framework for government and industry to prevent and manage non-native species nationwide.

4:30–5:00 PM

Making a List, Checking It Many, Many Times: How Species are Added to the Florida Noxious Weed and Invasive Plant List

*Patti J. Anderson
Florida Department of Agriculture and Consumer Services, Gainesville, FL

Exotic species have long played an important role in the agricultural and ornamental plants of the United States. Florida has welcomed many of these species as warmly as tourists to its amusement parks. Unfortunately, some of these visitors are not well-behaved. Among our most notorious ornamental introductions are Melaleuca quinquenervia (melaleuca or punktree) and Schinus terebinthifolia (Brazilian pepper or Christmasberrytree). These and other species currently listed as noxious weeds demonstrate the problems that can come from too much of a beautiful thing. As part of the Florida Department of Agriculture and Consumer Services, the Division of Plant Industry (DPI) has responsibility for protecting native and commercially grown plant species, in part by regulating noxious weeds and invasive species. DPI enforces regulations that limit the movement of noxious weeds and carries out decisions made by the state Noxious Weed Review Committee to add or remove species from the list of regulated plants or to exempt sterile cultivars of listed species. Without a requirement for screening exotic species before they are imported and released, Florida’s regulatory mechanisms depend on listing species after they prove to be pests. The procedures followed by the Noxious Weed Review Committee are intended to provide a science-based process for deciding whether a plant should be included on the Florida Noxious Weed and Invasive Plant List. The committee relies on risk assessments from USDA, the University of Florida, and other sources in making its determinations. Examples of plants added to this list and the process for adding new species demonstrate the need for information exchange and cooperation among researchers, regulators and the horticulture industry.
Sandra B. Wilson  
University of Florida, Gainesville

Carrie Reinhart Adams  
University of Florida, Gainesville

Sandra B. Wilson  
Indian River Research and Education Center, Fort Pierce, FL

Christine Wiese  
University of Florida, Gainesville

Invasive species have detrimental ecosystem impacts in that they reduce biodiversity and alter ecosystem function. They also have considerable economic impacts. While the scale of the problem is well-documented, there is less research concerning applied invasive plant control. This is problematic for managers who need to not only reduce invasive species, but also establish an appropriate native community in their place. Though active revegetation is widely attempted in restoration, these efforts are rarely incorporated into invasive species control plans. Revegetation may be beneficial for both establishing native species and for controlling future invasions. Planting native species may be particularly important to managing ornamental invasive plant species, because repeated re-introductions are typical, particularly if home landscapes neighbor natural areas. Primary unanswered questions associated with the effectiveness of revegetation efforts include: 1) under which circumstances is revegetation necessary?, 2) what species and plant material sources are appropriate?, and 3) what follow up treatments may be needed after planting? We have investigated restoration of Mexican petunia (Ruellia simplex)-dominated floodplain wetlands to explore control methods and revegetation techniques. This species is highly used in landscapes and popular among producers and consumers for its yearlong flowering, ease of propagation, and use under many landscape conditions. Studies reveal that while herbicide treatments effectively control Mexican petunia in the short-term, the return of native species does not follow naturally despite an intact and diverse seedbank. Preliminary experiments with revegetation techniques suggest that planting quick-to-establish native species suppresses Mexican petunia reinvasions and facilitates restoration. We offer our experimental approach as a model system to explore restoration of ornamental-invaded ecosystems, and highlight the important contribution of horticultural knowledge to the field of ecosystem restoration.

4:00–4:25 PM

**Precision in Irrigation Water and Nitrogen**

*Esmaeil “Essie” Fallahi  
University of Idaho, Parma

Bahar Fallahi  
University of Idaho, Parma

Precision in application of irrigation water and nutrients plays an important role in fruit yield and quality attributes of apples. Using fruit analysis alone or in combination with leaf analysis often permits more precise prediction of fruit quality. Leaf mineral analysis is a useful tool to diagnose apple tree deficiencies, but often is poorly related to fruit quality. In a long-term study, the impact of different irrigation systems and nitrogen levels on water use, tree growth, yield, biennial bearing, and mineral nutrients of ‘Fuji’ apples were studied. A single drip had similar fruit characteristics as those with a double drip as long as the same volume of water was used. However, application of water at 50% crop evapotranspiration level (50% ETc) reduced fruit size. Fruit yield and quality attributes, particularly size and color were drastically impacted by varying levels of nitrogen applications. In this study, the influence of minimum levels of water and nitrogen on apple trees will be discussed in detail.

4:25–4:50 PM

**Mineral Nutrients in Apples**

*Esmaeil “Essie” Fallahi  
University of Idaho, Parma

Bahar Fallahi  
University of Idaho, Parma

Mineral nutrients of ‘Fuji’ apples were studied. A single drip had similar fruit characteristics as those with a double drip as long as the same volume of water was used. However, application of water at 50% crop evapotranspiration level (50% ETc) reduced fruit size. Fruit yield and quality attributes, particularly size and color were drastically impacted by varying levels of nitrogen applications. In this study, the influence of minimum levels of water and nitrogen on apple trees will be discussed in detail.
Nutrition of Tart Cherry for Optimum Production
*Brent Black
Utah State University, Logan

5:15–5:40 PM
Nitrogen Requirements of Low-chill Peaches in a Subtropical Environment
*Mercy A. Olmstead
University of Florida, Gainesville

In the past five years there has been a rapid expansion of Florida peach acreage as citrus growers seek alternative options to maintain agricultural profitability. However, evergreen citrus production practices, specifically fertilization, are not optimized for low-chill deciduous peach production or quality. Early season harvest of fruit with short developmental periods result in long periods of excessive vegetative growth in the humid, subtropical climate. Thus, this project sought to identify ideal nitrogen fertilization rates for newly established and mature peach orchards in Florida. Five nitrogen rates (0, 45, 90, 179, and 269 kg·ha⁻¹ of N) were applied to six-year-old mature ‘TropicBeauty’ trees grafted onto ‘Flordaguard’ rootstock. In a separate experiment, identical fertilization rates were applied with different application methods (granular vs. fertigation) as a split-split-plot in a newly-established orchard with ‘TropicBeauty’ and ‘UFSharp’ grafted onto ‘Flordaguard’. Vegetative measurements, yield, and fruit quality characteristics were measured from 2011–14. In mature orchards, few significant differences were observed in vegetative growth parameters. Trees receiving the two lowest N rates tended to have smaller trunk cross-sectional area and fewer vegetative and floral buds, while large amounts of blind nodes were produced in all treatments. In young orchards, trees receiving 0 or 45 kg·ha⁻¹ of N were significantly smaller as indicated by pruning weights, but no difference was detected in bud distribution. Leaf N (%) increased along a linear gradient with increased N rate in both mature and young orchards; however leaf concentrations were excessive in both orchards (> 4.0%). Fruit from mature orchards showed no differences in fruit color, °Brix, pH or titratable acidity, despite having larger fruit when 269 kg·ha⁻¹ of N was applied. Consumer taste panels identified differences in appearance but not in flavor, texture, or overall liking. In this study, varying the N rate in a newly established orchard reflected differences better than in an existing orchard; perhaps because of the buffering capacity of the tree to mobilize N reserves from larger storage organs in the tree which are undeveloped in younger plantings.

Type, Quality, and Quantity of Data Collection in Vegetable Cultivar Trials
Sponsor: Vegetable Crops Management Working Group
Coordinator: Ajay Nair, nairajay@iastate.edu

Cultivar selection and development represent a major topic in vegetable production. For improved production and performance, identification of cultivars adapted to local conditions is critical. Researchers at land-grant universities, non-profit organizations, and commercial seed companies conduct cultivar trials to evaluate performance of vegetable cultivars. Studies focus on various plant traits such as yield, disease resistance, insect tolerance, winter hardiness, drought tolerance, product quality, and postharvest storability. In these trials yield is often measured in a scientific manner, but other important characteristics are often not measured, or are described using methods that don’t permit statistical analysis. This may occur because the investigator is not aware of characteristics important to growers, measurement requires specialized or expensive equipment or takes too much time, suitable rating systems have not been developed, or unfamiliar statistical methods are required for analysis. If these issues can be addressed, cultivar trials will provide even greater practical and scientific value. This workshop will cover principles for developing cultivar trials that meet both short and longer term goals of industry and scientists; practical methods for evaluating nutritional quality in cultivar trials; a case study identifying different priorities for cultivar traits among grower communities; and sensory analysis in cultivar trials. The workshop will emphasize best practices for cultivar trials in order to answer questions important to growers and the seed industry and also meet criteria for publication in a scientific journal. Given the broad impact, topics covered in this workshop will have application on crops beside vegetables.

Principles of Developing Cultivar Trials
*Matthew D. Kleinhenz
The Ohio State University, Wooster

Data Collection Beyond Harvest: Simple and Rapid Ways to Collect Information on Produce Composition, Storage Life, and Phytochemicals
*Penelope Perkins-Veazie
North Carolina State University, Plants for Human Health Institute, Kannapolis

Often, once yields are collected, it’s not clear what to do with produce from germplasm trials or production studies. Additional information can be helpful when trying to get that next manuscript published or determining the value of selections, but limits of space and time mean that data must be collected rapidly. Collection of total solids content and pH can be done using colorimeters and spectrophotometers. Some idea of shelf life, such as the rate of loss of weight or firmness can be done using a combination of subjective ratings and inexpensive instrumentation. In this presentation, instruments, rating systems, and types of data that can be collected will be discussed.
An asterisk (*) in front of a name indicates the presenting author.

4:45–5:10 PM
**Participatory Approach to Variety Selection Using Tomato as a Model**
*Lori Hoagland*
Purdue University, West Lafayette, IN

Participatory varietal selection is an approach that engages local growers in the selection of varieties that are best matched to their specific needs. In local food systems, consumers demand organic fruit with good flavor. Tomato growers often turn to heirloom varieties to meet this demand, but these varieties are susceptible to pathogens and other physiological disorders like catfacing. New high-yielding hybrid varieties have been developed that are resistant to pathogens and physiological disorders, but they often lack the flavor consumers are looking for. In addition, many organic growers prefer to save seed for planting in subsequent years. We conducted this project to identify important traits and select tomato varieties best adapted to organic production systems in the Midwest U.S. An on-line survey was used to identify desirable plant traits and determine whether organic and conventional growers differed in their preferences. Based on this information, thirty-six entries were selected and screened under organic management for two years using a randomized complete block design with four replicates. Each plot contained six tomato plants. The entries included heirloom, open-pollinated, and hybrid varieties, as well as several breeding populations. Early vigor, pest resistance, yield and fruit quality were recorded at multiple time points during each growing season. We identified several open-pollinated varieties that hold desirable traits and are well adapted to organic production systems in the Midwest. We also selected individual plants with desirable traits from our segregating breeding populations, and advanced accessions are now being evaluated in on-farm variety trials to develop improved tomato varieties.

5:10–5:35 PM
**Efficient Evaluation of Qualitative Traits in Multisite Trials**
*Thomas Björkman*
Cornell University, Geneva, NY

Trials of vegetable varieties can contribute valuable information about quality traits. In particular, growers need to know whether they will get the desired quality on their farm. There are two challenges to meet that simple goal. The first is that the variety trials need to be done at multiple locations to show whether the quality trait holds up in an environment similar to that of an interested grower. The second challenge is the quality traits generally have to be rated on a qualitative scale. To succeed in such a multi-site variety trial, the quality scale needs to be used consistently over time, and the raters at each location have to be trained to use the scale the same way. When multiple traits are to be evaluated, consistency is better achieved if the scale for each trait works the same way. For the Eastern Broccoli Project, we have developed a system that is working well. For each trait of interest we use a five-point scale, with objective criteria for each value. Furthermore for each trait a score of 3 represents marginal commercial quality, 4 represents desired commercial quality, and 5 is an even stronger expression of the characteristic. This simple consistency has allowed raters to work quickly and confidently, and to provide comparable scores in different locations. The resulting data have substantial power to assess wide adaptability, and suitability for a particular growing region.

5:35–6:00 PM
**Bridging the Gap Between the Grower and the Consumer: The Role of Sensory Analysis in Cultivar Trials**
*Annette L. Wszelaki*
University of Tennessee, Knoxville

While consumers often make fruit and vegetable purchasing decisions based on appearance the first time, repeat purchases are based on their past experience, including the taste, texture and aroma of the product. Cultivars can vary greatly in their sensory characteristics; for example, think of the differences in texture and taste between a ‘Granny Smith’ and ‘Red Delicious’ apple. In order to provide growers with a complete picture of the cultivar they choose to grow, beyond yield and disease resistance, sensory evaluation plays an important role. Sensory analysis is often used to assess consumer acceptance of new products and is a valuable tool in branding and marketing (i.e., Vidalia onions). Several types of sensory tests that can be incorporated into cultivar trials will be discussed in this talk, including discrimination or difference tests, descriptive analyses and affective or hedonic tests. This talk will outline how to plan for a sensory test in your field trial, how to set up a sensory analysis in the lab and statistical analysis of sensory data.

6:00–10:00 AM
**Applying Sensory Aspects in Plant Breeding**
Sponsor: Fruit Breeding and Vegetable Breeding Working Groups
Moderator: Mary Lu Arpaia, mlarpaia@ucanr.edu
Coordinators: Danny L. Barney, danny.barry@ars.usda.gov and Michael Mazourek, mm284@cornell.edu

For many culinary and ornamental crops, sensory considerations, such as color, taste, texture, and aroma, are critically-important. This workshop features a blend of classical techniques and cutting-edge molecular approaches used in modern breeding programs for tree fruit, small fruit, vegetable, and floral crops. Included is what will most certainly be a spirited interactive discussion between presenters and participants attending the workshop, as experts in diverse crops and breeding approaches share their experiences and insight.
Workshops

8:00–8:15 AM  
**Flavor Aspects in Modern Plant Breeding—An Overview**  
*Elizabeth Baldwin  
USDA-ARS, Fort Pierce, FL

8:15–8:30 AM  
**Pleiotropy in Breeding for Flavor in Vegetables**  
Michael Mazourek  
Cornell University, Ithaca  
*Lindsay E. Wyatt  
Cornell University, Ithaca, NY

8:30–8:45 AM  
**Breeding Mandarins That Consumers Cannot Resist**  
*Yuan Yu  
University of Florida, IFAS-Horticultural Sciences, Lake Alfred

8:45–9:00 AM  
**Sensory-assisted Strawberry Breeding**  
*Vance M. Whitaker  
University of Florida, Wimauma

9:00–9:15 AM  
**Catering to the Contemporary Floral Consumer Using Genetics, Biochemistry, and Psychophysics**  
*Thomas A. Colquhoun  
University of Florida, Gainesville

9:15–9:30 AM  
**Using Consumer Panels to Discover Seasonality and Acceptability of Avocado**  
*Mary Lu Arpaia  
University of California, Parlier

Wednesday, July 30  
8:00–10:00 AM  
**Improving Organic Vegetable Systems: Production Scale, Nutrient Management, and Integrated Approaches**  
Sponsor: Organic Horticulture Working Group  
Moderator/Coordinator: Xin Zhao, zxin@ufl.edu  
Objectives: The objective of this workshop is to promote research on organic vegetable production that is aimed at using integrated approaches to improve crop yields and optimize management practices at different scales of production. Depending on the crop and production scale, the organic vegetable management practices and cropping systems can vary considerably due to the need to cope with site-specific challenges to improve crop yields and effectiveness of production inputs. In this workshop, researchers from FL, GA, IA, and WI will present their work with different organic vegetable production systems and discuss future research needs for optimizing the organic management. Topics that will be explored include large-scale vegetable production operations, best management strategies, fertilization programs, and integrated approaches using organic amendments, cover crops, mulches, and reduced tillage.

8:00–8:25 AM  
**Large-scale Organic Vegetable Production in Florida**  
*Monica Ozores-Hampton  
University of Florida, SFREC, Immokalee

Florida is an important winter production area for fresh-market organic fruits and vegetables with 153 certified organic farms totaling 31,783 acres in 2011. Small farms are defined by the USDA as farms with sales of less than US$250,000/year representing over 90% of the number of certified organic farms. Thus, there are 15 large-scale (10%) organic farms mostly locate in south Florida due to the favorable weather conditions during the winter. The majority of these farms grow conventional and organic fruits and vegetables. The most common organic vegetable crops produced are tomatoes (round, roma-type, cherry, grape and heirlooms), peppers, strawberries, eggplants, squash, cucumber, cabbage, beets, kale, collards, and herbs. Traditional small-scale organic production depends on small, diverse plantings and complex management decisions to lower pest pressure and enhance soil fertility. In contrast, large-scale organic farms use polyethylene mulch, mowing, crop rotation with a cover crop such as sesbania and sorghum-sudangrass during the summer to decrease weeds, and a fertility program.
based on commercial, organic fertilizers. The main challenges of large-scale organic producers include the high cost of weed, disease, and insect controls, high labor requirement, and lower yields compared to conventional vegetable production systems.

8:25–8:50 AM

**Best Management Strategies for Organic Snap Bean Production in Wisconsin**

Courtney Pfad  
University of Wisconsin–Madison

Jeff Heller  
University of Wisconsin–Madison

*James Niemhuis  
University of Wisconsin–Madison

In Wisconsin, organic snap bean production for processing currently meets less than one-third of current demand. In spite of price incentives, it is especially difficult for processors to contract sufficient acres to meet demand due to the high risk and low yields associated with larger-scale organic production. The principal limited factors are 1) root rot disease, 2) nitrogen management, 3) seed corn maggot, and 4) availability of certified organic seed. In addition, early maturity and rapid growth is critical to snap bean cultivars to outcompete weeds.

8:50–9:10 AM

**Sweet Onion Yield as Affected by Organic Fertilization Rate**

*Juan Carlos Diaz-Perez  
University of Georgia, Tifton

Jesus Bautista  
University of Georgia, Tifton

Nelida Bautista  
University of Georgia, Tifton

Dharma Pitchay  
Tennessee State University, Nashville

Cliff M. Riner  
University of Georgia, Tifton

Organic production of short-day sweet onion (*Allium cepa* L.) is gaining popularity in Georgia. The objective was to determine the effects of organic fertilizer rate on onion yield and quality. The experiment was conducted in Tifton, GA, in the winter of 2012–13. Conventionally grown onion seedlings were planted in raised beds (1.8m centers), using four rows of plants per bed. Beds were covered with black plastic mulch and had two lines of drip tape per bed. Experimental design was a randomized complete block with five treatments (rates of organic fertilizer). The organic fertilizer (3N–0.9P–2.5K) was applied at 0, 2, 4, 6, and 8 t/ha to the beds and incorporated with rototiller before laying the plastic mulch. No further fertilizer was applied after planting. Yield differences were determined by differences in bulb weight, rather than bulb number. Onion marketable yield and individual bulb wt. increased with increasing fertilization rate. Highest marketable yield (13.1 t/ha) and mean marketable bulb weight (148 g/bulb) were obtained with the highest fertilization rate [8 t/ha fertilizer (ca. 240 kg/ha N)]. Yield responses indicate that the highest fertilization rate was likely insufficient to meet the nutrient needs of onion plants.

9:10–9:35 AM

**Using Anaerobic Soil Disinfestation in Organic Vegetable Production**

*Erin Rosskopf  
USDA—ARS, Fort Pierce, FL

David M. Butler  
University of Tennessee, Knoxville

Nancy Kokalis-Burelle  
USDA—ARS, Fort Pierce, FL

Jason Hong  
USDA—ARS, Fort Pierce, FL

Anaerobic soil disinfestation (ASD) or biological soil disinfestation (BSD) is a process that involves incorporation of a labile carbon source into soil, covering soil with polyethylene film to limit oxygen exchange, and saturating the treated soil to allow it to become anaerobic. This method has been shown to control many plant pathogenic fungi, bacteria, nematodes, and weeds. Rates of soil carbon amendment and soil temperatures have all been identified as important factors in developing effective levels of anaerobic activity and plant pathogen control. The putative mechanisms of ASD comprise of direct and indirect biological control, including the generation of organic acids and volatile compounds. In the investigation and application of the technique in Florida, the development of anaerobic conditions has not been correlated with weed control, but the use of clear plastic combined with organic amendments has resulted in the most significant reduction in weeds. Recent work has allowed for the substitution of totally impermeable film for solarization film, which would reduce the total amount of mulch film and eliminates one hurdle for adoption of ASD. Composted poultry litter has been utilized as a nitrogen source in one approach for ASD application and conventional vegetable growers have expressed concern over potential food safety issues related to the use of composted animal manures. The composted poultry litter serves to lower the C:N ratio during ASD treatment and potentially increases water holding capacity and microbial diversity in sandy soils with a history of soil fumigation. In order to address this concern, multiple organic residues with relatively high nitrogen content have been tested for their suitability as a component in ASD. Also, targeted human pathogen testing is being conducted on soil inputs, soil, and harvested fruit. ASD has been used to produce tomato, cucumber, bell pepper, eggplant, strawberry, and flower crops successfully and with no foodborne human pathogen detections. The approach can be scaled to accommodate small-to-medium-sized production systems and tailored to the availability of local waste product inputs.
Cover Crop, Mulch, and Organic No-till Effects on Organic Vegetable Production Systems

*Kathleen Delate
Iowa State University, Ames

Xin Zhao
University of Florida, Gainesville

Cynthia Cambardella
USDA Soil Tilth Lab, USDA–ARS, Ames, IA

This project addresses critical stakeholder needs for improving organic vegetable farming practices to optimize pest management, crop quality, and profitability, while enhancing soil quality. Treatments include three tillage comparisons: tilled followed by straw mulch, tilled without straw mulch, and organic no-till; and two organic fertility treatments: composted animal manure alone and with cover crops. In 2013, experiments were continued in Iowa and Florida across two contrasting soil types and climatic conditions using vegetable rotations appropriate for the region. A modified experimental design was used at the Florida site to include a plastic mulch vs. straw mulch comparison. Fall cover crops were planted in Iowa at a rate of 25 lb/acre hairy vetch and 90 lb/acre rye, while in Florida, only cereal rye was used. Cover crops were disked under or terminated with a roller/crimper. Because of extensive spring rains in 2013, cover crops were not disked until June 8 and not rolled until June 20, leading to a planting date three weeks behind schedule. Compost was applied at a rate of 100 lb N/acre and organic fertilizer side-dressed after vegetable crop establishment at 50 lb N/acre. In Iowa, organic crops performed similarly to the 2012 drought year, with tilled plots providing higher sweet corn yields, at 3,595 lb/acre, than organic no-tillage plots, at 1,554 lb/acre. While the tilled crops were more productive, the mulched and no-till tomatoes had higher quality fruit. In the Florida trial, the total marketable fruit number and weight of summer squash were significantly higher in the reduced till plots as compared with other treatments. Soil quality comparisons show greater soil carbon sequestration with cover crops and compost. Soil quality at the Florida site in January 2013 found total soil N, particulate organic matter C, extractable K and Mg, and electrical conductivity significantly lower in the tilled soils. Bulk density and extractable P were significantly greater with cover crops. Mulching and cover crops resulted in more extractable P and Mg and higher electrical conductivity. Overall, soil quality data in 2013 for these relatively unstructured Florida soils showed enhanced storage of soil N and biologically active soil C, and higher concentrations of plant nutrients in the no-till organic vegetable rotations compared to the tilled rotations.

Advances/Challenges in Plant Biotechnology for Horticultural Crop Improvement

Sponsor: Plant Biotechnology Working Group
Moderator/Coordinator: Manjul Dutt, manjul@ufl.edu

Objectives: 1) Increase our knowledge of some of the current advances in horticultural crop improvement through biotechnology. 2) Understand the challenges involved in the commercialization of a biotech horticultural commodity.

Numerous biotech crops, mostly agronomic and providing genetic resistance to herbicides and insects, have helped to alter the landscape of American agriculture. There has, however, been limited success in the commercialization of biotech horticultural crops, although there is great potential for its commercialization. This workshop will review some of the current advances in horticultural crop improvement through biotechnology and discuss the challenges involved in the successful commercialization of a biotech horticultural commodity.

Biotechnological Approaches for the Development of Improved Citrus Cultivars

*Jude W. Grosser
University of Florida, Lake Alfred

Manjul Dutt
University of Florida/IFAS, Lake Alfred

Biotechnology and Enhanced Pro-health Nutrient Metabolome of Fruit

*Avtar K. Handa
Purdue University, West Lafayette, IN

Germplasm Enhancement of Woody Species through Biotechnology

*Wenhao Dai
North Dakota State University, Fargo

Challenges in Biotechnology Biosafety for Horticultural Crop Improvement

*Rebecca Grumet

Rethinking Biotechnology Communication

*Kevin Folta
University of Florida, Gainesville
Artificial Seed and Cryopreservation in Horticultural Crops

Sponsor: Seed and Stand Establishment Working Group
Moderator: Juan Carlos Diaz-Perez, jcdiaz@uga.edu
Coordinator: Amir Ali Khoddamzadeh, aa.khoddamzadeh@okstate.edu

Objectives: The main objectives of this workshop are: a) to utilize the synthetic seed technology as a possible method for germplasm storage, transport and utilization of clonal plant populations; b) to provide theoretical experience of plant cryopreservation as the only vital way to conserve plant germplasm and living cells; and c) to discuss the challenges on seeds and plant materials conservation.

Tissue culture is an important process in plant propagation. After explant induction and somatic embryo/callus production, plant materials can be placed in a suitable medium to become seedlings or encapsulated and transformed to artificial/synthetic (syn) seed for short- or medium-term preservation. This process is called cryopreservation and has advantages over traditional micropropagation that can result in the need for excessive subculturing, unpredictable mutations or somaclonal variations, larger space requirements, and higher labor needs, which is costly. Synthetic seeds containing propagules (plants reproducible organs) such as nodes, shoots, callus, somatic embryos, and protocorms are contained in a gelatinous matrix of a combination of sodium alginate and calcium chloride. The use of in vitro derived axillary buds and shoot tips provides inexpensive, easily obtained propagules for storage. To date, cryopreservation is the only vital way to conserve plant germplasm and living cells in liquid nitrogen (LN). Cryopreservation also offers other advantages compared to other available storage approaches including stability of phenotypic and genotypic characters, freedom from contamination, and needs minimal storage space and maintenance requirements. New cryopreservation procedures are less complex and a programmable freezer is not required. This provides the suitability of these techniques to be used in any laboratory with basic facilities for tissue culture. A common feature to all the new protocols is that the critical step to achieve survival is the dehydration step, and not the freezing step, as in classical protocols. In addition, these techniques increased the applicability of cryopreservation to a wide range of horticultural crops. Seven different vitrification based procedures has been identified: (1) encapsulation-dehydration; (2) vitrification; (3) encapsulation-vitrification; (4) dehydration; (5) pregrowth; (6) pregrowth-dehydration; and (7) droplet freezing. In the past two decades, cryopreservation has been widely used as an alternative method for plant germplasm storage.

10:30–10:45 AM
Cryopreservation of Orchid Seeds, Protocorms, and Pollen

*Wagner Vendrame
University of Florida, Homestead
R.F. Galdiano Jr.
Universidade Estadual Paulista “Julio de Mesquita Filho”, Via de Acesso Prof. Paulo Donato Castellane, s/n, Jaboticabal, SP 14884-900, Brazil
R.T. Faria
Universidade Estadual de Londrina, Depto. de Fitotecnia, Centro de Ciências Agrárias, CP 6001, Londrina, PR 86051-990, Brazil
V.S. Carvalho
Universidade Estadual do Norte Fluminense, Laboratório de Fitotecnia, Centro de Ciências e Tecnologias Agropecuárias, Av. Alberto Lamego, 2000, Campos do Goytacazes, RJ 28013-602 Brazil

Orchids are very popular flowering plants worldwide, occupying top position in the international market as cut flowers and potted plants. In the United States, orchids rank second as flowering potted plants, just behind poinsettias, with an estimated wholesale value of US $200 million in 2011. Over-collection and habitat destruction have been reported as the main factors for the reduction in wild orchid natural populations. Therefore, conservation strategies for orchids need to be addressed. Cryopreservation has been widely regarded as an efficient tool for long-term storage of plant material and several cryopreservation methods have been developed for orchids. In addition to pres-
Herbaceous plants, shrubs, and trees, as well as aquatic and terrestrial animals, can be in the range of the impacts. The variety of impacts on biodiversity include the effects on the species, populations, and ecosystems. In the context of the impacts of land use changes on biodiversity, herbaceous plants, shrubs, and trees, as well as aquatic and terrestrial animals, can contribute to the conservation of species diversity, maintain the integrity of ecosystems, and provide ecological functions such as nutrient cycling, water regulation, and carbon sequestration. These functions are crucial for both the maintenance of ecosystems and the human well-being. In the context of the impacts of land use changes on biodiversity, herbaceous plants, shrubs, and trees, as well as aquatic and terrestrial animals, can contribute to the conservation of species diversity, maintain the integrity of ecosystems, and provide ecological functions such as nutrient cycling, water regulation, and carbon sequestration. These functions are crucial for both the maintenance of ecosystems and the human well-being.

**Workshops**

10:45–11:00 AM

**Potential Health Benefits Derived from Components in Seeds**

*Ram M. Uckoo*

Texas A&M University, College Station

Bhimanagouda S. Patil

Texas A&M University, College Station

G.K. Jayaprakasha

Texas A&M University, College Station

In recent years, the exploration of natural products for discovery of health promoting components that may prevent chronic diseases has taken a giant leap. The various sources for natural products include stems, leaves, roots, fruits, flowers and seeds. Among these, seeds are a good source of bioactive components such as polyphenols, anthocyanin’s, tannins, triterpenoids, and flavonoids and as well as rich in vitamins and minerals. These components have been demonstrated to have antioxidant, anticancer, antiproliferative, antibacterial and antifungal activities. They contribute significantly toward nutrition, health and well-being of populations worldwide. Due to their proven health benefits several seed extracts containing these bioactive components are currently commercially marketed. Although certain seed extracts have been evaluated for their bioactivities, a mechanistic approach is required to understand and determine potential active components. Among several species of citrus, fruits of Ichang pomelo are used as a traditional medicine. To identify the active components, we conducted a systematic study on extraction and chromatographic separation of the seeds. The ground seed powder was sequentially extracted using a Soxhlet apparatus using a wide range of solvents with increasing polarity. The extract obtained from ethyl acetate was further subjected to flash chromatographic separation using a silica gel column with a gradient mobile phase of hexane and acetone. The separation resulted in isolation of three limonoids which were identified by spectral analysis as deacetyl nomilin, nomilin, and limonin. Further studies are required to understand and elucidate the mechanistic mode of action in animal models. Results from this study suggest that seeds are a good source of bioactive components.

11:00–11:15 AM

**Bioreactor Technology for Mass Propagation of Plants**

*Elio Jimenez*

University of Florida, Homestead

Development of in vitro techniques has enabled rapid clonal propagation, regeneration, and multiplication of genetically manipulated superior clones, production of secondary metabolites, and ex situ conservation of valuable germplasm. Commercial micropropagation laboratories need to produce large number of high-quality plants at a low and efficient cost level. Large-scale plant propagation by using tissue culture techniques is often criticized because of the intensive labor requirements. Thus, special bioreactors have been developed to achieve maximum yield and high quality of the propagules; and to keep the production costs as low as possible by integration of automated control systems and simple low-cost devices. In this context, bioreactors based on the temporary immersion principle, also known as temporary immersion bioreactors (TIB) have been most applied for the multiplication of a wide range of plant species and with different regeneration pathways, including shoot multiplication via axillary bud proliferation, somatic embryogenesis, microtuber and microbulbs production. Efforts have been made toward the design of customized culture vessels, integrated control systems and illumination on TIB in order to increase plant quality, multiplication rate and biomass. Production strategies for plant propagation in TIB are discussed and examples are given to illustrate the possibilities for TIB integration in propagation and conservation of valuable germplasm.

Wednesday, July 30

10:15–12:15 PM

**The Fate of Fertilizer Formulations and Fertilizer Applications for Nurseries and Landscapes Under Increasing Composition- and Use-restrictions Imposed by Governmental Agencies in Florida and Beyond: Problems, Perspectives, and Solutions**

Sponsor: Plant Nutrient Management Working Group

Moderator/Coordinator: Joseph Albano, josepha@american-hort.org

Objectives: The objectives of the workshop are: 1) to identify local governmental concerns to nutrient runoff; 2) to understand the viewpoints of industry and allied trade on the issues related to legal restrictions on fertilizer formulations and application times; and 3) to get an overview of research on reducing nutrient runoff.

An asterisk (*) in front of a name indicates the presenting author.
Horticultural crop production and landscape maintenance in Florida and other states often occurs in proximity to wetlands, rivers, lakes, and coastal water body ecosystems. These geographical constraints mean that nutrient-laden runoff water can contaminate receiving ecosystems resulting in a process called eutrophication—simply, a change in nutrient levels, primarily nitrogen and phosphorus that alter native flora and fauna. Eutrophication can lead to excessive vegetative growth and cause harmful algal blooms that reduce light penetration and oxygen levels, and introduce biologically toxic compounds to water bodies. As a result, state and local governments are enacting regulations to change fertilizer formulations, such as omitting phosphorus, and regulating the timing of fertilizer applications, i.e. restrictions during the rainy season. These regulations are impacting the green industry crop producers and the landscape industry. This workshop aims to bring environmental interests, and nursery industry, fertilizer manufactures, and researchers together for a discussion on these issues from identifying problems to describing potential solutions.

10:15–10:30 AM
**Background Information on the Concerns of Nutrient Runoff to Sensitive and Protected Water Body Ecosystems in Florida**
*William Henriques
Environmental Toxicologist, U.S. Public Health Service (retired), Fort Pierce, FL

10:30–10:45 AM
**Representing Florida’s Landscape and Nursery Industry’s View Point on Fertilizer Restrictions**
*Mack Carraway
President, SMR Farms, LLC, and Chair, Environmental Research and Education Fund, Bradenton, FL

10:45–11:00 AM
**Representing the Fertilizer Industry’s View Point on Fertilizer Restrictions**
*Jack Peters
JR Peters, Inc., Allentown, PA

11:00–11:15 AM
**Opportunities and Implications of Current Containerized Ornamental Crop Nutrient Management Practices and Subsequent Nutrient Use Efficiency**
*Jim Owen
Virginia Tech, Virginia Beach

11:15–11:30 AM
**An Overview of Water Treatment Technologies for Remediating Runoff Water of Excess Nutrients**
*Sarah White
Clemson University, Clemson, SC

An asterisk (*) in front of a name indicates the presenting author.
sion outreach with irrigation from the basics of setting up and managing irrigation for new and beginning farmers to irrigation monitoring and scheduling for more experienced growers. In this workshop successful outreach programs on irrigation management of horticultural crops will be presented with instrumental monitoring and scheduling of irrigation on-farm and in nurseries, irrigation management for best crop response, and irrigation management to address environmental concerns of water conservation and nutrient management.

1:45–2:15 PM
**Extension Education Opportunities for Irrigation With Small and Beginning Farmers**

*Gordon C. Johnson*
University of Delaware, Georgetown

There has been an increase in the number of new and beginning farmers in the US and significant interest in urban agriculture and the production of horticultural food crops. Irrigation is a key component for production on these farms. In many areas of developing countries, irrigation is limited to hand watering and adoption of trickle irrigation can improve production considerably. In this session, extension outreach for irrigation, water management, and fertigation with new and beginning farmers will be discussed. Needs assessments have indicated that these growers want information on choosing irrigation equipment and supplies; irrigation design and layout; water sources, pumping, and water conveyance; irrigation timing and crop needs; soil water and irrigation monitoring; and irrigation scheduling. While excellent extension materials on irrigation for small farms are available in many states and irrigation supply companies in many areas serve as the primary expertise, extension on-farm demonstrations with irrigation have shown to be the most effective way to reach small growers and examples of successful demonstrations will be given. Appropriate technologies for irrigation on small farms will be discussed and demonstrated. Programs introducing gravity feed trickle irrigation systems in developing countries will be presented.

2:15–2:45 PM
**Florida Extension Programs Fine Tune Irrigation and Nutrient Management in Plasticulture**

*Robert Hochmuth*
University of Florida, Live Oak

Most vegetable growers in the Suwannee Basin region of North Florida are small to mid-sized growers (one to 300 acres), many who have adopted drip irrigation and plastic mulch culture since the late 1980s. Soils in the area are sandy with low water holding capacity (<10%) and low organic matter content (<1.5%). The recent development and adoption of statewide Best Management Practices in Florida in rule 5M-8 of the Florida Administrative Code (Florida Department of Agriculture and Consumer Services Office of Ag Water Policy) and the increase in production costs, have emphasized the need for improved irrigation practices and a better understanding of water movement in mulched beds. Growers’ understanding of the interdependence between fertilization, irrigation, and nutrient leaching below the root zone was increased through a targeted effort of on-farm Extension projects. Florida Extension agents and specialists have coordinated several projects at the regional Suwannee Valley Agricultural Extension Center, near Live Oak, FL. The educational approach was to first demonstrate the new technology at the Center via field days and workshops, then follow-up by demonstrating that technology on leading grower’s fields throughout the region. The most popular demonstration taken to the farms was the use of blue dye injected into the drip irrigation system to see how quickly the water moves downward in the soil in their field. This has been demonstrated on at least 25 farms from 2004 to 2013 after demonstrations began at the Center in 2001. By combining several Extension educational programs in the Suwannee Valley area, growers have made great progress toward adopting BMPs voluntarily. During this long term effort, 50 growers saw and learned from one or more demonstration on their own farm and they often served as early adopters which helped Extension agents teach other plasticulture growers how to adopt the BMPs. Growers are more likely to adopt BMPs when they can evaluate them on their own farm. Long term educational program efforts including hands-on teaching workshops at a University facility combined with on-farm demonstrations proved to be a very effective strategy in helping vegetable growers using plasticulture improve water and nutrient management practices on well over 5,000 acres.

2:45–3:15 PM
**Partnering with Commercial Growers to Implement Sensor-based Irrigation Control**

*John D. Lea-Cox*
University of Maryland, College Park

Our group has been working with field (soil-based) nurseries, container-nurseries and greenhouses to implement sensor-based irrigation management strategies over the past four years. We have implemented wireless sensor networks to monitor soil and substrate moisture conditions and automatically control irrigation events based on sensor readings, which have reduced water applications in many instances by 50% to 75% depending on the crop being grown, and daily environmental (weather) conditions. We are also using these sensor networks to monitor electrical conductivity in the root zone and runoff water for better nutrient management. This presentation will illustrate various case-studies, to show how we are configuring and scaling these sensor networks to target specific problems—increasing water use efficiency, reducing nutrient runoff and reducing disease—while shortening crop production times and increasing crop quality for ornamental growers.

3:15–3:45 PM
**Field Experiences with Soil Moisture Monitoring Techniques in Commercial Vegetable Production**

*James Adkins*
University of Delaware, Georgetown

Since 2001, the University of Delaware has been looking toward
soil moisture sensing as a tool to improve irrigation scheduling for commercial vegetables and small fruits on the Delmarva Peninsula. The lack of locally generated and reliable ET modeling crop coefficients for commercial vegetables in the humid Mid-Atlantic has created a “seat of the pants” approach toward irrigation management. Multiple on-farm research projects were conducted with cooperating farmers to determine the most accurate, affordable and user friendly soil moisture equipment for sandy soils. Additional on-farm research has been conducted to define the ideal sensor placement relative to field variability, root zone depth, and emitter spacing. This presentation will discuss soil moisture sensing options including Sentek, Decagon (5TE & 5TM), Trime TDR, Tensiometers (electronic & manual), Watermarks, Spectrum FieldScout, and Aquaterr; how to determine the ideal sensor placement in the field and the response from farmer cooperators regarding the value of monitoring. Future extension outreach goals with the project will be detailed.

Wednesday, July 30 1:45–3:45 PM

New Innovations in Commercial Horticultural Applications

Sponsor: ASHS Industry Division
Coordinator: Negar Mahdavian, ASHS Headquarters; nmahdavian@ashs.org

This workshop is designed to introduce new and innovative technologies available for research, teaching and extension. Presentations are made by companies who exhibit at the annual meeting and will concentrate on new and/or innovative aspect of their company or products.

1:45–2:05 PM

Performance Specifications of New Controlled Environment

*Richard Marusyk
CONVIRON, Winnipeg, MB, Canada

2:05–2:25 PM

I. Wireless Sensor Networks (for Remote Analysis of Environmental Data)
II. Cloud-Based, Real-Time Data Analysis Tool

*Wendy Sayre
Spectrum Technologies, Inc.

2:25–2:45 PM

LAI-2200C Plant Canopy Analyzer

*Eric Price
LI-COR

Leaf area index (LAI), the ratio of leaf surface area to ground surface area, is a key variable when studying or comparing plant biomass. An accurate and non-destructive method for measuring LAI is the LAI-2200C Plant Canopy Analyzer, which measures light transmission through the canopy and uses an inverted gap fraction technique to calculate LAI. With the inclusion of a new light scattering correction, this instrument consistently outperforms other methods in a variety of canopy types and sky conditions.

2:45–3:05 PM

Using ARM Software to Plan Experiments Based on Required Precision

*Steven Gylling
Gylling Data Management

One challenge of conducting experiments is to design experiments to have a reasonable probability of distinguishing anticipated treatment differences. ARM software includes tools that assist with planning experiments, such as a statistical power test and a randomization quality reviewer. Using such tools can help improve the precision of experiments.

3:05–3:25 PM

The Advantages of Measuring Ethylene Using the CI-900 Portable Ethylene Analyzer

*Andrea Melnychenko
CID Bio-Science, Inc.

Wednesday, July 30, 2014

2:00–4:00 PM

Student Career Workshop:
Speed-dating on Career Options: 2nd Edition

Sponsor: ASHS Industry Division
Moderator/Coordinator: Jeffrey Norrie, jnorrie@acadian.ca

Objectives: To provide students short and quick “live” autobiographies from several well-known Industry researchers; to hear their stories on education, research pathways and career choices; and solicit ideas on their own career options and opportunities. When it comes to determining career pathways, students can be faced with vastly different opportunities. These career choices can include positions in Industry, university, government or even private consulting. Given that Industry often leads to exciting and rewarding careers, this workshop introduces students to Industry scientists and technical people in a fun and quick-paced way. Scientists from several horticultural companies will give a brief description of their education, past experience, current roles and responsibilities, and provide humble advice for students looking at career options, with emphasis on how their education has supported their career path. Besides a quick Q&A, students can take time afterward to mingle and discuss career ideas with the speakers.

Speakers:

*Derek D. Woolard
Valent BioSciences Corp.

*Holly Little
Acadian Seaplants, Ltd.

*Gary Stutte
N/ACID BioScience
Wednesday, July 30  

*John D. Abbott  
Syngenta Crop Protection

*Larry D. Knerr  
Tanimura & Antle

*Roland Leatherwood  
Everris

*Neil Yorio  
Lighting Science Group

*Dave Barcel  
Lighting Science Group

*Angela Davis  
HM Clause

**Workshops**

3:20–4:00 PM  
**Cultivating Horticulture as a National Priority**  
*John D. Lea-Cox  
University of Maryland, College Park

**Wednesday, July 30  2:00–4:00 PM**  

**Unique Blueberry Production Practices for Subtropical and Tropical Climates**  
Sponsor: American Pomological Society  
Moderator/Coordinator: Fumiomi Takeda, Fumi.Takeda@ars.usda.gov  
Coordinator: Michele Warmund, warmundm@missouri.edu  
Objectives: This workshop will review research on low-chill blueberry cultivars grown in warm climates and production systems with current challenges and knowledge gaps. Many temperate-zone fruit plants require a period of low temperatures in winter to grow vegetatively and produce flowers uniformly in the spring. Insufficient chilling of some blueberry cultivars results in delayed and erratic budbreak, as well as poor fruit set. Chill-hour accumulation in Central and South Florida can be less than 150 hours, but blueberry production in these two areas is increasing. Low-chill blueberry cultivars, innovative cultural methods, and the use of hydrogen cyanamide in early winter have allowed blueberry growers in these regions to harvest fruit in March and April when the price of fresh blueberries is high (>$13/kg). This workshop will summarize breeding efforts to develop low-chill blueberries with high fruit quality, application of chilling models to predict plant responses, the role of plant growth regulators for producing blueberries in tropical and subtropical environments, and novel practices used to mitigate lack of chilling.

2:00–2:15 PM  
**An Overview of the Blueberry Industry in Florida**  
*Gary England  
University of Florida/IFAS Extension, Yalaha

2:15–2:35 PM  
**Prospects for Low-chill Blueberry Cultivars with High Fruit Quality**  
*James W. Olmstead  
University of Florida, Gainesville

2:35–2:55 PM  
**Role of Plant Growth Regulators in Blueberry Production Under Low-chill Conditions**  
*Jeffrey G. Williamson  
University of Florida, Gainesville

An asterisk (*) in front of a name indicates the presenting author.

HortScience 49(9) Supplement—2014 ASHS Annual Conference  
S107
Mitigating the Effects of Insufficient Chilling Using Novel Cultural Practices
*Fumiomi Takeda
USDA–ARS, Kearneysville, WV

Blueberry Chilling Model Dilemmas
*Michele Warmund
University of Missouri, Columbia

This session will review research on low-chill blueberry cultivars grown in warm climates and production systems with current challenges and knowledge gaps.

Wednesday, July 30 8:00–10:00 AM
Spotlight on Centers for Innovation in Research and Development
Sponsor: ASHS Industry Division
Coordinator: Jeffrey Norrie, jnorrie@acadian.ca
Objectives: This workshop will highlight the activities and experiences of several Innovation Centers, and showcase their collaborative research efforts with emphasis on application technology-transfer and commercial opportunities.

The creation of centers of Excellent and Innovation in Research and Development are a novel way to bring together like minds. The synergy formed between University, Government, and Industry researchers has resulted in many technical advances and commercial opportunities. This workshop will highlight the activities and experiences of several Innovation Centers, including the Ohio Bioproducts Innovation Center, the Plants for Human Health Institute, the Vineland Innovation Centre, and the University of Florida Innovation Center. We hope to bring together ASHS members from all research stripes to see and discuss what can be accomplished when we bring our competencies together to work toward commercialization and application.

8:00 AM
The Florida Innovation Hub—Making Today’s Idea Tomorrow’s Business
*John Byatt
University of Florida

8:15 AM
OBIC 2.0 and the Biobased Product Ecosystem
*Dennis Hall
Ohio Bioproducts Innovation Center

Thursday, July 31 8:00–10:00 AM
The Role of Qualitative Research to Further the Understanding of the Horticultural Lived Experience
Sponsor: Human Issues in Horticulture Working Group
Moderator/Coordinator: Carolyn W. Robinson, cwrobinson@auburn.edu
Objectives: 1) Discuss how qualitative research has been used in horticulture thus far, 2) Present basic techniques of qualitative research and how it differs from other types of research. 3) Give participants the chance to discuss qualitative methods and learn how to incorporate them into their research practices.

Qualitative research is the norm in horticultural peer-reviewed literature; however, there is still a need for qualitative research. Qualitative research is highly accepted in education and other fields of the sciences, but its use in horticulture has been very limited. There are some significant uses for qualitative research in horticulture, and some questions that can only be answered by talking to people, observing people, and collecting detailed, non-measurable data about their experience. This session will provide a platform for scientists, policy makers, and scholars to learn about the challenges and opportunities of qualitative research and help give them the impetus to incorporate qualitative methods into their own programs.

8:00–8:30 AM
Qualitative Research in Consumer Horticulture and Focus Groups
*Bridget K. Behe
Michigan State University, East Lansing

8:30–9:00 AM
Qualitative Data Used to Reinforce Quantitative Data
*Tina Marie (Waliczek) Cade
Texas State University, San Marcos

9:00–10:00 AM
Panel Discussion
Thursday, July 31 8:00–10:00 AM

**The Science of Consumer Horticulture**

Sponsor: Consumer Horticulture and Master Gardeners Working Group

Coordinator: Ellen Bauske, ebauske@uga.edu

Objectives: The objective of this workshop is to encourage extension specialists, researchers and educators to work collaboratively to consolidate and create educational resources for the gardening public and better capitalize on funding opportunities that advance or improve the science of gardening as it impacts nutrition, environmental stewardship, food safety/security, and human health and wellbeing.

Management of urban and residential landscapes and gardens can have a tremendous impact on food production, nutrition and human health, water consumption, water quality, green waste, and energy consumption. Although hard to quantify, there is evidence to suggest that more land is managed in backyards than in all of the U.S. National Parks combined. Yet there is a lack of research documenting the impact of various management strategies and the potential environmental and human health benefits to the landowner and the community as a whole. Addressing research questions in consumer horticulture presents many challenges. Research questions span many disciplines and environments. Multidisciplinary teams of researchers, educators, managers, policymakers, and other stakeholders are often needed to conduct collaborative research addressing the issues mentioned above. Funding is often a challenge. This workshop will present information, foster discussion and provide suggestions for future topics of interest across the region.

8:00–8:30 AM

**Working Together & Building Effective Teams:**

*Mary H. Meyer

University of Minnesota, Chaska

Working in teams has increased the effectiveness of outreach for consumer horticulture Extension Educators in the North Central region. The Consumer Horticulture Working Group, funded by the North Central IPM Center, has delivered 4 successful webinars that have attracted thousands of participants, including hundreds of groups led by local Extension Educators. Collaboration has included the selection of timely topics, presentations by Extension specialists and faculty from several universities, with promotion and support by Extension Educators across the North Central states. Duplication of teaching effort is minimized and training reaches individuals ($10 fee) and groups (free), which are usually arranged locally by Extension Educators.

Pre and post tests and webinar evaluations show participants learn a lot from these webinars and provide suggestions for future topics of interest across the region. Collaboration of team members is via phone conference calls and email discussions. The webinars are delivered via umn.connect with open access for participants with the web address. eXtension has provided the public access and promotion of the webinars through the learn.extension.org and hosts the paid registration for individual participants. Income supports the presenters, technical support, and can be used by individual states to further support their extension work in consumer horticulture.

8:30–9:00 AM

**Funding Challenges and Open Discussion of Options and Opportunities**

*Dave Close

Virginia Cooperative Extension, VirginiaTech, Blacksburg

9:00–9:30 AM

**Defining Research Goals: An Interview with Dr. Tom Bewick, National Program Leader, Horticulture USDA–NIFA**

*Gary Bachman

Mississippi State University, Biloxi

9:30–10:00 AM

**Getting Started: Landscapes and Gardens for Better Living Southern Region Research Activity and Open Discussion of Research Objectives**

*Richard E. Durham

University of Kentucky, Lexington

Thursday, July 31 10:15 AM–12:15 PM

**Eye Tracking Technology Revolutionizes Horticultural Consumer Research**

Sponsor: Marketing and Economics Working Group

Moderator/Coordinator: Bridget K. Behe, behe@msu.edu

Objectives: The objectives of this workshop are to introduce the technology, present “best practices” for equipment use and study design, convey good data extraction techniques, and present research results.

Eye tracking technology is revolutionary to consumer research because it enables scientists to follow information processing through the visual path. Much of the literature relates to packaged consumer goods and the act of reading. A review of the key papers helps to set the stage to understand how eye tracking technology can be used to study horticultural purchases. Paper 2—Horticultural research has been done with one of two types of devices: glasses and computer monitor-mounted. However, the equipment has its challenges and difficulties. Understanding the set-up and subject calibration processes can increase data collection utility. Paper 3—The plethora of data which can be extracted from any one eye tracking study can be overwhelming. Establishment of useful parameters and areas of interest are one key step to successful data extraction and analyses. Data extraction presents its own chal-

An asterisk (*) in front of a name indicates the presenting author.
challenges, so some time saving measures have been developed. Visual data are not normally distributed, presenting further challenges to subsequent analyses. Paper 4—While sustainability has become a hot topic in the green industry, imbedded within sustainability is the concept of wise water use, both in production of plants and in their use in the landscape. In this project, we investigated, profiled, and determined the value that consumer segments place on “green” marketing (sustainability) and “blue” marketing (water conservation) related to woody plant production and use in the landscape. We used three methods including consumer auctions, on-line survey, and eye-tracking of retail displays to examine the effect that water conservation-related signage has on plant purchases. Paper 5—Participants from 6 locations viewed 5 unique plant displays with 3 manipulated signs per display to total 27 total treatment images. Three signs spanned the back, upper portion of each display to (a) identify the plants, (b) convey a fabricated horticultural production method, and (c) convey price. While identification sign was central to all displays, price and production method were changed depending on the plant type. Signs posted on the left were more likely to receive the first fixation and had more fixations compared to those on the right. When price sign location was further compared by price level, no significant difference was detected in fixation count, but high and medium prices on the left side were observed faster than a low price, and all three were looked at before any level of price if shown in the right side of the display.

10:15–10:30 AM
Eye Tracking Equipment for Consumer Research
*Bridget K. Behe
Michigan State University, East Lansing

10:30–10:45 AM
Literature, Findings, and Lessons from Non-horticultural Uses of Eye Tracking
*Jennifer Dennis
Purdue University, West Lafayette, IN

10:45–11:00 AM
Eye Tracking Data Extraction Triumphs and Challenges
*Lynnell Sage
Michigan State University, East Lansing

11:00–11:15 AM
Ascertaining the Influence of Water Conservation Signage on Plant Purchasing Behavior
*Charles R. Hall
Texas A&M University, College Station

11:15–11:30 AM
What Does Eye Tracking Reveal About the Effects of Buying Impulsiveness on the Horticultural Choice?
*Hayk Khachatryan
University of Florida, Apopka

Although consumer behavior research has investigated impulsive buying behavior since the early 1950s, no studies explored the relationship between eye gaze metrics, buying impulsiveness scores and purchase decisions. The present study is a preliminary approach to setting consumer purchase decisions as a function of not only product attributes, but also individuals’ buying impulsiveness and eye gaze measures, which were collected using an eye tracking device during choice experiments. Specifically, we investigate the moderation effects of eye gaze measures on the relationship between buying impulsiveness and consumers’ purchase intentions.

11:30–11:45 AM
Price Signs to the Left of Center Have More Visual Activity Than Signs to the Right of Center
*Bridget K. Behe
Michigan State University, East Lansing

Thursday, July 31, 2014
10:15 AM–12:15 PM
Irrigation Systems and Current Technologies Available for Use in Vegetable Crop Production
Sponsor: Water Utilization and Management Working Group
Moderator/Coordinator: Lincoln Zotarelli, lzota@ufl.edu

The purpose of this workshop is to encourage and facilitate the mutual exchange of ideas and information concerning the use of irrigation systems and tools in various aspects of horticultural research, extension, education, and industry. In this workshop, Lincoln Zotarelli and associated colleagues will provide the most up-to-date information on the current irrigation systems and technology available for vegetable production in Florida. Talks will focus on conversion of irrigation systems, economics, salinity problems, irrigation technologies including the use of soil moisture sensors and smart phone applications. The workshop will also explore how irrigation may influence vegetable production and provide a conceptual framework to better understand how irrigation practices and tools can improve the efficiency of resource use in horticulture.

10:15–10:30 AM
Irrigation Systems for Vegetable Production in Florida: The Good, the Bad, and the Ugly
*Lincoln Zotarelli
University of Florida, Gainesville
10:30–10:45 AM  
**Seasonal Climate Review and Outlook: Possible Vegetable Production Impacts**  
*Daniel Dourte  
University of Florida, Gainesville

10:45–11:00 AM  
**Agroclimate Web and Smartphone Tools for Vegetable Production**  
*Clyde Fraisse  
University of Florida, Gainesville

11:00–11:15 AM  
**Economics of Alternative Irrigation Technologies in Florida Vegetable Production**  
*Tatiana Borisova  
University of Florida, Gainesville

11:15–11:30 AM  
**Irrigation and Salinity Problems in Vegetable Production**  
*Jeffrey Ullman  
University of Florida, Gainesville

11:30–11:45 AM  
**Strategies for Conversion of Seepage to Drip Irrigation: Cabbage Case Study**  
*Charles Barrett  
University of Florida, Gainesville

11:45 AM–12:00 PM  
**Irrigation Scheduling and the Use of Soil Moisture Sensor on Vegetable Crops**  
*Lincoln Zotarelli  
University of Florida, Gainesville

12:00–12:15 PM  
**Smartphone App for Irrigation on Vegetable Crops**  
*Kelly Morgan  
University of Florida, Immokalee
Index of Authors, Coordinators, and Moderators for Colloquia and Workshops

A
Abbott, John D. .................................. S107
Abraham, John .................................. S88
Adams, Carrie Reinhardt ..................... S96
Adkins, James ................................. S105
Adkins, Scott ................................. S89
Albano, Joseph ................................. S103
Anderson, Patti J. .............................. S95
Anderson, Vicky ............................... S92
Arnold, Michael A. ......................... S76
Arpaia, Mary Lu ............................... S91, S98, S99

B
Bachman, Gary ................................. S109
Bai, Jinhe ........................................ S79
Baldwin, Elizabeth ............................ S79, S99
Barcel, Dave ..................................... S107
Barney, Danny L. .............................. S98
Barrett, Charles ................................. S111
Barros, R. Orellana ............................ S75
Barros, V ........................................ S75
Bauske, Ellen ................................. S109
Bautista, Jesus ................................. S100
Bautista, Nelida ................................. S100
Bayer, Amanda .................................. S81
Beaulieu, John C. .............................. S90, S91
Beckman, Thomas G. ......................... S89
Behe, Bridget K. ............................... S108, S109, S110
Bi, Guihong ................................. S92, S93, S94
Björkman, Thomas ............................ S98, S107
Black, Brent ..................................... S97
Black, Zack ...................................... S84, S90
Bomford, Michael K. .......................... S77
Borisova, Tatiana .............................. S111
Brandle, Jim ................................. S108
Brecht, Jeffrey K. .............................. S75, S91
Bruck, Denny ...................................... S87
Brumfield, Robin G. ....................... S93, S94
Bryla, David R. ................................. S68, S69, S70
Brym, Zachary ................................. S81
Butler, David M. ............................. S100
Byatt, John ................................. S108

C
Cade, Tina Marie (Waliczek) ............... S108
Cambardella, Cynthia ........................ S101
Campbell, Craig ............................. S83
Carey, Edward E. .............................. S84
Carraway, Mac .................................. S104
Carvalho, Sofia D. ............................. S71
Carvalho, V.S. ................................. S102
Chaparro, José X. .............................. S89
Cheng, Lailiang ................................ S96
Close, Dave ..................................... S109
Cochran, Diana ............................... S92, S93
Colquhoun, Thomas A. ..................... S71, S99
Conneway, Renee ............................. S92
Contreras-Barragan, Beatriz A. .......... S76
Craker, Lyle ................................. S77
Dai, Wenhao ................................. S101
Darnell, Rebecca L. .......................... S69
Davis, Angela .................................. S107
Davis, Jeanine M. ............................. S77
Delate, Kathleen ............................... S101
DeMoranville, Carolyn J. .................. S70
Dennis, Jennifer ............................... S110
DeVincentis, Alyssa ........................... S93
Diaz-Perez, Juan Carlos ..................... S83, S84, S100, S102
Dole, John ...................................... S83
Dourte, Daniel ................................ S111
Dunn, Bruce L. ................................. S102, S104
Durham, Richard E. .......................... S109
Dutt, Manjul ................................. S101

E
Emond, Jean Pierre .......................... S91
Enciso, Juan ...................................... S76
England, Gary ................................. S107

F
Fallahi, Bahar ................................. S96
Fallahi, Esmaeil “Essie” ..................... S96
Faria, R.T. ................................. S102
Fernandez, Rodney Thomas ............... S92, S93, S94
Fisher, Paul R. .............................. S78
Flory, S. Luke ............................... S95
Folta, Kevin ................................. S71, S82, S101
Fraisse, Clyde ............................... S111
Freyre, Rosanna ............................... S78
Fulcher, Amy F. ............................... S92, S93, S94

G
Galdiano Jr., R.F. ............................. S102
Geneve, Robert L. ............................ S92, S93, S94
Girardin, Mark ............................... S91
Gmitter, Fred G. ............................... S88
Griffis Jr., John L. ............................ S80
Grosser, Jade ................................. S101
Grosser, Jade W. ............................... S88
Grumet, Rebecca ............................. S101
Gu, Mengmeng ............................... S80, S81
Gunter, Chris ............................... S91
Gutierrez-Rodriguez, Eduardo ............ S91
Gylling, Steven ............................... S106

H
Hall, Charles R. ............................... S110
Hall, Dennis ................................. S108
Handa, Avtar K. ............................... S101
Hanna, Wayne ............................... S104
Hassell, Richard L. .......................... S89
Haynes, Cynthia ............................. S85
Hebert, Vincent ............................... S87
Heller, Jeff ................................. S100
Henriques, William ......................... S104
Hoagland, Lori ............................... S98
Index of Authors, Coordinators, and Moderators for Colloquia and Workshops

Hochmuth, George J. ..................... S86
Hochmuth, Robert .......................... S105
Hong, Jason .................................. S89, S100
Hu, Bizhen .................................. S90
Hummer, Kim E. ............................. S82

I
Iglesias, Lindsy ............................... S87

J
Jacobsen, Krista .............................. S92
Janick, Jules ................................. S81, S82
Jayaprakasha, G.K. .......................... S103
Jimenez, Elio ................................. S103
Johnson, Gordon C. ......................... S104, S105

K
Khachatryan, Hayk ........................... S110
Khoddamzadeh, Amir Ali .................... S102
Kim, Hye-Ji .................................. S79, S80, S81
Kleinhenz, Matthew D. ..................... S90, S97
Klick, Jimmy .................................. S86, S87
Kline, Wesley L. .............................. S91
Knerr, Larry D. ................................. S107
Knox, Gary W. ................................. S95
Kobayashi, Hideka ............................ S76
Kobayashi, Kent D. ........................... S77, S81
Koeser, Andrew ............................... S92, S93, S94
Kokalis-Burelle, Nancy ........................ S89, S100
Kopsell, Dean A. .............................. S72
Krug, Brian .................................... S78
Kubota, Chieri ................................. S89
Kusakabe, Ayako .............................. S76

L
Lea-Cox, John D. ............................. S81, S105, S107
Leatherwood, Roland ........................ S107
Li, Tongyin .................................... S94
Liburd, Oscar ................................. S87
Lieurance, Deah .............................. S95
Lila, Mary A. ................................. S108
Little, Holly .................................. S106
Lopez, Roberto G. ........................... S72, S78, S81
Lovell, Sarah T. ............................... S94

M
MacKay, Bruce ............................... S78
Mahdavian, Negar ............................ S106
Malladi, Anish ................................. S96
Mangan, Francis X. .......................... S75
Manthey, John A. ............................. S79
Marchese, A. ................................. S75
Marusyk, Richard ............................. S106
Marynowski, Susan ........................... S77
Massa, Gioia D. ............................... S71
Mazourek, Michael ........................... S98, S99
McCollum, Greg .............................. S80
McConnell, James ............................ S78
Melgar, Juan Carlos ........................... S76
Melnichenko, Andrey .......................... S106
Merhaut, Donald .............................. S104
Meyer, Mary H. ............................... S83, S109
Miles, Rebecca ............................... S85
Moore, Jonathan ............................. S107
Morgan, Kelly ................................. S111
Morris, Jay ................................. S74
Morrow, Robert C. ........................... S72
Moyseenko, Jennifer B. ...................... S90

N
Nabhan, Gary Paul .......................... S82
Nair, Ajay ................................. S97
Nambuthiri, Susmitha ........................ S92, S94
Nelson, Shad D. .............................. S76
Neumann, Jason .............................. S84, S90
Nienhuis, James ............................. S100
Niou, Genhua ................................. S92, S93, S94
Norikane, Joey ............................... S72
Norrie, Jeffrey ............................... S91, S106, S108
Nyoike, Tereisa ............................... S87

O
Olmstead, James W. .......................... S107
Olmstead, Mercy A. ........................... S97
Owen, Jim ................................. S104
Ozones-Hampton, Monica ................... S99

P
Patil, Bhimanagouda S. ..................... S73, S74, S76, S103
Paull, Robert E. .............................. S80
Perkins-Veazie, Penelope .................... S79, S89, S97
Peters, Jack ................................. S104
Petri, Aaron C. ............................... S94
Pfad, Courtenay ............................. S100
Pitchay, Dharma ............................. S100
Pocock, Tessa H. ............................. S71
Poling, Barclay ............................... S84
Pomper, Kirk William ........................ S77
Porter, Wendell ............................... S85
Potts, Shay .................................... S86
Price, Eric ................................. S106
Pritts, Marvin P. ............................. S68

R
Redman, Paul ............................... S83
Riner, Cliff M. ............................... S100
Robinson, Carolyn W. ...................... S108
Robinson, Terence Lee ....................... S96
Rodriguez-Saona, Cesar .................... S88
Rom, Curt R. ................................. S85
Rosskopf, Erin ............................... S89, S100
Runkle, Erik S. ............................... S72
Ruter, John M. ............................... S104

S
Sage, Lynnell ............................... S110
Sams, Carl E. ................................. S72
Sayre, Wendy ............................... S106
Short, Stephanie ............................ S90
Sial, Ash ....................................... S86
Smith, Adrienne M. .......................... S96
Some, Koussao ............................... S84
Stewart, J. Ryan ............................. S93, S94
Stravato, Laurent ........................... S84
Strik, Bernadine C. .......................... S68, S69, S70
Stutte, Gary ................................. S106
Sullivan, Dan M. ............................. S70
Sun, Youping ............................... S92, S94

T
Takeda, Fumiomi .............................. S107, S108
Tanigoshi, Lynell ............................ S87
Index of Authors, Coordinators, and Moderators for Colloquia and Workshops

<table>
<thead>
<tr>
<th>Authors</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thosar, Abhay</td>
<td>S73</td>
</tr>
<tr>
<td>Uckoo, Ram M.</td>
<td>S73, S74, S76, S103</td>
</tr>
<tr>
<td>Ullman, Jeffrey</td>
<td>S111</td>
</tr>
<tr>
<td>van Echtelt, Esther Hogeveen</td>
<td>S72</td>
</tr>
<tr>
<td>VanSickle, John</td>
<td>S74</td>
</tr>
<tr>
<td>Vendrame, Wagner</td>
<td>S102</td>
</tr>
<tr>
<td>Verlinden, Sven</td>
<td>S92</td>
</tr>
<tr>
<td>Walker, Sonia D.</td>
<td>S90</td>
</tr>
<tr>
<td>Wall, Gretchen</td>
<td>S91</td>
</tr>
<tr>
<td>Wang, Xueni</td>
<td>S92, S93, S94</td>
</tr>
<tr>
<td>Warmund, Michele</td>
<td>S108</td>
</tr>
<tr>
<td>Warmund, Michele R.</td>
<td>S107</td>
</tr>
<tr>
<td>Whipker, Brian E.</td>
<td>S78</td>
</tr>
<tr>
<td>Whitaker, Vance M.</td>
<td>S99</td>
</tr>
<tr>
<td>White, Sarah</td>
<td>S104</td>
</tr>
<tr>
<td>Wiese, Christine</td>
<td>S96</td>
</tr>
<tr>
<td>Williamson, Jeffrey G.</td>
<td>S69, S107</td>
</tr>
<tr>
<td>Wilson, Sandra B.</td>
<td>S85, S96</td>
</tr>
<tr>
<td>Woolard, Derek D.</td>
<td>S106</td>
</tr>
<tr>
<td>Wszelaki, Annette L.</td>
<td>S91, S98</td>
</tr>
<tr>
<td>Wyatt, Lindsay E.</td>
<td>S99</td>
</tr>
<tr>
<td>Yang, Wei Qiang</td>
<td>S87</td>
</tr>
<tr>
<td>Yao, Shengrui</td>
<td>S80</td>
</tr>
<tr>
<td>Yorio, Neil</td>
<td>S107</td>
</tr>
<tr>
<td>Yu, Yuan</td>
<td>S99</td>
</tr>
<tr>
<td>Zhang, Aijun</td>
<td>S88</td>
</tr>
<tr>
<td>Zhang, Donglin</td>
<td>S81</td>
</tr>
<tr>
<td>Zhao, Wei</td>
<td>S79</td>
</tr>
<tr>
<td>Zhao, Xiaojie</td>
<td>S94</td>
</tr>
<tr>
<td>Zhao, Xin</td>
<td>S84, S88, S90, S99, S101</td>
</tr>
<tr>
<td>Zotarelli, Lincoln</td>
<td>S110, S111</td>
</tr>
</tbody>
</table>

An asterisk (*) in front of a name indicates the presenting author.
The Evaluation and Release of New Strawberry Selections for the Eastern Region of the United States

William Hlubik*
Rutgers Coop. Res. Extn. of Middlesex, North Brunswick, NJ; hlubik@aesop.rutgers.edu

Peter Nitzsche
Rutgers University, Long Valley, NJ; nitzsche@aesop.rutgers.edu

Jessica Buitrago
Rutgers University, Watchung, NJ; jbaculis@rci.rutgers.edu

Winfred Cowgill
Rutgers Coop. Extn, Flemington, NJ; cowgill@njaes.rutgers.edu

Gojko Jelenkovic
Rutgers University, Piscataway, NJ; jelenkovic@aesop.rutgers.edu

Daniel Ward
Rutgers University, New Brunswick, NJ; dward@rcre.rutgers.edu

The primary goal of the Rutgers/ New Jersey Agricultural Experiment Station strawberry breeding program is to develop new strawberry varieties with outstanding flavor which are better adapted to the climate and growing conditions of the Eastern region of the United States. During the past seven years, New Jersey growers, Rutgers researchers and Extension faculty have collaborated on evaluating the most promising strawberry selections from the program. These advanced strawberry selections have undergone field trials to evaluate their performance under various farm-management systems. Currently, with funding from the Walmart Foundation and administered by the University of Arkansas System; Division of Agriculture, Center for Agricultural and Rural Sustainability, this research has been expanded to include trials on ten New Jersey farms, two research stations in New Jersey and in three other states. Progress on this project includes patent applications for three selections, negotiations to license at least one selection to a commercial nursery and the continued evaluation of four additional selections. Data collected from the trials includes flavor, plant vigor, fruit yield, fruit size, brix, and fruit firmness. Current data indicates that two of the new selections, designated NJAES A and B, have average berry weights statistically similar to or greater than the commercial cultivar ‘Chandler’. The fruit yield of one of the new selections, NJAES A, is also statistically similar to the commercial cultivar ‘Chandler’. This work has created growing interest in the new selections and an indication of the potential marketability of these new selections within the region.

Specified Source(s) of Funding: The Walmart Foundation
A Genetic Analysis of Fruit Firmness in Strawberry

Luis F. Osorio*
University of Florida, Wimauma; lfosorio@ufl.edu

Vance Whitaker
University of Florida, Wimauma; vwhitaker@ufl.edu

The University of Florida strawberry breeding program regularly generates information on genetic parameters for fruit quality traits in order to inform crossing and selection decisions. The main objectives of this study were to determine heritabilities and multiple correlations (additive, genotypic, and phenotypic) among traits for marketable yield, average fruit weight (fruit size), soluble solids content (SSC) and fruit firmness in the main breeding population during the 2012–13 and 2013–14 seasons. A partial diallel mating design of 76 full-sib families from 27 parents in 2012 and of 63 full-sib families from 19 parents in 2013 was used to establish a cloned progeny trial in each season at the UF/IFAS Gulf Coast Research and Education Center at Wimauma, FL. Narrow-sense heritabilities were estimated as h2 = 0.30 to 0.33 for marketable yield, h2 = 0.53 to 0.45 for average fruit weight, h2 = 0.16 to 0.33 for SSC and h2 = 0.24 to 0.41 for fruit firmness. Broad-sense heritabilities for all four traits varied from H2 = 0.31 to 0.67, showing large estimates of dominance variance for marketable yield in both seasons and of epistatic variance for average weight, SSC and fruit firmness. Phenotypic, additive and genotypic correlations between firmness and other traits were small, but moderate and favorable additive (ra = 0.40 ± 0.24) and genotypic correlations (rg = 0.35 ± 0.09) were found between marketable yield and average weight in season 2013-2014. Large unfavorable additive (ra = -0.69 ± 0.18 and -0.86 ± 0.11) and genotypic correlations (rg = -0.47 ± 0.07 and -0.52 ± 0.09) were obtained between marketable yield and SSC in both seasons. Moderate genetic gains should be obtained from recurrent selection based on breeding values for all four traits, using a selection index that appropriately weights each trait according to its economic value.

Effects of Strawberry Volatiles on Consumer Sensory Responses

Tomas Hasing*
University of Florida, Wimauma; thasing@ufl.edu

Vance M. Whitaker
University of Florida, Wimauma; vwhitaker@ufl.edu

Linda Bartoshuk
University of Florida, Gainesville; lmbart@ufl.edu

David G. Clark
University of Florida, Gainesville; geranium@ufl.edu

Michael L. Schwieterman
University of Florida, Gainesville; schwiet@ufl.edu

Kevin Folta
University of Florida, Gainesville; kfolta@ufl.edu

The most important flavor compounds in strawberry fruit are sugars, organic acids and volatiles. Previously volatiles were thought to merely provide aroma and to create flavor when integrated with the tastes evoked by sugars and acids. However, recent analyses suggest that volatiles can contribute to sweetness as well. The objective of this study was to determine whether certain volatiles affect panelists’ perceptions of sweetness and flavor intensity independently from the amount of total sugars (TS) and titratable acidity (TA) in strawberry fruit. This work builds on a previously published study by fitting more comprehensive statistical models to the data. Fifty-four samples from 34 genotypes were harvested across 12 evaluation dates during the 2010–11 and 2011–12 strawberry growing seasons in west-central Florida. An average of 105 panelists per evaluation rated sweetness and flavor intensity of the fruit using a hedonic general labeled magnitude scale from 0 to +100. At each evaluation subsamples from each genotype were kept to quantify volatiles as well as TS and TA. Sweetness and flavor ratings were regressed against first and second order terms of TS and TA, including the first order interaction. After eliminating non-significant terms from these two models, each volatile was introduced one at a time to estimate one regression line per volatile for sweetness and one regression line per volatile for flavor. Sweetness and flavor ratings increased linearly with TS. While TA did not affect sweetness, its first and second degree terms were highly significant for flavor intensity. Out of the 81 volatiles quantified across all samples, 19 affected sweetness (ten positively and nine negatively) and 17 affected flavor ratings (ten positively and seven negatively). Only 12 volatiles affected both sweetness and flavor ratings, seven positively and five negatively. Three of these seven volatiles with positive effect had large standardized coefficients, a measure of their relative importance when compared to the magnitude of the other coefficients within each model. Their size represented between 22% and 26% of the TS coefficient in sweetness models and between 32% and 43% in flavor models. Two of the five volatiles that detract from sweetness and flavor also stood out. Both coefficients represented 24% of the TS coefficient in sweetness models and 31% and 33% in flavor models. Breeders can target these compounds to increase consumers’ acceptance of new cultivars and perhaps to increase sweetness perception without increasing sugar content.

Specified Source(s) of Funding: USDA

Validating Microsatellite Markers Linked to Remontancy in Octoploid Strawberry

Natalia Salinas-Aponte*
Oregon State University, Corvallis; salinasn@oregonstate.edu

Daeil Kim
Chungbuk National University, Cheongju; dkpomo@gmail.com
The RosBREED project is focused on enabling marker-assisted breeding via discovery and development of DNA tests for the most valuable QTLs that are associated with traits that are important to breeders, producers, and consumers of rosaceous crops, including strawberry. The production season for strawberries is a very narrow window of a few weeks in the Pacific Northwest and Midwest, largely dominated by short-day strawberry cultivars. While the development of remontant (day-neutral) cultivars has greatly expanded the cropping season, their cultivation in the US has thus far been limited to California, mostly due to their sensitivity to spring and summer heat. Marker-assisted selection (MAS) will facilitate the development of new remontant cultivars and selections representing diverse strawberry breeding germplasm and 42 pedigreed seedling populations. Plants were considered remontant if they flowered in the Spring and after July 16th. Remontancy was also determined quantitatively as the number of weeks of flowering after July 16. For 2013, the number of flower trusses and the number of flowers per truss were counted, cut and counted again after four weeks. The number of runners was also recorded for each accession. Genotypic data was obtained in the 947 strawberry individuals for two SSRs flanking the FaPFRU gene reported to control remontancy in CDC and from six SSRs associated with six TTH remontancy QTLs. Many strongly remontant types were discovered that could provide novel sources of heat tolerance. The microsatellite allele dosage and configuration establishment method, where possible, is being used to quantitatively establish the full allelic configuration at the eight SSRs. Association between marker alleles and haplotypes for these SSR markers and remontancy will be presented.

Specified Source(s) of Funding: RosBREED Project

9:30–9:45 AM

**The Application of Precision Breeding for Crop Improvement Is Fully Consistent with the Plant Lifecycle: The Utility of PB for Grapevine**

Dennis J. Gray*

University of Florida/IFAS, Apopka; djg@ufl.edu

Zhijian, T. Li

University of Florida/IFAS, Apopka; zzli@ufl.edu

Jonathan R. Jasinski

University of Florida/IFAS, Apopka; beetlebo@ufl.edu

Trudi Grant

University of Florida/IFAS, Apopka; trudigrant@ufl.edu

Manjul Dutt

University of Florida/IFAS, Lake Alfred, FL; manjual@ufl.edu

Sadanand Dhekney

University of Wyoming, Sheridan; sdhekney@uwyo.edu

Precision breeding (PB), in which only defined genetic elements from sexually-compatible parents are utilized, is a logical extension of conventional breeding inasmuch as it is fully consistent with the plant lifecycle. The PB approach has particular promise to develop improved cultivars of grapevine (*Vitis* sp.), which is unique among all crop plants due to its special sensory attributes. A relatively small number of well-known elite cultivars and their landraces account for the majority of world wine production. They are subject to significant disease pressures, making substantial chemical control and sanitation necessary in many regions. Although better genetic resistance is urgently required to ease production, elite grapevine cultivars cannot be improved by conventional breeding because of major obstacles, which include inbreeding depression, self-incompatibility and a long lifecycle. Due to such limitations, it is not possible to add specific and urgently needed genetic traits to elite cultivars. However, technology to bypass these obstacles is finally available. Over
the years we developed the crucial cell culture and gene insertion systems for a wide range of grapevine varieties. Completion of the genome sequencing of *V. vinifera* ‘Pinot Noir’, along with in-depth computational analyses, only recently provided the final piece needed to enable PB of grapevine. A concern expressed against PB has centered on the fact that insertion sites for such genetic elements are random and may cause “unintended consequences”; however such concerns overlook the fact that plant sexual reproduction randomly induces far greater variability through the many types of meiotic crossovers and transposition. Such well-known and expected meiotic variability is the reason that plant breeders must make so many controlled pollinations and evaluate often thousands of progeny in order to find one desirable individual. Precision breeding, which instead utilizes the more stable mitotic pathway, is more predictable, less disruptive, and more efficient than that of conventional breeding because only specific traits are transferred and key obstacles are avoided. However, with new varieties under development, substantial field evaluation, as is the norm for conventionally-bred crops, will be required to determine whether precision-bred versions of elite cultivars will possess desirable attributes and/or otherwise be useful.

Specified Source(s) of Funding: FDACS Viticulture Trust Fund, NIFA/USDA/SCRI

9:45–10:00 AM

**Transcriptome Data for Rabbiteye Blueberry (**Vaccinium virgatum** ‘Premiere’) from Tissue and Developmental Timepoints**

Timothy A. Rinehart*

USDA–ARS SHL, Poplarville, MS; tim.rinehart@ars.usda.gov

*Vaccinium virgatum* (syn *V. ashei*) is commonly known as rabbiteye blueberry and native to the Southeastern United States. Cultivars are typically grown from North Carolina south to Florida and west to Texas for commercial blueberry production. In the Southeast, plants exhibit superior environmental tolerance and have fewer disease and insect concerns that highbush varieties (*Vaccinium corymbosum*), although some southern highbush (*Vaccinium corymbosum x Vaccinium darrowii*) include *V. virgatum* in their genetic backgrounds. Extensive genomic work has been done on *V. corymbosum*, both diploid and tetraploid, but not much has been done with *V. virgatum*, which is hexaploid. Our study included five *V. virgatum* cultivars; TifBlue, Climax, PowderBlue, Austin, and Premiere. Tissues were collected from clonally propagated plants for each cultivar at multiple developmental stages including buds, berries, leaves, and roots. Tissue was also collected from root and leaves during drought treatments. First sequencing results were produced for all growth stages of ‘Premiere’ using Nextera kits and Illumina instruments. Transcriptomes were compared to existing genomic resources for highbush to determine relative overlap.
est *B. tabaci* nymphal population inhabited on plants supplied with 30% NH₄⁺. T. absoluta infestation was increased on plants supplied with 15% NH₄⁺ in 2013. Nitrogen application rate of 140 mg/L N provided higher tomato yield and lower *B. tabaci* density than standard of 205 mg/L N.

Specified Source(s) of Funding: Republic of Croatia, Ministry of Agriculture

8:30–8:45 AM

**Soil Organic Matter Solutions for Peri-urban Market Farms**

Rebecca N. Brown*
University of Rhode Island, Kingston; brownreb@uri.edu

Jeff Pieper
Colorado State University Extension, Eagle; pieperj@my.uri.edu

Rebecca J. Long
University of Rhode Island, Kingston; rlong86@hotmail.com

Soil organic matter is key to soil health. Organic matter supports fungi and macro-invertebrates in the root zone, increases aggregate stability, absorbs water and nutrients, and helps to reduce crustling and compaction. Maintaining sufficient soil organic matter levels in vegetable fields is challenging, as most vegetables produce little crop residue, and growers rely on tillage to create seedbeds and control weeds, insects, and diseases. One solution is to rotate vegetable crops with high-biomass cover crops. This often is not economically practical for peri-urban market farmers because of high land costs and the need to maximize the length of the growing season. At the University of Rhode Island we have been investigating ways to build soil organic matter without removing land from vegetable production. Zone tillage combined with a killed rye covercrop increased soil organic matter by 8.7% after three years, but yields were very low as the covercrop interfered with weed control and competed with the crop for nitrogen. Over the same time period soil organic matter in the conventionally tilled treatment decreased by 15% despite winter cover crops of cereal rye. Perennial living mulch of ryegrass and white clover in the wheel tracks maintained soil organic matter at a constant level. Yields were comparable to or better than the conventionally-tilled treatment in the first year. In years 2 and 3 yields were similar to the conventionally tilled treatment for melons, cucumbers, and carrots but significantly lower for tomatoes, lettuce, and brassica. The living mulch competed with the vegetables, and complicated weed control at the interface between mulch and planting row. It also complicated use of plastic mulch. Intercropping with crimson clover after vegetable establishment did not decrease yields, but it also failed to prevent loss of organic matter. Another approach to maintaining soil organic matter is to amend soil with waste organic matter from the surrounding urban area. After one growing season there were no clear differences in soil organic matter levels but also no significant differences in yields of sweet corn, potatoes, or butternut squash when organic waste materials applied at a rate of 9500 kg organic matter/ha were compared to control plots receiving only synthetic fertilizer. Six materials are being tested: dehydrated food waste; composted yard waste; class A biosolids + yard waste co-compost; recycled paper fiber waste; gelatin manufacturing waste; and mixed feedstock compost made from yard waste, stable sweepings, fish processing waste, and food waste.

Specified Source(s) of Funding: Northeast SARE and the RI Ag Experiment Station

8:45–9:00 AM

**Summer Cover Crops and Plastic Mulch Affect Fall Lettuce (Lactuca sativa L.) Production**

Ajay Nair*
Iowa State University, Ames; nairajay@iastate.edu

Jennifer Tillman
Iowa State University, Ames; jtilman@iastate.edu

Raymond Kruse
Iowa State University, Ames; rakruse@iastate.edu

Cover crops have generated wide interests among fruit and vegetable growers in the country. In vegetable cropping systems, in addition to traditionally grown cover crops such as cereal rye and hairy vetch, there are wide choices available. Short duration summer cover crops such as cow pea, sorghum sudangrass, buckwheat, etc. are being increasingly utilized to add organic matter, suppress weeds, and enhance soil quality and health. Another product that has become ubiquitous in vegetable production is black plastic mulch. Black plastic mulch provides benefits such as weed suppression, moisture retention, and reduced nutrient leaching, but it can also increase soil temperature to a level that could hurt plant roots. Vegetables such as lettuce could be affected due to high soil temperatures. This study investigated effects of three summer cover crops (buckwheat, cow pea, sorghum sudangrass, or no-cover crop) and four mulch treatments (black, blue, red, and white plastic mulch) on fall lettuce production. The study was conducted at the Horticulture Research Station, Ames, IA. Experimental design was a split-plot design with four replications. Cover crops were the whole plot and mulch treatments were the split plot factors. Cover crops were seeded on 20 June, and 10 July in 2012 and 2013, respectively. Cover crops were terminated 60 days after seeding and lettuce ‘Nancy’ was transplanted on raised beds with plastic mulch treatments. Plants were fertigated using drip irrigation. Cover crops significantly affected marketable lettuce yield. Lettuce growing in the cow pea treatment produced the highest marketable weight followed by no-cover crop and buckwheat treatment. Sorghum sudangrass did not produce any marketable lettuce. Lettuce in the sorghum sudangrass treatment showed poor growth and severe stunting. There was no effect of mulch treatments on marketable weight; however, lettuce plants growing on red plastic mulch had the highest total leaf area. Lettuce in cow pea or no-cover crop treatment had higher number of leaves than buckwheat or sorghum sudangrass. Results from this study indicate a detrimental effect of buckwheat and sorghum sudangrass on lettuce yield and quality. This could be due to allelopathic properties of those cover crops. Growers could minimize this risk by planting let-
tuce 10–14 days after cover crop termination. Although plastic mulch did not affect marketable yield, they have the potential to alter leaf number and leaf area.

Specified Source(s) of Funding: NCR-SARE

9:00–9:15 AM

**Water Saving Strategies for Leafy Greens in Southwest Texas**

Daniel I. Leskovar*
Texas A&M AgriLife Research, Uvalde; d-leskovar@tamu.edu

Alma Solis-Perez
Texas A&M AgriLife Research, Uvalde; Alma.Solis-Perez@ag.tamu.edu

Chenping Xu
Texas A&M AgriLife Research, Uvalde; CXu@ag.tamu.edu

Marco Palma
Texas A&M University, College Station; MAPalma@tamu.edu

The Wintergarden is a semi-arid region of southwest Texas known for its intensive irrigated vegetable crops. However, vegetable production in this region is experiencing an increasing scarcity of water resources and more frequent and severe drought events, which combined are greatly affecting total productivity and the overall economy of the region. At the same time, consumer demand for high-quality, attractive, and locally produced vegetables is rapidly increasing. This study evaluated water use efficiency (WUE) and product quality of high-value leafy vegetables grown under three irrigation systems: low energy precise application (LEPA), subsurface drip irrigation (SDI), and hydroponic-nutrient film technique (NFT), and two irrigation rates: 70% as deficit and 100%ETc as well-watered control. In spinach, yield and WUE were reduced at 70% ETc under LEPA, while this response was cultivar dependent under the SDI. In lettuce the overall WUE slightly increased at 70% ETc under LEPA, being also cultivar dependent under the SDI. In kale and collard, 70% ETc caused a slight reduction in yield under SDI. Lettuce grown under the NFT system had an average a 40% lower head FW than those grown in open field; however, their WUE was 8-fold greater and their growth cycle 40% shorter. Similar trends were measured for kale and collards under the NFT system. This study suggests that the effects of deficit irrigation on yield and WUE of leafy greens grown in this region is highly dependent on the crop species, cultivars and irrigation systems. Water savings in the hydroponic production system were > 90% as compared to those under open fields.

Specified Source(s) of Funding: TDA-SCBP

9:30–9:45 AM

**Monitoring Nutrient Uptake and Growth Patterns of Onion Crops to Improve Fertilizer and Water Management**

Andre S. Biscaro*
University of California Cooperative Extension, Ventura; asbiscaro@ucdavis.edu

Michael D. Cahn
University of California Cooperative Extension, Salinas; mdcahn@ucdavis.edu

Timothy K. Hartz
University of California, Davis; tkhartz@ucdavis.edu

Richard F. Smith
University of California Cooperative Extension, Salinas; rifsmith@ucdavis.edu

Information of nutrient uptake and water use of onions in California is very limited. The crops shallow root system and sensitivity to mild water stress creates a conducive environment for off-site movement of nitrate. The objective of this study was...
to develop information of crop growth and nutrient uptake patterns to help growers target the right amount and time of water and fertilizer applications. Aboveground biomass nitrogen (N), phosphorus (P) and potassium (K), crop canopy coverage and root growth were estimated by 8 to 15 measurements throughout the 2013 growing season of three onion varieties in three fields located in Lancaster, CA. Varieties A and B (intermediate-day) were seeded on 18 and 28 Feb. and harvested on 8 Aug., while variety C (long-day) was seeded on 12 Apr. and harvested on 16 Sept. Mean seasonal aboveground biomass nutrient accumulation for variety A was greater than varieties B and C and estimated at 189.4, 52.8 and 276.0 lbs/A of N, P and K, respectively. Canopy growth patterns of varieties A and B were very similar, with steady growth (10% to 95% of ground coverage between 80 to 130 days after planting (DAP), while the canopy of variety C increased from 10% to 85% between 70 to 90 DAP. Root depth development (measurements not replicated) was also very similar between varieties A and B, and reached maximum depth of 21 and 22 inches, respectively, at 115 DAP, while variety C reached the maximum depth of 16 inches at 98 DAP. Overall, similar canopy coverage and root depth patterns between varieties A and B could be explained by similarities in variety type (intermediate-day) and seeding-harvesting dates. Greater aboveground biomass nutrient accumulation of variety A may be explained by a longer growth season (172 days) and consequently greater biomass accumulation. Nitrogen uptake and canopy growth data were analyzed by regression procedures for developing algorithms that estimate N uptake and coefficients for calculating crop water use from reference evapotranspiration data. The parameters of these models will be incorporated into the web-based software, CropManage (https://ucanr.edu/cropmanage), which assists growers in determining appropriate irrigation and N applications for their crops.

9:45–10:00 AM

**Growth and Yield of Chinese Cabbage by Soil Application of Microbe Complex Fluid**

Won Bae Kim*
National Institute of Horticultural and Herbal Science, RDA, Suwon; wbkim55@korea.kr

Jin Heung Kim
G World Group Ltd., Seoul; airmousa@naver.com

Yong Wook Jin
G World Group Ltd., Seoul; jyw2676@naver.com

Experiments with korean microbe complex fluid(KMCF) were conducted to investigate effects of soil application on the growth and yield of chinese cabbage cv. Huimori. KMCF showed the physico-chemical charateristics of pH 3.8, EC 2.7, potassium 517.3ppm, calcium 298.2ppm, magnesium 80.9ppm,phosphorus 960.4ppm, iron 5.95ppm, copper 0.07ppm, zinc 0.42ppm and manganese 1.20ppm. Tray soil application of KMCF solution diluted by a concentration of 10% with water promoted the seedling growth of chinese cabbage in 106 cells for 23 days after sowing, leaf number 7.6 per plant and fresh weight 5.1g per plant, compared to water application, leaf number 6.9 per plant and fresh weight 3.6g per plant. Once field soil application of KMCF solution diluted by a concentration of 10% with water at 2 weeks before seedling planting dedicated the growth promotion and yield increase of chinese cabbage after 3 months, fresh weight 2,383g per plant and head weight 1,402g per plant, compared to water application, fresh weight 1,915g per plant and head weight 1,027g per plant. Twice field soil application of KMCF solution diluted by a concentration of 10% with water at 2 weeks before seedling planting and just before seedling planting accelerated the growth promotion and yield increase of chinese cabbage after 3 months, fresh weight 2,723g per plant and head weight 1,576g per plant. Percentage of inorganic component, T-N, CaO and MgO, in the upper leaves of chinese cabbage harvested was the highest in case of twice soil application of KMCF solution.

Specified Source(s) of Funding: NIHHS

---

Monday, July 28, 2014

**Water Utilization and Management 1**

Moderator: Marc van Iersel; mvanier@uga.edu

8:30–8:45 AM

**Chlorine Efficacy to Control Phytophthora nicotianae in Solutions Containing Peat Particles or Nitrogen Salts**

Rosa E. Raudales*
University of Connecticut, Storrs; rosa.raudales@uconn.edu

Paul R. Fisher
University of Florida, Gainesville; pfisher@ufl.edu

Jennifer L. Parke
Oregon State University, Corvallis; jennifer.parke@oregonstate.edu

The efficacy of chlorine to control Phytophthora nicotianae in the presence of nitrogen salts or increased concentrations of peat was evaluated under laboratory conditions. Solutions with peat at 0, 10, 20, 40, or 80 mg·L⁻¹ were inoculated with P. nicotianae at 10,000 zoospores/mL and were then combined with 0, 2, or 4 mg·L⁻¹ of chlorine with 10 minutes contact time. In a separate experiment, ammonium sulfate ((NH₄)₂SO₄) or potassium nitrate (KNO₃) at 50 mg·L⁻¹ nitrogen were combined with 0, 2, or 4 mg·L⁻¹ of chlorine and inoculated with P. nicotianae with 10 minutes and 24 hours contact time. In the absence of chlorine, peat, or nitrogen, 92% or 81% of tomato leaves were infected after 10 min or 24 h, respectively. Increasing chlorine concentration decreased the infection of tomato leaves exposed to the solutions to ≤ 12.5% and to 0% infection after 10 minutes and 24 hours, respectively. Peat at all concentrations levels and fertilizer applications. Aboveground biomass nitrogen (N), phosphorus (P) and potassium (K), crop canopy coverage and root growth were estimated by 8 to 15 measurements throughout the 2013 growing season of three onion varieties in three fields located in Lancaster, CA. Varieties A and B (intermediate-day) were seeded on 18 and 28 Feb. and harvested on 8 Aug., while variety C (long-day) was seeded on 12 Apr. and harvested on 16 Sept. Mean seasonal aboveground biomass nutrient accumulation for variety A was greater than varieties B and C and estimated at 189.4, 52.8 and 276.0 lbs/A of N, P and K, respectively. Canopy growth patterns of varieties A and B were very similar, with steady growth (10% to 95% of ground coverage between 80 to 130 days after planting (DAP), while the canopy of variety C increased from 10% to 85% between 70 to 90 DAP. Root depth development (measurements not replicated) was also very similar between varieties A and B, and reached maximum depth of 21 and 22 inches, respectively, at 115 DAP, while variety C reached the maximum depth of 16 inches at 98 DAP. Overall, similar canopy coverage and root depth patterns between varieties A and B could be explained by similarities in variety type (intermediate-day) and seeding-harvesting dates. Greater aboveground biomass nutrient accumulation of variety A may be explained by a longer growth season (172 days) and consequently greater biomass accumulation. Nitrogen uptake and canopy growth data were analyzed by regression procedures for developing algorithms that estimate N uptake and coefficients for calculating crop water use from reference evapotranspiration data. The parameters of these models will be incorporated into the web-based software, CropManage (https://ucanr.edu/cropmanage), which assists growers in determining appropriate irrigation and N applications for their crops.

9:45–10:00 AM

**Growth and Yield of Chinese Cabbage by Soil Application of Microbe Complex Fluid**

Won Bae Kim*
National Institute of Horticultural and Herbal Science, RDA, Suwon; wbkim55@korea.kr

Jin Heung Kim
G World Group Ltd., Seoul; airmousa@naver.com

Yong Wook Jin
G World Group Ltd., Seoul; jyw2676@naver.com

Experiments with korean microbe complex fluid(KMCF) were conducted to investigate effects of soil application on the growth and yield of chinese cabbage cv. Huimori. KMCF showed the physico-chemical charateristics of pH 3.8, EC 2.7, potassium 517.3ppm, calcium 298.2ppm, magnesium 80.9ppm,phosphorus 960.4ppm, iron 5.95ppm, copper 0.07ppm, zinc 0.42ppm and manganese 1.20ppm. Tray soil application of KMCF solution diluted by a concentration of 10% with water promoted the seedling growth of chinese cabbage in 106 cells for 23 days after sowing, leaf number 7.6 per plant and fresh weight 5.1g per plant, compared to water application, leaf number 6.9 per plant and fresh weight 3.6g per plant. Once field soil application of KMCF solution diluted by a concentration of 10% with water at 2 weeks before seedling planting dedicated the growth promotion and yield increase of chinese cabbage after 3 months, fresh weight 2,383g per plant and head weight 1,402g per plant, compared to water application, fresh weight 1,915g per plant and head weight 1,027g per plant. Twice field soil application of KMCF solution diluted by a concentration of 10% with water at 2 weeks before seedling planting and just before seedling planting accelerated the growth promotion and yield increase of chinese cabbage after 3 months, fresh weight 2,723g per plant and head weight 1,576g per plant. Percentage of inorganic component, T-N, CaO and MgO, in the upper leaves of chinese cabbage harvested was the highest in case of twice soil application of KMCF solution.

Specified Source(s) of Funding: NIHHS

---

Monday, July 28, 2014

**Water Utilization and Management 1**

Moderator: Marc van Iersel; mvanier@uga.edu

8:30–8:45 AM

**Chlorine Efficacy to Control Phytophthora nicotianae in Solutions Containing Peat Particles or Nitrogen Salts**

Rosa E. Raudales*
University of Connecticut, Storrs; rosa.raudales@uconn.edu

Paul R. Fisher
University of Florida, Gainesville; pfisher@ufl.edu

Jennifer L. Parke
Oregon State University, Corvallis; jennifer.parke@oregonstate.edu

The efficacy of chlorine to control Phytophthora nicotianae in the presence of nitrogen salts or increased concentrations of peat was evaluated under laboratory conditions. Solutions with peat at 0, 10, 20, 40, or 80 mg·L⁻¹ were inoculated with P. nicotianae at 10,000 zoospores/mL and were then combined with 0, 2, or 4 mg·L⁻¹ of chlorine with 10 minutes contact time. In a separate experiment, ammonium sulfate ((NH₄)₂SO₄) or potassium nitrate (KNO₃) at 50 mg·L⁻¹ nitrogen were combined with 0, 2, or 4 mg·L⁻¹ of chlorine and inoculated with P. nicotianae with 10 minutes and 24 hours contact time. In the absence of chlorine, peat, or nitrogen, 92% or 81% of tomato leaves were infected after 10 min or 24 h, respectively. Increasing chlorine concentration decreased the infection of tomato leaves exposed to the solutions to ≤ 12.5% and to 0% infection after 10 minutes and 24 hours, respectively. Peat at all concentrations levels and
but had no effect on zoospore density at 2 or 4 mg L⁻¹ applied Cl. Ten minutes contact time was therefore adequate for both free chlorine (hypochlorous acid) and total chlorine (nitrogenated chlorine compounds chlorine) to control zoospores. Despite the positive results of chlorination under these controlled conditions, filtration and extended contact time of chlorine are recommended to reduce chlorine demand in commercial applications until more organisms are tested.

Specified Source(s) of Funding: USDA–ARS Floriculture and Nursery Research Initiative, Floriculture Research Alliance at the University of Florida (floriculturealliance.org), and Water Education Alliance for Horticulture (watereducationalliance.org)

8:45–9:00 AM

Hydraulic Properties of Peat-based Substrates: The Importance of Hydraulic Conductance

Marc van Iersel*
University of Georgia, Athens; mvanier@uga.edu

Sue Dove
University of Georgia, Athens; sdove@uga.edu

James S. Owen
Virginia Tech, Virginia Beach; jim.owen@vt.edu

The availability of water to plants grown in soilless substrates is typically evaluated with substrate moisture release curves, which describe the relationship between substrate water content and substrate matric potential. Past studies have generally concluded that there is little or no plant available water left at substrate matric potentials (Ψm) of -30 kPa. However, plant water potential is typically much lower than -30 kPa and the substrate-to-plant water potential gradient should allow for continued water uptake. This suggests that plant water uptake may not be limited by substrate matric potential. We hypothesize that hydraulic conductivity may limit water movement in soilless substrates. To test this, we measured substrate water content, matric potential, and evapotranspiration from a peat-perlite substrate (80:20, v:v) simultaneously. These results were then used to determine substrate moisture release curves and hydraulic conductivity. The substrate moisture release curves showed a typical trend, with the pF declining from -0.8 (Ψm = 0.6 kPa) at a substrate water content of approximately 75% (by volume) to -2.9 (Ψm = -74 kPa) at a substrate water content of 21%. The hydraulic conductivity was approximately 3,000 cmm⁻¹ higher at a substrate water content of 36% (0.098 cm/d) than at 21% (0.00004 cm/d). This dramatic decrease in hydraulic conductivity as the substrate dries out is consistent with our hypothesis that hydraulic conductivity may limit plant water uptake. As plants are transpiring and take up water from the substrate, they create a depletion zone around the roots. The low hydraulic conductivity of dry substrates may limit water flow into this depletion zone and limit the ability of roots to extract water from throughout the container, thus decreasing or limiting plant water uptake. To optimize water availability, the effect of substrate pore size distribution on hydraulic conductivity should be taken into account.

Specified Source(s) of Funding: Funding for this research was provided by USDA-NIFA-SCRI award no. 2009-51181-05768.

9:00–9:15 AM

Modeling Water Use of Bedding Plants as a Function of Light Interception

Peter Otieno Alem*
University of Georgia, Athens; peteralem@yahoo.com

Marc van Iersel
University of Georgia, Athens; mvanier@uga.edu

Paul Thomas
University of Georgia, Athens; pathomas@uga.edu

Scheduling greenhouse irrigation is a difficult task, because crop water use depends on both crop size and environmental conditions. Most growers schedule irrigation using timers or based on experience, but excessive irrigation is common. The development of models that describe crop water use requirements based on environmental variables, such as temperature, vapor pressure deficit and photosynthetic photon flux can help provide growers with quantitative irrigation guidelines. Light intercepted by plants may be one of the most important environmental variables that affect plant water use and could be a valuable tool for modeling plant water use. The objectives of this study were to measure light interception and quantify its effects on water use of four bedding plant species (impatiens ‘Accent Coral Star’, Dianthus chinensis ‘Ideal Rasberry’, Petunia × hybrida ‘Dreams Burgundy’ and ageratum ‘Blue Hawaii’). Seedlings were transplanted into 15 cm pots filled with a peat-perlite substrate with controlled release fertilizer (16N–2.6P–9.0K) incorporated at a rate of 9 g/pot. Substrate water content was maintained at 0.40 m³ by an automated, soil moisture sensor-controlled, irrigation system. To achieve different levels of light and light interception, half of plants were shaded for 3 consecutive days each week. Canopy light interception was measured three times a week using a ceptometer (AccuPAR LP-80). The total amount of light intercepted by each crop over the course of the study was calculated from canopy light interception and the daily light integral. Water use was calculated from the number of irrigation events recorded by a data logger. Plant water use was correlated with light interception among all the species (R² = 0.66). However, there was interspecies variability in light interception and in the correlation between light interception and daily water use. When analyzed by species, water use of petunia and impatiens was correlated better with light interception (R² = 0.78 and 0.66, respectively) than that of dianthus and ageratum (R² = 0.45 and 0.58, respectively). Despite similar leaf areas among ageratum, petunia and impatiens (7977, 7543 and 10869 cm² plant, respectively), the maximum measured light interception for ageratum (75%) was lower than that of petunia (85%) and impatiens (93%) at the same age. Accurate light interception data may be harder to collect in ageratum and dianthus (with a more creeping growth habit) than in impatiens and petunia (with a more upright habit), thus affecting the correlation between measured light interception and water use.
Scaling Sensor Networks to Estimate Horticultural Crop Water Use in a Watershed in Ecuador

John D. Lea-Cox*
University of Maryland, College Park; jlc@umd.edu
Bruk E. Belayneh
University of Maryland, College Park; belayneh@umd.edu
David Kohanbash
Carnegie Mellon University, Pittsburgh, PA; dkohanba@cmu.edu
Rachel Conrad
U.S. Department of State, Quito; rachel_conrad13@pitzer.edu

We have deployed four weather stations in the Dulcepamba watershed in Bolivar province, southern Ecuador, to estimate the water demand of horticultural crops for farmers, who are faced with restrictions on irrigation water use concessions. This effort is part of a larger project that is also gathering stream-flow and socio-economic data from farmers in this area. The situation has arisen as a private hydroelectric project has been granted a concession of 6.3 m$^3$ per second of water at the confluence of the two major rivers at the base of the watershed, for the next 50 years. Each weather station is deployed in a different climatic zone in the watershed; each consists of an EM50G data logger (Decagon Devices, Inc.), and sensors measuring air temperature, relative humidity, vapor-pressure deficit, wind speed and direction, total radiation and rainfall. One-minute environmental data are averaged and logged every 5 minutes. The logged data are transmitted over the internet to a cloud server via a subscriber identity module (SIM) card in the EM50G logger, which is configured for the local cellular service provider. All data from the server are then downloaded into Sensorweb software (Carnegie Mellon) to a computer located in College Park, MD. Individual crop water demand is then computed using the FAO Penman-Monteith model, which has been incorporated as a “growing tool” within Sensorweb. The daily rainfall totals and crop water demands are calculated, based on average crop coefficient (Kc) values, and used to estimate the weekly irrigation water need for cacao, banana, blackberry, bean in each section of the watershed. The difference between weekly crop water demand and rainfall data are being aggregated in a simple, open access website so the community can easily access this information, to quickly determine whether they need to irrigate their crops or not. The study is also quantifying total acres of irrigated land for each crop (using satellite imagery and ground-truth data in a geographic information system database), so the seasonal data can be scaled for total crop irrigation water demand. Periodic stream flow measurements are also being made on the major rivers in the watershed to quantify water availability. This will be used to estimate whether the total water flow will be adequate to support the prioritized needs of farmers for crop irrigation water concessions, in relation to the water concession awarded to the hydroelectric company.

Specified Source(s) of Funding: USDA-SCRI Award # 2009-51181-05768

An asterisk (*) following a name indicates the presenting author.
Grafting combines two or more varieties to create tomato plants that often outperform standard ungrafted ones, especially under stress. Grafting requires severing the root-shoot axis and, therefore, immediate and presumably total interruptions of photosynthesis and communication and transport throughout the plant axis. How quickly do xylem flow above the graft union and scion growth return? Are these rates influenced by pre- and post-grafting environments (e.g., light levels)? The literature appears to offer neither answers to these questions nor a protocol to develop them. Typically, grafted plant survivorship is scored subjectively using a binary scale; however, structural and other events required to return the new plant axis to full function are rarely documented. We set out to develop a quantitative protocol for assessing the resumption of xylem flow above the graft union and scion growth. Hypothesizing that gross carbon budgets influence wound healing, we tested this protocol using groups of plants exposed to different light levels after grafting. Tomato (*Solanum lycopersicum*; Maxifort – rootstock and Celebrity – scion) seedlings were grafted using the cleft method and placed into one of two climate-controlled chambers (0 PPF – dark, 135 PPF 14 h – light) for 9 days at 24/20 C (day/night). Healing responses including graft union development and whole plant re-growth were monitored 3, 5, 7, 9 days after grafting. Early-phase vasculature reconnection was assessed using a translocateable dye (Erythrosine). Grafted plants were excised at the soil line and placed in 0.7% (m/v) dye solution for 15 min; distances that the dye traveled from the point of excision and graft union were recorded, along with measures of stem diameter and rootstock and scion length. Digital images of the developing canopy and transmittance readings of dyed stems (spectroradiometer) were also taken. Survivorship equaled 100% in both groups of plants but dye traveled farther and stem diameter and length were larger in plants exposed to 135 versus 0 PPF. The data illustrate that graft healing is a continual process, benchmarks for which can change with time and light levels. Dye distance and other measures detected differences between groups of experimental plants that external observation (i.e., survivorship ratings) did not. Additional use of this method may lead to a greater understanding of the process of graft healing.

Specified Source(s) of Funding: USDA-SCRI; Ceres Trust Foundation; The OSU-OARDC and OSUE
Induction of Somatic Embryos in Five Varieties of *Hibiscus sabdariffa*

Kenya Emanuel*
University of the Virgin Islands, Kingshill; rasken@yahoo.com

Thomas W. Zimmerman
University of the Virgin Islands, Kingshill; tzimmer@uvi.edu

*Hibiscus sabdariffa*, also referred to as sorrel or roselle, is a tropical crop grown for its colorful fleshy and tart calyx. The ability to apply molecular breeding to sorrel for plant improvement is inhibited by the lack of a protocol for somatic embryogenesis and regeneration. The purpose of this research was to evaluate the influence of 2,4-D concentration on the induction of somatic embryogenesis from cotyledon explants of sorrel. Seeds of six sorrel varieties (100, JAK, 128, KDN, 245, TTB) were surface disinfected and germinated in vitro. Cotyledons from two-day-old germinating seedlings were sliced into 1.5 mm strips and placed in petri plates containing MS medium with 60, 120, 180, 240 and 360 mM 2,4-D. After four weeks embryos were observed emerging from the vascular bundle in the expanded cotyledon of five varieties. Successful somatic embryo induction improved as the 2,4-D concentration increased to 240 mM for slices of five varieties. Successful somatic embryo induction emerged from the vascular bundle in the expanded cotyledon. Cytokinins had a greater impact than GA3 or BR on shoot growth during the initial proliferation in G.30 and B.9.

Genetic Characterization of Eastern Filbert Blight-resistant Hazelnut Seedlings from Turkey, Latvia, and Lithuania

Kaitlin Morey*
Rutgers University, New Brunswick, NJ; kmorey81@gmail.com

Megan Muehlbauer
Rutgers University, New Brunswick,NJ; meganmu@scarletmail.rutgers.edu

Josh Honig
Rutgers University, New Brunswick, NJ; honig@aesop.rutgers.edu

John M. Capik
Rutgers University, New Brunswick, NJ; capik@aesop.rutgers.edu

Thomas J. Molnar
Rutgers University, New Brunswick, NJ; molnar@aesop.rutgers.edu

Rutgers University. From this collection, 46 trees were found

The production of hazelnuts (*Corylus avellana*) in the eastern U.S. has been severely limited by the disease eastern filbert blight (EFB), caused by the fungus *Anisogramma anomala*. The development of EFB-resistant plants is considered to be the most effective means to control this disease and much progress has been made in the past decade to develop improved, EFB-resistant cultivars. To search for new sources of resistance, germplasm based on open-pollinated (OP) seed was obtained from Turkey, Latvia, and Lithuania. Over 1000 seedlings were exposed to *A. anomala* annually over 6 years in the field at Rutgers University. From this collection, 46 trees were found

**Oral Presentations**

Monday, July 28, 2014

**Undergraduate Student Oral Competition**

Moderator: Nathan C. Phillips; nate.phillips@mtsu.edu

12:15–12:30 PM

**Induction of Somatic Embryos in Five Varieties of *Hibiscus sabdariffa***

Kenya Emanuel*
University of the Virgin Islands, Kingshill; rasken@yahoo.com

Thomas W. Zimmerman
University of the Virgin Islands, Kingshill; tzimmer@uvi.edu

*Hibiscus sabdariffa*, also referred to as sorrel or roselle, is a tropical crop grown for its colorful fleshy and tart calyx. The ability to apply molecular breeding to sorrel for plant improvement is inhibited by the lack of a protocol for somatic embryogenesis and regeneration. The purpose of this research was to evaluate the influence of 2,4-D concentration on the induction of somatic embryogenesis from cotyledon explants of sorrel. Seeds of six sorrel varieties (100, JAK, 128, KDN, 245, TTB) were surface disinfected and germinated in vitro. Cotyledons from two-day-old germinating seedlings were sliced into 1.5 mm strips and placed in petri plates containing MS medium with 60, 120, 180, 240 and 360 mM 2,4-D. After four weeks embryos were observed emerging from the vascular bundle in the expanded cotyledon slices of five varieties. Successful somatic embryo induction improved as the 2,4-D concentration increased to 240 mM for the varieties 100, KDN, 128, TTB and 245. 2,4-D can be used to induce somatic embryos from young cotyledon tissue in vitro.

Specified Source(s) of Funding: USDA-NIFA-Hatch and USDA-NIFA-Insular Tropical Grant funds

12:30–12:45 PM

**Assessment of Extracellular Enzymes Produced by Fungi Isolated from Muscadine Grapes**

Laura E. Poplawski*
University of Tennessee, Knoxville; lpoplaws@utk.edu

Dennis J. Gray
University of Florida/IFAS, Apopka; djg@ufl.edu

An asterisk (*) following a name indicates the presenting author.
An asterisk (*) following a name indicates the presenting author.

to be highly resistant or tolerant to the disease (30 from Turkey, 13 from Latvia, and 3 from Lithuania). However, since they are from OP seed little is known of their genetic background. The purpose of this study was to use simple sequence repeat (SSR) markers to characterize the relationships and genetic diversity of these new EFB-resistant plants in comparison to a panel of reference cultivars. Thirty SSR markers were amplified and used to fingerprint each accession. The resulting peaks were scored using GeneMarker v4.1 and the resulting allelic data was analyzed in PowerMarker v3.5 to obtain marker summary statistics, including PIC, gene diversity, and heterozygosity. The allelic data was then used to create a UPGMA dendrogram. Following the cluster analysis, a population structure analysis was run with the program STRUCTURE 2.3.4. Our preliminary results show that the Turkish and Latvian seedlings were placed into distinct clusters generally along with reference cultivars from similar origins. Interestingly, most of the new seedlings were grouped into genetically distinct clusters devoid of previously known sources of resistance. Thus, these new accessions should contribute to the germplasm base available for breeding new resistant plants while providing a means to maintain and/or increase genetic diversity.

Specified Source(s) of Funding: Northern Nut Growers Association, Aresty Undergraduate Research Center, New Jersey Agricultural Experiment Station

1:00–1:15 PM

Influence of Vesicular-Arbuscular Mycorrhizae on Growth, Development, and Nutrient Absorption of Sunflower

Caitlin LaComb*
University of Maryland Eastern Shore, Princess Anne; cececel@umes.edu

Corrie P. Cotton
University of Maryland Eastern Shore, Princess Anne; cpcotton@umes.edu

Fawzy M. Hashem
University of Maryland Eastern Shore, Princess Anne; fmhashem@umes.edu

Lurline E. Marsh
University of Maryland Eastern Shore, Princess Anne; lemarsh@umes.edu

Sunflowers are often referred to as hyper-accumulators since they have the ability to uptake excess soil nutrients without causing toxicity to the plant. Vesicular-Arbuscular Mycorrhizae (VAM), a naturally occurring beneficial microorganism found in soil, is known to improve plant uptake of macro and micronutrients through a symbiotic relationship formed between fungi and plant. The objective of this study was to examine the effect of VAM on growth, development, and nutrient absorption of sunflowers. The study was conducted at the University of Maryland Eastern Shore Agricultural Experiment Station in a complete randomized design with two treatments (Control and VAM) and three replications each. Three sunflower varieties were used in this experiment; Lemon Queen, Mammoth, and Mexican. Sunflower seeds were sown in small plug trays containing Promix, allowed to germinate in the greenhouse, and seedlings were transplanted in the field. VAM was applied twice; during sowing of the seeds and at transplanting. Each variety was harvested at its respective flowering stage. Plant height, number of flowers, fresh weight of shoots, roots, and flowers, and root length were determined. Shoots, roots, and flowers were dried, ground separately, and sent to A&L Eastern Laboratories, Inc. for nutrient analysis. Soil was collected pre- and postharvest and also sent for nutrient analysis. VAM had no significant effect on plant height, number of flowers, fresh weight of shoots, roots, and flowers, and root length of ‘Mammoth’ and ‘Lemon Queen’; however, there was significant differences in the number of flowers and root fresh weight in the Mexican variety. There was no significant difference among treatments in nutrients absorbed in the shoots of all sunflower varieties; however, there were significant differences in the concentration of sulfur and copper in roots of the ‘Mexican’ plants, and nitrogen and iron concentration and magnesium and boron concentration in flowers of ‘Mammoth’ and ‘Mexican’, respectively. ‘Mexican’ sunflowers hyper-accumulated higher amounts of nutrients from soil when compared to the other sunflower varieties. Further studies are needed to identify sunflower varieties with higher ability to hyper-accumulate undesirable excess of soil nutrients.

1:15–1:30 PM

Manipulating Flowering Time in Citrus Using a TAL-based Effector Switch

Katie L. Rogers*
University of Florida, Gainesville; kdrogers@ufl.edu

Vicente J. Febres
University of Florida, Gainesville; vjf@ufl.edu

Gloria A. Moore
University of Florida, Gainesville; gamoore@ufl.edu

Citrus has a long juvenility period. It typically takes a tree planted from seed about 8–10 years to flower. This presents a problem for citrus breeders when trying to select for disease resistance or horticultural traits because it often takes decades to make the serial crosses necessary to produce a commercially suitable variety. Three flowering locus T (FT) genes homologous to Arabidopsis FT have been identified in citrus (CiFT1, CiFT2 and CiFT3). Previous work at the University of Florida transforming citrus and tobacco individually with any of the CiFT genes behind a constitutive promoter suggested that CiFT3 was the most active of these genes. In ‘Duncan’ grapefruit, ‘Carizzo’ citrange, and ‘Pineapple’ sweet orange explants were transformed with the genomic CiFT3 gene behind a constitutive figwort mosaic virus (FMV) promoter, flowering occurred in vitro, preventing shoot production. The same phenotype occurred when citrus was transformed with a CiFT3 derived from cDNA in an otherwise identical construct. In tobacco, used as a model plant in these experiments, was transformed with a CiFT3 construct the time from planting to flowering was reduced from 170 to 50 days. By
utilizing a transcriptional activator-like (TAL) effector designed to bind specifically to the endogenous CiFT3 gene promoter fused to an ecdysone receptor (EcR) - based expression switch and the virus protein VP16 transcriptional activator domain it will be possible to chemically induce flowering in citrus. Only when the EcR portion is activated by the field-approved chemical methoxyfenozide the TAL-EcR-VP16 fusion protein will be translocated to the nucleus and subsequently activate transcription of the target gene. The efficacy of this chemically-inducible promoter system will be evaluated using the β-glucuronidase (GUS) gene under the expression control of the chemically induced CiFT3 promoter in a tobacco model system and in citrus with the endogenous CiFT3. If successful, this system will enable breeders and growers to strategically regulate the initiation of flowering when plants are young and promote blossoming at an advantageous time.

Specified Source(s) of Funding: Citrus Research and Development Foundation

1:30–1:45 PM

**In Situ Vernalization: A Novel Method for Accelerated Biennial Vegetable Crop Seed Production**

Lauren Brzozowzki*
University of Wisconsin, Madison; brzozowzki@wisc.edu

Irwin Goldman
University of Wisconsin, Madison; ilgoldmu@facstaff.wisc.edu

Biennial vegetable crops, like beet (*Beta vulgaris*), carrot (*Daucus carota*) and onion (*Allium cepa*), have a life cycle that spans two growing seasons, and are hence time and resource-intensive to breed and to harness for seed production. We sought to determine if environmental conditions could be manipulated to shorten the life cycle of these plants, thus hastening seed production, through a novel “in situ vernalization” (ISV) method. In this method, 7–8 week old seedlings of three varieties (inbred, University of Florida, Fort Pierce hybrid, and OP) of each species were exposed to temperatures of 4 °C for 7–8 weeks in two different settings: a controlled temperature chamber and an outdoor cold frame. The control consisted of the corresponding roots subjected to 12–16 weeks of vernalization at 4 °C to 10 °C according to standard methods. After ISV/vernalization, all treatments were relocated to a warm (15 °C) greenhouse, with 16 hour photoperiod, to promote flowering. After 13 weeks, all plants with floral structures were moved to a warmer (20 °C) greenhouse for seed production. ISV treatment was successful for beets, as beet seedlings that underwent ISV flowered at rates as high as, or higher than, control beets. However, all carrot and most onions that underwent ISV failed to produce floral structures, while the control carrots and onions flowered.

The flowering beets have been crossed within ISV and control groups and, later, the seed production rates and seed quality will be compared. This study has led to a better understanding of vernalization requirements in all species, and has provided a more economical and straightforward model for beet seed production.

Specified Source(s) of Funding: Hilldale Undergraduate Research Fellowship, royalty and state funds

---

**Monday, July 28, 2014**

**Vegetable Crops Management 2**

Moderator: Rose Ogutu, Delaware State University, Dover; rogutu@desu.edu

1:45–2:00 PM

**Vegetable Pest Management Strategies in North Florida**

Muhammad Haseeb*
Florida A&M University, Tallahassee; Muhammad.Haseeb@famu.edu

Tavia Gordon
Florida A&M University, Tallahassee; taviagordon@yahoo.com

Gohar Umar
Florida A&M University, Tallahassee; Gohar.Umar@famu.edu

Bobby Phills
Florida A&M University, Tallahassee; Bobby.Phills@famu.edu

Insect pests cause serious damage to spring and summer vegetable crops in North Florida. These pests include: silverleaf whitefly, *Bemisia argentifolii*; the green peach aphid, *Myzus persicae*; southeastern green stinkbug, *Nezara viridula*; brown stink bug, *Euschistus servus*; potato aphid, *Macrosiphum euphorbiae*; leaf footed bug, *Leptoglossus phyllopus*; western flower thrips, *Frankliniella occidentalis*; melon thrips, *Thrips palmi*; eastern flower thrips, *Frankliniella tritici*; Florida flower thrips, *Frankliniella bispinosa*; tobacco thrips, *Frankliniella fusca*; southern armyworm, *Spodoptera eridania*; beet armyworm, *Spodoptera exigua*; yellowstriped armworm, *Spodoptera ornithogalli*; pepper weevil, *Anthonomus eugenii*; kudzu bug, *Megacopta cribraria*; squash bug, *Anasa tristis*; Colorado potato beetle, *Leptinotarsa decemlineata*; leafminer, *Liriomyza sativae*, *L. trifoli*; tomato pinworm, *Keiferia lycopersicella*; and tomato fruitworm or corn earworm, *Helicoverpa zea*. Insect pests that carry vegetable diseases were considered most serious which included thrips and whiteflies species. To provide necessary skills and hands-on training to stakeholders and clientele, Florida A&M University initiated an extension IPM project in 2010 to implement integrated pest management (IPM) strategies in specialty crops and communities. Since then, we have organized several workshops, field days and on-site demonstrations with a view to manage pests using IPM strategies. These commodity-wise strategies include regular scouting or monitoring for pest problems, identifying pests & beneficial species, and their life stages, keeping good records of pests, use of proven best management practices, use of plant-mediated pest management tactics, practicing good sanitation, conservation of biological controls agents, and application of minimum use of selective pesticides. Every year, seasonal vegetables were cultivated and training & demonstrations were carried out and underserved communities were served. Indeed, by adopting IPM strategies, participating...
Hollow Heart in Triploid Watermelons
Gordon C. Johnson*
University of Delaware, Georgetown; gcjohn@udel.edu
Donald Seifrit
University of Delaware, Newark; dseifrit@UDel.Edu

Successful fruit set and development in triploid watermelons consists of eight phases: 1) flowering of triploids and diploid pollenizers, 2) pollen production by diploid pollenizers, 3) pollen transfer from diploids to triploids, 4) pollen germination and pollen tube growth, 5) fertilization-like event, 6) hormone release, 7) cell division, and 8) cell expansion and fruit enlargement. Photosynthate production and movement to developing fruits is critical in the cell division and cell expansion stages. It is theorized that a reduction in the amount of pollen that germinates and successfully produces pollen tubes will cause reduction in hormones released during the fertilization-like event and limit initial cell division leading to smaller fruits and hollow heart disorder. Experiments have shown that limiting pollen increases hollow heart in triploid watermelons. Experiments were conducted from 2011-2013 where pollenizers were spaced at a 1:10 ratio with selected triploids. In 2011 there was increased hollow heart incidence (hhi) in triploid watermelons starting 1.5 m from a pollenizer crown: at 1.5 m hhi was 12%; at 3.0 m, 28%. In a 2012 study, there was delayed fruit set and increased hhi with increasing distance from pollenizer plants. This relationship was linear in the cultivar ‘Liberty’ but not in the cultivar ‘SS7187’. In 2013, it was shown that under pollen limited conditions, less dense fleshed varieties (Liberty, SS7187) had 312-432% more hollow heart than more dense fleshed watermelon varieties (Crunchy Red and AC9651). Hand pollination studies in 2011 and 2013 showed reduced hhi with increased amounts of pollen. Pollen transfer studies showed that ~500 pollen grains are necessary for triploid watermelon fruit set but ~1000 pollen grains were necessary for full fruit size and reduced hhi. Growth regulator studies from 2011-2013 showed that auxin (2,4-D, IBA) and cytokinin (6BA, CPPU) applications improved early fruit set. The theory that pollination, hormone activity, and cell division in early watermelon fruit development determines hollow heart incidence and severity will be discussed. Recommended management to reduce hollow heart includes insuring adequate pollen availability with matched pollenizer selection, use of mixed pollenizers with different flowering peaks, planting extra pollenizers, maintaining vigor of vines and planting to avoid cold weather at pollination. To improve pollen transfer, place extra bees, place hives in several locations around or in the field, consider using bumblebees for plantings where flowering occurs in colder weather, time bee placement properly, and manage pesticides to reduce effects on bees.

Yield and Economic Considerations for Planting Density of Sweet Corn (Zea mays)

Christopher C. Gunter
North Carolina State University, Raleigh; chris_gunter@ncsu.edu

Rose Ogutu*
Delaware State University, Dover; rogutu@desu.edu

The high demand of fresh tomatoes and value added tomato products has made early production of tomatoes in high tunnels a popular practice by Delaware small farmers. Five varieties of tomatoes were started during the spring of 2012 and 2013 in a 24 x 48 ft. high tunnel using different trellising systems as follows; determinate variety ‘Organic King’ were caged; indeterminate varieties Mountain Fresh’, ‘Better Boy’, ‘Early Goliath’ and ‘Prudence Purple’ were either trellised using Florida weave, or staked. Tomatoes were transplanted into back plastic-covered raised beds at a spacing of 2 ft. between plants. Plants were drip irrigated and fertigated using fish emulsion. Soil nutrient status was evaluated before and after production period and air temperatures in the high tunnel tracked. Tomato fruit yields from six harvests over a period of nine weeks were quantified by counting and weighing mature tomatoes ready for fresh market. The ‘Organic King’ produced the most highly marketable tomatoes, with the longest shelf life. The ‘Prudence Purple’ variety grew very large and tall and had high yields. Trellising using Florida weave was less time consuming than staking for indeterminates, while caging required a larger spacing between plants, than was provided. There was a difference in tomato yields between the two years of production.

An asterisk (*) following a name indicates the presenting author.
Optimizing yields for any crop is critical in order to maximize profitability. An important yield component in the production system is plant arrangement and density. The main objectives of this experiment were to determine the ideal plant density for yield, quality and economics for sweet corn. Two sweet corn field trials were conducted in Swan Quarter, NC, in 2012, using the fresh market sweet corn hybrids ‘Obsession’ and ‘Garrison’. The experimental design was a split-split plot randomized complete block, with four replications per field test. Six populations were examined, ranging from the lowest density of 29,640 plants/ha to the highest population of 79,040 plants/ha. Rows were planted in single or twin rows. Harvested ears were graded and quality data were collected, with ears of lengths between 15.2 and 17.8 cm being “select” and ears of length greater than 17.8 cm being “premium”. A plant population of 79,040 plants/ha produced the greatest quantity of both select and premium ears, and would generate the greatest revenue, although the increases in revenue become much smaller after increasing the plant density past 59,280 plants/ha. Ear quality suffers at the expense of increased yield, with increasing population density resulting in shorter, lighter ears. The ideal plant population should produce a high yield, or more importantly revenue, while meeting the quality standards of the producer. It appears that a plant density of 59,280 plants/ha produces revenue similar to the highest population densities investigated, 61,160 and 79,040 plants/ha, without incurring any unnecessary decreases in ear weight and length, which decrease linearly for every increase in plant density. The use of twin rows had a minimal impact on yield and quality when compared with single rows.

2:45–3:00 PM

**Variety Evaluation of Compact Growth Habit Tomatoes with Jointless Pedicels for the Florida Mature-green Fresh Market**

Aline Coelho Frasca*
University of Florida/IFAS, Immokalee; acfrasca@gmail.com

Monica Ozores-Hampton
University of Florida, Southwest Florida Research and Education Center, Immokalee; ozores@ufl.edu

John W. Scott
University of Florida/IFAS, Wimauma; jwsc@ufl.edu

Craig Stanley
University of Florida/IFAS, Wimauma; cdstan@ufl.edu

Eugene McAvoy
University of Florida/IFAS, LaBelle; gmcavoy@ufl.edu

The majority of the tomato (*Solanum lycopersicum*) varieties grown for the Florida fresh-market are hybrids with a determinate upright growth habit that require staking, tying, pruning, and manual harvest. These cultural practices account for as much as 55% of the total tomato production cost estimated at $14,000/acre. Mexico is the major Florida competitor for fresh-market tomatoes in the U.S. and its ability to produce tomatoes at lower cost per unit forces the Florida industry to implement new production systems to reduce cost and/or to increase yields and fruit quality. Compact growth habit (CGH) tomatoes are determinate hybrid varieties that have shortened internodes and strong side branching due to the brachytic gene (br), and can grow prostrate or upright due to unidentified gene(s). This two-trait combination results in a low-growing, spreading tomato plant with no staking, tying, or pruning requirements. Therefore, the objective of this study was to evaluate six CGH tomato breeding lines on yield and postharvest fruit quality. The CGH tomato breeding lines were provided by the University of Florida Tomato Breeding Program (UF-TBP). The experiment was conducted in a commercial tomato field in Immokalee, FL, during Spring 2013. The experimental design was a randomized complete block with four replications. The bed-shoulder slope was modified to allow improved drainage. Fruit were harvested two times at the mature-green stage and graded into marketable yield size categories and unmarketable culls (sunscald, off-shape, and other defects). Postharvest evaluation included subsampling fruit at first harvest, ripening with ethylene gas, and measuring fruit firmness, color, total soluble solids, and pH. Breeding line 8916 had the highest extra-large marketable fruit yield in the first and total season harvests. Breeding line 8834 had the lowest first and total season harvest yields. Extra-large fruit yields decreased in the second harvest for all breeding lines. The most commonly observed defects were sunscald and off-shape with 41% and 36% of the total unmarketable fruit category, respectively, or 11% and 9% of the average total fruit harvested. There were no differences in postharvest quality among the six breeding lines tested except for pH. Compact growth habit tomatoes may be a viable option for the Florida mature-green fresh market based on yield and fruit quality.

Specified Source(s) of Funding: Florida Tomato Committee

3:00–3:15 PM

**Soil Management to Improve the Sustainable Productivity of Winter Fresh Market Vegetable Crops in Miami–Dade County**

Qingren Wang*
UF/IFAS Miami-Dade Extension, Homestead, FL; qrwang@ufl.edu

Teresa Olczyk
UF/IFAS Miami-Dade Extension, Homestead, FL; twol@ufl.edu

Yuncong Li
Tropical Research and Education Center, UF, Homestead, FL; yunli@ufl.edu

Miami-Dade is one of major counties in the United States to produce winter fresh market vegetables. However, the major challenges for local growers are the gravelly soil lying on the hard-bed rock, intensive nutrient leaching caused by torrential summer rainfall, a vulnerable Everglades environment adjacent to the agricultural area, and a shallow aquifer. All these features make soil management crucially important to sustain the productivity of vegetables in this particular area. Cover crops, such
as sunn hemp and velvet bean, grow vigorously during the rainy summer, can scavenge residual nutrients applied from previous season and accumulate in plant tissues. This approach, on one hand, can reduce nutrient leaching, and on the other hand, it can improve soil fertility after incorporated into the soil for vegetable growth. In addition, growing sunn hemp can effectively suppress root-knot nematodes that are one of the dominant pests in vegetable crops, especially okra, tomato, and peppers. Other practices, such as applications of compost and soil amendments, can also improve soil nutrient withholding and increase crop yield of winter vegetables.

3:15–3:30 PM

Mechanical Thinning versus Hand Thinning in Lettuce

Guangyao (Sam) Wang*
University of California, Holtville; samwang@ucanr.edu
Khaled M. Bali
University of California, Holtville; kmbali@ucanr.edu
Jiangang Liu
China Agricultural University, Beijing; ljgwr0619@gmail.com
Kelly Thorp
U.S. Arid-Land Agricultural Research Center, Maricopa, AZ; Kelly.Thorp@ars.usda.gov
Qingquan Chu
China Agricultural University, Beijing; cauchu@cau.edu.cn

The availability and the high cost of hand labor in California have been forcing vegetable growers to search for mechanical ways to replace manual management practices. Mechanical thinning in lettuce has been developed in recent years by a few companies. Mechanical thinners employ digital cameras to identify each lettuce seedling, analyze the spacing, and remove unwanted plants by spraying a material (salt, acid based fertilizer, or herbicide) over to kill them. Three field experiments were conducted on romaine heart lettuce at Holtville, CA, during September 2013 and April 2014 to test if mechanical thinners can increase crop uniformity and crop yield. A mechanical thinner from Vision Robotics Corporation (San Diego, CA) was used to thin the lettuce mechanically. Manual thinning was used as the control. The treatments in each experiment were replicated twice with a plot size of six 2-m wide and 400-m long beds. In-row spacing was measured after the thinning and overhead images were analyzed to measure plant size and uniformity during growing seasons. The impacts of mechanical and manual thinning on lettuce yield and uniformity were determined at each harvest by measuring plant size in two areas of 6 m² in each plot and counting harvested boxes in the stripes. Mechanical thinning increased uniformity of in-row spacing and increased percentage of plants with desired in-row spacing of 9–12 inches. Mechanical thinning also increased plant size at about 2 weeks after mechanical thinning (1 week after hand thinning) and plant uniformity at harvest. However, crop yield was not significantly affected by mechanical thinning. This is due to more plants were left in the hand thinning treatments. Our study suggests that mechanical thinning can increase plant uniformity, maintain crop yield, and reduce labor cost in romaine heart lettuce.

Monday, July 28, 2014

Produce Quality, Safety, and Health Properties

Moderator: Byron Shock; byron.shock@oregonstate.edu
2:00–2:15 PM

Surface Irrigation Systems That Deliver Bacteria to Vegetable Crops

Byron Shock*
Scientific Ecological Services, Ontario, OR; byron.shock@gmail.com
Clinton C. Shock
Oregon State University, Ontario; clinton.shock@oregonstate.edu

Malheur County, Oregon has a surface irrigation canal systems dating from early in the 20th century. The county is also a leading producer of beef and onions. The FDA is proposing to adopt the EPA’s primary contact recreational water standard (235 colony-forming units (CFU) E. coli/100 ml and 126 CFU E. coli/100 ml on a 5-sample geometric rolling mean) for vegetable crop production. In Malheur County, surface irrigation water delivery systems maximize scarce water by reusing runoff water from other growers. Agricultural drain water is mixed with relatively clean project water to provide ample supply to all growers. Agricultural drain water in runoff reuse systems enhances the amount of water available. However, it carries high microbiological contaminant loads picked up from each user, including from enclosed livestock, small mammals and birds that live and feed in agricultural fields, and waterfowl and birds that live and feed in agricultural wetlands. It can be demonstrated that runoff water for reuse cannot meet FDA’s proposed rule for agricultural water. Options for producers will be discussed.

2:15–2:30 PM

Survival of E. coli on Onions during Curing

Clinton C. Shock*
Oregon State University, Ontario; clinton.shock@oregonstate.edu
Jose Maria Pinto
Oregon State University, Ontario; Jose.Pinto@oregonstate.edu
Harry Kreeft
Western Laboratories, Parma, ID; harry@westernlaboratories.com
Byron Shock
Scientific Ecological Services, Ontario; byron.shock@oregonstate.edu

The Food and Drug administration has expressed concern that onions (Allium cepa) irrigated with water contaminated with high rates of Escherichia coli could harbor E. coli on their surface or interior. The relationship between the E. coli in the irrigation water to the E. coli on onion bulbs after field curing, harvest, and packout has not been studied. To determine if E. coli should be
of concern in onion production, we sought to measure the die-off of *E. coli* on onions between the last irrigation and harvest and the presence of *E. coli* on onions after packout. Well water was tested and had no *E. coli*; ditch water intentionally run across a pasture prior to use had 218 to > 2400 MPN of *E. coli*/100ml. Onions were sampled from those furrow irrigated (ditch water) and those drip irrigated (well water) starting at lifting 3 September 2013 for four consecutive weeks. At 0 and 28 days after lifting, both interior and exterior of the onions were tested for *E. coli*. At 7, 14, and 21 days after lifting, only the exterior of the onions was tested. None of the onions contained *E. coli* internally at 0 or 28 days after lifting. At lifting *E. coli* was present on the exterior of both the drip and furrow irrigated onions and seemed to be largely unrelated to the irrigation water. The exterior *E. coli* contamination decreased rapidly after lifting. After harvest and packout on 14 October 2013, *E. coli* was not detected on the onion bulb exteriors from either irrigation treatment. *E. coli* introduced into the onion field through furrow irrigation was not present on or in the packed out onion bulbs.

2:30–2:45 PM

**Detection and Characterization of *Salmonella* Species and Correlation with Microbial Indicators in North Carolina Tomato Production Environments**

Diane Ducharme*
NCSU- Horticultural Science, Raleigh, NC; Diane_Ducharme@ncsu.edu

Chris Gunter
NCSU- Horticultural Science, Raleigh, NC; cgunter@ncsu.edu

Penelope Perkins-Veazie
NCSU - Horticultural Science, Kannapolis, NC; penelope_perkins@ncsu.edu

Lee-Ann Jaykus
NCSU- Food, Bioprocessing and Nutritional Science, Raleigh, NC; Lajaykus@ncsu.edu

Otto Simmons
NCSU - Biological and Agricultural Engineering, Raleigh, NC; odsimmon@ncsu.edu

Eric Brown
FDA/CFSAN, College Park, MD; eric.brown@fda.hhs.gov

Insook Son
FDA/CFSAN, College Park, MD; insook.son@fda.hhs.gov

Jie Zheng
FDA/CFSAN, College Park, MD; Jie.zheng@fda.hhs.gov

Rebecca Bell
FDA/CFSAN, College Park, MD; Rebecca.Bell@fda.hhs.gov

At $1 billion in 2012, fresh-market tomatoes (*Solanum lycopersicum*) rank as one of the highest value vegetables in the U.S. With improved varieties, high nutritional value, and documented health benefits, demand for tomatoes in the American diet is increasing. However, multiple epidemiologically confirmed salmonellosis outbreaks have been associated with contaminated tomatoes, many of which were produced in eastern United States. Because of this, tomatoes remain one of the leading causes of produce-related foodborne outbreaks. Limited data exists on the prevalence of *Salmonella* or the relationship between the presence of *Salmonella* and the traditional microbial fecal contamination indicator generic Escherichia coli (*E. coli*) in these farm production systems. The primary purpose of this project is to identify endemic environmental niches for *Salmonella*, to characterize the isolates, and to correlate *Salmonella* presence with generic *E. coli* concentrations in tomato production systems. Environmental samples were collected from three agriculturally diverse farms in North Carolina during the 2012 and 2013 production seasons. Samples of tomato fruit, blossom, leaf, weeds, soil, and water/sediment samples (*n = 1010*) were analyzed for the presence of *Salmonella* using a modified FDA Bacteriological Analytical Manual (BAM) method as well as by real-time PCR. Isolates were genotyped using pulse-field gel electrophoresis. Generic *E. coli* was enumerated in monthly water samples (*n = 48*) collected at the source and throughout the field irrigation system using the IDEXX Colilert and Quanti-Tray 2000 system (theoretical detection limit of 1 MPN/100ml). *Salmonella* was isolated in June (10 isolates for 2013 only), July (28 isolates), August (35 isolates) and September (42 isolates) with 59% (68/115) of isolates from water, 33% (38/115) from sediment, 4% (5/115) from tomato fruit, and 3% (4/115) from soil. 61% (70/115) of the isolates were identified to seven *Salmonella* serotypes, including Agona, Berta, Hartford, Montevideo, Newport, Paratyphi B and Typhimurium, each having potential clinical significance. Using a positive threshold value of 235 MPN/100 ml, as proposed in the pending Food Safety Modernization Act, generic *E. coli* was predictive of *Salmonella* sp. 81% of the time (False Positives = 17% (8/48); False Negatives = 2% (1/48)). On these farms, the major environmental niche (92%) for *Salmonella* appears to be water sources and sediment, which remain prominent and seasonally consistent across both production years. A better understanding of environmental sources, persistence, and routes of contamination for *salmonellae* in tomato production environments will assist with identification and implementation of on-farm remediation and better management for potential microbial contaminants.

Specified Source(s) of Funding: Lifesource Biomedical LLC and the U.S. Food and Drug Administration

2:45–3:00 PM

**Survival of Microorganisms Isolated from Fresh Produce and Production Fields and Inoculated into Pesticide Solutions**

Hidemi Izumi*
Kinki University, Kinokawa; izumi@waka.kindai.ac.jp

Kosuke Kitada
Kinki University, Kinokawa

Izumi Iwasaki
Kinki University, Kinokawa

Microflora of several produce (broccoli, cucumber, lettuce, etc.) rank as one of the highest value vegetables in the U.S. Tomatoes, many of which were produced in eastern United States. Because of this, tomatoes remain one of the leading causes of produce-related foodborne outbreaks. Limited data exists on the prevalence of *Salmonella* or the relationship between the presence of *Salmonella* and the traditional microbial fecal contamination indicator generic *Escherichia coli* (*E. coli*) in these farm production systems. The primary purpose of this project is to identify endemic environmental niches for *Salmonella*, to characterize the isolates, and to correlate *Salmonella* presence with generic *E. coli* concentrations in tomato production systems. Environmental samples were collected from three agriculturally diverse farms in North Carolina during the 2012 and 2013 production seasons. Samples of tomato fruit, blossom, leaf, weeds, soil, and water/sediment samples (*n = 1010*) were analyzed for the presence of *Salmonella* using a modified FDA Bacteriological Analytical Manual (BAM) method as well as by real-time PCR. Isolates were genotyped using pulse-field gel electrophoresis. Generic *E. coli* was enumerated in monthly water samples (*n = 48*) collected at the source and throughout the field irrigation system using the IDEXX Colilert and Quanti-Tray 2000 system (theoretical detection limit of 1 MPN/100ml). *Salmonella* was isolated in June (10 isolates for 2013 only), July (28 isolates), August (35 isolates) and September (42 isolates) with 59% (68/115) of isolates from water, 33% (38/115) from sediment, 4% (5/115) from tomato fruit, and 3% (4/115) from soil. 61% (70/115) of the isolates were identified to seven *Salmonella* serotypes, including Agona, Berta, Hartford, Montevideo, Newport, Paratyphi B and Typhimurium, each having potential clinical significance. Using a positive threshold value of 235 MPN/100 ml, as proposed in the pending Food Safety Modernization Act, generic *E. coli* was predictive of *Salmonella* sp. 81% of the time (False Positives = 17% (8/48); False Negatives = 2% (1/48)). On these farms, the major environmental niche (92%) for *Salmonella* appears to be water sources and sediment, which remain prominent and seasonally consistent across both production years. A better understanding of environmental sources, persistence, and routes of contamination for *salmonellae* in tomato production environments will assist with identification and implementation of on-farm remediation and better management for potential microbial contaminants.

Specified Source(s) of Funding: Lifesource Biomedical LLC and the U.S. Food and Drug Administration

An asterisk (*) following a name indicates the presenting author.
Japanese apricot, persimmon, and satsuma mandarin) and field environments including agricultural water and pesticide solutions diluted with agricultural water were evaluated. Microbial counts of the vegetables ranged from 2.8 to 6.2 log cfu/g, while those of the fruits were below the detection level. The microflora of vegetables and fruits were comprised of 2 to 24 species of bacteria and 1 to 14 species of molds. Microbial populations in agricultural water varied among the water sources, the population being highest in river water (3.4 log cfu/ml) and lowest in well water (below the limit of detection). When pesticide products were diluted with agricultural water such as well water, river water, and mountain spring water, the microbial counts increased to > 4 log cfu/ml. The diversity of bacteria and mold flora was similar in the agricultural water and pesticide solutions. The same 14 species belonging to 8 genera of bacteria and 9 species belonging to 9 genera of molds were detected in both the produce and agricultural water or pesticide solutions. Among the isolates, six bacterial species belonging to the genera Bacillus, Chryseobacterium, Enterobacter, and Pseudomonas and 6 mold species belonging to the genera Ascochyta, Aureobasidium, Coniothyrium, Arthrinium, Cladosporium, and Fusarium were examined for their ability to survive or grow in two fungicide and four insecticide solutions diluted to their recommended concentrations. Individual cultures of these microorganisms and Escherichia coli O157:H7, representing a human pathogen, were inoculated at 102 cfu/ml into the pesticide products or their active ingredients. Following incubation at 30 °C for 3 days for bacteria and 7 days for molds, five of the pesticides supported the growth of inoculated E. coli O157:H7, E. cloacae, C. indolgenes, P. oryzihabitans, or A. pullulans. These microorganisms did not survive after inoculation into any active ingredient of the pesticides, except for P. oryzihabitans that survived in one ingredient and A. pullulans in 3 ingredients. These results suggest that the pesticide solution could be a source of preharvest contamination and that the presence of the inert additives in the formulation of some pesticides could provide nutrients for microbial growth.

Specified Source(s) of Funding: JSPS KAKENHI Grant Number 24658033

3:00–3:15 PM

The Five-year Anniversary of the Arizona Leafy Green Marketing Agreement: What Works and What Doesn’t

Kurt D. Nolte*
University of Arizona, Yuma; knolte@ag.arizona.edu
Channah M. Rock
University of Arizona, Maricopa; channah@ag.arizona.edu

In Spring 2007, a group of California handlers of leafy greens established the Leafy Greens Products Handler Marketing Agreement (LGMA) in response to the September 2006 E. coli outbreak that was attributed to spinach grown in the Salinas Valley. The spinach recall resulting from the outbreak, and the consequential lack of consumer confidence in the industry, had a disproportionate impact on produce farmers and handlers in California and Arizona, since nearly 89% of leafy greens sold in the United States come from these two states. A voluntary program, the LGMA has been widely accepted by the produce industry, grocers and foodservice firms. Arizona also adopted an LGMA and has been implementing the program since 2008. Although the LGMA is an agreement between produce shippers, many of its compliance requirements fall upon growers to implement, as it requires signatory members to source their leafy greens solely from growers found to be in compliance with a set of food safety provisions called “best practices.” The LGMA guidelines are technically voluntary, but because produce companies that purchase over 99% of Arizona’s leafy greens have committed to selling only products grown in compliance with the LGMA, the standard has essentially become mandatory for many Arizona farmers. The LGMA offered hope of a respite from private industry standards and the requirement that they comply with multiple standards in order to sell to multiple buyers. However, the food safety benefits to companies participating in the LGMA are unclear. No food safety protocol guarantees safe food, nor is it known where the contamination of the lettuce took place. For farmers, the expected gains from having one standard applied consistently across the leafy greens industry have not materialized. Some produce buyers who adopted the LGMA continue to enforce their own standards as well, requiring farmers to be audited for both. Small farm, conservation and wildlife groups are concerned about the stringent guidance on wildlife, noncrop vegetation and water testing. These groups also worry that small and biodiverse farms are being forced to choose between market access and their biodiversity and conservation goals. This presentation provides a specific overview of the Leafy Green Marketing Agreement as it relates to the ramifications of existing and proposed protocols, while recognizing that the one-size-fits-all approach may not be appropriate especially when identifying the diversity of farm sizes and production methods present in the U.S. food system.

Specified Source(s) of Funding: “Improving the Safety and Post-Harvest Quality of Field Grown Organic Leafy Greens: Assessment of Good Production Practices Along the Farm to Fork Continuum”

3:15–3:30 PM

Exogenous Methyl Jasmonate Treatment Increases Glucosinolate Biosynthesis and Quinone Reductase Activity in Kale Leaf Tissue

Kang Mo Ku*
University of Illinois at Urbana-Champaign; ku8@illinois.edu
John A. Juvik
University of Illinois at Urbana-Champaign; juvik@illinois.edu

Methyl jasmonate (MeJA) spray treatments were applied to the kale varieties ‘Dwarf Blue Curled Vates’ and ‘Red Winter’ in replicated field plantings in 2010 and 2011 to investigate alteration of glucosinolate (GS) composition in harvested leaf tissue. Aqueous solutions of 250 µM MeJA were sprayed to saturation...
An asterisk (*) following a name indicates the presenting author.

Oral Presentations

3:30-3:45 PM
**Exploring Plant-UV Interactions with Greenhouse Tomatoes: Stress, Flavor, and Phytochemicals**

Michael Dzakovich*

Purdue University, West Lafayette, IN; mdzakovi@purdue.edu

Cary A. Mitchell

Purdue University, West Lafayette, IN; cmitchel@purdue.edu

Fruits harvested from off-season greenhouse tomato plants tend to be mealy, nutritionally mediocre, and bland. By contrast, tomatoes of the same varieties grown outdoors in the summer tend to have a reputation of superior fruit flavor and nutritional quality. Still, varieties that produce excellent fruit outdoors can yield mediocre fruit when grown in greenhouses. Therefore, environmental factors may be a critical mediator of fruit quality rather than genetics, per se. Presently, there is a gap in knowledge with regard to the role of UV-B radiation (280–320 nm) in determining greenhouse tomato quality. Since UV-B radiation is uniquely present outdoors, but largely absent within glass greenhouses, we hypothesize that UV-B supplemental radiation will impart quality attributes typically associated only with ‘garden-grown’ tomatoes onto greenhouse tomatoes. To test this hypothesis, greenhouse tomatoes supplemented with UV-B radiation were compared with unsupplemented controls. Fruits were analyzed for basic physicochemical attributes (total soluble solids, citric/ascorbic acid content, pH, and electrical conductivity). Carotenoids, phenolics, and volatile organic compounds were quantified, providing a broad canvas of nutritional and sensory attributes. An organoleptic sensory panel complemented this study by determining the sensory relevance of various chemical differences. To further understand greenhouse tomato responses to UV-B radiation, photosynthetic efficiency, stomatal conductance, and leaf fluorescence were assessed to provide markers of physiological stress that UV-B radiation might impart to supplemented plants in the greenhouse environment. Lastly, tomato fruits grown seasonally in a nearby field plot were assessed as above to provide a chemical/sensory baseline for ‘garden-grown’ tomato fruits.

Specified Source(s) of Funding: NIFA SCRI Grant 2010-51181-21369

Monday, July 28, 2014

**Temperate Tree Nut Crops and Tropical Horticultural Crops**

Moderator: Megan Muehlbauer; meganmu@eden.rutgers.edu

4:00–4:15 PM

**Physiology of Fruit Growth as a Function of Heat in Commercial Pistacia vera Species**

Cara J. Allan*

University of California, Davis; callan@ucdavis.edu

Louise Ferguson

University of California, Davis; lferguson@ucdavis.edu

During the summer season the growth of many plants is a function of temperature, specifically heat. Determining the degree-day requirement (DD) is done by simultaneously measuring both the accumulated temperatures above a certain plant species requirement (DD) is done by simultaneously measuring both the accumulated temperatures above a certain plant species along with the plant’s growth and correlating the two. Once the degree-day accumulation for a specific cultivar has been collected this data can be formatted to stage-determining equations which can then be used as a prediction tool. Pistachio has three major growth stages; stage I relates to the growth of the empty fruit; stage II refers to a period of time where the pistachio shell increases in hardness; and stage three begins when the embryo begins growing until the pistachio splits, indicating the harvest readiness. This information can be used to direct field production practices. For example we will know if there is a difference in the timing of shell split among cultivars to determine which blocks to harvest first. In this study we have sampled from the ‘Kerman’, ‘Golden Hills’, ‘Lost Hills’, ‘Kalehghouchi’ and ‘Pete 1’ cultivars. In this first year the growth of five cultivars as a function of accumulated...
degree days from a local temperature monitor was measured at eight different locations in California. All stage I growth terminates at 500 DD. Stage II differed among cultivars with ‘Lost Hills’ hardening earliest at 1,600 DD and ‘Kaleghouchi’ being the slowest at 2,100 DD. ‘Golden Hills’ initiated stage III at 900 DD followed by ‘Pete 1’ at 1,000. Kaleghouchi at 1,100 and ‘Kerman’ and ‘Lost Hills’ at 1,200 DD. The total heat units necessary for all cultivars to fully ripen and split was approximately 2400 degree days, except ‘Golden Hills’ which required approximately 100 DD less, averaging 2300 degree days. All the cultivars were similar in their in their weight accumulation as a response to degree day accumulation. The data resulted in a typical double sigmoid growth curve for all cultivars.

Specified Source(s) of Funding: California Pistachio Research Board

4:15–4:30 PM
Flow Volume and Carbohydrate Composition of Late Winter Xylem Sap Influences Subsequent Crop Load in Pecan
Bruce W. Wood*
USDA–ARS, Byron, GA; Bruce.Wood@ars.usda.gov

Alternate bearing (AB) by individual trees is a major biological problem for producers of pecan [Carya illinoinsensis (Wangenh.) K. Koch] nuts. The linkage between flowering, and subsequent crop-load, with early-season carbohydrate composition and flow volume of xylem sap is unknown. Multiyear field studies of mature ‘Cheyenne’ and ‘Moneymaker’ pecan trees in either “On” or “Off” phases of AB were evaluated regarding this linkage. Sap flowing from trunks of ‘Cheyenne’ trees just prior to, and at time of, budbreak consisted of hexoses (fructose and glucose), a disaccharide (sucrose), polysaccharides (raffinose and stachyose), and sugar alcohols (xylitol and sorbitol). Sucrose is the overwhelmingly dominate simple carbohydrate at this growth stage, comprising 55% to 75% of the total molar composition, regardless of tree bearing status or sampling time during late winter and early spring as buds swell and break. Both sap flow volume and concentration of individual simple carbohydrates were much greater in “On” phase than “Off” phase trees. In the case of sucrose, the dominant carbohydrate, sap from “On” phase trees average ≈20-fold more sucrose that of “Off” phase trees. Sap concentration of all carbohydrates were much greater in “On” phase than “Off” phase trees. In the case of sucrose, and possibly other carbohydrates, moving toward axillary bud meristems of shoots during “late winter” at about the time of “bud swelling” is likely a major factor influencing the final phase of floral development in early spring and therefore subsequent crop load.

4:30–4:45 PM
Genetic Diversity of Anisogramma anomala and Its Implications for Breeding Eastern Filbert Blight Resistant Hazelnuts
Megan Muehlbauer*
Rutgers University, New Brunswick; meganmu@scarletmail.rutgers.edu
Thomas J. Molnar
Rutgers University, New Brunswick, NJ; molnar@aesop.rutgers.edu
Josh Honig
Rutgers University, New Brunswick, NJ; honig@aesop.rutgers.edu
Kaitlin Morey
Rutgers, The State University of New Jersey, New Brunswick; kmorey81@gmail.com
Ning Zhang
Rutgers, The State University of New Jersey, New Brunswick, NJ; zhang@aesop.rutgers.edu

Eastern filbert blight (EFB), caused by the fungus Anisogramma anomala, is a major limiting factor to commercial hazelnut production in North America. Until now, little work has been done to analyze the genetic diversity of the fungus, which is endemic to a wide area of the eastern United States and spread to the Pacific Northwest in the 1960s. This lack of knowledge hampers current breeding efforts to develop plants expressing durable resistance to EFB. The goal of this project was to elucidate the genetic diversity and population structure of A. anomala using simple sequence repeat (SSR) markers. A total of 26 SSR markers were used to amplify 204 isolates of the fungus collected from throughout North America. Cluster and population structure analyses were performed on the resulting peak data to discern the genetic diversity and relationships among both individuals and populations of isolates. The SSR marker summary statistics showed an average of nine alleles per loci and an average expected heterozygosity of 0.72, which indicates that the isolates tested were more genetically diverse than was initially hypothesized for A. anomala based on prior internal transcribed spacer region sequence studies. Further, the cluster and population structure analysis showed distinct genetic differences between populations of isolates collected from different regions, as well as evidence for the spread of distinct isolates from one region to another. The results of the cluster and population structure analyses and their possible implications in terms of breeding hazelnut plants expressing durable resistance will be discussed.

Specified Source(s) of Funding: New Jersey Agricultural Experiment Station; Rutgers Center for Turfgrass Science, Hatch
A study was conducted on *Mangifera casturi*, *Mangifera lalijiwa*, *Mangifera rubrapatela*, *Mangifera odorata*, *Mangifera lauraina*, *Mangifera zeylanica*, and *Mangifera* sp. (‘Rampagni’) grown at the Fairchild Tropical Botanic Garden living collection located in Homestead, FL. These species are part of a *Mangifera* species collection that currently consists of 40 accessions collected or native to Brunei Darussalem, Cambodia, Indonesia, Malaysia, Thailand, and the Philippines. There exists limited information on bloom morphology of wild mango relatives and most information in the literature was derived from herbarium specimens. Information collected includes color, petal number, hermaphrodite/male ratio, aroma, and panicle architecture. The study was conducted from November 2012 to January 2013 and again from November 2013 to January 2014, which coincides with the flowering season of these species. Inflorescences were randomly selected from each tree, photographed and drawn for evaluation of flowering morphology structure of the 6 species. In terms of floral morphology, they all have differing percentages of hermaphrodite and male flowers; 5 to 6 petals; range in color from cream to white, burgundy and red; aromas from lilacs to jasmine; and variable panicle branching patterns. *Mangifera casturi*, *Mangifera lalijiwa*, *Mangifera rubrapatela*, *Mangifera zeylanica*, and *Mangifera lauraina* have more hermaphrodite flowers than *M. odorata*, and *M.* sp. ‘Rampagni’. Hermaphroditic to male ratios were greater in these two species in both years. *Mangifera casturi* has hermaphrodite flowers (74%), and male flowers (24.5%). *Mangifera lalijiwa* has hermaphrodite flowers (71%), and male flowers (26%). *Mangifera rubrapatela* has hermaphrodite flowers (88%) and male flowers (12%). *Mangifera lauraina* has (62%) and male flowers (38%), compare with *Mangifera odorata* than had (21%) hermaphrodite flowers and *Mangifera* sp. (‘Rampagni’) with (15%) of hermaphrodite flowers. The relationship between hermaphrodite and male flowers are discussed as well as the ramifications for breeding and fitness as parents for crosses with *Mangifera indica*.
The goal of this greenhouse study was to investigate the drought tolerance effects of magnetized, chelated liquid iron fertilizer on two water stressed legumes. The objectives were to quantify the effects of four treatments on foliar gas exchange, soil moisture, and plant growth for velvet bean (Mucuna pruriens) and soybean (Glycine max) plants. The four treatments included two foliar applications for chelated liquid iron fertilizer (2.5% and 5%) with a conventional boom sprayer with and without magnets in the spray lines. Plant and soil measurements were then recorded during two separate water stress events that lasted 24 and 13 days, respectively. Stomatal conductance, transpiration, and internal carbon dioxide increased by 31%, 46%, and 24% for the magnetized fertilizer applications when compared to baseline data. In contrast, stomatal conductance did not change while transpiration, internal carbon dioxide, and leaf temperature increased for the non-magnetic treated plants. During the second water stress event stomatal conductance was positively correlated with soil moisture (0.2311) for the non-magnetic application, but was negatively correlated (-0.0903) with the magnetic application. Photosynthesis increased by 15% and 21%, for soybeans and velvet beans, respectively, for the magnetized iron fertilizer (2.5%) application, when measured during the second water stress event. Also, photosynthesis was positively correlated with soil moisture (0.3233) and negatively correlated (-0.1220) for the non-magnetic and magnetic applications, respectively, during the second water stress event. Instantaneous water use efficiency increased 114% for the magnetized fertilizer when compared to the non-magnetic applications, for both water stress events when averaged across the fertilizer rates and legume species. Improved drought tolerance in row crops such as dry beans and soybeans, with a single magnetized fertilizer application, would be cost effective, and easily adapted into current cropping systems. Soybean irrigation rates would decrease approximately 108,617 to 203,652 gal/ac/yr if crop water use efficiency could be increased by 20 or 30% with a single, magnetized fertilizer application to the crop foliage.

4:30–4:45 PM

Using Scaled Sensor Networks to Estimate Green Roof Stormwater Runoff

Olyssa Starry
Portland State University, Portland, OR; ostarry@pdx.edu
Whitney Griffin
University of Maryland, College Park; wagner1@umd.edu
Bruk E. Belayneh
University of Maryland, College Park; belayneh@umd.edu
David Kohanbash
Carnegie Mellon University, Pittsburgh, PA; dkohanba@cmu.edu
John D. Lea-Cox*
University of Maryland, College Park; jlc@umd.edu

Green roofs are increasingly recognized as an effective strategy for mitigating storm water runoff. However, in order to effectively quantify storm water retention and efficiency of green roofs at any scale, we need to be able to resolve two important issues: (1) Monitoring of green roofs is both resource-intensive and very expensive, especially in retrofit situations and; (2) Green roofs have both physical and biotic components, both of which change over time. We have installed two cellular-enabled (Em50G) sensor networks on two commercial roofs in MD and TX to quantify storm water retention and efficiency of green roofs at any scale. This model estimates runoff based on actual measured rainfall and evapotranspiration using simple water balance approach, whereby precipitation (P) is set to equal evapotranspiration (ET) plus runoff (R) minus any change in storage (P = ET + R - deltaS). Environmental (air temperature, relative humidity, total radiation, wind speed and direction) are collected every 1 minute and the average logged every 5 minutes; soil temperature and moisture data (Echo-TM, Decagon Devices, Inc.) are collected on a 15-minute basis along drainage transects on each roof. Data are transmitted via EM50G nodes every six hours to a cloud server (Decagon Devices, Inc.); data are downloaded and imported into Sensorweb software on a computer in College Park MD. Sensorweb allows a secure data-sharing platform for precipitation events. A study was conducted comparing the LSU irrigation system to a timed nursery irrigation system. The study was conducted for six months beginning May 2013 at a container nursery operation in Folsom, LA fitted with overhead irrigation. Two cultivars of Gardenia jasminoides, ‘Frostproof’ and ‘August Beauty,’ were grown in 11.4-L containers under the LSU or timed irrigation systems. Six months after initiating the study, growth index and biomass in ‘Frostproof’ were similar between irrigation systems while ‘August Beauty’ exhibited increased growth index, biomass, and leaf number under the LSU irrigation system. Overall, the LSU irrigation system applied 44% less irrigation and resulted in 64% less leachate compared to the timed irrigation system for the 6 month growing cycle. The LSU irrigation system is capable of reducing nursery irrigation consumption and leaching while producing similar or higher quality plants compared to a timed irrigation system.
all collaborators in the project (MD, TX, OR and PA) over the internet using a browser interface. Results from two case study installations are provided. The first case study takes place on a 20,000 square foot retrofit extensive green roof in Washington, DC. The second case study takes place on a 30,000 square foot installation in Houston TX. Preliminary findings from the roof in Texas indicate that previous irrigation practices maintained a frequently saturated substrate and generated potentially unnecessary runoff. Changes in irrigation revealed that dry down (from approximately 25% to less than 10% VWC) might last as long as a week for the weather conditions observed in April 2014. Future work will investigate how to optimize green roof performance through precision irrigation. These examples illustrate how we can cost-effectively monitor relatively remote locations in real-time using these sensor networks, and provide the data for analysis among research groups anywhere in the world.

Specified Source(s) of Funding: USDA-SCRI Award 2009-51181-05768

4:45–5:00 PM

Scaling Sensor Networks for Scheduling Irrigations in a Commercial Pot-in-Pot Nursery

Bruk E. Belayneh*
University of Maryland, College Park; belayneh@umd.edu

David Kohanbash
Carnegie Mellon University, Pittsburgh, PA; dkohanba@cmu.edu

John D. Lea-Cox
University of Maryland, College Park; jlc@umd.edu

Wireless sensor networks (WSNs) can be used as monitoring systems in nurseries and provide direct feedback on tree water needs and environmental conditions, thereby adding value to existing irrigation systems. More advanced WSNs can make irrigation control decisions based on real-time root zone-soil moisture conditions, and have been shown to significantly reduce water and nutrient leaching from nursery tree pot-in-pot production. However, deployment of WSNs in large operations can be costly if done without considering scaling-up strategies for both monitoring and control purposes. In 2013, we implemented a scaling strategy at a large pot-in-pot nursery using six indicator species representing different functional water use groups: low (dogwood and crepe myrtle), medium (hornbeam and red oak) and high (river birch and red maple). Two rows of each species (n = 10 per row) were installed in a small block on the nursery. The volumetric water content (VWC) of five trees in each row was sensed using 10HS soil moisture sensors (Decagon Devices, Inc.). One row of trees from each species were irrigated using grower-scheduled cyclic irrigations; the second rows of trees were independently irrigated using VWC set-point strategy. Badger flow meters (Badger Meters, Inc.) were installed at the beginning of each row to measure irrigation amounts. Runoff volume and leachate electrical conductivity for each row were measured, respectively, by ECRN-100 rain gauge and ES-2 sensor (Decagon Devices, Inc.). All sensor readings were logged by a combination of Em50R (monitoring) and nR5-DC (control) data loggers on 15-minute basis and relayed to a base-station in the farm office. Sensorweb software (Carnegie Mellon University), with nR5 nodes, was utilized to schedule micro-pulse irrigation events to the sensor-controlled rows based on VWC set-points and running averages of five sensors in each row. For the study period from March to November 2013, total irrigation water applications were computed and compared. For all species, the sensor-controlled irrigation strategy used less water compared to the grower-scheduled irrigation. Irrigation water savings were 56.6% (dogwood), 70.8% (crepe myrtle), 49.1% (hornbeam), 45.0% (red oak), 16.9% (river birch) and 10.3% (red maple). Water savings were highest for the low water use species and lowest for the high water use species. For all tree species, there were no significant differences in tree growth rates (based on tree caliper measurements taken at 15 cm height) between the two irrigation strategies.

5:00–5:15 PM

Why is the Irrigation Running in the Rain?

Liz Felter*
University of Florida, Orlando; lfelter@ufl.edu

Michael D. Dukes
University of Florida, Gainesville; mddukes@ufl.edu

Paul F. Monaghan
University of Florida, Gainesville; paulf@ufl.edu

The gap between what home owners’ perceptions and practices are when it comes to caring for their yard particularly their irrigation practices are contributing to the water shortages in Orange County, Florida. Residents of Orange County, Florida, were chosen as a population of interest because Orange County is included within the Central Florida Coordination Area (CFCA), an area created by the Southwest Florida, South Florida and St. Johns River Water Management Districts. The CFCA action plan limits additional groundwater withdrawals to no more than what was permitted in 2013, as new water permits will not go past 2013 unless supplemental water supplies are committed to meet demands after 2013 (CFCA 2010). Therefore, Orange County Utilities (2010) must focus on water conservation as the primary source of water for new residents. The purpose of the study was to examine the perceptions of homeowners in Orange County, Florida who have automated irrigation systems concerning Community Based Social Marketing (CBSM) strategies that could be employed to reduce water used for lawn care. The study also looked at the pragmatic approach of social marketing and the effectiveness of CBSM to bring about behavior change. The practical strategies used by CBSM seek to determine the barriers to behavior change and to understand the accepted societal behaviors, also known as norms. Once barriers and norms are established, the use of CBSM has a greater opportunity to be successful. This study used qualitative research methods through the use of focus groups. The focus group participants consisted of residents from Orange County, Florida, who were determined by the water utility company to be high water users. A total of four focus groups were conducted which included 32 participants.
and represented 20 different homeowner associations (HOAs). Emerging themes for barriers revealed pressure from the HOAs to have perfect grass, lack of knowledge about proper lawn care, confusion over when to water per week and the inability to use the irrigation timer correctly. Participants indicated that the norm was to abide by the water restrictions and have a nice lawn. The responses also indicated that following water restrictions was their primary means of conservation. Using CBSM strategies, a program tailored to the target audience (HOAs) should be created to encourage pro-environmental behavior change.

**Tuesday, July 29, 2014**

**Plant Biotechnology 1**

**Moderator:** Cai-Zhong Jiang; cjiang@ucdavis.edu

8:00–8:15 AM

**A HD-ZIP Transcription Factor Regulates Flower Senescence via Ethylene and ABA Cross-talks in Petunia**

Xiaoxiao Chang  
University of California, Davis; xxchang6@163.com  
Linda Donnelly  
USDA–ARS, Davis, CA; lmdonnelly@ucdavis.edu  
Michael S. Reid  
University of California, Davis; msreid@ucdavis.edu  
Cai-Zhong Jiang*  
USDA–ARS, Davis, CA; cjiang@ucdavis.edu

Flower senescence is a genetically controlled developmental process. Transcription factors play an important role in plant growth and development. We found that a homeodomain-leucine zipper transcription factor, PhHD-Zip, is up-regulated during petunia flower senescence from transcriptome analysis. Virus-induced gene silencing of PhHD-Zip extended flower life by 20% both in unpollinated and pollinated flowers. Silencing PhHD-Zip also dramatically reduced ethylene production and the abundance of transcripts of genes involved in ethylene (ACS, ACO), ABA (NCED) biosynthesis as well as senescence-related marker genes (SAG12, SAG29). On the other hand, over-expression of PhHD-Zip accelerated petunia flower senescence accompanying with enhanced expression of ethylene biosynthesis-related genes. Furthermore, PhHD-Zip transcript abundance in petunia flowers was increased by application of hormones (ethylene, ABA) and abiotic stresses (dehydration, NaCl and cold). Our results suggest that PhHD-Zip plays an important role in regulating petunia flower senescence through cross-talk of ethylene and ABA.

Specified Source(s) of Funding: USDA

8:15–8:30 AM

**Identifying Genes Involved in Pollination-induced Corolla Senescence in Petunia**

Michelle L. Jones*  
The Ohio State University/OARDC, Wooster; jones.1968@osu.edu  
Shaun R. Broderick  
The Ohio State University/OARDC, Wooster; broderick.38@buckeyemail.osu.edu

The shelf life and marketability of ornamental plants can be increased by delaying flower senescence. While many genes that are differentially expressed during flower senescence have been identified, we still do not have a detailed understanding of the pathways that are involved in the initiation of corolla senescence. We created strand-specific, paired-end RNA-sequencing libraries from corollas of pollinated and unpollinated Petunia hybrida flowers at 12, 18, and 24 hours, in order to identify genes that are regulating pollination-induced flower senescence. Nearly 0.5 billion reads were sequenced using Illumina HiSeq technology. De novo assembly after pre-processing generated more than 161K contigs, which were paired down to a 33K unigene library. Over two thousand differentially expressed contigs were identified in pollinated corollas using the statistical package DESeq2. Weighted gene correlation network analysis was used to assign contigs into modules based on expression patterns. Three pollination-specific modules were identified from this analysis. One module (red) had increased expression across all pollinated corollas in all time points. The other two modules (cyan and grey) had a peak of gene expression in pollinated corollas 18 hours after pollination. A total of nine unique, enriched KEGG pathways were identified, many of which are directly involved in metabolic processes. In the red module, four enriched KEGG pathways were identified, including plant-pathogen interaction. Many of these genes are calcium and calmodulin-related genes often involved in cell signalling. The grey module was enriched for five KEGG pathways including the regulation of autophagy and ubiquitin mediated proteolysis. The cyan module had two enriched KEGG pathways, glycerolipid metabolism and endocytosis. These data show that gene changes occur in the corolla within 12 hours after pollination, and that senescence is induced well before fertilization. The identification of enriched KEGGs allows for a more directed selection of genes for future characterization. The goal of this research is to identify the best targets for manipulating flower senescence and improving shelf life.

Specified Source(s) of Funding: The OSU D.C. Kiplinger Endowment

8:30–8:45 AM

**Over-expression of an ABA Biosynthesis Gene (NCED) with a Stress-inducible Promoter Improves Drought Tolerance in Petunia (Petunia hybrida)**

Alejandro Estrada  
University of California Davis; acestrada@ucdavis.edu  
Michael S. Reid  
University of California Davis; msreid@ucdavis.edu  
Cai-Zhong Jiang*  
USDA–ARS, Davis, CA; cjiang@ucdavis.edu

Drought stress during shipping and retail reduces the postproduction quality, marketability and shelf life of potted and bedding
An asterisk (*) following a name indicates the presenting author.

Volatile Emissions in Apple Fruit

Randolph Beaudry*
Michigan State University, East Lansing; beaudry@msu.edu
Carolina Contreras
Michigan State University, East Lansing; contre33@msu.edu
Jin Ho Kang
Michigan State University, East Lansing; kangjh@msu.edu
Daniela Urbina
Universidad de Talca, Talca; durbina@utalca.cl

The involvement of LOX pathway activity in the formation of aroma compounds in apple has been suggested in numerous studies, but the nature of that involvement is incompletely understood. While there is little disagreement in the contribution of LOXs to the formation of C-6 aldehydes induced by the disruption of apple tissue, it is not clear whether LOXs contribute significantly to autonomously-produced volatiles from intact fruit. We explored the expression of all 22 LOX genes in apple for 8 time points throughout ripening (immature to senescent stage). Only 16 LOX genes could be amplified in the fruit. Phylogenetic analysis of the 22 LOX gene sequences, classified 13 of them with a 13-LOX predicted function, 8 with a 9-LOX predicted function and 1 with unknown function. The expression of most of genes exhibited no discernable pattern during ripening; only 6 LOXs were expressed in a ripening-dependent manner. Quantitative RT-PCR was performed on these 6 LOX candidates. Of these, 2 13-LOX genes were down-regulated during ripening, one 9-LOX gene underwent a decline throughout ripening, and two 9-LOX genes were sharply up-regulated as ripening progressed. Changes in the cis-3-hexenal production correlated with the expression of the 13-LOX genes undergoing a decline. A rise in the production of hexanal, hexanol and hexyl esters paradoxically correlated with the putative 9-LOX genes. Confocal microscopy analysis of transiently expressed 13- and 9-LOXs suggests that the 13-LOXs are localized in the chloroplasts or cell wall/plasmalemma while the 9-LOXs are localized in the cell wall/plasmalemma and the nucleus.

Specific Source(s) of Funding: USDA

Expression and of Putative Lipoxygenase (LOX) Genes Relative to LOX-dependent Aroma Volatile Emissions in Apple Fruit

Randolph Beaudry*
Michigan State University, East Lansing; beaudry@msu.edu
Carolina Contreras
Michigan State University, East Lansing; contre33@msu.edu
Jin Ho Kang
Michigan State University, East Lansing; kangjh@msu.edu
Daniela Urbina
Universidad de Talca, Talca; durbina@utalca.cl

One 13-LOX gene underwent a brief transient rise at the onset of ripening, one 9-LOX gene underwent a decline throughout ripening, and two 9-LOX genes were sharply up-regulated as ripening progressed. Changes in the cis-3-hexenal production correlated with the expression of the 13-LOX genes undergoing a decline. A rise in the production of hexanal, hexanol and hexyl esters paradoxically correlated with the putative 9-LOX genes. Confocal microscopy analysis of transiently expressed 13- and 9-LOXs suggests that the 13-LOXs are localized in the chloroplasts or cell wall/plasmalemma while the 9-LOXs are localized in the cell wall/plasmalemma and the nucleus.

Specific Source(s) of Funding: USDA

Response of Iron Regulated-transporter Genes (IRT) to Iron Deficiency in Populus tremula L.

Danqiong Huang
North Dakota State University, Fargo; danqiong.huang@ndsu.edu
Wenhao Dai*
North Dakota State University, Fargo; wenhao.dai@ndsu.edu

Iron chlorosis is one of the severe problems in alkaline/calcareous soil, resulting in yield loss and nutrition limitation in plants. Research suggested that iron chlorosis could be caused either by iron deficiency in the environment or dysfunction of iron absorption and transportation of plants. As a key transporter of iron, iron regulated-transporter (IRT) genes control iron transportation from the root surface to the leaf where iron is used for synthesis of chlorophyll. In this study, expression of two PtIRT genes (PtIRT1 and PtIRT3) in two phenotypes (PtY, a wild type and PtG, a putative mutant) of Populus tremula ‘Erecta’ responding to iron deficiency was determined using real-time PCR. The PtIRT1 gene highly expressed in roots and its expression was rarely detected in other tissues; however, PtIRT3 expressed in the root, leaf, shoot tip, and stem. In roots, the abundance of PtIRT1 was much more than that of PtIRT3 under iron deficiency condition. Expression of PtIRT1 significantly increased at day 3 and reached its peak at day 6 after iron deficiency treatment. PtIRT3 responded iron deficiency faster than PtIRT1 in roots and its expression reached its peak at day 1 and then decreased at day 3 after iron deficiency treatment. Similar expression pattern of PtIRT1 and PtIRT3 was observed in PtG and PtY; however, the expression level of PtIRT was much higher in PtG than in PtY.

Tuesday, July 29, 2014

Pomology 1

Moderator: Shengrui Yao; yaos@nmsu.edu

Date Palm Cultivation in Saudi Arabia: Current Status and Future Prospects for Development

Khalid Al-Redhaiman*
Qassim University, Buraydah; khalid1963@hotmail.com

Status and Future Prospects for Development

Khalid Al-Redhaiman*
Qassim University, Buraydah; khalid1963@hotmail.com

Date Palm Cultivation in Saudi Arabia: Current Status and Future Prospects for Development
Date palm possesses a distinguished position in many middle east countries, in general, and in the Kingdom of Saudi Arabia, in particular. In 2011, KSA ranks top of the world as regarding the number of date palm trees. Total number of palms in KSA exceeds 25 million palms, covers more than 170 thousand hectares (KSDA, 2011). Moreover, KSA ranks the second of the world as regarding the total production of date fruits as it produced 1122822 MT in 2011 (FAO, 2011). Date palm cultivation expanded very rapidly in Saudi Arabia during the last two decades. Total number of palms in KSA increased from 13 million trees in 1990 to more than 25 million palms in 2011 (the increment exceeded 92.3 %) (KSDA, 2011). In addition, the total production of date fruits increased from 530000 MT in 1990 to more than 1122822 MT in 2011 (the increment exceeded 111.6 %) (FAO, 2011). Moreover, the total area of date palm increased from 55000 ha in 1990 to more than 170000 ha in 2011 (the increment exceeded 218.1 %) (KSDA, 2011).

In Saudi Arabia, there are more than 400 date palm varieties, of which only about 40 varieties with an economic value, spread in 7 Saudi provinces characterized by fitting climate for the growth and fruiting of the date palm. Riyadh, Qassim, eastern province, and Medina are the most famous production areas in SA. Sukkary, Saquee, Ekhlasy, Ajwa, Barhee, Anbara, Safawi, Rothana, Rashodya, and Khedry are the most economic well-known cultivars in SA.

8:15–8:30 AM

**Applications of ReTain Reduce Ovule Senescence and Improve Fruit Set in Sweet Cherry**

Matthew Whiting  
Washington State University, Prosser; mdwhiting@wsu.edu  
Lu Zhang*  
Washington State University, Prosser; lu.zhang5@email.wsu.edu

Our previous research revealed that low productivity of several sweet cherry (*Prunus avium* L.) cultivars is due to the premature senescence of ovules. ReTain®, is a plant growth regulator with the active ingredient aminoethoxyvinylglycine (AVG) that inhibits ethylene biosynthesis. In this project, we assessed the potential to improve fruit set with applications of ReTain® to sweet cherry cultivars exhibiting chronically low commercial productivity. Using ‘Tieton’ and ‘Regina’ trees in both experimental and commercial orchards we conducted rate and timing trials with ReTain®. Three ReTain® rates were compared (166 g/acre, 333 g/acre and 499 g/acre) with water treated control trees with applications made at ca. 10% bloom.

The role of application timing was assessed with 333 g/acre of ReTain® applied at ‘popcorn’, 10% bloom, 50% bloom, and full bloom. Fruit set was determined on two limbs per tree by counting flowers, and fruit just prior to harvest. In addition, ovule viability of flowers was assessed 48 hours after flowers had opened from samples collected 24 hours after ReTain® treatments were applied at both the first white and fully open stages in the field. We recorded significant improvements of fruit set from treatment with ReTain®. At 10% bloom, the highest rate increased fruit set by 124% in ‘Tieton’ and 63% in ‘Regina’.

Overall, we recommend single applications of ReTain® at early stages of flowering, with moderate to high rates (i.e. 333 – 499g/acre) to improve fruit set.

Specified Source(s) of Funding: Washington Tree Fruit Research Commission, Agricultural Research Center of WSU
Developing a Robust, Predictive Model for Sweet Cherry (*Prunus avium* L.) Flowering, Comparing Eastern Oregon and Mesic Nordic Climates

Clive Kaiser*
Oregon State University, Milton-Freewater; clive.kaiser@oregonstate.edu

Leonard Coop
Oregon State University, Corvallis; coopl@science.oregonstate.edu

Mekjell Meland
Bioforsk, Lofthus; mekjell.meland@bioforsk.no

Phenological observations are sensitive tools for identifying plant responses to climatic changes. Flowering dates for ‘Bing’ sweet cherries have been recorded in Milton Freewater, Oregon and in Ullensvang, western Norway for the several decades. In Norway, over the last decade the onset of the phenophases of sweet cherry during the spring tended to be earlier in Ullensvang, western Norway. The effects of air temperature during the winter and spring months during two 5-year periods, 1996-2000 (P1) and 2003-2007 (P2) in relation to the start of flowering (first bloom) of early maturing ‘Burlat’ and mid-season ‘Van’ were studied. Average winter temperatures (January – February) were similar (3.3 °C) in both these two 5-year periods however, average March and April temperatures were slightly warmer (3.2 °C and 4.0 °C) and (6.9 °C and 7.3 °C), respectively. Average temperatures during the first half of May were similar for both 5-year periods (10.1 °C). Timing of flowering phenophases were statistically different between P1 and P2 for both cultivars. Mean data for ‘Burlat’ and ‘Van’ first bloom were 8 days earlier during P2, May 2 for ‘Burlat’ and May 1 for ‘Van’. Indeed, during both P1 and P2, for both cultivars the onset of first bloom was 5 days earlier and 8 days later than the long-term average dates respectively. Full bloom occurred 3 days after first bloom and flowering ended 14 days after first bloom. Clearly, increased temperatures of the spring months, March through April sped up flower development significantly. Growing degree-days (GDD), single sine based, 2 °C base supported this difference; a mean of 221 GDD accumulated during March-April on average during P2 vs. only 197 during P1. A model of sweet cherry ‘Van’ bloom dates had lower error rates, using a 2 °C base, 254 GDD to bloom, and starting date of March 1, whereas a recent bloom model developed for sour cherry in Michigan, USA used a 4 °Cbase temperature. (Ref: Zavalloni, C., J.A. Andresen, J.A. Flore. 2006. Phenological models of flower bud stages and fruit growth of ‘Montmorency’ sour cherry based on growing degree-day accumulation. J. Amer. Soc. Hort. Sci. 131:601-607.)

Specified Source(s) of Funding: Norwegian Agricultural Research Institute

Changes in Not-from-concentrate ‘Wonderful’ Pomegranate Juice through Pilot Plant Pressing, Ultrafiltration, and HTST Pasteurization and Storage

John C. Beaulieu*
USDA–ARS, New Orleans, LA; John.Beaulieu@ars.usda.gov

Steven W. Lloyd
USDA–ARS, New Orleans; steven.lloyd@ars.usda.gov

Jeanne M. Lea
USDA–ARS, New Orleans; Jeanne.lea@ars.usda.gov

Michael A. Watson
USDA–ARS, New Orleans; Michael.A.watson@ars.usda.gov

Maureen A. Tully
USDA–ARS, New Orleans; Maureen.tully@ars.usda.gov

Casey C. Grimm
USDA–ARS, New Orleans; casey.grimm@ars.usda.gov

Karen L. Bett-Garber
USDA–ARS, New Orleans; Karen.bett@ars.usda.gov

Rebecca E. Stein-Chisholm
Active Organic, Lewisville; rstein07@gmail.com

Consumer awareness of health benefits in phytonutrient-rich foods and aggressive marketing have resulted in expanding markets for superfruits. Superfruits have become mainstream within the juice and functional beverage category. Yet, health promoting polyphenolic compounds are susceptible to polymerization and degradation during processing, and can produce undesirable bitterness and astringency. The long-term success of pomegranate use and expanding markets may not be sustained if possible off-flavors associated with processing, bitterness and astringency are not studied, understood, and ultimately resolved. A pilot plant hydraulic press was used to press 80 Kg whole ‘Wonderful’ pomegranates, resulting in not-from-concentrate (NFC) juice that was ultrafiltered (0.2 µm, polyvinylidene fluoride, BRO/BUF pilot membrane unit) prior to cold-fill HTST pasteurization (MicroThermics). The experiment consisted of 2 repeated presses and ultrafiltrations, and excess juice resulted in a 3rd repeated batch, used for pasteurization and storage in 250-ml glass bottles at 4 °C. Qualitative parameters (color, °Brix, pH, TA), anthocyanidins, organic acids and volatiles (SPME GC-MS) were analyzed. Color generally increased after crude pressing upon pasteurization, then a*, b* and C* decreased through 2 months storage at 4 °C. Delphinidin, cyanidin and pelargonidin all increased slightly from crude press through ultrafiltration then all decreased upon pasteurization, and markedly through 2 months storage at both 4 and 25 °C. Total anthocyanidins decreased 55.8% and 95.8% through 2 months storage at 4 and 25 °C, respectively. The following compounds decreased from pasteurization through
storage, at both temperatures: 2-methyl-3-buteno-2-ol, ethyl acetate, (Z) & (E)-3-hexenal, 1-hexanol, 1,4-cineole, linalool, 4-terpineol and α-terpineol. Yet, β-damascone and 2,4-dibutylphenol increased, across the board. Ethanol and 1-octanol increased only at 25 °C. Compounds such as β-nercene, ethyl hexanoate, α-cedrene, β-cedene and italicene were observed in crude pressed and ultrafiltered juices, and sometimes immediately after pasteurization (day 0) but, were lost through storage. On the other hand, benzaldehyde, hexyl acetate and 2-ethyl-1-hexanol were only observed after 1 month storage. Statistical interpretation and attempts to correlate anthocyanins with quality and volatile compounds is underway.

9:15–9:30 AM

**Vitamin C Content of Jujube Fruit and Its Changes during Fruit Development and Processing**

Shengrui Yao*

NMSU Alcalde Center, Alcalde, NM; yaos@nmsu.edu

Jujube (Ziziphus jujuba), also called Chinese date, belongs to the Rhamnaceae family. Jujube has been cultivated for more than 4000 years in China for both nutritional and medicinal uses. Jujube fruit not only tastes sweet but its vitamin C (Vc) content is higher than most well-known ‘Vc-rich’ fruit and vegetables like orange, kiwi fruit, strawberry, papaya, pineapple, chili pepper, green/red pepper, kale, broccoli, etc. Jujubes are also called natural vitamin C pills. With its handy size, it would be a good source for people’s daily vitamin C requirement. Jujube cultivars were introduced into the US 100 years ago, but the research and commercially available cultivars are very limited. Jujubes are distributed over a wide area in the US and they grow and produce well especially in the Southwest. To promote this nutritious fruit and increase its planting acreage, the NMSU Alcalde Center has collected cultivars in the US and imported cultivars directly from China for a total of over 50 cultivars. Fruit vitamin C content of 40 cultivars and its changes after four basic cooking procedures- steaming, boiling, pie making, and jam making were measured. Cultivars varied in their vitamin C content from 200 to 600 mg/100 g fresh weight. During the fruit maturation process, the green/cream stage fruit had higher vitamin C content than fully matured fruit (80-100% red/brown color). If customers are concerned about jujube’s health benefit, a cultivar’s vitamin C content should be considered as well as other fruit quality characteristics. The small fruit of sour jujube (Ziziphus spinosa) is without much flesh for fresh eating, but has higher vitamin C content than cultivated cultivars (Z. jujuba) and could be used for processing healthy drinks or food. After steaming or boiling, over 80% of vitamin C was preserved in the fruit. When fruit were used for jam, the final product retained over 80% of the vitamin C content of the fresh fruit. Jujube pie only preserved 45% to 50% of its original vitamin C content. Compared with reports of over 90% vitamin C loss during the sun-drying process, fresh processed products preserve vitamin C well.

Specified Source(s) of Funding: This project is supported by a USDA Agricultural Marketing Service Specialty Crop Block Grant through the New Mexico Department of Agriculture.

Tuesday, July 29, 2014

**Consumer Horticulture and Master Gardeners**

Moderator: Pamela J. Bennett; bennett.27@osu.edu

8:00–8:15 AM

**Selection of Horticultural Crops for a Small-scale Integrated Farm System in the Tropical Environment of Guam**

Mari Marutani*

University of Guam, Mangilao; marutani@uguam.uog.edu

An integrated model farm at the University of Guam aims to be a profitable agricultural system while conserving natural resources and meeting consumer demands. The farm consists of three sections: (1) horticultural field crop production, (2) aquaponics, and (3) cage-free egg production in agroforestry. The integrated production system emphasizes biodiversity, a multiple cropping system, utilization of renewable farm resources, and soil and water conservation. The aquaponics system adds a new horticultural practice in the tropics, suggesting a great potential for leafy lettuce (*Lactuca sativa L.*) and sweet basil (*Ocimum basilicum L.*) for local markets. Additional income comes from calamansi (*Citrofortunella microcarpa*) and Ti leaf, Cordyline fruticosa (*L.*) A. Chev and hot pepper (*Capsicum annuum L.*).

Several other vegetable crops are grown for short periods of time; however, the return has been negligible in the farm operation. This case study presents selection of horticultural crops for a small-scale integrated model farm in the tropical urban environment of Guam based on selection criteria including plant adaptability to tropical island environments, the farm operation system and consumer acceptance.

Specified Source(s) of Funding: USDA/HATCH

8:15–8:30 AM

**The Extension Master Gardener National Committee: History, Structure, and Status**

Pamela J. Bennett*

Ohio State University Extension, Springfield; bennett.27@osu.edu

Terri James

University of Nebraska, Lincoln; tjames2@unl.edu

Lelia Scott Kelly

Mississippi State University Extension Service, Verona; leliak@ext.msstate.edu

Gail Langelotto

Oregon State University, Corvallis; gail.langelotto@oregonstate.edu

David Moen

University of Minnesota, Andover.; moenx010@umn.edu

An asterisk (*) following a name indicates the presenting author.
The Extension Master Gardener (EMG) program was developed in 1973 in the state of Washington. Since then, there have been a few iterations of a committee structure to help guide the program on a national level. Today, there is the Extension Master Gardener National Committee (EMGNC) that consists of elected representatives from four geographical regions and the directors of nationwide projects. The purpose of the committee is to provide a national focus and contact point for the nation-wide EMG program. The committee was formed in 2006. The EMGNC facilitates inclusion of county and state gardening information in eXtension; provides a channel for contacting, funding, and training EMGs to be front line detectors/information providers on national, critical issues related to home yards and landscapes; facilitates national collaboration to avoid redundancy in development of educational materials, and expedites collaboration with federal agencies, funders and professional organizations for input and funding for national issues and priorities. In 2012, the Extension Master Gardener Task Force was established with the goal of developing resources to support state and county EMG coordinators. The topics that were identified as priority were: Recruitment, selection and placement of EMG volunteers; development and retention of volunteer leaders; interpersonal relationships/volunteer interactions; and evaluation. In addition, the committee was tasked with developing national standards for EMG volunteer programs as well as an online repository for EMG resources. The EMGNC supported and voted to adopt the mission and standards and is working to promote these nationwide. Objectives of the EMGNC include the facilitation of national cooperation and communication among states; facilitation of national collaborations; promote the sharing of EMG state projects and successes; provide a network to mobilize EMGs as frontline information providers on critical or emergency national horticultural issues; enhance and promote national recognition of the EMG program, collaborate with eXtension communities of practice; and coordinate the annual National Coordinator’s Conference.

In 2011, Ohio State University Extension (OSUE) had several retirements in the area of Agriculture and Natural Resources which left a void in many counties in the area of answering home gardening questions. In addition, several counties were left without Master Gardener Volunteer (MGV) leadership which meant these counties were struggling with meeting clientele needs. At the same time, the eXtension Ask an Expert program was available. The Educator realized the need and recruited MGVs to answer questions via the eXtension online program, calling the program Ask a Master Gardener (AaMG). The goal for the OSUE AaMG program was two-fold: 1) to assist counties that did not have Agriculture Educators as well as those counties whose MGV programs were small or struggling; and 2) to become the go-to resource for consumer gardening information in Ohio. Extension Administration supported this program by providing money for a 40% FTE Program Manager to help oversee the questions and answers and financial resources to develop marketing materials for the program. The Program Manager position is ongoing and the marketing dollars are for a three year period of time to get the program up and running. The Educator and Program Manager developed advertising materials which included a rack card, magnets with the web address, and an icon for the website, and a table top display. Other marketing materials have been distributed by MGV programs throughout the state and more than 20,000 magnets and 10,000 rack cards have been distributed. In 2013 we had 93 MGVs in 34 counties answering questions. During the May through August growing season, they answered 911 questions out of a total 1,396 that came into OSU Extension overall. They spent approximately 680 hours answering questions and contributing their services to OSUE. They are eager to learn and develop skills in the area of diagnosing plant problems. We provide training webinars, pay for registration fee for statewide Diagnostic Workshops and other programs for the volunteers. Extension administration is overwhelmingly supportive of this program. Director Keith Smith has indicated that it’s well worth the money as it frees up Extension Educators to focus on other local issues as opposed to home gardening questions. We are utilizing a group of capable, trained volunteers in order to allow our Educators time for other program efforts.

8:30–8:45 AM

**Implementing the eXtension Ask an Expert Program with Master Gardener Volunteers**

**Pamela J. Bennett**
Ohio State University Extension, Springfield; bennett.27@osu.edu

**Denise Johnson**
Ohio State University Extension, Springfield; johnson.2541@osu.edu

In 2011, Ohio State University Extension (OSUE) had several

An asterisk (*) following a name indicates the presenting author.
through gardening individuals will develop friendships through garden contacts. Initially, in 2011 the Community Garden plots were 30’ x 30’ and plots were downsized to 20’ x 25’ in 2012 to the present. Gardeners were able to grow their own fruits and vegetables from April to December of each year. At the beginning of each year, gardeners attend workshops. The workshop topics include Beginning Gardening, Weed Control, Fertilization, Composing and Irrigation. Over the past two years we have had over 270 people working individually or in groups to plant, grow and maintain their own garden plots. Evaluation of how much produce was grown, harvested and the amount of saving to each gardener is being evaluated by surveying each Community Gardener participants. Garden participants planted, maintained and harvested their “own” fruits and vegetables, gardeners stated “they started to make healthier food choices” and “their produce was much fresher than the grocery stores produce.” Ten (10) gardeners stated they lost between 5 and 10 pounds due to their involvement with gardening therefore, reducing obesity. Many participants exercise through gardening and the garden participants developed social contacts and reported “going fishing with other gardeners.” Eighty percent (80%) gardeners reported growing enough produce to consumer all summer and fall and to freeze for the winter, many shared extra produce with other families and friends. Four (4) gardeners worked in large groups to grow produce for themselves and distributed fresh foods to church members and community organizations. Twenty-five (25) gardeners reported saving averaging $500 to $600 per plot for the growing season and twenty (20) others saved between $150 and $300 per plot. Eighty-five percent (85%) of the gardeners have been involved with the TSU Community since the garden’s inception in 2011.

Specified Source(s) of Funding: Tennessee State University Cooperative Extension Program

9:00–9:15 AM

**WSU Master Gardener Online Training**

Nicole Martini*

Washington State University, Puyallup; nmartini@wsu.edu

Washington State University (WSU) Extension has been training Master Gardener Volunteer Educators on sustainable gardening and conservation practices since 1973. Each county within the state trains new Master Gardeners annually. However, these counties vary greatly in population density and location to urban areas, as well as, WSU Extension Research Centers, most of which are located on the Western side of the state. For this reason, accessibility to quality teachers who are typically WSU research scientists was always a challenge for the Master Gardener Programs on the east side of the state. To address the need for consistency in education of Master Gardeners on basic horticultural principles. Examples of the WSU Extension Master Gardener online training, one of the first online trainings in the country developed for Master Gardeners, will also be shared.

9:15–9:30 AM

**An Analysis of Gardening Interest among Students Involved in a School Gardening Project**

Bobby Fletcher*

LSU AgCenter, Baton Rouge, LA; bhfletcher@agcenter.lsu.edu

Janet Fox

LSU AgCenter, Baton Rouge, LA; jfox@agcenter.lsu.edu

Melissa Cater

LSU AgCenter, Baton Rouge, LA; mcater@agcenter.lsu.edu

Over the last 20 years, school gardening has become a national movement (Blair 2009). School gardens provide a critical link between traditional forms of schooling and holistic multi-disciplinary, experiential learning approaches (Williams, 2008). Gardens provide an atypical environment to the sterile classrooms (Smith & Motsenbocker, 2005). While countless studies have been conducted confirming the many benefits of school gardens, there is a lack of literature exploring promoting a positive gardening attitude. The 4-H Seeds for Service School Garden Program is an interdisciplinary garden project designed to educate youth in ten high poverty schools while they serve their community (Fox, 2009). The purpose of this evaluation was to determine if there is a connection between gardening experience and attitude toward gardening. A matched pretest-posttest design was used. Data were collected from student garden participants using a questionnaire developed by Poston, Shoemaker, and Dzewaltowski (2005). This attitude survey probes participants’ sense of competence. Completed matched questionnaires were obtained from 65% of youth (n = 465) participating in the school garden program. In this survey, males represented a majority (52%) with females at 48%. The largest group of participants (46%) were 6-8th graders followed by 3rd-5th graders with 29%. Almost half of the participants (47%) were Caucasian followed by African Americans at 41%. When examining gardening attitudes, there was a significant change in attitudes toward gardening, t(299) = 5.52, P < 0.001, when comparing pre-test to post-test scores. Participants reported that all gardening experiences had significant relationships to gardening attitude. Growing a flower, vegetable or herb garden had the strongest relationship with an attitude to garden (r = 0.433, P < 0.00) followed by having a family vegetable garden (r = 0.262, P < 0.00). The study found the strongest relationship between a positive gardening attitude and having a garden of any kind. Based on these results, it’s critical that Extension professionals promote gardening of any kind from container gardening to vegetable gardening to impart a positive attitude toward gardening. Extension professionals should develop projects that families can do in the garden and with the vegetables, fruit and flowers that are produced in the garden. A school garden allows students to work in a

An asterisk (*) following a name indicates the presenting author.
non-threatening outdoor environment where they can interact and learn about and become interested in gardening. A school garden can become an integral part of your classroom and can improve student learning.

Specified Source(s) of Funding: Learn and Serve Grant

9:30–9:45 AM

**SprOUTing Growers: A Train-the-Trainer Program for Extension Professionals Working with Beginning Growers of Specialty Crops**

Annette L. Wszelaki*
University of Tennessee, Knoxville; annettew@utk.edu

Mary A. Rogers
University of Minnesota, St. Paul; roge0168@umn.edu

David W. Lockwood
University of Tennessee, Knoxville, TN; dlockwood@utk.edu

Faith Critzer
University of Tennessee, Knoxville; faithc@utk.edu

Megan Bruch
University of Tennessee, Spring Hill, TN; mlbruch@utk.edu

Alice Rhea
formerly University of Tennessee, Knoxville; arhea@utk.edu

In Tennessee and across the country, there is a growing demand for local produce and direct marketing is on the rise through farm markets, farmers markets and community supported agriculture (CSA). However, many of these markets have a higher demand than supply of produce. This demand is due to consumers wanting to reconnect with the land and get to know the farmers who are producing their food and the production practices that they use. While the demand is on the rise, the age of our farmers is also increasing, with the average age of 55-years old for a farmer in the United States. As these farmers age and retire, farm land is lost to development and other enterprises. In order to preserve the farmland and meet the supply for local production, the older generation of farmers needs to be replaced with a new generation. To stimulate interest in farming and provide those interested with the tools they need to succeed, a comprehensive program titled ‘SprOUTing Growers’ was developed for beginning growers. The objective of this project was to develop modules for a 10-part workshop series to provide potential growers with the business planning and management, agricultural production, food safety and marketing tools that they need to properly plan and carryout a farming venture. To make the program more accessible and comprehensive, a train-the-trainer format was adopted, where the Extension agents are given the modules to deliver to clientele in their area for a nominal fee. This innovative program is a collaboration of a multi-disciplinary team at the University of Tennessee composed of the Departments of Plant Sciences, Agricultural and Resource Economics, and Food Science & Technology and the Center for Profitable Agriculture.

Specified Source(s) of Funding: USDA-Specialty Crop Block Grant

---

Tuesday, July 29, 2014

**Ornamental Plant Breeding**

Moderator: Zhanao Deng; zdeng@ufl.edu

8:00–8:15 AM

**Breeding and Introduction of Hardy Perennials and Shrubs at Star Roses and Plants**

Michele Scheiber*
Star Roses and Plants and NovaFlora LLC, West Grove, PA; mscheiber@novaflora.com

Emily Alff
Star Roses and Plants and NovaFlora LLC, West Grove, PA; ealff@novaflora.com

Michael Dobres
Star Roses and Plants and NovaFlora LLC, West Grove, PA; mdobres@novaflora.com

NovaFlora, is the in-house breeding division of Star Roses and Plants. Ornamental plant breeding at SR&P focuses on developing perennials, shrubs and roses that combine superior aesthetic characteristics with environmental adaptability and pest resistance. The process between idea conception and cultivar release is a multi-year, multi-step process. Projects are chosen based on consumer demands and market trends. Information is weighed against industry standards to determine opportunities for improvement within a specific species or genus. Once targets have been indentified, research is conducted to determine breeding and economic feasibility of the proposed project. Numerous techniques ranging from traditional breeding to mutagenesis to molecular biology are employed to develop hybrid populations to be screened for identification and introduction of new cultivars. A rigorous multi-region, multi-year trialing program that culminates with plant patenting, marketing and national distribution follows the screening process. For global markets, we partner with key distributors and growers around the world.

8:15–8:30 AM

**Polyploid Initiation in Hawaii Tree Species**

David Lingenfelser*
University of Hawaii, Honolulu; djl278@hawaii.edu

Ken W. Leonhardt
University of Hawaii, Honolulu; leonhard@hawaii.edu

In Hawaii, many plant species commonly used by landscapers yield abundant large fruits that can injure people/property, attract rats and other pests, create an unsightly appearance and potentially become invasive. Sterile forms of these landscaping plants would eliminate their high-maintenance and invasive characteristics. Polyploid forms of plants, particularly triploids, are often sterile. Autotetraploids also frequently display some degree of sterility. In addition, polyploids typically exhibit unique physical characteristics such as thicker leaves, larger organs, and higher levels of chemical compounds. A project was initiated to create tetraploid forms of eight commonly utilized species of trees: *Thespesia populnea, Calophyllum*...
Relationships among Caladium Species: New Insights from Cytological and Molecular Marker Analyses
Zhanao Deng*
University of Florida, Wimauma; zdeng@ufl.edu
Mike McLaughlin
Marie Selby Botanical Gardens, Sarasota, FL; mmclaughlin@selby.org

The genus Caladium is a member of the Araceae family, and several of its species are cultivated as ornamentals. The exact number of species and the relationship among its species need to be better defined. In recent years, we conducted cytological and molecular marker analysis of Caladium species accessions that were collected from South and Central America by the Marie Selby Botanical Gardens, and detected a wide range of genome size and chromosome number variation in these accessions. The Caladium genome size ranged from 2.98 pg/2C to 9.89 pg/2C and seemed to fall into two groups. Large Caladium genomes appear to be duplicated from small genomes. Seven chromosome numbers, 2n = 18, 20, 24, 26, 30, 34, and 38, were observed in these accessions. Molecular marker analysis based on simple sequence repeats further revealed the genetic relatedness of Caladium accessions at the molecular level. Our research results suggest a close relationship among Caladium hortulanum, Caladium bicolor, and Caladium schomburgkii, support the species status of Caladium humboldtii and Caladium picturatum, and support the new species status of Caladium clavatum. Caladium marmoratum, Caladium praetermissum, and Caladium steudneriifolium showed different chromosome numbers and could be considered as distinct species, yet they could be misidentified when solely based on plant morphology. Our studies also suggest that genome duplication, chromosome loss or addition, and chromosome rearrangements might have played very important roles in Caladium evolution.

Induction, Regeneration and Characterization of Tetraploids in Caladium
Xiaodong Cai
Yangtze University, Jingzhou; caixiao.dong@163.com
Shixiao Xu
University of Florida, Wimauma; xushixiao36@gmail.com
Zhanao Deng*
University of Florida, Wimauma; zdeng@ufl.edu

Interspecific and intergeneric crosses were performed between species in the genera Baptisia and Thermopsis with the goal to create hybrids with the best qualities of both parents. Baptisia australis (L.) R. Br. was used as both male and female parent in intergeneric crosses. Thermopsis chinensis Benth. ex S. Moore, T. lupinoides (L.) Link, and T. villosa Fernald & B.G. Schub. were used as male and female parents in both interspecific and intergeneric crosses. Interspecific crosses produced a higher percentage of fertile crosses and number of seeds per fertile cross than intergeneric crosses. Germination rate was not different between interspecific and intergeneric crosses. B. australis consistently produced less seed per cross when used as either male or female parent than Thermopsis species in both interspecific and intergeneric crosses. When comparing species in both interspecific and intergeneric crosses to determine the best female parents, we found no difference among female parents for percentage of fertile crosses or germination rate. When comparing species to determine the best male parents, no difference was found for percentage of fertile crosses or germination rate in either interspecific or intergeneric crosses. Since seedlings could be obtained from both interspecific and intergeneric crosses, production of a Baptisia–Thermopsis hybrid is feasible and the breeding program should be continued. Progeny is being evaluated to confirm hybrid status and select the best plants for the next generation of crosses. Other steps to be taken in this breeding program are the addition of new Baptisia species as parents, use of bridge parents, and selection of the species producing the most fertile crosses for male and female parents.

Interspecific and Intergeneric Hybridization in Baptisia and Thermopsis
Susan M. Hawkins*
University of Georgia, Athens; darkstar@uga.edu
John M. Ruter
University of Georgia, Athens; ruter@uga.edu
Carol D. Robacker
Georgia Station, University of Georgia, Griffin, GA; croback@uga.edu

Interspecific and intergeneric crosses were performed between species in the genera Baptisia and Thermopsis with the goal to create hybrids with the best qualities of both parents. Baptisia australis (L.) R. Br. was used as both male and female parent in intergeneric crosses. Thermopsis chinensis Benth. ex S. Moore, T. lupinoides (L.) Link, and T. villosa Fernald & B.G. Schub. were used as male and female parents in both interspecific and intergeneric crosses. Interspecific crosses produced a higher percentage of fertile crosses and number of seeds per fertile cross than intergeneric crosses. Germination rate was not different between interspecific and intergeneric crosses. B. australis consistently produced less seed per cross when used as either male or female parent than Thermopsis species in both interspecific and intergeneric crosses. When comparing species in both interspecific and intergeneric crosses to determine the best female parents, we found no difference among female parents for percentage of fertile crosses or germination rate. When comparing species to determine the best male parents, no difference was found for percentage of fertile crosses or germination rate in either interspecific or intergeneric crosses. Since seedlings could be obtained from both interspecific and intergeneric crosses, production of a Baptisia–Thermopsis hybrid is feasible and the breeding program should be continued. Progeny is being evaluated to confirm hybrid status and select the best plants for the next generation of crosses. Other steps to be taken in this breeding program are the addition of new Baptisia species as parents, use of bridge parents, and selection of the species producing the most fertile crosses for male and female parents.

Interspecific and Intergeneric Hybridization in Baptisia and Thermopsis
Susan M. Hawkins*
University of Georgia, Athens; darkstar@uga.edu
John M. Ruter
University of Georgia, Athens; ruter@uga.edu
Carol D. Robacker
Georgia Station, University of Georgia, Griffin, GA; croback@uga.edu

Interspecific and intergeneric crosses were performed between species in the genera Baptisia and Thermopsis with the goal to create hybrids with the best qualities of both parents. Baptisia australis (L.) R. Br. was used as both male and female parent in intergeneric crosses. Thermopsis chinensis Benth. ex S. Moore, T. lupinoides (L.) Link, and T. villosa Fernald & B.G. Schub. were used as male and female parents in both interspecific and intergeneric crosses. Interspecific crosses produced a higher percentage of fertile crosses and number of seeds per fertile cross than intergeneric crosses. Germination rate was not different between interspecific and intergeneric crosses. B. australis consistently produced less seed per cross when used as either male or female parent than Thermopsis species in both interspecific and intergeneric crosses. When comparing species in both interspecific and intergeneric crosses to determine the best female parents, we found no difference among female parents for percentage of fertile crosses or germination rate. When comparing species to determine the best male parents, no difference was found for percentage of fertile crosses or germination rate in either interspecific or intergeneric crosses. Since seedlings could be obtained from both interspecific and intergeneric crosses, production of a Baptisia–Thermopsis hybrid is feasible and the breeding program should be continued. Progeny is being evaluated to confirm hybrid status and select the best plants for the next generation of crosses. Other steps to be taken in this breeding program are the addition of new Baptisia species as parents, use of bridge parents, and selection of the species producing the most fertile crosses for male and female parents.

Interspecific and Intergeneric Hybridization in Baptisia and Thermopsis
Susan M. Hawkins*
University of Georgia, Athens; darkstar@uga.edu
John M. Ruter
University of Georgia, Athens; ruter@uga.edu
Carol D. Robacker
Georgia Station, University of Georgia, Griffin, GA; croback@uga.edu

Interspecific and intergeneric crosses were performed between species in the genera Baptisia and Thermopsis with the goal to create hybrids with the best qualities of both parents. Baptisia australis (L.) R. Br. was used as both male and female parent in intergeneric crosses. Thermopsis chinensis Benth. ex S. Moore, T. lupinoides (L.) Link, and T. villosa Fernald & B.G. Schub. were used as male and female parents in both interspecific and intergeneric crosses. Interspecific crosses produced a higher percentage of fertile crosses and number of seeds per fertile cross than intergeneric crosses. Germination rate was not different between interspecific and intergeneric crosses. B. australis consistently produced less seed per cross when used as either male or female parent than Thermopsis species in both interspecific and intergeneric crosses. When comparing species in both interspecific and intergeneric crosses to determine the best female parents, we found no difference among female parents for percentage of fertile crosses or germination rate. When comparing species to determine the best male parents, no difference was found for percentage of fertile crosses or germination rate in either interspecific or intergeneric crosses. Since seedlings could be obtained from both interspecific and intergeneric crosses, production of a Baptisia–Thermopsis hybrid is feasible and the breeding program should be continued. Progeny is being evaluated to confirm hybrid status and select the best plants for the next generation of crosses. Other steps to be taken in this breeding program are the addition of new Baptisia species as parents, use of bridge parents, and selection of the species producing the most fertile crosses for male and female parents.
in vitro to regenerate plantlets. Out of 445 plantlets regenerated and established in the greenhouse, 82 showed variation from the control plants in leaf shape, color, and/or thickness. These variants were analyzed for nuclear DNA contents, and 50 plants were found to be tetraploids. The highest rate of tetraploid induction was 31.7% and occurred in the treatment where leaf segments were cultured in 0.2% colchicine for 4 d. Morphological characterization revealed that tetraploids had much smaller leaf length/width ratio, longer stomata but lower stomata densities, thicker petioles, thicker leaves, and thicker main veins, compared to their diploid counterparts. The remaining 32 variants were found to be diploids, but their nuclear DNA contents varied to some extent, which may indicate potential chromosomal changes in these variants. Several types of leaf coloration pattern changes were observed on these variants. Results from the present study suggest that induced tetraploidy can result in significant morphological changes in caladium, thus it can be a valuable tool in caladium breeding.

Specified Source(s) of Funding: Florida Legislature General Appropriations FY 2012

9:15–9:30 AM

Identification of Partial Resistance to Black Spot in an Incomplete Diallel Diploid Rose Population

Q. Dong*
Texas A&M AgriLife Research and Extension Center, Dallas; qiannidong@tamu.edu

D.H. Byrne
Texas A&M University, College Station; dbyrne@tamu.edu

K. Ong
Texas A&M University, College Station; kevo@tamu.edu

X. Wang
Texas A&M University, College Station; xw-wang@tamu.edu

Black spot disease, caused by the fungus Diplolarcajon rosae Wolf, is the most serious disease of landscape roses (Rosa hybrid L.) worldwide. Partial (horizontal) resistance has been documented in roses, which is non-race specific and a more durable resistance compared to complete (vertical) resistance in wild environment controlled by multiple genes. However, the responsible QTLs remain unidentified. In this project, we identified the responses to race 8 of D. rosaeusing the detached leaf assay (DLA) in sixteen hybrid populations, which were from a partial diallel mating experiment by crossing diploid parents with a high to moderate level of partial resistance to black spot crossed with several susceptible roses. Results from DLA indicated that the distributions of responses to this pathogen in some populations are skewed toward extreme reactions, i.e., either better resistance or susceptibility. Broad and narrow heritability estimated by genetic variances were high (> 0.9) for both leaf area with symptoms (LAS) and lesion length (LL). Similar results were estimated from offspring mid-parents regression, in which narrow sense heritability is 0.86 and 0.74 for LAS and LL, respectively. Hybrid populations that segregate for partial resistance (PR) could be utilized for PR related QTL(s) identification and mapping.

Specified Source(s) of Funding: Monsanto Breeding Fellowship, Texas AgriLife Research

9:30–9:45 AM

Clone Variation and Taxon Discrimination of Distylium Using ISSR Markers

Yujie Yang*
Central South University of Forestry and Technology, Changsha, Hunan; yangyujie910@gmail.com

Josh Kardos
Plant Introductions, Inc., Watkinsville, GA; josh@plantintroductions.com

Donglin Zhang
University of Georgia, Athens; donglin@uga.edu

Zhihui Li
Central South University of Forestry and Technology, Changsha; susuzx@126.com

Matt Dirr
University of Georgia, Athens; mattd7979@yahoo.com

Xiaoling Jin
Central South University of Forestry and Technology, Changsha; jxl0716@hotmail.com

Distylium is a popular ornamental plant in Asian countries and recently is gaining popularity in the eastern United States. Three new cultivars were recently marketed in the nursery industries and garden centers and confusion of new and existing cultivars caused the problem. To better understand the genetic relationships and identify the named cultivars, thirty-eight accessions of Distylium and one Sycopsis sinensis were collected and analyzed using ISSR markers. A total of 234 markers were generated from 15 primers and 195 markers (83.3%) were polymorphic markers. Both D. racemosum and D. myricoides were in the trade and majority of Distylium were derived from their hybrid. Seedling population from the hybrid had been evaluated for the last eight years and three cultivars were selected and released to the industry based on their performance and ISSR markers fully supported them as independent cultivars. ‘Emerald Height’ inherited much more genes from D. racemosum, while ‘Vintage Jade’ and ‘Blue Cascade’ were genetically closer to D. myricoides. Based on both morphological and DNA data, two clones should be further evaluated for their potential as new cultivars. Three anonymous plants were identified as ‘Vintage Jade’. One seedling plant with a very slow growing rate and whitish to pinkish new foliage was similar to ‘Spring Frost’ and their ISSR markers were almost identical. The plant recently had new sprouts and restored its normal branch growth rate. Further studies should address this phenomenon on its gene expression.

An asterisk (*) following a name indicates the presenting author.
Assessment of Long-term Peach Evaluation Data Reveals Fruit Trait Distribution and Selection Tendencies

Chunxian Chen*  
USDA–ARS, SEFTNRL, Byron, GA; Chunxian.Chen@ars.usda.gov

William R. Okie  
USDA–ARS, SEFTNRL, Byron, GA; william.okie@ars.usda.gov

Conventional plant breeding has a long history of success. Although it is often a daunting job, it is still the most common approach used in today’s variety improvement programs. Efficient production of hybrids with potential for release as new varieties with desired traits relies on optimal selection of parents and long comprehensive evaluation on thousands of hybrids. Decades of efforts have led to the release of over a dozen peach (Prunus persica) varieties in the USDA–ARS stone fruit breeding program at Byron, GA, as well as producing many superior selections and much valuable evaluation data. Assessment of the data could facilitate further optimization of parents and crosses combinations, and ensure continuous improvement of breeding efficiency. Fruit evaluation data collected over 30 years from a wide range of peach varieties and seedling selections was analyzed. A normal distribution was observed for fruit size (median diameter = 2.4 inches, average = 2.405), and ripening date (median = June 30). Other traits, including fruit set, external blush, attractiveness, firmness, freeness, shape, pubescence, and overall eating quality, showed an uneven distribution toward the desired directions, which was expected since data was rarely taken on discarded hybrids. The median value of fruit set was 7 and the average 6.590 on a scale of 0–9, suggesting this trait had been maintained in a majority of selections. Blush and attractiveness showed a similar distribution where 7 was the median for both and 6.806 and 6.945 were the averages, respectively, on a 0–9 scale, indicating the selection tendencies were toward a higher blush coverage but with some classic yellow background to indicate the ripening stage. Correlation analysis showed only blush (relatively objective) and attractiveness (subjective) were somewhat positively correlated (R = 0.413), consistent with the tendencies. But set and size were not negatively correlated (R = 0.004), inconsistent with a usual expectation and some reports. However, set-size data might be confounded by mixing seedling selections with named varieties, as well as by the impact of ripening season. How to further use the evaluation data and the assessment summary to advance the future breeding objectives will be discussed.
DNA tests that predict valuable trait levels are essential for widespread adoption of marker-assisted breeding (MAB) of rosaceous tree fruits. The RosBREED project has facilitated development of PCR-based DNA tests for valuable traits in peach, apple, and sweet cherry, including peach fruit quality and disease resistance. Based on quantitative trait loci (QTLs) discovered on peach chromosomes 7, 3, 4, 1, and 6, by RosBREED collaborators for fruit sweetness and acidity, blush, slow ethylene production, and fruit bacterial spot resistance, respectively, DNA tests were developed at Washington State University in collaboration with the University of Arkansas (UA) and Clemson University (CU) peach breeding programs. These tests resulted from successful conversion of single nucleotide polymorphism haplotypes into simple sequence repeat (SSR) markers. The trait predictiveness of four tests, G7Flav-SSR (for flavor), Pp-MYB10-SSR (skin blush), Xap-SSR (bacterial spot resistance), and SMF-SSR (slow-melting flesh) were confirmed on standard cultivars and UA and SC germplasm. The DNA test G7Flav-SSR differentiated low (L), medium (M), and high (H) sweetness and acidity alleles; Pp-MYB10-SSR differentiated low (bl) and high (Bl) blush alleles; Xap-SSR differentiated susceptible (S), intermediate (I), and resistant (R) bacterial spot alleles; and SMF-SSR differentiated alleles for slow (B) and fast (A) ethylene evolution after harvest. Validation of these DNA tests was conducted on unselected, independently phenotyped families. All four tests were refined for high-throughput genotyping. In 2014, this suite of DNA tests along with flesh type (endoPG-6) and fruit acidity (CP-PCT040B) markers were used to provide marker-assisted seedling selection in the UA program. This advance in DNA-informed breeding represents an example of successful collaboration among institutions and across disciplines. Other DNA tests evolved from successful conversion of single nucleotide polymorphism haplotypes into SSR markers. The trait predictiveness of four tests, G7Flav-SSR (for flavor), Pp-MYB10-SSR (skin blush), Xap-SSR (bacterial spot resistance), and SMF-SSR (slow-melting flesh) were confirmed on standard cultivars and UA and SC germplasm. The DNA test G7Flav-SSR differentiated low (L), medium (M), and high (H) sweetness and acidity alleles; Pp-MYB10-SSR differentiated low (bl) and high (Bl) blush alleles; Xap-SSR differentiated susceptible (S), intermediate (I), and resistant (R) bacterial spot alleles; and SMF-SSR differentiated alleles for slow (B) and fast (A) ethylene evolution after harvest. Validation of these DNA tests was conducted on unselected, independently phenotyped families. All four tests were refined for high-throughput genotyping. In 2014, this suite of DNA tests along with flesh type (endoPG-6) and fruit acidity (CP-PCT040B) markers were used to provide marker-assisted seedling selection in the UA program. This advance in DNA-informed breeding represents an example of successful collaboration among institutions and across disciplines. Other DNA tests emerging from RosBREED include those for the prediction of peach maturity date and mealiness, apple acidity, sweetness, and firmness, and sweet cherry maturity time, blush, and firmness. By harnessing the power of collaboration, specifically the integration of pedigree, phenotypic, and genotypic data generated by RosBREED team members for QTL discovery, the development of breeding-relevant DNA tests was possible. Tools such as the DNA tests developed during the course of this project are now available to make DNA-based predictions a routine part of tree fruit breeding.

Specified Source(s) of Funding: RosBREED
Identification of QTL Underlying Powdery Mildew and Bacterial Canker Infection in Sweet Cherry (Prunus avium L.)

Yunyang Zhao
Washington State University, Prosser; yunyang.zhao@email.wsu.edu

Josephine Udodirim Mgbechi-Ezeri
Washington State University, Prosser; j.mgbechi-ezeri@email.wsu.edu

Kenneth B. Johnson
Oregon State University, Corvallis; johnsonk@science.oregonstate.edu

Umesh Rosyara
Michigan State University, East Lansing; rosyara@msu.edu

Amy F. Iezzoni
Michigan State University, East Lansing; iezzoni@msu.edu

Cameron Peace
Washington State University, Pullman; cpeace@wsu.edu

Amit Dhingra
Washington State University, Pullman; adhingra@wsu.edu

Nnadozie Oraguzie*
Washington State University, Prosser; noraguzie@wsu.edu

Powdery mildew (PM), caused by Podosphaera clandestina, and bacterial canker (BC), caused by Pseudomonas syringae pv. Syringae, are the major diseases of sweet cherry in the USA. Incorporation of natural resistance into elite cultivars would be an effective way to reduce reliance on fungicide and pesticide use and facilitate the transition to sustainable production systems. This study was designed to identify quantitative trait loci (QTL) underlying PM and BC infection to facilitate development of new resistant cultivars. Six hundred pedigree-linked germplasm lines were used in this study. PM was scored in the field on a 0–5 scale (0 = no visible symptoms and 5 = very severe infection on leaves) from 2011 to 2013. BC phenotyping was performed by inoculating five healthy and newly emerging leaves with 10 µl of 108 CFU/ml bacteria suspension mixed with 0.5% surfactant by mid-rib wound method in a detached leaf assay. Disease was scored in the lab on a 0–4 scale (0 = no necrosis and 4 = total necrosis). Approximately 1100 single nucleotide polymorphism (SNP) and four simple sequence repeat (SSR) markers were used for determining genome-wide marker-locus-trait associations. One PM QTL mapped on top of linkage group (LG) 5 in the three years while others mapped on LGs 1, 3 and 6 in a single year. For BC, one major QTL was identified on top of LG 5. The co-location of QTL for both diseases on LG 5 will be explored further to develop a breeding strategy for the two diseases combined.

Interspecific Crosses in Ziziphus Species

Noemi Tel-Zur*
Ben Gurion University of the Negev, Sde-Boquer 84990; telzur@bgu.ac.il

Armine Asatryan
Ben-Gurion University of the Negev, Sede Boqer; asatryan@post.bgu.ac.il

Three species of Ziziphus Mill. [Z. jujuba Mill., Z. mauritiana Lam. and Z. spina-christi (L.) Wild.] comprising a total of seventeen cultivars/genotypes were selected to perform interspecific crosses over a period of two flowering seasons under semi-arid conditions in the Negev desert of Israel. Twenty one cross combinations were done, comprising a total of 724 controlled pollination events, and resulted in 51 fruits (7.0%). Among the crosses that set fruits, that of Z. mauritiana × Z. spina-christi resulted in the highest total percent of fruit set (11.7%), and the reciprocal cross, resulted in a total fruit set of 8.7%. Only few fruits were obtained from the crosses Z. jujuba × Z. spina-christi and Z. mauritiana × Z. jujuba with 7.4 and 2.5% fruit set, respectively. With the exceptions of Z. jujuba × Z. mauritiana and Z. spina-christi × Z. jujuba, aborted and/or viable embryos were obtained in all cross combinations, showing that interspecific fertilization may occur among the studied species. The largest number of viable embryos was obtained from the cross Z. mauritiana × Z. spina-christi. Few hybrids germinated and developed, but none survived. Our study showed that gene flow among these three species may be possible in natural conditions or can be used in future breeding programs to create reproductively viable cultivars specifically adapted to semi-arid regions. However, it is uncertain whether these hybrids can germinate, grow and become established under current environmental conditions.

Relationships of Apple Rootstock Mediated Nutrient Concentrations in Leaves and Fruit of Gala Apples

Gennaro Fazio*
USDA-ARS, Geneva, NY; gf35@cornell.edu

Terence Lee Robinson
New York State Agricultural Experiment Station, Geneva, NY; tlr1@cornell.edu

Diverse apple rootstocks possess different capacities to absorb mineral nutrients from soil and transfer them to the grafted scion variety. A replicated field experiment of Gala scion grafted onto a population of 186 rootstocks (progeny of Ottawa 3 × Robusta 5) segregating for many apple important apple rootstock traits was used to monitor the dry matter concentration of nitrogen (N), potassium (K), phosphorous (P), calcium (Ca), magnesium (Mg), sulfur (S), iron (Fe), copper (Cu) manganese (Mn) and aluminum (Al) in mature leaf and immature fruit tissue. Correlation analysis revealed many significant relationships among mineral nutrients in fruit and leaves. Leaf and fruit P and K and leaf Mg...
were positively correlated and trunk cross sectional area was negatively correlated with fruit concentration of S, N, Cu, and Mg in order of decreasing effect and significance. Trunk cross sectional area was positively correlated with leaf concentration of K, P, and Ca in order of decreasing effect and significance. Rootstocks with different abilities to increase uptake of NPK and micro-nutrients in leaves and fruit might have a significant effect on the productivity of the orchard as well as fruit size and quality during storage. Given the importance of fruit calcium concentrations to postharvest fruit quality, increasing the availability of calcium and other important nutrients to growing fruit is a major target for this research. We describe how these relationships may be used in breeding new rootstocks tailored to nutrient needs of commercial apple varieties.

11:30–11:45 AM

Selecting Verticillium Wilt-resistant Olive Genotypes by Classical Breeding
Carlos Trapero*
Universidad de Córdoba, Córdoba; carlostrapero@uco.es
Concepcion M. Díez
Universidad de Córdoba, Córdoba; conchisingular@yahoo.es
Luis Rallo
Universidad de Córdoba, Córdoba; lrallo@uco.es
Francisco J. López-Escudero
Universidad de Córdoba, Córdoba; ag2loesj@uco.es
Diego Barranco
Universidad de Córdoba, Córdoba; dbarranco@uco.es

Verticillium wilt is the most destructive disease in olive (Olea europaea) production in the Mediterranean basin as well as in countries where olive is also being planted nowadays. The disease is caused by the fungus Verticillium dahliae. As other soilborne pathogens, control of the disease is very difficult to achieve and the use of resistant cultivars or rootstocks is one of the most efficient measures. However, nowadays the number of cultivars identified as resistant to the disease is very low. Due to these reasons, obtaining olive material resistant to Verticillium wilt is nowadays a major objective in the olive breeding program of the University of Córdoba, Spain. A screening procedure was developed, using the root dip inoculation technique with a highly virulent isolate of the fungus. This protocol has allowed evaluating the resistance to V. dahliae in several thousands of olive seedlings in controlled conditions. About 10 percent of the evaluated genotypes were highly resistant to the disease. In a second phase, the selected resistant genotypes are grown under forced conditions and after 6 months are planted in fields highly infested by the pathogen, where their field resistance to the disease, together with other agronomical traits are tested during 3–4 years. Then, the desired genotypes are replicated for further field trials. The genotypes evaluated following this procedures have been obtained from crosses and open pollination of olive cultivars, wild olives and other Olea species. According to the results, cultivar ‘Frantoio’ and a few wild olive accessions usually yielded more than 40% of resistant genotypes and therefore are the best sources to breed for Verticillium wilt resistance. However, a low proportion of resistant genotypes was also obtained in many crosses, even in those obtained from susceptible parents. Results about inheritance of resistance to Verticillium wilt in olive are also presented.

Specified Source(s) of Funding: Andalusian Regional Government (project P10-AGR6573) and “Interprofesional de Aceite de Oliva Español” Association

Tuesday, July 29, 2014

Genetics and Germplasm 1

10:00–10:15 AM

Faster and Cheaper Microsatellite Projects with Plants

Bryan J. Peterson*
University of Maine, Orono; bryan.j.peterson@maine.edu

William Graves
Iowa State University, Ames; graves@iastate.edu

Researchers with limited budgets and expertise may find it challenging to isolate and genotype microsatellite loci from plants, especially plants for which no prior genomic information is available. Next-generation sequencing promises to be a rapid, economical approach to microsatellite isolation from plants, although enrichment of genomic DNA for simple sequence repeat (SSR) motifs often is required. Such enrichment adds time and expense, and it may yield a biased sample of genomic SSRs. Therefore, we evaluated the suitability of the Illumina Hiseq 2500 platform for isolation of microsatellites from raw genomic DNA of an obscure shrub, Dirca palustris L. (Thymelaeaceae), by next-generation sequencing without prior enrichment. We used a Perl script developed by others to mine raw sequence data for SSRs and to conduct quality control of SSR loci. We also evaluated the use of fluorescently tagged universal primers and multiplexed genotyping to decrease costs further. Sequence data from 1/5 of a single lane comprised 26.89 million fragments, 19,200 of which contained di-, tri-, or tetra- nucleotide SSRs. Among all SSR fragments, 5,280 contained flanking sequences suitable for stringent primer design. Screening for copy number yielded 496 loci, most of which (89%) contained di-nucleotide SSRs. We evaluated 38 tri-nucleotide loci for amplification and polymorphism, which yielded 12 loci that were polymorphic among plants from one population of D. palustris. Several universal primers were used as tags for fluorescence-based genotyping of amplification products, which eliminated costs associated with fluorescently labeling a primer at each locus. Multiplexing amplification products into groups of four loci for genotyping generated a 75% savings in genotyping costs compared with genotyping amplification products individually. These approaches facilitate rapid and economical microsatellite identification and genotyping from plants with no prior genomic information.
Verticillium wilt of lettuce is caused by two races of the fungus *Verticillium dahliae*. Complete resistance to race 1 is conferred by the Vr1 gene, while only partial resistance to race 2 is known. Additional sources of race 2 or race non-specific resistance are needed. The disease causes discoloration of root vascular tissues followed by wilting of lower and cap leaves in iceberg lettuce resulting in plant death. Iceberg cultivars that delay symptoms past market maturity could reduce crop losses, but it is not known if this is a heritable trait. The objective was to evaluate the rate of wilting symptom development relative to market maturity in 34 iceberg cultivars adapted to diverse locations. The susceptible cultivar Salinas and the breeding line RH11-1798 carrying the Vr1 gene were used as controls. Cultivars were tested in three replicated experiments in a Salinas, CA, field infested with a race 1 isolate. At three time points, each plot was evaluated for foliar symptom severity (FS, 0 = no symptoms to 5 = all visible leaves wilted) and head maturity (HM, 0 = open head, 3 = harvest maturity to 5 = over-mature heads). Ten heads per plot were evaluated for root discoloration, which was used to calculate disease incidence (DI, % symptomatic plants). Cultivars were compared using Relative Marginal Effects (RME) of ranked data in a repeated measures ANOVA. Cultivars differed significantly for HM, DI, and FS (*P* < 0.001) at each time-point. Therefore, the time needed for each cultivar to reach market maturity and their rate of symptom development was different. FS and HM were significantly correlated at the last rating (*r* = 0.39, *P* < 0.001). The RME for FS on the last rating for Climax (1.7), Anuenue (2.8), Desert Storm (2.8), Reine des Glaces (3.1), and Bubba (3.2) were significantly lower than Salinas. All cultivars had significantly higher FS than RH11-1798 (0.6). The HM of these cultivars was past harvest maturity, ranging from 3.6 to 4.3 except for Bubba (2.8). Despite low FS, DI was high in Desert Storm (65%), Bubba (80%) and Climax (85%) indicating susceptibility. Iceberg cultivars with delayed foliar symptoms may be useful for reducing crop losses from Verticillium wilt. Additional research is needed to determine if these cultivars exhibit delayed foliar symptoms against both races. Crosses have been made with cultivars with delayed foliar symptoms and those that quickly develop wilting to generate populations to study the suitability of this trait for breeding resistance to *V. dahliae*.

Specified Source(s) of Funding: California Leafy Green Research Board

**Genomic Diversity of Four Closely Related Wild Tomato Species As Revealed by Genotyping-by-sequencing**

Joanne A. Labate*  
USDA–ARS, Geneva, NY; joanne.labate@ars.usda.gov

Larry D. Robertson  
USDA–ARS, Geneva, NY; larry.robertson@ars.usda.gov

Susan R. Strickler  
Boyce Thompson Institute for Plant Research, Ithaca, NY; suzy.strickler@gmail.com

Lukas A. Mueller  
Boyce Thompson Institute for Plant Research, Ithaca, NY; lam87@cornell.edu

Wild tomato species have been exploited for many decades to develop cultivated tomato varieties that can resist biotic and abiotic stresses. The highly variable wild tomato species *Solanum peruvianum sensu lato* (s.l.) has been reclassified into four distinct species—*Solanum peruvianum sensu stricto*, *Solanum corneliomuelleri*, *Solanum huaylasense*, and *Solanum arcanum*. However, the genetic relationships within and among the four species are not well understood. We used genotyping by sequencing (GBS) to develop tens of thousands of mapped single nucleotide polymorphisms (SNPs) in order to analyze genetic relationships within and among species. Origins of accessions in Peru, Ecuador, and Chile were mapped using geographical information systems (GIS). Isolation by distance, pairwise genetic distances and number of clusters were estimated using population genetics approaches. Isolation by distance was strongly supported and was relatively more pronounced between interspecific compared to intraspecific pairs. Eriopersicon and Arcanum species groups were genetically distinct from each other with the exception of *S. huaylasense*, which showed 50% membership proportions in each group. *S. peruvianum* and *S. corneliomuelleri* were not significantly differentiated from each other. Many thousands of SNP markers were identified that could potentially be used to distinguish pairs of species, including *S. peruvianum* versus *S. corneliomuelleri*, if they are verified on larger numbers of samples. Diagnostic markers will be valuable for delimiting morphologically similar and interfertile species in germplasm management. Approximately 12% of the SNPs rejected a genome-wide test of selective neutrality based on differentiation among species. These are candidates for more comprehensive studies of adaptive divergence within this species complex. These DNA markers will be valuable for working with these highly similar and closely related species in tomato breeding and conservation of wild populations.

Specified Source(s) of Funding: CRIS Project No. 1910-21000-024-00D
Tomato Rootstock Resistance to Bacterial Wilt (Ralstonia solanacearum): Effects of Genotype and Cold Stress on Epidemic Profile

Jonathan P. Kressin*
North Carolina State University, Raleigh; jpkressi@ncsu.edu
Emily J. Silverman
North Carolina State University, Raleigh; ejsilver@ncsu.edu
Frank J. Louws
North Carolina State University, Raleigh; frank_louws@ncsu.edu
Dilip Panthee
North Carolina State University, Mills River, NC; dilip_panthee@ncsu.edu

Tomato (Solanum lycopersicum L.) is the second most important vegetable crop in the world. In the U.S., fresh market tomato production farm value was $0.86 billion in 2012, with Florida and North Carolina (NC) producing 38.6% of national production (34.7% and 3.9% respectively). In both states (2007), 99% of tomato growing acres were harvested for fresh market. Bacterial Wilt (BW) caused by Ralstonia solanacearum (Rs) is a devastating disease of tomato in tropical and subtropical environments around the world with losses of 70% to 100% in the Southeast U.S. in heavily infested fields. Vegetable grafting of commercial scions onto disease resistant rootstocks has been developed as a viable management strategy for BW in tomato, particularly for fresh market. Bacterial wilt resistance in tomato rootstock germplasm, however, is quantitative and partial. A greenhouse resistance study using 10 variably resistant tomato rootstocks lines (not grafted; mixture of open-pollinated and commercial hybrids), Florida 47 susceptible commercial control, and two NC Rs isolates was carried out from October 2013–February 2014. Rootstock lines including ‘H7997’ and ‘H7998’ and hybrid lines ‘Cheong Gang’ (Seminis) and RST-04-106-T (DP Seeds) were highly resistant to both NC strains, quantitatively. Other rootstock lines including ‘CRA66’, RST-04-105-T (DP Seeds), and several BHN selections had intermediate resistance. Rootstock hybrid ‘Maxifort’ (DeRuiter) and scion hybrid ‘FL47’ were highly susceptible, as anticipated. Disease scores were complemented stem imprints on semi-selective media and vascular browning scores. Bacterial streaming assays and ELISA assays were used to verify the presence of the pathogen. A severe cold weather event caused plants to be exposed to 9 °C two nights in a row, causing recoverable cold damage after disease had reached a stable plateau. Following cold stress, a second substantial phase of wilting was observed, mostly in resistant rootstocks, which again reached a stable plateau. Analysis of epidemic phases suggests that susceptibility to BW can be early, late, or bi-phase depending on genotype, and possibly Rs isolate. Additionally, it suggests that the late phase epidemic is at least partially induced by environmental stress (cold temperature). This research has implications for BW resistance screening methodology, resistant genotype breeding selection criteria, elucidation of some environmental influences on disease severity and temporal phenomenon, rootstock selection for grafted management of BW, and, potentially, the geographic influence of Rs on tomato genotypes and environments.

Specified Source(s) of Funding: USDA-Specialty Crops Research Initiative

Evaluation and Characterization of a Genetically Diverse Musa Germplasm Core Subset

Brian Irish*
USDA–ARS, TARS, Mayaguez, PR; brian.irish@ars.usda.gov
Julie Sardos
Bioversity International, Montpellier; j.sardos@cgiar.org
Nicolas Roux
Bioversity International, montpellier; n.roux@cgiar.org
Ricardo Goenaga
USDA–ARS, Mayaguez, PR; ricardo.goenaga@ars.usda.gov

The USDA–ARS, Tropical Agriculture Research Station is responsible for curating germplasm of several regionally and internationally important agricultural crops. Evaluation and characterization of Musa (bananas) genetic resources are an important component of programmed research. In a global collaborative effort lead by Bioversity International, a select group of genetically and morphologically distinct Musa sp. germplasm accessions (the ‘Taxonomic Reference Collection’ or TRC) were evaluated and characterized over two cropping cycles. Following greenhouse acclimatization, four in-vitro propagated plants for each of 34 accessions provided by the Bioversity International’s global Musa collection (also called the International Transit Centre–ITC) were field-established at the USDA–ARS, TARS Isabela research farm on June 17th, 2010. Beginning at flowering and during the mother cropping cycle, data was collected for a total of 32 descriptors with an additional 15 images taken at key developmental stages. During the second cycle (1st ratoon) a more comprehensive set of descriptors (121) collected for all accessions were gathered. During the mother and first ratoon growing cycles, environmental data as well as important agronomic traits (e.g., bunch weight, number of fruits, and cycling time) we evaluated. Guidelines, which included IPGRI’s (now Bioversity International) 1996 version of ‘Descriptors for Banana’, were provided to use as a reference during the field exercise. As the TRC included diverse genetic groups of Musa sp. germplasm accessions, the range in descriptors varied greatly. At the TARS, four of the original 34 accessions appeared failed to grown ‘normally’ and/or did not flower. Interpretation of descriptors was not always straightforward; therefore some adjustments in data collection methodologies were incorporated. Descriptor records and images from the TARS evaluation site have been summarized and shared with Bioversity International personnel who are in the process of collating data from all other participating collaborators worldwide to assess trait stability across agro-environments. Preliminary results of the summarized information across international sites indicate that standardization of cultural practices and a clear
interpretation of the descriptors by curators (of diverse native languages) collecting the data is critically important in order to compare and summarize across sites. Unique accessions in the TRC have been included in the permanent collection at TARS and are available for distribution in limited quantities for research and educational purposes.

11:15–11:30 AM

Genetic Diversity of Suksdorf’s Desert Parsley [Lomatium suksdorfii (S. Watson) J.M. Coult. & Rose] in the Columbia Gorge

Theodore J. Kisha
USDA–ARS, Pullman, WA; Theodore.kisha@ars.usda.gov
Barbara C. Hellier*
USDA–ARS, Pullman, WA; barbara.hellier@ars.usda.gov

Suksdorf’s desert parsley [Lomatium suksdorfii (S. Watson) J.M. Coult. & Rose] is a perennial forb of the carrot family (Apiaceae) with a global and state (Washington) ranking as “rare or uncommon” (21-100 occurrences), state (Washington) status as “sensitive”, and federal status as a “species of concern”. Its habitat is limited to Klickitat County in Washington and Hood River and Wasco Counties in Oregon. Species of Lomatium have historically been consumed by Native Americans and have been reputed to have saved tribes from the 1918 flu epidemic. Laboratory studies of root extracts of Lomatium species have shown anti-viral and anti-bacterial effects. Suksdorfin, which is isolated from the fruit of Lomatium suksdorfii, was found to inhibit HIV-I replication in the T cell line H9. Our study using TRAP markers and the software STRUCTURE shows the six locations collected can be placed in four distinct populations with admixture between locations within populations. Knowledge of the extent, distribution, and structure of genetic diversity of L. suksdorfii in its limited habitat can provide a tool for breeders to exploit and improve its medicinal qualities, while maintaining the ecological health of the populations.

Specified Source(s) of Funding: Collection expedition funded by the USDA–ARS Plant Exchange Program

11:30–11:45 AM

External Morphology Analysis and Intraspecific Variations among Habitats of Allium victorialis var. platyphyllum in Korea

Won Bae Kim*
National Institute of Horticultural and Herbal Science, RDA, Suwon; wbkim55@korea.kr
Ki Oug Yoo
Kangwon National University, Chuncheon; yooko@kangwon.ac.kr

Taxonomic study in external morphology analysis was conducted to understand the intraspecific difference among three habitats (Ulleungdo, Jirisan and Odaesan) of Allium victorialis var. platyphyllum in Korea. Intraspecific variations among Allium victorialis var. platyphyllum populations including three habitats and 41 individuals were investigated based on the randomly amplified DNA polymorphisms derived from PCR (polymerase chain reaction) method. External morphology such as bulb color, leaf blade length and width, petiole length, total leaf length, peduncle length, perianth lobe length and width, length of another and filament were useful characters for the identification of populations in three habitats. Eleven primers out of 81 primers (80 random [10-mer] primers, one 15 mer [M13 core sequence] primer) screened resulted in DNA polymorphisms (61.5%) in all of the tested plants, producing 83 randomly and specifically amplified DNA fragments. Ulleungdo population was discrete from the other two populations at the 0.77 of similarity index value of DNA polymorphisms. But Jirisan and Odaesan population were not differentiated from each other. For the variation of each population, Ulleungdo population showed lower level of variation with similarity index of 0.92 than Jirisan and Odaesan populations with 0.86 and 0.87, respectively.

Specified Source(s) of Funding: Rural Development Administration, Korea
In the past decade, we have been conducting field research with controlled release N fertilizers (CRN) using replicated, randomized, complete-block or split-plot treatment designs. More recently, experiment-demonstrations were conducted in grower fields to expand the range of production scenarios and implement an outreach component to these studies. CRN management frequently, but not always, provided production and economic advantages compared to traditional split application of standard fertilizers (sidedress and/or water run N). Results show that it is of paramount importance to match product N release with crop N demand in specific crop production windows. Placement can also be an issue when temperatures are extremely warm. Research also shows that the probability of positive production and economic outcomes is increased as soil texture becomes increasingly coarse or irrigation management more problematic. Specific outcomes to alternative production practices using CRN will be discussed.

Oral Presentations

10:45–11:00 AM

**Soil Surfactant Increases Nutrient Use Efficiency and Yield of Potato Grown on Sandy Soil in Florida**

Guodong Liu*
University of Florida, Gainesville; guodong@ufl.edu

David Dinkins
USDA–ARS Natioal Soil Dynamics Laboratory, Auburn, AL; David.Dinkins@ars.usda.gov

Moshe Doron
University of Florida, IFAS, Gainesville; moshik@ufl.edu

The acreage of tomatoes grown in Florida is 35,000 acres and the total yearly value is more than $160 million. Florida potatoes are grown primarily in sandy soils, which have low water-holding capacity and high nutrient leaching due to its coarse sized particles. Soil surfactant is a surface-active substance with both hydrophilic (water-loving) and lipophilic (fat-loving) properties like soaps and detergents. These amphiphilic properties can significantly improve soil quality, reduce water repellency, and increase the capacity for holding water and nutrients in sandy soil. The objectives of this research were to: (1) evaluate the effect of a surfactant on nutrient use efficiency and (2) assess the yield enhancement of the surfactant on potatoes grown in sandy soil. Nutrient use efficiency (lb lb⁻¹) was defined as potato yield increment per pound of applied nutrients. The results from this study will include that plant growth, leaf greenness, yield, and nutrient use efficiency of the tested potato cultivars, ‘Atlantic’ and ‘Red LaSoda’.

11:00–11:15 AM

**Machine that Bands Compost Shows Promise in Sweet Corn (Zea mays L.) and Tomato (Lycopersicon lycopersicum)**

William B. Evans*
Mississippi State University, Crystal Springs; wbe1@ra.msstate.edu

Haile Tewolde
USDA–ARS, Starkville, MS; Haile.Tewolde@ars.usda.gov

Sarah Reynolds
Mississippi State University, Gulfport; s.red.reynolds@gmail.com

Tom Way
USDA–ARS National Soil Dynamics Laboratory, Auburn, AL; Tom.Way@ars.usda.gov

An application machine capable of applying fine organic materials in bands under the soil surface has been developed by the USDA National Soil Dynamics Laboratory. In 2013, we teamed up to test the machine for the first time on vegetable fields. For these trials, sweet corn and tomatoes were grown using standard local practices, except that plots received one of four initial fertilizer application treatments: no pre-plant fertilizer, banding composted chicken (Gallus gallus) broiler litter (CBL) below and to the side of the planting row, broadcasting CBL to the rows or bed tops prior to final bedding; or broadcasting a balanced synthetic fertilizer in a similar way. All plots received later side-dressing as calcium nitrate through drip irrigation.

An asterisk (*) following a name indicates the presenting author.
Excavation revealed distinct CBL bands below and to the side of the rows as expected. Corn ear length was significantly shorter in the unfertilized controls. SPAD readings were also lower in these plots on June 28, but not at harvest on July 29. Analysis of the number of marketable ears, and the width and mean weight of these ears revealed no other significant difference among treatments. Tomato yield parameters were similar in all treatments except the unfertilized control, where measured yield and quality attributes were lower. Data from this first year indicates that banding organic materials may be a way of achieving yields comparable to those achieved with broadcasting and incorporating compost or synthetic fertilizer. The study also shows that the organic materials banding machine has potential to successfully apply organic materials as bands to the side of a vegetable crop row. This study is being repeated in 2014 with additional emphasis on soil and tissue nutrient status.

Specified Source(s) of Funding: USDA Soil Tilth Lab and CRIS Project MIS-149141

11:15–11:30 AM

**The Effect of Biochar on Root Growth of Large Crabgrass**

Karen A. Mitchell

Purdue University, West Lafayette, IN; karen.mitchell@gmail.com

Janna Beckerman

Purdue University, West Lafayette, IN; jbeckerm@purdue.edu

Anjali Iyer-Pascuzzi

Purdue University, West Lafayette, IN; asi2@purdue.edu

Jeff Volenec

Purdue University, West Lafayette, IN; jvolenec@purdue.edu

Kevin D. Gibson

Purdue University, West Lafayette, IN; kgbison@purdue.edu

Biochar is a carbon-rich residue similar to charcoal that is incorporated into the soil to increase nutrient retention and water holding capacity, which in turn increases crop productivity, as well as to sequester carbon. Biochar can increase plant productivity but relatively little is known about the effect of biochar on root growth. We assessed the effect of biochar on large crabgrass (*Digitaria sanguinalis* L. Scop.), a common weed, grown in rhizotrons under growth chamber conditions. Soil mixed with or without biochar was placed between two clear acrylic sheets in either a full or split design. In the full design, rhizotrons were filled with unamended soil or soil amended with 2% biochar (wt/wt) in the split design, amended and unamended field soil, each occupying half of the rhizotron vertically, was used. Biochar produced at 450 °C from two different feedstocks was used. The nutrient rich biochar was produced from a mixture of loblolly pine and switchgrass. The nutrient poor biochar was produced from a mixture of pine, fir, and spruce. At 38 days after transplant, the rhizotrons were scanned with a flatbed scanner, and plants were harvested. Plant height, tiller number, and component dry weight (root, leaf, shoot) were measured. In the solid design, both types of biochar increased the number of tillers produced by large crabgrass. The nutrient rich biochar reduced the partitioning of biomass to roots relative to the nutrient poor biochar and the unamended soil. When grown in the split design rhizotron, large crabgrass root dry weight was greater in the side amended with biochar, regardless of the type of feedstock. These results suggest that biochar can have a significant effect on root growth.

11:30–11:45 AM

**Effect of Foliar Application of Micronutrients (Zn & B) on Vegetative and Reproductive Growth of Mango (**Mangifera indica** L.) var. Langra**

Malik Ferdosi*

University of the Punjab, Lahore; malikferdosi@yahoo.com

An experiment was designed to investigate the effect of micronutrients i.e. (B & Zn.) on vegetative and reproductive growth of mango (*Mangifera indica* L.) variety Langra. Data revealed that the maximum flushes (686) were emerged in the plants related with treatment T1 0.8% H3 BO3 as compared to control T0 (572). The maximum panicles (433) were emerged in the plants treated with T4 1% Boric Acid (H3 BO3) and 1.2% zinc sulphate as compared to control (305) and T1 0.8% H3 BO3 (362). The analysis showed that maximum yield/plant (52.60kg) was recorded in the treatment T1 0.8% H3 BO3 as compared to control (40.57 kg).

An asterisk (*) following a name indicates the presenting author.
with and without MaxCel® were used in ‘Gala’ apple. Application of ACC at the rate of 250 ppm or 350 ppm significantly reduced fruit set, increased fruit size, and improved fruit quality, while ACC at 150 ppm or Ethrel at 300 ppm did not result in sufficient thinning in ‘Gala’ apple. In ‘Fuji’, ACC at rates of 300 or 450 ppm showed effective fruit thinning and resulted in larger fruit with better quality attributes. In Study 2, Control trees had numerically the highest fruit set while trees with MaxCel® alone applied at 1% at 5-10 mm stage and those receiving Sevin and NAA had the lowest fruit set in ‘Gala’ apple. While there were numerical improvements, there were no statistically significant differences in fruit set within System-Cal™ treatments and between the System-Cal™ treatments and Control. It seems that ACC is a promising post-bloom thinner for apple, especially when used at the 20 mm stage where few thinners are effective. This naturally occurring phytohormone deserves to be further studied under different climate conditions and in different cultivars of apples.

Specified Source(s) of Funding: ValentBioscience, Idaho Apple Commission

10:30–10:45 AM

**Effects of Pollen Source and Seed Number on Fruit Set, Fruit Quality, and Flower Initiation of Apple**

Khalil R. Jahed*
Purdue University, west lafayette, IN; kjahed@purdue.edu

Peter M. Hirst
Purdue University, West Lafayette, IN; hirst@purdue.edu

In apple, adequate pollination and fertilization is required for fruit set and subsequent fruit growth. Limitations in fertilization could potentially be due to the rate of pollen tube growth or the interaction of the pollen with the tissues within the ovary. Both these factors are presumed to be influenced by the genetic interaction between male gametophyte and female tissues of the flower. To evaluate the roles of these two factors in affecting fruit set and return bloom, the pollen of three cultivars, Red Delicious, Gala, and Ralph Shay Crabapple, were applied to Honeycrisp flowers. Hand pollinations were performed under bee exclusion tents. Fruit set, seed number, fruit quality and flower development in bourse buds were measured. Preliminary data showed that fruit set and return bloom both increased when Red Delicious and Gala were used as male gametophytes and were lower with crabapple as the pollen source. However, pollen source did not affect fruit quality and maturity. Seed numbers were positively correlated to fruit weight, but not to fruit quality or fruit maturity. Seed number had no significant impact on return bloom. Male gametophyte had positively effect on soluble solid concentration (SSC), the amount of sugar in the apple fruit. These results suggest that prevailing pollen source and seed numbers can increase fruit set, fruit quality and return bloom of apple.

Specified Source(s) of Funding: USAID

10:45–11:00 AM

**Evaluating Scaling Relationships of Branching Structure and Biomass Partitioning in Managed Orchard Fruit Species**

Zachary Brym*
Utah State University, Logan; zack.brym@usu.edu

Tests of the Metabolic Theory of Ecology for plant species are largely limited to naturally occurring species and minimally managed plantation species. My study explores if scaling relationships described for natural systems are conserved in domesticated and highly manipulated (i.e., pruned) orchard systems. I measured diameter, length, and stem biomass at a branch level for five 20-year-old minimally managed tart cherry (*Prunus cerasus, P. mahaleb* rootstock) trees and 19 eight-year-old highly managed apple (*Malus domestica*) trees with various growth controlling rootstocks at the Utah State University Kaysville Experimental Orchard. In addition to branch-level measurements, I calculated canopy volume and other tree-level architecture descriptors like branching ratio and branching path fraction. Preliminary results suggest that scaling predictions are highly conserved in orchard species independent of management intensity. For instance, trunk diameter and total stem biomass are highly correlated on a log-log scale with a nearly parallel slope to the 8/3 scaling prediction. This work also includes a strong applied component for orchard management. Canopy shape and structure models will be fitted to yield data in commercial orchards to include a constraints-based approach to horticulture where tree architecture and growth is manipulated to maximize fruit yield per resource input. The selected model will use a scaling approach influenced by the Metabolic Theory of Ecology to simulate various horticultural management strategies on tree fruit physiology.

Specified Source(s) of Funding: Utah State University Research and Graduate Studies & Utah State University Ecology Center

11:00–11:15 AM

**Functional Characterization and Identification of Single Nucleotide Polymorphisms in KRP4 and KRP5, Two Negative Regulators of Cell Production in Apple**

Anish Malladi*
University of Georgia, Athens; malladi@uga.edu

Lisa K. Johnson
University of Georgia, Athens; lbklima@uga.edu

Fruit growth in apple (*Malus domestica*) is achieved through a combination of cell production and expansion, processes which are in-turn regulated by multiple genes. Cell production is regulated by the progression of individual cells through the cell cycle. Multiple cell cycle genes closely associated with the regulation of cell production during different stages of flower and fruit development have been previously identified in apple. Two such genes are the cyclin dependent kinase inhibitors, referred to as KRPs (Kip-Related Proteins; KRP4 and KRP5). The proteins encoded by KRP4 and KRP5 are associated with...
reduced cell production activity. Functional characterization of these genes may help determine their roles in the control of fruit growth and size in apple. To achieve this objective, transgenic Arabidopsis thaliana plants expressing either the apple KRP4 or KRP5 were generated. Phenotypic observations of these plants revealed smaller, greatly serrated leaves, and altered floral morphology, similar to that noted in plants overexpressing the Arabidopsis KRP2 gene. These results suggest that the apple KRP4s are negative regulators of cell production and thereby organ growth. Identification of polymorphisms in these genes may help to lead the development of markers associated with the control of cell production and organ growth. To achieve this objective, the coding regions of KRP4 and KRP5 in multiple Malus domestica accessions were sequenced. Several polymorphisms identified in the coding region of KRP4 may result in amino acid differences that can potentially alter KRP4 function. Together, data from this study suggest that KRP4 and KRP5 negatively regulate cell production and fruit growth in apple.

11:15–11:30 AM

Performance of Geneva Rootstocks Trained to Four Production Systems with Two Initial Tree Types

Terence Lee Robinson*
New York State Agricultural Experiment Station, Geneva, NY; tlr1@cornell.edu

Stephen A. Hoying
Cornell University, Highland, NY; sah19@cornell.edu

Mario Miranda-Sazo
Cornell University, Newark, NY; mrm67@cornell.edu

Michael J. Fargione
Cornell University, Highland, NY; mjf22@cornell.edu

In 2006 we planted a 1 ha field trial which compared 7 Geneva rootstocks (G.16, G.41, G.11, G.935, G.4210, G.6210 and G.30) along with B.9, M.9, M.26 and M.7 as controls with Gala and Honeycrisp as the scion varieties. Each rootstock was trained to 4 high-density systems: Slender Pyramid (840 trees/ha), Vertical Axis (1284 trees/ha), Slender Axis (2244 trees/ha), and Tall Spindle (3262 trees/ha). Within the Tall Spindle system we compared fully feathered nursery trees (2 years in the nursery) and bench-grafted trees (no time in the nursery but directly planted to the field after grafting). Cumulative yields (years 1-8) were highest for the Tall Spindle system followed by the Slender Axis, Vertical Axis and Slender Pyramid which had the lowest yield. The bench-grafted trees had much lower early yield than the fully feathered trees. Among rootstocks, G.16, G.11, G.41 and M.9 had the highest yield with Gala while B.9 had lower yield. With Honeycrisp, G.16, B.9, G.11 and M.9 had the highest yield while G.41 had lower yield. An economic analysis using the first 8 years of yield data and estimated yield through year 20 showed that the Tall Spindle system was the most profitable systems followed by the Slender Axis, Vertical Axis and the Slender Pyramid. Among tree types, the feathered trees were more profitable over 20 years than the direct-plant bench grafts despite the much lower initial cost of the bench grafts. Specified Source(s) of Funding: NY Apple Research and Development Program, NY Farm Viability Institute

11:30–11:45 AM

Spur versus Whole-tree Regulation of Apple Flowering

Mohkles A. ELsysy*
Purdue University, West Lafayette, IN; melsysy@purdue.edu

Peter M. Hirst
Purdue University, West Lafayette, IN; hirst@purdue.edu

Flowering regulation in apple trees is important because biennial bearing is challenging for the apple industry. Apple flowering is generally thought to be influenced by many factors including crop load, seed number and bourse length. However it is unclear how these factors exert their control. In this study we investigated how these different factors contribute to the control of flower induction and whether this is regulated locally in the spur or if it is under the control of the whole tree system. Seven different thinning treatments were applied manually, which varied in the total number of fruit per tree and fruit number per spur. The appropriate number of fruiting spurs was tagged and fruits were removed from the rest of the tree. Fruit weight, seed number, seed weight, bourse number, bourse length, bud diameter and flowering differentiation per spur were recorded. This experiment was conducted in spring 2011, 2012 and 2013, but no data were collected in 2012 due to a severe spring freeze. In 2013, the methods were modified so that individual spurs could be tracked rather than averages and proportions being calculated. In 2011, there were no significant differences in the proportion of flowers on tagged spurs among treatments suggesting that fruiting on the rest of the tree did not influence flowering on tagged spurs. It appeared that the local, within spur fruiting status had stronger impact. Bearing one or two fruits on the same spur had a similar effect on return bloom. Fruit weight and seed number had a negative linear relationship with flower formation. This experiment will help us to characterize the local versus general regulation of apple flowering and aims to improve our current understanding of apple tree regulation of flowering.

11:45 AM–12:00 PM

Root Pruning Reduces Vigor in High-density d’Anjou Pear Orchards

Matthew Arrington*
Oregon State University, Hood River; matthewaarrington@gmail.com

Aritz Kerman
University of Valencia Polytechnic; aritzkerman@gmail.com

Mateus Da Silveira Pasa
Federal University of Pelotas; mateus.pasa@gmail.com

Todd Einhorn
Oregon State University, Hood River; todd.einhorn@oregonstate.edu

An asterisk (*) following a name indicates the presenting author.
It is crucial that expenses associated with orchard establishment are recovered early. This is especially important with high-density plantings; however, for pear, non-precocious and vigorous young trees limit the commercial adoption of high-density designs. Root pruning has been successfully used to control shoot and canopy growth in high-density, European pear orchards, while simultaneously improving fruit set and yield efficiency. A thorough evaluation of root pruning in US pear orchards, however, has not been performed. Therefore, we used the inherently high-vigor cultivar ‘d’Anjou’ on OH&CF 87 rootstock to investigate root pruning at two separate sites: 6th-leaf, moderate-density (769 trees/ha); and, 4th-leaf, high-density (2,243 trees/ha) orchards. Initially, we hypothesized that root pruning would result in an inverse relationship between tree vigor (the season of root pruning) and return bloom, fruit set and yield (the year following application). We compared single- and double-sided root pruning treatments (applied at ~10% of full bloom, 45 cm from tree trunks to a depth of 45 cm) with and without application of AVG (aminoethoxyvinylglycine hydrochloride, ReTain®, Valent Biosciences; 823 g per ha rate, applied 10 days after full bloom), to untreated controls. Vegetative growth was reduced at both sites relative to the severity of root pruning (i.e., single- vs. double-sided), though the magnitude of the response differed between sites as a function of tree age. At the conclusion of the second season (root pruning was not performed in year 2), carry-over effects of root pruning on vegetative growth were roughly half those observed after year-one. In the 6th-leaf orchard, root pruning resulted in reduced fruit set, yield and harvested fruit size the year of the application, likely attributed to higher stress associated with a greater percentage of root volume removed compared to the 4th-leaf, younger trees. In year 2, only the double-sided root pruning treatment produced greater return bloom, fruit set and yield relative to controls, but fruit size remained smaller. This yield recovery, however, was not high enough to compensate for year-1 deficits. At the 4th-leaf site, we did not observe any negative effects on fruit set, fruit growth rate, yield or fruit size the year of root pruning. Application of AVG led to a twofold increase in fruit set and yield, irrespective of root pruning. AVG-treated trees had slightly smaller fruit size, though this was likely an indirect effect of higher crop loads. New insights for developing root pruning programs for pear will be discussed.

Tuesday, July 29, 2014

**Viticulture and Small Fruits 1**

Moderator: Sanliang Gu; sanliang@csufresno.edu

1:45–2:00 PM

**Bird Management in Fruit Crops: Economic, Consumer, and Biological Perspectives**

Catherine Lindell*
Michigan State University, East Lansing; lindellc@msu.edu

Stephanie A. Shwiff
USDA/APHIS/WS National Wildlife Research Center, Fort Collins, CO; stephanie.a.shwiff@aphis.usda.gov

Paul D. Curtis
Cornell University, Ithaca, NY; pdc1@cornell.edu

Philip H. Howard
Michigan State University, East Lansing; howardp@msu.edu

Karen M.M. Steensma
Trinity Western University, Langley, BC; steensma@twu.ca

George M. Linz
USDA/APHIS/WS National Wildlife Research Center, Bismarck, ND; george.m.linz@aphis.usda.gov

Jason R. Boulanger
Cornell University, Ithaca, NY; boulanger@cornell.edu

Nikki Lynn Rothwell
Michigan State University, Traverse City, MI; rothwel3@msu.edu

Juliet E. Carroll
Cornell University, Geneva, NY; jec3@cornell.edu

Chi-Ok Oh
Michigan State University, East Lansing; och@msu.edu

Colleen L. Burrows
Washington State University, Bellingham, WA; cburrows@cahnrs.wsu.edu

Mark A. Longstroth
Michigan State University, Paw Paw, MI; longstr7@anr.msu.edu

Clive Kaiser
Oregon State University, Milton-Freewater, OR; clive.kaiser@oregonstate.edu

David P. Lusch
Michigan State University, East Lansing; lusch@msu.edu

Shayna L. Wieferich
Michigan State University, East Lansing; shaynwief@gmail.com

Heidi M. Henrichs
Cornell University, Ithaca, NY; hmh75@cornell.edu

Deanna Leigh
Western Washington University, Bellingham, WA; deanna.leigh1@mytwu.ca

Megan E. Shave
Michigan State University, East Lansing; shavemeg@msu.edu

Rachael A. Eaton
Michigan State University, East Lansing; rachael.a.eaton@gmail.com

Zachary B. Herrnstadt
Michigan State University, East Lansing; herrnsta@msu.edu

Aaron M. Anderson
USDA/APHIS/WS National Wildlife Research Center, Fort Collins, CO; aaron.m.anderson@aphis.usda.gov

Consumers are eating more fruit because of positive health effects, increasing the importance of fruit production in the global economy. Birds damage and consume large quantities of cultivated fruit. At the same time, birds provide recreational activities, economic activity from bird watching, and ecosystem services in the form of pest consumption. Thus, bird management is crucial to increasing fruit production but must be done...
Heat Summation: Maximum or Average Temperatures to Interpret Degree Days Based on Daily Minimum and Hourly Average Temperatures with Growing Degree-Days (GDD) has been widely used for heat tracking and integrating information from these areas we can better understand costs and benefits of bird management strategies and inform fruit producers, consumers, and policy-makers. We documented economic effects of bird damage through a survey distributed to fruit growers from five states.Growers estimated bird damage to sweet cherries in 2011 as between 4.8 and 31.4%, depending on the state, to tart cherries between 3.0 and 26.7%, to blueberries between 3.8 and 18.2%, to wine grapes between 2.9 and 9.2%, and to ‘Honeycrisp’ apples between 0.4 and 7.4%. Using these estimates, along with state-specific price, production, and acreage data, financial losses from birds were calculated. For blueberries, for example, statewide losses ranged from $586,000 in New York to $14,052,000 in Michigan. Wine grape losses ranged from $2,472,000 in Michigan to $49,100,000 in California. We surveyed 1,000 consumers to quantify preferences and willingness to pay for fruit produced with various bird management practices. We then conducted experimental auctions to adjust willingness to pay measures. Preliminary results showed consumers were willing to pay more for fruit produced with bird management strategies like falconry or nest boxes that attract bird predators. They were not willing to pay as much for fruit produced with bird management strategies like lethal shooting or solutions sprayed on the crops. Our biological fieldwork focuses on both field and regional scales. On the field scale, results indicate greater damage in small fields and at edges compared to interiors of fields, particularly edges next to woody vegetation. Promising bird deterrent techniques slated for large-scale replicated trials include air dancrs and field-specific intensive management. Using nest boxes to attract bird predators is a low-cost, low-maintenance addition to pest management strategies. On a regional scale, bird damage is greater in years when overall fruit yields are lower, making bird management a higher priority in these years.

2:00–2:15 PM

Comparison of Growing Degree Hours Based on Hourly Average Temperatures with Growing Degree Days Based on Daily Minimum and Maximum or Average Temperatures to Interpret Heat Summation

Sanliang Gu*
California State University, Fresno; sanliang@csufresno.edu
Adnan Sabuwala
California State University, Fresno; asabuwala@csufresno.edu
Hemant Gohil
California State University, Fresno; hemant_gohil@hotmail.com

Growing degree-days (GDD) has been widely used for heat summation in region classification and phenology prediction. It is usually calculated from the mean of daily minimum and maximum temperatures with a pre-determined base temperature. The present study compares GDD with growing degree hours (GDH) to examine the source and magnitude of errors in heat summation calculation. Heat summation was calculated as a simple rectangular integration of the mean or average temperatures above 10 °C at an interval of one day for GDD or one hour for GDH. Daily GDD was calculated from the mean of daily maximum and minimum temperatures (GDDmm) or daily average of 1440 minutely measurements (GDDavg). Daily GDH was calculated as the sum of 24 GDH values from hourly average of 60 minutely measurements for a given day (GDHavg). Cumulative and total GDD or GDH was obtained by adding up daily values during the growing season. GDDmm exhibits the most error, under- or over-estimating heat summation most of the time. GDDavg, on the other hand, only underestimates heat summation when temperatures are low. Errors in heat summation calculations are associated with the asymmetrical distribution of diurnal temperatures and the base temperature, dependent upon the resolution of the temperature data. The asymmetrical distribution results in the mean of daily minimum and maximum temperatures to be unequal to the daily average temperatures at a higher resolution. The error due to asymmetrical distribution cannot be fixed in GDDmm, due to the vast variation and the lack of consistent patterns in temperature distribution. Base temperature as a lower threshold, in combination with the asymmetrical distribution, also contributes to the error of heat summation calculation especially in GDDmm or GDHavg. When temperatures are higher than the base temperature during only part of the day but the daily mean or average temperatures are equal or lower than the base temperature, GDH accumulates growing degree, but GDD does not, leading to an underestimate of heat summation. GDHavg improves the estimation of heat summation over GDDmm or GDHavg by using temperature data at a much greater resolution (24x), allowing the inclusion of all hourly temperatures higher than the base temperature in heat summation calculation. GDH estimates heat summation much more accurately and should be used instead of GDD, especially GDDmm, when hourly temperatures are available.

Specified Source(s) of Funding: California State University Agricultural Research Institute

2:15–2:30 PM

A Comparison of Non-destructive Imaging and Destructive Load Cells for Grape Yield Estimation

Stephen T. Nuske*
Carnegie Mellon University, Pittsburgh, PA; nuske@cmu.edu
Luis Sanchez
E&J Gallo Winery, Modesto, CA; luis.sanchez@ejgallo.com

Vineyard systems are spatially and temporally variable in terms of soil and vine characteristics. However, soil and vine management decisions are applied uniformly, which leads to inefficiencies in water and nutrient use and also limits potential fruit yield and quality. The first step to enabling variable management in vineyards is to be able measure the variability.

An asterisk (*) following a name indicates the presenting author.
Many methods are available, but most are complex, expensive and feasible for just a small subsample of the vine population. Ideally measurements should be inexpensive and include the entire vineyard. We present and discuss two sensing strategies for efficiently measuring crop size variation, deployed across an 11-year-old, 10.5-ha Petite Sirah vineyard in Galt, CA. One strategy is non-destructive, using continuous images of the fruit zone of the vines taken from a farm vehicle during the growing season. The non-destructive measurements are generated from image-processing algorithms that detect and count the berries within the imagery. The second strategy is a destructive measurement as it is taken at the time the vineyard is machine-harvested, with the fruit continuously weighed by a load cell placed under the belt of the discharge conveyor. Both forms of measurement are geo-referenced, dense and high-resolution, and are processed into yield maps that capture the spatial variability in a vineyard. We compare and contrast the respective yield maps to assess the accuracy of measurements. In particular, we consider the spatial accuracy by comparing the respective yield variation patterns between the maps. We find striation patterns with large variations in yield through the vineyard, running parallel with the rows. The patterns raise a number of topics, such as the origin of the yield patterns (underlying soil variation vs. vineyard management practices) and also the question of how to sub-sample the measurements effectively to reduce the chance that unexpected yield variations are missed. We study the sub-sampling problem in detail and assess the impact of reducing the measurement density on the overall accuracy of the yield forecast.

2:30–2:45 PM

Grafted Blueberries: An Option for Mechanical Harvest?

Bruno Casamali*
University of Florida, Gainesville; bcasamali@ufl.edu

Rebecca L. Darnell
University of Florida, Gainesville; rld@ufl.edu

Jeffrey G. Williamson
University of Florida, Gainesville; jgrw@ufl.edu

Profitability of the fresh market blueberry industry in the southeastern U.S. is limited due to high production costs, which include extensive soil inputs to increase organic matter and decrease pH, as well as costs for hand-harvesting. Mechanical harvesting systems decrease production costs; however, fruit losses occur due to the multi-caned architecture of the plants. Sparkleberry (V. arboreum) is a wild species adapted to higher pH, low organic matter soils, and exhibits a single-trunk growth habit. These characteristics raise the possibility that this species may be useful as a rootstock for commercial blueberry production, increasing soil adaptation and efficiency of mechanical harvest. The objectives of this research are to evaluate yield, pack out efficiency, and berry quality of two southern highbush blueberry cultivars, grown on pine-bark amended or non-amended soils, and either hand- or mechanically-harvested. Four “genotypes” (own-rooted or grafted onto V. arboreum ‘Meadowlark’) were grown in non-amended and pine-bark amended soils. Data were collected during the 2012/2013 season. For both cultivars, own-rooted/ hand-harvested plants grown in pine-bark amended soil had the greatest marketable yield compared with all other treatments. The yield reduction of mechanically compared with hand-harvested fruit was due to harvesting of unripe and damaged berries, and ground losses. Grafted plants reduced ground loss during harvest by ~45% compared with own-rooted plants. For both cultivars, hand-harvested berries or berries from own-rooted plants had superior firmness compared with mechanically-harvested berries or berries from grafted plants. In general, mechanically-harvested berries of both cultivars had a greater SSC/TTA ratio than hand-harvested berries. Even though mechanical harvesting reduced marketable yield compared with hand harvesting, the reduced costs associated with mechanical harvesting, combined with the reduction in ground losses in mechanically-harvested grafted compared with own-rooted plants, indicate that additional research into the use of grafted blueberry as a new mechanically-harvested production system is warranted.

Specified Source(s) of Funding: USDA–SCRI Grant 2009-02533

2:45–3:00 PM

Harvest Method and Packing Line Impact on Rabbiteye [V. virgatum (syn. V. ashei)] Blueberry Cultivars Brightwell and Powder Blue

Erick Smith*
University of Georgia, Tifton; ericks@uga.edu

Renee Holland
University of Georgia, Alma; reneemh@uga.edu

In Georgia, Rabbiteye blueberry cultivars extend the harvest season by 3 to 4 weeks beyond Southern Highbush (V. corymbosum interspecific hybrids) harvest. However, rabbiteye blueberry fruit can be difficult to manage after harvest due to softening and bruising. In 2013, a study was conducted in Southeastern Georgia on fruit from ‘Brightwell’ and ‘Powder Blue’ to assess the impact of mechanical harvest and packing line on fruit quality. Fruit were harvested on 28 June from the Blueberry Research Farm in Alma, GA by either hand (HH) or machine harvest (MH), taken to a packing shed, field heat removed, and ran across a packing line the next day. Fruit were packaged in 0.5 L clamshells and either stored at 0.5°C at 85% RH or analyzed (50 fruit per treatment) for bruising (1 = 0% to 25%, 2 = 26% to 50%, 3 = 51-75%, 4 = 76% to 100%) and firmness [g/mm² (FirmTech2, Bioworks, Inc. Wamego, KS)]. Fruit were taken from storage weekly and analyzed for firmness and bruising. Fruit treatments were HH pre or post packing line and MH pre or post packing line. Though the fruit were of poor quality at harvest, the impact of packing line was significant. At harvest, ‘Brightwell’ HH, pre packing line, fruit were 32% firmer than MH fruit. When comparing HH fruit pre and post packing line, there was a 15% loss in firmness and MH fruit did not reflect an impact. Bruising was not significant for the HH fruit across the packing line; however, through storage...
bruising increased from 3 to 4. At harvest, ‘Powder Blue’ HH, pre packing line, fruit were 16% firmer then MH fruit. When comparing HH fruit pre and post packing line, there was a 26% loss in firmness and MH fruit lost 13% firmness. For both HH and MH, bruising was significant for fruit ran across the packing line: 3 to 4. Through storage, both cultivars showed no further decline in quality. This work indicates the impacts of both the mechanical harvest system and packing line can contribute to a decline in fruit quality of blueberry.

Tuesday, July 29, 2014

Local Food Systems and Human Issues in Horticulture

Moderator: Gail M. Hansen de Chapman; ghansen@ufl.edu

1:45–2:00 PM

Healthy, Local Food For All: Joining SNAP Education and Agroecology

Kelly Young*
University of Arizona, Phoenix; kyoung@arizona.edu
Traci Armstrong Florian
University of Arizona, Phoenix; tarmstro@cals.arizona.edu
Jessica Davenport
University of Arizona, Phoenix; dmdavenp@cals.arizona.edu
Marina Acosta
University of Arizona, Phoenix; marinaa@cals.arizona.edu

The local food movement is still going strong, but has not reached into every demographic. Lack of grocery stores in many communities, combined with limited public transportation makes access to locally produced fresh fruits and vegetable nearly impossible for some of the most vulnerable populations. Despite efforts, participation remains low in programs that encourage the use of federal nutrition assistance benefits to purchase fruits and vegetables at farmers markets. Gardening education offered through the University of Arizona Cooperative Extension in Maricopa County has been largely focused on Master Gardener training with some classes offered, at cost, to the general public. Until recently, there was no formal partnership between the traditional Extension horticulture programs and federally funded nutrition education programs, such as the USDA’s Supplemental Nutrition Assistance Program-Education (SNAP-Ed), which are administered by Family, Consumer and Health Science Extension programs and other community awardees. Since federal fiscal year (FY) 2011, SNAP participants can use their benefits to buy food-producing plants and seeds at approved merchant sites. And in FY2013, funding was provided through the SNAP-Education program to hire a full-time program garden coordinator to work with SNAP-eligible K-8 schools, emergency food pantries and subsidized housing projects. This new program provides gardening support to eligible sites through training, technical support, curricula, seeds, and a tool-lending program. The following year, in FY2014, as the SNAP-Ed program progressed, funding was made available to hire a full-time local food access program coordinator to increase the availability of locally produced fruits and vegetables available to SNAP participants. To increase the amount of local food being grown in Arizona, a program was implemented that supports new growers for local markets to become viable, sustainable businesses. To empower people that are interested in supporting community food projects, a series of workshops was held that explored local food systems, community organizing, fundraising and navigating policy, rules and regulations.

2:00–2:15 PM

Assessing the Strengths and Weaknesses of Polk County Food Systems Security

Mary E. Henry*
University of Florida, IFAS, Bartow, FL; mbhenry@ufl.edu
Whitney M. Fung
University of Florida IFAS, Bartow, FL; whitneymfung@ufl.edu

According to a recent survey from the Pew Research Center, Americans that have difficulty putting food on the table increased from 16% in 2007 to 24% in 2013. Communities are now reacting to various issues that affect food systems whether it involves local businesses, farmers, limited income and vulnerable populations, or families. Using USDA resources and local data, counties can assess the current situation of poverty, food insecurity, and a wealth of other factors that play a role in this issue. This presentation will discuss the current status of food security in an agriculturally robust Central Florida County with limited crop diversity. A synopsis of pertinent USDA statistics describe the need for increased food security, layered with local food infrastructure data such as access to processing facilities, to assess the potential of direct to consumer/ institution/ restaurant marketing strategies to increase food security while providing entrepreneurial small farms a profitable business opportunity. Ideas for programming and limitations will be shared as well as an overview of existing and potential partnerships to affect change and improve the overall food security picture.

2:15–2:30 PM

The EARTH (Education and Resiliency through Horticulture) Program After Four Years

Cynthia Haynes*
Iowa State University, Ames; chaynes@iastate.edu
Kevin Duerfeldt
Iowa State University, Ames; kduerf@iastate.edu

The EARTH (Education and Resiliency through Horticulture) Program is a donor funded school gardening and service learning partnership between Iowa State University (ISU), Ames, IA, and Gifft Hill School (GHS), St. John, U.S. Virgin Islands. The program was developed at a participatory planning meeting in February 2010 that included administrators, faculty, and an undergraduate student from ISU, and board members, administrators, teachers, and parents from GHS. This unique program provides opportunities to learn through experience and
An asterisk (*) following a name indicates the presenting author.

HortScience 49(9) Supplement—2014 ASHS Annual Conference  S163

interactions for both college students and youth. Since summer of 2010, ISU has sent 2-4 undergraduate students each semester to St. John to teach horticulture and environmental science to 6th-8th grade youth at GHS. Interest from other teachers has led to the expansion of the program to other grades and subjects. In addition to supervised lesson planning, instruction, and assessment, ISU students maintain edible and ornamental gardens and complete an individual legacy project. Three graduate students have been part of the EARTH Program, assisting with program administration and completing their master’s research in areas including information systems for school gardens, impact of school gardens on student attitudes and beliefs, and teacher perceptions of educational goals. Lessons learned during the first four years of the EARTH Program include: 1) Experience gained in balancing goals, perspectives, and priorities between program stakeholders. 2) Adding a summer internship for ISU students extended the season and allowed for better use of facilities. 3) Efficient use of multipurpose spaces achieves multiple program goals and incorporates community service and involvement. 4) Including entrepreneurship opportunities to teach youth important skills while providing a potential revenue stream. For example, adding chickens manages insect pests, reduces food waste, provides coop construction projects, and creates an opportunity to offer a high school youth to gain micro-enterprise experience marketing eggs. Future goals for the program begin with a second participatory strategic planning session scheduled for summer 2014. This meeting will review the programs progress and allow stakeholders to voice opinions. Discussions will include how to diversify program revenues, form stronger partnerships with local universities, and become more active in national school gardening and farm to school organizations. We will explore how to better integrate EARTH with other curricula at GHS and develop relationships with other school gardens using distance education technologies.

2:30–2:45 PM

Effects of Horticultural Therapy on Cancer Patients’ Psychological Well-being in Different Therapeutic Environments

Hui-Mei Chen
National Taiwan University, Taipei; huimeichen@ntu.edu.tw
Hung-Ming Tu*
National Taiwan University, Taipei; lovealllive@yahoo.com.tw

Cancer has topped the leading causes of death in Taiwan for the past three decades. The disease induces not only physical symptoms, but also serious psychological problems. For cancer patients, horticultural therapy with conventional therapy has been utilized to improve psychological status. Anecdotal evidence has demonstrated that contact with nature is good for human health and well-being. Horticultural therapy in therapeutic environments, such as outdoor gardens, might extend general health benefits without serious side effects. Few empirical studies, however, have reported on the effects of horticultural therapy in different therapeutic environments. The purpose of this study is to assess the psychological well-being of patients receiving horticultural therapy and compare the benefits of horticultural therapy across different therapeutic environments for cancer patients. Cancer patients from Formosa Cancer Foundation in Taiwan were invited to join a horticultural therapy program. The study examined four groups in different environments, including one control group and three experimental groups: the original indoor classroom (control), an indoor classroom with the view of a mountain photograph (experiment 1), an indoor classroom with the view of a garden photograph (experiment 2), and an outdoor garden (experiment 3). The four groups participated separately in the same six-week horticultural therapy program in different environments from 2011–13. All groups responded to pre- and post-test questionnaires. The State Anxiety Inventory was used to assess participants’ positive and negative emotions. In addition, participants were asked to write down three adjectives describing the activity environment. The results revealed that cancer patients expressed more positive emotions after the six-week horticultural therapy program in all four groups of cancer patients; also, their negative emotions decreased, except for the experiment 2 groups in an indoor classroom with the view of a garden photograph. The experiment 1 groups in an indoor classroom with the view of a mountain photograph showed the best effect of increasing positive emotions and decreasing negative emotions. Most participants in the four groups used adjectives expressing peaceful feelings to describe their activity environment, including relaxing, tranquil, comfortable, pleasant, and etc. Finally, the experiment 3 groups in the outdoor garden expressed more vital feelings than the other three groups, using such words as novel, exciting, and delightful.

Specified Source(s) of Funding: National Science Council of Taiwan

2:45–3:00 PM

An Investigation of How Perceptions of Florida-friendly Landscapes Could Influence Acceptance and Agreement Between Homeowners and Home Owner Association Boards

Gail M. Hansen de Chapman*
University of Florida, Gainesville; ghansen@ufl.edu
Laura A. Sanagorski
University of Florida, Gainesville; lsanagorski@ufl.edu
Paul F. Monaghan
University of Florida, Gainesville; paulf@ufl.edu
Esen A. Momol
University of Florida, Gainesville; eam@ufl.edu
Claire E. Lewis
University of Florida, Gainesville; clairelewis@ufl.edu
Taylor B. Clem
University of Florida, Gainesville; Taylorclem87@gmail.com

Florida-Friendly LandscapingTM (FFL) is described as “quality landscapes that conserve water, protect the environment,
are adaptable to local conditions and drought tolerant” by Fla. Stat. §373.185. FFL is promoted in 67 counties in Florida through cooperative extension educational programming. As outdoor water use accounts for 60% of residential water use, this environmentally friendly approach to landscaping can result in significant water savings. This study utilized focus group methodology to explore participant perceptions and preferences through the lens of Community-Based Social Marketing (CBSM), a method for encouraging the adoption of behaviors that are beneficial to the community. A major component in planning a CBSM campaign is in understanding the audience’s social norms and perceptions toward a behavior, including the benefits and barriers associated with its adoption. A total of six focus groups were conducted in three different areas of the state. At each location, two focus groups were conducted separately with Homeowner Association (HOA) board members and residents. A number of emergent themes have been identified. First, the researchers found a very high value placed on aesthetics by both populations under study, and discovered that these visual expectations drive many landscape practices. Additionally, the homeowners were found to be aware of the relationship between their landscaping practices and water quantity and a few mentioned the relationship between landscape practices, particularly fertilizer in stormwater runoff, and water quality. Many of the homeowners preferred a more natural look. Most agreed the landscape ordinances were fair, describing the rules as political and social issues, rather than environmental. The presence of neighborhood covenants and associations, and complaints from neighbors who dislike a certain look were identified as major barriers to homeowners implementing more environmentally sustainable landscapes. Many of the board representatives focused solely on a landscape’s aesthetic function, particularly color in the landscape, with little mention of the connection with its environmental functions, with the exception of water use. A number of the members indicated the more natural landscapes were not aesthetically pleasing, and mentioned that the look of a Florida-Friendly landscape was not well defined. Many felt that turf grass adds value to a landscape, while the natural look detracted from a property’s worth. This study’s contribution to an understanding of neighborhood perceptions and norms will allow Extension agents to create wider acceptance and understanding of the issues in residential landscape practices, with the ultimate goal of improving Florida’s water supply and quality.

Specified Source(s) of Funding: Center for Landscape Conservation and Ecology Enhancement Grant

Tuesday, July 29, 2014

3:00–3:15 PM

School Garden-based Pulse Biology and Nutrition Education to Increase Consumption of Targeted Foods in K-12 Students

Kelly A. Atterberry
Washington State University, Mount Vernon; kelly.atterberry@wsu.edu

Carol A. Miles*
Washington State University, Mount Vernon; milesc@wsu.edu

LeeAnne Riddle
Washington State University, Bellingham; lriddle@wsu.edu

Susan Kerr
Washington State University, Mount Vernon; kerrs@wsu.edu

Drew Betz
Washington State University, Bellingham; betz@wsu.edu

Janice Rueda
Wayne State University, Detroit, MI; rueda@wayne.edu

Currently in the United States, heart disease is the leading cause of death, while diabetes is seventh. Despite the evidence that pulses in the diet may reduce risks of these diseases, they are an underutilized food. Garden-based biology and nutrition education can be an effective tool for teaching K-12 students healthy eating habits which will likely be carried into adulthood. The goal of this study is to determine if garden-based education has an effect on knowledge and food choices in K-12 students. In fall 2013, a STEM-focused curriculum was created and implemented for fourth and ninth grades, and was repeated for fourth grade in spring 2014. Lessons were taught 17 Sept. to 1 Oct. in 2013 (2 schools), and 7 Mar. to 1 June in 2014 (5 schools). Lessons included planting, harvesting, and threshing dry beans in the school garden as well as hands-on activities with beans in the classroom. In Fall 2013, students who were in the classes participated in a pre- and post-education survey and a plate waste study. Results from the student survey indicate pulse biology knowledge increased 18% (fourth grade) and 38% (ninth grade), while there was an increase of 51% (fourth grade) and 8% (ninth grade) in the number of students who preferred to have more beans served in their school cafeteria. Results from the plate waste study showed a 6% increase in consumption of the bean dish by the ninth grade class that received the education, while the control group (class that did not receive education) showed a 4% increase. Due to different menu items that were served pre- and post-education for the fourth grade, the plate waste study measurements for this class were not comparable. In spring 2014, educators who observed a single fourth grade lesson completed a brief retrospective self-evaluation, and results indicated an 8% increase in confidence and a 36% increase in interest in teaching pulse biology and nutrition education in the classroom. In addition, survey participants indicated the lesson: promoted critical thinking (4.6 out of 5), fostered cooperative learning (4.6), encouraged decision making (3.6), developed sequencing/ordering skills (4.8), and strengthened problem solving skills (4.0). Overall, most teaching objectives were met in this study, and there were positive changes in students’ knowledge regarding pulse biology and nutrition, and on students’ preferences toward pulses served in school cafeterias. Additionally, there was increased interest among K-12 educators to teach pulse education.

Specified Source(s) of Funding: American Pulse Association (APA), Northwest Agriculture Research Foundation (NARF)
Measurement of SPAD values (relative chlorophyll index) gives instant, repetitive, non-destructive estimation of plant nitrogen status. A study was conducted to verify the technique in Romaine lettuce (Lactuca sativa) for the nutritional status of elements nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), sulfur (S), magnesium (Mg) and iron(Fe). The treatments consisted of N, P, K, Ca, S, Mg or Fe deprived solutions plus a control with complete modified Hoagland nutrient solution. SPAD value measurement of N, P, K, Ca, S, Mg and Fe deficient plant leaves at different stages of development, leaf position on the plant and physiological age corresponded significantly with the visual nutrient symptoms as compared to normal. The SPAD value of N deficient matured leaves and S and Fe deficient young leaves declined with the physiological age of the plant. Whereas, the SPAD value of the entire K deficient plants had higher SPAD value than normal. This may give a false indication of normal plants. Therefore, SPAD value needs to be used with caution, especially in K deficient leaves, which appeared darker green with a SPAD value in the ascending order of 35 matured < 37 young < 39 old < 45 recently matured leaves, while normal leaf tissue SPAD values were 28 young < 30 matured < 33 old < 34 recently matured leaves. Greener leaf pigmentation does not always represent healthy plant. There was no significant difference in the SPAD value at early P deficient compared to normal leaves. SPAD value could be used to monitor and manage the nutritional status of Romaine lettuce provided the measurements are specific to leaf position, area of the leaf surface and the physiological age of the leaf. Significant reduction in growth was noted in N, P, K, Ca, S, Mg and Fe deprived plants, with dry mass declined by 18%, 3%, 29%, 9%, 16%, and 17%, respectively, compared to normal.

Specified Source(s) of Funding: International Plant Nutrition Institute
Electrical conductivity (EC) is commonly used as an indicator of fertilizer levels in soilless substrates. The EC can be determined as bulk EC (bEC, the EC of the combined solid, water and air phases) and as pore water EC (pwEC, the EC of the solution in the substrate). Since pwEC represents the EC of the solution that roots are exposed to, this measurement is more relevant for crop production. In situ EC sensors can simplify EC measurements and allow for continuous monitoring of substrate fertility level over time. However, these sensors generally determine bEC. Hilhorst developed a model to estimate pwEC from bEC and dielectric permittivity ($\varepsilon_b$, directly related to substrate volumetric water content (VWC)). One of the parameters in the Hilhorst model is the permittivity of dry soil/substrate ($e'\sigma_b = 0$), which is assumed to be similar for different soils/substrates. However, $e'\sigma_b = 0$ may depend on the dielectric properties of the substrate and the measurement frequency of the dielectric sensor. Our objective was to determine $e'\sigma_b = 0$ using four different sensors to optimize pwEC measurements in two soilless substrates (peat:perlite and peat:vermiculite). We collected data in both substrates, using a wide range of substrate VWC (0.22 to 0.55 m$^3$) and three different fertilizer levels (0.5, 1.5, and 2.5 g·L$^{-1}$) to get a broad range of pwEC values. Substrate temperature, $\varepsilon_b$, and bEC were measured with four different sensors (GS-3, Decagon Devices; HydraProbe II, Stevens Water Monitoring Systems; SigmaProbe and WET-2, Delta-T). A small amount of substrate solution was subsequently sampled using a juice press and the EC of this solution was measured. The solution EC was assumed to represent pwEC. These data were used to back solve the Hilhorst equation to calculate $e'\sigma_b = 0$. We found that $e'\sigma_b = 0$ is not a constant and depends on $\varepsilon_b$, bEC, and their interaction. The value of $e'\sigma_b = 0$ also differed among sensors and substrates. More accurate estimates of $e'\sigma_b = 0$ can result in more accurate pwEC measurements. However, the accuracy of pwEC measurements still needs to be evaluated with an independent data set. Accurate pwEC measurements could be used to help guide fertilization decisions and potentially for automated fertigation control.

Specified Source(s) of Funding: Funding for this research was provided by USDA-NIFA-SCRI (award no. 2009-51181-05768) and CAPES Foundation–Ministry of Education, Brazil (BEX 2620/13-8).

2:30–2:45 PM

**Leaf Growth and Nutrient Element Uptake by Adventitious Roots of Collards in Hydroponic Solution of Variable Composition**

Jonathan N. Egilla*
Lincoln University, Jefferson City, MO; egillaj@lincoln.edu

Rose Ogutu
Delaware State University, Dover; rogutu@desu.edu

Isabelle Nyirakabibi
Lincoln University, Jefferson City, MO; Nyirai@lincoln.edu

With proper sanitation and growth rejuvenation, collards may be maintained in hydroponic culture for nine to twelve months for repeated leaf harvesting, thereby reducing the frequency of starting new crops from seed, and thus avoiding the longer lag time from seedling establishment to first harvest. Growth rejuvenation involves induction of adventitious roots on stems by carefully timed root pruning. Leaf growth and leaf macronutrient and micronutrient uptake of collards (Brassica oleracea var. Acephala ‘Champion’) was determined at 42 days after root pruning 77-day old seedling plants. Root pruned plants were established in Nutrient Film Technique (NFT) hydroponic culture with three sources of nutrient solution (15N-2.2P-12.5K [F1]; 15N-7.0P-14.1K [F2]; and 20N-8.7P-16.6K [F3]). All nutrient sources supplied 200 mg nitrogen (N) per liter plus micronutrients. The ratios of nitrate (NO3$^-$-N) to ammonium (NH4$^+$-N) and Urea-N were 3.63:1, 1.54:1 and 0.43:1 for F1, F2, and F3; and the Urea-N content were 2.05, 2.60 and 10.10% of the total N supply, respectively. Whereas F1 contained 66.7 mg calcium (Ca) per liter, F2 and F3 had no Ca. The rate of adventitious root growth was highest with F1 and lowest with F3. Marketable yield of young fully expanded leaves (leaf count [LC], fresh weight [LFW]) were significantly affected by nutrient source (F1 > F3 > F2; P ≤ 0.002). With F1, leaf N and phosphorus (P) were within the sufficiency range for collards while potassium (K) and Ca were below the lower limit of the sufficiency range. Leaves have sufficient levels of magnesium (Mg) and sulfur (S), regardless of nutrient source. Leaf macronutrient content was highest with F1, which promoted higher leaf growth than either F2 or F3. With the exception of iron (Fe), leaf micronutrients were above the lower limit of the sufficiency range. Across nutrient source, LFW and LDW were positively correlated with N, P, K, Fe and manganese ([Mn]; R ≥ 0.5707, R$^2$ ≥ 0.3141; P < 0.0001), but negatively correlated with leaf aluminum (Al) content (R = -0.5383, R$^2$ = -0.5106; P < 0.0001). These observations suggests that leaf growth was limited by lower N, P, K, Ca and Fe in F2 and F3 plants, due to reduced growth of adventitious roots compared with F1. Subsequent experiments will further assess the effect of low Ca as well as high NH4$^+$-N and Urea-N to NO3$^-$-N ratio on adventitious root growth of collards.

Specified Source(s) of Funding: NIFA Project No. MOLU-HYDROPONICS-05. Lincoln University of Missouri.

2:45–3:00 PM

**Determining Variability within Leaf Analysis and Reflectance Sensor Sampling Methods**

Bruce L. Dunn*
Oklahoma State University, Stillwater; bruce.dunn@okstate.edu

Stephen Stanphill
Oklahoma State University, Stillwater; stephen.stanphill@okstate.edu

Carla Goad
Oklahoma State University, Stillwater; carla.goad@okstate.edu

Leaf nitrogen concentration (LNC) has been correlated with Soil Analysis Plant Development (SPAD) and atLEAF chlorophyll
Boron and Salinity Stress Interaction and Effects on Grafted and Ungrafted Tomato Plants

Francesco Di Gioia
Università degli Studi di Bari ‘Aldo Moro’, Bari; francesco.digioia@unicas.it

Donato Buttaro
CNR-National Research Council of Italy, Bari; donato.buttaro@ispa.cnr.it

Angelo Signore
Università degli Studi di Bari ‘Aldo Moro’, Bari; angelo.signore@uniba.it

Boron toxicity represents one of the most feared abiotic stresses limiting vegetable production in certain coastal areas of the Mediterranean Basin and it is often associated to salinity stress. A greenhouse experiment was carried to evaluate the effects of boron and salinity excess on growth, yield and fruit quality performance of tomato (Solanum lycopersicum L.) plants cv ‘Ikram’, ungrafted or grafted onto interspecific tomato hybrid rootstocks (S. lycopersicum × S. habrochaites) ‘Arnold’ and ‘Big Power’. Grafted and ungrafted plants were grown in pots containing perlite and fertigated with drip irrigation with a complete nutrient solutions containing: a standard boron level (25 µM B), an excess of boron (925 µM B) or a combined excess of boron and NaCl (925 µM B and 30 mM NaCl). Growth analysis, 30 days after treatments differentiation, revealed that in presence of 925 µM of B grafted plants produced, on average, a leaf area and a shoot fresh and dry biomass 62.5%, 66.0%, 40.7%, and 29.8% higher than that of ungrafted plants, respectively. Under combined boron and salinity excess, grafted plants leaf area, fresh and dry shoot weight resulted to be on average 29.5%, 40.7%, and 29.8% higher than that of ungrafted plants, respectively. On average, plant analyses showed that boron content in bottom and apical leaves resulted to be 40% and 71% lower, respectively, in plants grown with the combined excess of boron and salinity compared to those grown under boron excess. Grafted plants showed a lower leaf boron content as compared to ungrafted ones, when subject to a combined excess of boron and salinity, either in bottom (about 30%, on average) and apical (about 22%, on average) leaves. While in presence of boron excess, only plants grafted onto ‘Arnold’ showed a lower leaf boron content with respect to ungrafted plants either in bottom (39%) and apical (47%) leaves. In terms of yield, the excess of boron and the combined excess of boron and salinity caused on average a fruit yield reduction of 50 and 70%, respectively, as compared to plants nourished with the control nutrient solution. Grafted plants produced on average 30% more than ungrafted ones. Fruit quality was positively influenced by the salinity stress, while was not affected by boron excess or by grafting. In conclusion, grafting can improve tomato tolerance to boron excess and to the combined excess of boron and salinity by reducing leaf boron content and enhancing plant growth and productivity.

Specified Source(s) of Funding: The research was funded by MIUR-PRIN 2007 and 2009 (Ministry of Education, University and Research, Italy, Project: “Vegetable grafting: Biophysical basis, effects on crop and product quality.”
Tuesday, July 29, 2014

**Genetics and Germplasm 2**
Moderator: German Sandoya; gsandoya@ucdavis.edu

**2:00–2:15 PM**

**Construction of SSR Profile Database for Cultivar Identification of Apple and Their Applicability to Distinctness Examination in Korea**

Jee-Hwa Hong*
Korea Seed & Variety Service, Suwon; hongjh19@korea.kr
Yong-Sham Kwon
Korea Seed & Variety Service, Suwon; yskwon3@korea.kr
Keun-Jin Choi
National Institute of Horticultural & Herbal Science, Suwon; kjchoi1001@korea.kr

Apple (*Malus × domestica* Borkh.) belongs to the genus *Malus* of Rosaceae family. Forty apple cultivars have been registered at the Korea Seed & Variety Service for Plant Variety Protection. Molecular markers have many advantages for cultivar identification due to their independence from environmental influences. We employed 305 simple sequence repeat (SSR) primers to use for cultivar identification of apple. Of the 305 primer pairs, 57 SSR markers showed polymorphism in 8 cultivars. Among the 57 SSR markers, 29 SSR markers were observed reproducibility and band clearance. We constructed SSR profile database containing 67 cultivars using capillary electrophoresis system. Totally 207 polymorphic amplified fragments were obtained using 29 SSR markers. Two to twelve SSR alleles were detected for each locus with an average of 7.14 alleles per locus. Average polymorphism information content (PIC) was 0.656, ranging from 0.354 to 0.847. Genetic distance of clusters ranged from 0.19 to 1.00 by unweighted pair-group method with arithmetical average (UPGMA) based on Jaccard’s distance coefficients. A total of 45 cultivars were discriminated by 29 SSR marker genotypes. These SSR markers were used to examine distinctness of candidate cultivars using genetic relationship between existing and candidate cultivars. The most similar cultivar to the candidate cultivar will be used as a comparative cultivar or for the close distinctness examination of candidate cultivars.

**2:15–2:30 PM**

**A Comparison of Genome-wide SNP Markers in Octoploid Strawberry Between the Affymetrix IStraw90 Axiom® Array and a Targeted Sequencing Approach**

Sujeet Verma*
University of Florida, Wimuana, FL; sujeet.verma@ufl.edu
Marcio Resende
RAPiD Genomics, Gainesville; mresende@rapid-genomics.com
Matias Kirst
University of Florida, Gainesville; mkirst@ufl.edu

Cultivated strawberry is an allo-octoploid in the Rosaceae. Strawberry breeders are interested in using marker-assisted selection for genetic enrichment of current breeding germplasm, but the complexities of the octoploid genome create various challenges. Single nucleotide polymorphism (SNP) markers are abundantly available in plant genomes, and high-resolution, polymorphic and sub-genome specific SNPs markers are highly desirable to identify allelic variation for robust marker-locus-trait associations. Recent development of the first genome-wide array-based scanning platform, Axiom IStraw90®, for octoploid strawberry, enabled sub-genome specific genotyping of 25 individuals that were also genotyped by a targeted sequencing (TS) approach at University of Florida (UF), Gainesville. These individuals included a small University of Florida, Fort Pierce mapping population and UF breeding materials (cultivars, selections and founders). A preliminary comparison was made between these two techniques for several parameters including genomic coverage, polymorphism, genotype frequencies, marker density, minor allele frequencies and polymorphism information content (PIC). Sub-genome specific alleles (A/B format) from the IStraw90 Axiom® array and alleles (A/T/G/C format) from TS approach were present in different combinations among these 25 individuals. Both methods had similar genomic coverage and marker density appeared higher in the TS approach. Future work will use a larger number of array-based SNPs and determine sub-genome specificity of SNP markers of the TS approach using more pedigree-linked individuals and higher genome coverage.

Specified Source(s) of Funding: Gulf Coast Research and Education Center, University of Florida

**2:30–2:45 PM**

**A Comparative Genetic Diversity Analysis of Big-bracted Dogwoods**

Robert Mattera*
Rutgers University, New Brunswick, NJ; robertmattera343@gmail.com
Josh Honig
Rutgers University, New Brunswick, NJ; honig@aesop.rutgers.edu
Jennifer Vaiciunas
Rutgers University, New Brunswick, NJ; vaiciunas@aesop.rutgers.edu
John M. Capik
Rutgers University, New Brunswick, NJ; capik@aesop.rutgers.edu
Thomas J. Molnar
Rutgers University, New Brunswick, NJ; molnar@aesop.rutgers.edu

An asterisk (*) following a name indicates the presenting author.
The big-bracted dogwoods (Cornus sp.) are a group of popular woody ornamental trees. There are hundreds of named cultivars spanning C. florida, C. kousa, and C. nuttallii, as well as interspecific hybrids between the three. Rutgers University has had an active dogwood breeding program for over 40 years, releasing 14 cultivars, and is home to a large germplasm collection holding many advanced-generation, interspecific hybrids. The purpose of this study was to analyze the genetic diversity and relationships of 100 commonly available cultivars and 230 interspecific hybrid breeding selections held in the Rutgers germplasm collection in addition to confirming pedigree records and identifying possible male parents of seedlings derived from open pollination. Twenty simple sequence repeat markers were amplified and used to fingerprint each accession. Peaks were scored using GeneMapper v5. The data obtained were inputted into the cluster analysis program NTSYSpc to generate a UPGMA dendrogram that depicts the relationships between samples. A Bayesian population analysis was also obtained. A discussion of the results, including implications for future dogwood breeding efforts, will be presented.

Specified Source(s) of Funding: New Jersey Agricultural Experiment Station, the Rutgers Center for Turfgrass Science, Hatch funds provided by USDA-NIFA

2:45–3:00 PM

**Autopolyploid Induced Sterility in the African Tulip Tree (Spathodea campanulata)**

Ken W. Leonhardt*

University of Hawaii, Honolulu; leonhard@hawaii.edu

The African tulip tree (Spathodea campanulata, Bignoniaceae) is a West African evergreen tree that has been introduced throughout the tropics as an attractive landscape species and has become an invasive pest in managed and natural ecosystems in Hawaii, the Cook Islands, Fiji, Guam, Samoa, Tahiti, and Vanuatu due to its prolific production of light-weight, wind-dispersed seeds. A sterile, non-seeding form of this species would be desirable for landscape purposes. Since a triploid (3N) plant, the progeny of a tetraploid (4N) crossed to a diploid (2N) would likely be sterile, attempts were made to first create a tetraploid plant by treating meristems of diploid seedlings with solutions of colchicine. Tetraploid and mixoploid (2N and 4N tissues) plants were created. Ploidy increase was verified by guard cell measurements and flow cytometry. One mixoploid plant has shown a high level of sterility, having produced over 100 inflorescences in the past three years resulting in just a single fruit, while control plants produce 6 to 10 fruits per inflorescence.

3:00–3:15 PM

**Morphological and Physio-chemical Characterization of Five Canistel Accessions at the Subtropical Horticulture Research Station in Miami Florida**

Hamide Gubbuk*

Akdeniz University, Antalya; gubbuk@akdeniz.edu.tr

An asterisk (*) following a name indicates the presenting author.
Citrus Canker and Huanglongbing Diseases

Production of Transgenic Citrus Resistant to Citrus Canker and Huanglongbing Diseases

Guixia Hao*
USDA–ARS, Ft. Pierce, FL; guixia.hao@ars.usda.gov

Ed Stover
U.S. Horticultural Research Laboratory, USDA–ARS, Ft. Pierce, FL; ed.stover@ars.usda.gov

Y-P Duan
USDA–ARS, Ft. Pierce; yongping.duan@ars.usda.gov

Goutam Gupta
Los Alamos National Lab, Los Alamos, NM; gxg@lanl.gov

Huanglongbing (HLB or citrus greening disease) caused by Candidatus Liberibacter asiaticus (Las) is a great threat to the U.S. citrus industry. There are no proven strategies to eliminate HLB disease and no cultivars identified with strong HLB resistance. Citrus canker is also an economically important disease associated with a bacterial pathogen (Xanthomonas citri). As part of the USDA citrus breeding program we are trying to develop citrus resistant to both HLB and citrus canker through expression of antimicrobial peptides (AMPs). In grape, enhanced Xylella fastidiosa resistance was reported from expression of a chimeral AMP-peptide (comprised of an AMP and a peptide with high bacterial membrane affinity) vs. the AMP alone. Our study is being conducted with the AMP D4E1, a plant thionin, and a chimeric AMP composed of D4E1 linked to thionin. We generated transgenic Carrizo and Hamlin with each of these constructs through Agrobacterium-mediated transformation. So far we have obtained verified transformants of 26 Carrizo and 10 Hamlin with chimeric AMP insertion, 28 Carrizo and 10 Hamlin with thionin, and 20 Carrizo and 20 Hamlin with D4E1 insertion. Gene expression was confirmed by reverse transcriptase PCR (RT-PCR) in some transgenic lines. Transgenic Carrizo lines containing these constructs were infiltrated with X. citri strain 3213. Several transgenic lines expressing the chimeric AMP/thionin showed marked canker resistance. Through 30 days after infiltration, some transformants have shown no canker symptoms with low but detectable levels of X. citri. These promising transgenic plants have been replicated and will be tested for HLB resistance.

Specified Source(s) of Funding: CRDF
field under high inoculum pressure for 3 years have consistently tested negative for the presence of the bacterium. Our results suggest that the NPR1 gene could potentially provide enhanced tolerance to HLB. These transgenic lines can potentially also provide tolerance to other diseases affecting citrus.

3:45–4:00 PM
RNA Interference Provides High-level, Stable Resistance to Plum Pox Virus
Michel Ravelonandro
INRA, Bordeaux; Michel.ravelonandro@bordeaux.inra.fr
Ralph Scorza*
USDA-ARS, Appalachian Fruit Research Station, Kearneysville, WV; Ralph.Scorza@ars.usda.gov

Plum transformed with an intron hairpin RNA CP (ihpRNA-CP) was resistant to PPV infection through RNA silencing involving both small interfering RNA (siRNA) and a methylated virus transgene. Silencing specifically targeted the PPV genome and led to the degradation of viral RNA in the model plant species Nicotiana benthamiana and the natural Prunus domestica host. Plums inoculated with the major PPV strains, 3 widespread PPV strains (D, M, and Rec), and the atypical EA strain did not allow systemic spread of PPV in greenhouse-grown transgenic ihpRNA-CP plum over multiple cycles of vegetative growth and cold-induced dormancy. PPV ihRNA-CP N. benthamiana displayed an immunity reaction and also allowed for the testing of PPV-C, a strain that can infect cherry species but was unable to infect P. domestica. This stable resistance demonstrated in plum based on the accumulation of siRNA can prevent PPV infection and can also act as a “curative” when PPV is inoculated through graft inoculation. Regardless of PPV strain variability based on geography, host species, epidemiology, serotypes of the CP protein, and substitutions of nucleotides at the NH2-terminus of CP of the PPV strains tested, we show that the use of a PPV-CP intron hairpin (ihp) RNA is an effective strategy to specifically target the PPV genome. We provide methods and tools that demonstrate a reliable path toward developing PPV resistance suitable for protecting stone fruit orchards.

4:00–4:15 PM
Identification of Candidate Genes Associated with X-disease Resistance in Chokecherry (Prunus virginiana L.) through Comparative Genomics
Yinghai Liang*
Jilin Academy of Agricultural Sciences of China, Gong Zhuling; Yinghai.liang@ndsu.edu
Danqiong Huang
North Dakota State University, Fargo; danqiong.huang@ndsu.edu
Wenhao Dai
North Dakota State University, Fargo; wenhao.dai@ndsu.edu

Recent advances in sequencing technology accelerate the completion of whole genome sequencing for a few model species; however, whole genome sequences of many other species still remain unsequenced including chokecherry, a unique Prunus species for both genetics and disease resistance research due to its tetraploid nature and known-variations in disease resistance (a destructive disease of stone fruit trees). One quantitative trait locus (QTL) located on a genetic linkage group of chokecherry was recently detected to be associated with X-disease resistance. In this study, the DNA walking strategy was used to extend, clone, and sequence the flanking regions of the identified SSR marker linked to X-disease resistance. A total of 4748 bp chokecherry DNA sequence that includes the SSR marker was sequenced. As a query sequence, the 4748 bp DNA was aligned with the whole genome sequence of peach (Prunus persica) using BLASTN (http://www.phytozome.net/search.php). One sequence in feature 1 in scaffold 2 in peach genome showed a high similarity (90.5% identity percentage and E-value = 0) with the chokecherry sequence among 14 identified scaffolds. The target region (homologous to 4748 chokecherry DNA) on scaffold 2 was extended to 400 kb (200 kb of each direction) as a candidate region for further analysis. Twenty-eight transcripts were identified in this region. Functional annotation was conducted through Pfam, gene ontology (GO) terms, and Kyoto Encyclopedia of Genes and Genomes (KEGG). Seventeen (of 28) transcripts showed function annotation information. Of which, seven transcripts code plant transposase, one codes protein kinase with serine/threonine/tyrosine kinase (STYKc) domain and leucine rich repeat (LRR) domain, one codes plant transposase, and others involve in coding of zinc finger protein, pentatricopeptide repeat protein, and short chain dehydrogenase protein. Determination of functions and structures of potential resistance (R) genes in this region are underway. Identification of candidate genes/regions will certainly open perspectives for plant molecular breeding.

4:15–4:30 PM
Engineering Tolerance to the Diaprepes Root Weevil (Diaprepes abbreviates L.) through Expression of the Snowdrop Lectin (Galanthus nivalis agglutinin; GNA) in Citrus
Manjul Dutt*
University of Florida, Lake Alfred; manjul@ufl.edu
Raquel Campos-Herrera
University of Neuchâtel, Neuchâtel
Fahiem El-Borai
University of Florida, Lake Alfred; fahiem@ufl.edu
Larry Duncan
University of Florida, Lake Alfred; N/A
Jude Grosser
University of Florida, Lake Alfred; jgrosser@ufl.edu

Diaprepes abbreviates is a major pest of citrus in Florida. This weevil has a wide host range and in addition to citrus can feed on many ornamental plants and other economically important crops such as corn, sweet potato and sugarcane. In citrus, the larvae feed on the roots, girdling the structural roots and prevent-
plants succumbed to fungal diseases within the same growth and development. Conversely, most non-transformed control showed outstanding resistance to a range of major fungal diseases under field conditions, the selected lines containing VvPR1 also relatively little infection, suggesting a high level of resistance. Whereas over 90% of VvPR1-expressing plant lines displayed controls developed moderate to severe powdery mildew infection, non-transformed any significantly lowered number of P. syringae colonies compared to control plants, suggesting that VvPR1 genes are also capable of conferring antibacterial activity. Our findings demonstrate the potential of this class of genes in the development of improved grapevine via Precision Breeding.

Specified Source(s) of Funding: the Florida Department of Agriculture and Consumer Services’ Viticulture Trust Fund and the USDA/NIFA Specialty Crops Research Initiative.

Tuesday, July 29, 2014
Marketing and Economics 1
Moderator: John Majsztrik; jcmajsz@umd.edu
5:00–5:15 PM
Queens (Crowns) & Characters—Using State Partners in Programs
Karen M. Stauderman*
University of Florida, DeLand; kstauderman@ufl.edu

There is a need to build alliances with state and national organizations with extension programs. Farmer’s Market events are great opportunities to strengthen these partnerships. UF/IFAS Extension is committed to promoting Florida commodities, marketing ideas and resources from our state partners. UF/IFAS Extension along with Volusia County Farm Bureau joined forces to create four seasonal celebrative events in Volusia County that aimed at directing consumers to identify state ambassadors that promote Florida commodities. The success of these events was a measure of media coverage and cooperation from our partners on Volusia County Citrus Day, Volusia County Watermelon Day and Strawberry Celebration. Additionally, it was to highlight the state Mascots ‘Jammer’, ‘Captain Citrus’, ‘J-Slice’ and both the Florida and National Watermelon Queens. These mascots and spokespeople promote national and Florida fruits including strawberries, watermelons and citrus. Agents worked with media publishing articles in local magazines and newspapers, web sites, newsletters along with television and radio interviews and air time coverage. As a result of these events, stakeholders remained committed to another year in partnership. Under current budgeting cuts, state associations benefited by the educational opportunity and media exposure. As a direct result of these events, the stakeholders, Florida Strawberry Growers Association (FSGA), Florida Citrus Association, Florida Watermelon Association, and the National Watermelon Association all remain committed to another year of participation. New state and regional partners Florida Farm Bureau, the Florida Strawberry Festival have offered to col-

---

An asterisk (*) following a name indicates the presenting author.
laborate as future partners for continued success.

5:15–5:30 PM

**How Much Are Ornamental Growers Willing to Pay for Irrigation Technology?**

John Majsztrik*
University of Maryland, Laurel; jcmajsz@umd.edu

Erik Lichtenberg
University of Maryland, College Park; elichten@umd.edu

Monica Saavoss
University of Maryland, College Park; msaavedr@umd.edu

Agricultural water use typically accounts for 80% or more of consumptive water use, and up to 90% of water use in many western states. Population growth, changing rainfall patterns, and drought will continue to stress the relationship between water for agriculture and domestic uses. One way to reduce agricultural consumption is through increasing water application and uptake efficiency through better irrigation management practices. Scheduling irrigation in ornamental operations is often based on past experience and qualitative information (container weight, plant or substrate appearance, etc.) that a grower gathers. Wireless Sensor Irrigation Networks (WSIN) have been shown to provide accurate, quantitative, real-time monitoring and control of moisture status which, in on farm trials, has reduced irrigation costs, lowered plant loss rates, shortened production times, and decreased pesticide application, while increasing yield, quality, and profit. An original survey was used to investigate grower perceptions of WSIN and determine likely initial acceptance, ceiling adoption rates, and profitability of this technology in the nursery and greenhouse industry. Adoption rates for a base system and demand for expansion components were found to decrease with increasing price, as was expected. Our estimates indicate that the overall adoption rate of WSIN is likely going to be higher than other forms of precision irrigation (e.g. drip). The estimated price sensitivity of a grower’s willingness to adopt this technology suggests that diffusion will occur more quickly than drip irrigation. Our estimates suggest that this technology will have the greatest appeal for growers who specialize in ornamental production. Growers earning greater shares of income from ornamental production were willing to pay more for a base system and purchase a larger number of expansion components. We estimated that growers who were willing to purchase additional nodes expect investment in this technology to earn significant profit, which is consistent with findings from experimental studies.

Specified Source(s) of Funding: USDA–NIFA SCRI Award #2009-51181-05768

5:30–5:45 PM

**Public Benefits of Wireless Sensor Irrigation Network Adoption**

John Majsztrik*
University of Maryland, Laurel; jcmajsz@umd.edu

Dennis King
University of Maryland, Solomons; dking@umces.edu

Elizabeth Price
University of Maryland, Solomons; eprice@umces.edu

Using wireless sensor irrigation networks (WSIN) in ornamental production has been shown to result in many benefits for growers, including water savings, reduced production times, improved plant quality, and reduced plant losses. These on-farm benefits increase profitability, and potential adoption rates. Higher adoption rates and efficiency gains through use of WSIN should also lead to public benefits through reduced environmental impacts. Since this technology is relatively new, public benefits could not be measured directly and therefore had to be estimated. Benefit estimates are based on results from on-farm research conducted during the project period, combined with publicly available state and regional information. Reductions in water use and air and water emissions for six U.S. agricultural regions, the U.S. overall, and the six states that make up the Chesapeake Bay watershed were calculated. Assuming an average adoption rate of 50% in ornamental operations, estimated impacts included annual water savings of about 223 billion litres (the equivalent of 400,000 U.S. households annually). Reductions in annual carbon dioxide (CO2) emissions associated only with the reduced energy use from pumping less water, resulted in cutting 36,232 Mg of CO2 (equivalent to removing 7,500 cars annually). Reduced fertilizer applications and more efficient irrigation also resulted in emission reductions of 282,000 kg nitrogen and 182,000 kg phosphorous, while maintaining plant nutrient uptake. These contributions to water and air quality were achieved in ways that generate significant profits for growers, but would cost hundreds of thousands of dollars to achieve using conventional urban or agricultural best management practices (i.e. wastewater treatment plant upgrades). If WSIN technologies are adopted in other areas of specialty horticulture (e.g., fruit, vegetable and nut production) or in agronomic crops [i.e. corn (*Zea mays*) and wheat (*Triticum* sp.),] the indirect and induced private and environmental benefits are likely to be significantly higher. Overall, WSIN have the potential to improve production efficiency and increase profitability, while also decreasing water, nutrient application and runoff rates, and reducing air emissions.

Specified Source(s) of Funding: USDA–NIFA SCRI Award #2009-51181-05768

5:45–6:00 PM

**The Relationship Between Costs and the Carbon Footprint of Flowering Trees and Shrubs**

Dewayne L. Ingram*
University of Kentucky, Lexington; dingram@uky.edu

Charles R. Hall
Texas A&M University, College Station; c-hall@tamu.edu

University researchers have recently quantified the value of carbon sequestration provided by landscape trees (Ingram, 2012; Ingram, 2013). However, no study to date has captured the economic costs of component horticultural systems while...
conducting a life cycle assessment of any green industry product. This study attempts to fill that void. The nursery production system modeled in this study was a field-grown, 5-cm (2 in) caliper Cercis canadensis ‘Forest Pansy’ in the Lower Midwest. Partial budgeting modeling procedures were also used to measure the sensitivity of related costs and potential benefits associated with short-run changes in cultural practices in the production systems analyzed (e.g. transport distance, postharvest activities, fertilization rates, and plant mortality). Total variable costs for the seedling and liner stages combined amounted to $2.93 per liner, including $1.92 per liner for labor, $0.73 for materials, and $0.27 per liner for equipment use. The Global Warming Potential (GWP) associated with the seedling and liner stages combined included 0.3123 kg of carbon dioxide equivalents (CO2e) for materials and 0.2228 kg CO2e for equipment use. Total farm-gate variable costs (the seedling, liner, and field production phases combined) amounted to $37.74 per marketable tree, comprised of $9.90 for labor, $21.11 for materials, and $6.73 for equipment use, respectively. However, postharvest costs (e.g. transportation, transplanting, take-down, and disposal costs) added another $33.78 in labor costs and $27.08 in equipment costs to the farm-gate cost, yielding a total cost from seedling to end of tree life of $98.60. Of this, $43.68 was spent on labor, $21.11 spent on materials, and $33.81 spent on equipment use during the life cycle of each marketable tree. As per an earlier study, the life-cycle GWP of the described redbud tree, including GHG emissions during production, transport, transplanting, take-down, and disposal would be a negative 63 kg CO2e (Ingram et al., 2012). These combined data can be used to communicate to the consuming public the true (positive) value of trees in the landscape.

Specified Source(s) of Funding: Horticultural Research Institute

Wednesday, July 30, 2014

Impact of Consumers’ Visual Attention to Product Attributes on their Willingness-to-pay for Apple Juice

Alicia L. Rihn*
University of Minnesota, St. Paul; recka008@umn.edu
Chengyan Yue
University of Minnesota, St. Paul; yuechy@umn.edu

Consumers are exposed to a large amount of visual stimuli while they are making their purchasing decisions. Determining what product attributes are visually noticed and impact purchasing decisions is challenging. Eye-tracking and experimental auctions were conducted to estimate consumer willingness-to-pay (WTP) for different apple juice attributes. Attributes included production methods (organic, “all natural”) and origin (local, domestic, import). Tobit models were used to analyze the data. The analysis of eye-tracking data allowed researchers to relate consumers’ visual search behavior with their WTP bids for the products. We found consumers’ visual attention increases for important or complex product attributes that positively or negatively affect their WTP bids. Participants who fixate more on the organic logo or “all natural” are willing to pay more for apple juice. Conversely, participants who fixate more on imported apple juice are willing to pay less for apple juice. Consumers’ socio-demographics impact their WTP bids and visual attention to product attributes. We conclude retailers could use in-store marketing strategies to improve the visibility of attributes that improve consumers’ WTP.

Specified Source(s) of Funding: UMN GIA

Wednesday, July 30, 2014

Citrus Crops

Moderator: YongPing Duan; yongping.duan@ars.usda.gov

Development of Molecular Markers for Mandarin Flavors and Colors Using a High-throughput Goldengate Assay

Yuan Yu*
University of Florida, IFAS-Horticultural Sciences, Lake Alfred; ymmzyz@ufl.edu
Chunxian Chen
USDA–ARS, SEFTNRL, Byron, GA; Chunxian.Chen@ars.usda.gov
Jinhe Bai
USDA–ARS, USHRL, Fort Pierce, FL; Jinhe.Bai@ars.usda.gov
Anne Plotto
USDA–ARS, USHRL, Fort Pierce, FL; anne.plotto@ars.usda.gov
Elizabeth Baldwin
USDA–ARS, USHRL, Fort Pierce, FL; Liz.Baldwin@ars.usda.gov
Fred Gmitter
University of Florida, IFAS-CREC, Lake Alfred; fgmitter@ufl.edu

Consumer awareness of health benefits of phytonutrients such as carotenoids in citrus fruits is increasingly becoming a driver in consumer purchases. Volatile aromatics and carotenoids are the two major interrelated chemical components that determine citrus fruit flavors and colors. Improvement in seedlessness, flavor and color ranks high among the prioritized breeding goals for mandarin (Citrus reticulata Blanco). Given long seedling juvenility, large tree size, and associated costs in citrus breeding, trait-associated marker development and marker-assisted selection could potentially lead to a more expeditious and economical approach to these challenges. The objectives of this project were to construct high-density mandarin genetic maps and to identify single nucleotide polymorphism (SNP) markers associated with fruit flavors, colors, as well as other fruit quality traits, using an Illumina GoldenGate assay containing 1,536 BAC end sequence-associated SNPs and a population of 116 ‘Fortune’ × ‘Murcott’ University of Florida, Fort Pierce hybrids generated in the University of Florida Citrus Research and Education Center (UF-CREC) breeding program. These fruit quality traits, including fruit size and weight, seed number, juice percentage, flavedo and juice colors, sugar and acids, and juice

An asterisk (*) following a name indicates the presenting author.
flavors, were investigated in 2011 and 2012 harvest season. The integrated mandarin genetic map consisted of 752 SNPs on 380 marker sites, spanning 1306 cM on nine linkage groups. The SNPs sequences were blasted and aligned to the Clementine genome, and most genome sequences showed high identities between these mandarin hybrids and Clementine. The coverage of the integrated genetic map on the Clementine genome varied among nine scaffolds from 82% of scaffold 2 to 98.8% of scaffold 4. A total of 42 QTLs were identified, with 18 of them being stable over samplings and mapped as major QTLs. Multiple QTLs in a genome region on linkage group 4 were detected for flavedo color space value L, a, b, a/b, and juice color space value a, a/b through samplings. Carotenoid biosynthetic pathway genes pds1 and ccd4 were found within this genome region. Identification of QTLs for flavors is in process. QTLs are being validated in other mandarins. Several candidate genes are being under analysis.

8:15–8:30 AM

Thermotherapy and the Molecular Mechanism Behind the Success of Heat Treatment for the Control of Citrus Huanglongbing

Melissa Doud
USDA–ARS USHRL, Fort Pierce, FL; melissa.doud@ars.usda.gov

Feng Luo
Clemson University, Clemson, SC; luofeng@clemson.edu

Yunsheng Wang
Clemson University, Clemson, SC; yunshew@clemson.edu

Lijuan Zhou
USDA–ARS USHRL, Fort Pierce, FL; ljzhou2011@gmail.com

Ed Stover
USDA–ARS USHRL, Fort Pierce, FL; ed.stover@ars.usda.gov

YongPing Duan*
USDA–ARS USHRL, Fort Pierce, FL; yongping.duan@ars.usda.gov

Huanglongbing (HLB), a systemic and destructive disease of citrus, is associated with three species of α-proteobacteria, ‘Candidatus Liberibacter asiaticus’ (Las), ‘Ca. L. africanus’ and ‘Ca. L. americanus’. Previous studies have found distinct variations in temperature sensitivity and tolerance among these species. Las, the most prevalent and heat-tolerant species, can thrive at temperatures as high as 35 °C. Our earlier work has shown that Las bacteria in potted HLB-affected citrus were significantly reduced and often eliminated when exposed to continuous temperatures of 40°C to 42 °C for a minimum of 48 hours. To determine the feasibility and effectiveness of thermotherapy in the field, portable greenhouses were placed over commercial and dooryard citrus to achieve therapeutic temperatures through solarization. Within weeks after treatment, most trees responded with vigorous new growth. Las titer was greatly reduced for more than one year after treatment and trees continued to grow well. Unlike with potted trees, exposure to high heat was not sufficient to eradicate the Las population in field conditions. This may be attributed to reduced temperatures at night, rather than continuous high temperatures, and failure to achieve therapeutic temperatures in the root zone. Despite the presence of Las in heat-treated field citrus, many trees continue to produce large flushes and grow vigorously two to three years after treatment. RNA-seq was used to monitor changes in gene expression of HLB-affected trees exposed to the heat treatment. Seventy eight genes were identified as differentially expressed before and after heat treatment. Thirty one genes were up-regulated after heat treatment. Among thirty one genes, there are four heat-shock related genes, one TIR-NBS-LRR gene, one peroxidase, one copper amine oxidase, two P450 genes, and one CBL-interacting protein kinase. Forty seven genes were down regulated in the heat treatment samples. Among these forty seven genes, there were one homogentisate phytyltransferase, two osmotin genes, two HXXXD-type acyl-transferase family proteins, and one WRKY transcription factor. These data indicate that heat treatment does have beneficial effects on citrus gene expression in addition to affecting Las survival.

Specified Source(s) of Funding: Florida Department of Agriculture Specialty Crop Block Grant and Citrus Research and Development Foundation

8:30–8:45 AM

Breeding “Sweet Oranges” at the USDA U.S. Horticultural Research Laboratory

Ed Stover*
USDA–ARS, Ft. Pierce; ed.stover@ars.usda.gov

Randall Driggers
USDA–ARS, Fort Pierce; randy.driggers@ars.usda.gov

Jack Hearn
USDA–ARS retired, Fort Pierce; hearn927@bellsouth.net

Jinhe Bai
USDA–ARS, Fort Pierce; jinhe.bai@ars.usda.gov

David Hall
USDA–ARS, Fort Pierce; david.hall@ars.usda.gov

The sweet orange is the most extensively planted tree fruit in the world. Sweet orange is an interspecific hybrid rather than a true species. Cultivars are mutations selected over generations (possibly millennia) of clonally propagating the original hybrid. Leading sweet orange cultivars have traits that are much-appreciated by consumers, and commercial producers/processors have a hard-won understanding of optimal handling. Unfortunately sweet orange also has some serious problems, especially high susceptibility to the disease huanglongbing. Plant breeders have attempted to create improved sweet oranges for decades. However, hybrids from sweet orange crossed with sweet orange reportedly do not produce sweet-orange-like fruit, and breeders reported no sweet-orange-like hybrids despite numerous crosses. In 1989 USDA/ARS released ‘Ambersweet’ [(‘Clementine’ x ‘Orlando’) x Sweet Orange], which was extraordinary in its resemblance to sweet orange. Chemical and organoleptic evaluations resulted in acceptance of ‘Ambersweet’ as a “sweet
orange”, and it was widely planted in Florida, but suffered from low productivity. A new generation of sweet-orange-like hybrids are under evaluation, all with ‘Ambersweet’ as a parent. Volatile profiles were compared to ‘Ambersweet’ and ‘Hamlin’ sweet orange. The profiles of five of the hybrids were closer to ‘Hamlin’ than is ‘Ambersweet’ and are also sweet-orange-like in appearance and from informal sensory panel analysis. One hybrid peels more easily than sweet orange. Several conventional hybrids in the USDA breeding program are displaying apparent resistance to huanglongbing, with some ‘Clementine’ x ‘Orlando’ hybrids among the most promising. The new sweet-orange-like hybrids are currently being challenged with huanglongbing in replicated trials.

8:45–9:00 AM
**Advanced Production Systems for Fresh Citrus in Florida**

Barrett Gruber*
University of Florida, IFAS-IRREC, Fort Pierce; bgruber@ufl.edu

Brian Boman
University of Florida, IFAS-IRREC, Fort Pierce; bjbo@ufl.edu

Arnold W. Schumann
University of Florida, Lake Alfred; schumaw@ufl.edu

Fred G. Gmitter
University of Florida/IFAS, Lake Alfred; fgmitter@ufl.edu

Jude W. Grosser
University of Florida/IFAS, Lake Alfred; jgrosser@ufl.edu

Fresh citrus fruit production in the state of Florida has been limited in recent years due to the effects of huanglongbing (HLB) disease. The causal pathogen of HLB, *Candidatus Liberibacter asiaticus*, is vectored by the Asian citrus psyllid (*Acidalia citri*). Affected citrus trees display chlorotic leaves and limbs, and fruit is usually discolored, misshapen, and otherwise of sub-standard quality. In November, 2013, a series of trials were initiated at the University of Florida, Indian River Research and Education Center in Fort Pierce. These trials are evaluating different, new production scenarios for fresh citrus (focusing on ‘Ray Ruby’ grapefruit and ‘Valencia’ orange) in the age of HLB in Florida. Production elements of interest are high-density tree planting (i.e., greater than 400 trees/acre), drip liquid-fertilization, and weather-sensor guided irrigation scheduling. Collectively, these elements of interest are referred to as “Advanced Production Systems” (APS) and are being compared to control plots of grapefruit and orange planted according to conventional methods (i.e., less than 200 trees/acre and using dry, granular fertilizer). It is expected that the APS tree blocks will come into profitable bearing earlier than blocks planted at conventional standards, and that this accelerated fruit production will help offset the negative pressure of HLB. Included in these trials are protected culture grapefruit plantings that are evaluating the feasibility of producing fresh fruit in enclosed structures. These structures were made with screen cloth that physically separates the tree and the ACP insect vector. In this respect, HLB development should be prevented in grapefruit trees planted within these enclosures, relative to open-air grapefruit plantings. The system of covered fruit production is referred to as “Citrus Undercover Production Systems” (CUPS) and has ‘Ray Ruby’ grapefruit planted at super-high densities (i.e. greater than 800 trees/acre) with drip liquid-fertilization. These trials are on-going; however, their progress-to-date, with regards to tree-growth, will be reported and discussed.

9:00–9:15 AM
**Evaluation of Commercial Citrus Cultivars for Field Tolerance/Resistance to Huanglongbing in East Central Florida**

Sharon Inch*
U.S. Horticultural Research Laboratory, USDA/ARS, Fort Pierce, FL; Sharon.Inch@ars.usda.gov

Ed Stover
U.S. Horticultural Research Laboratory, USDA/ARS, Ft. Pierce, FL; ed.stover@ars.usda.gov

Citrus huanglongbing (HLB) is caused by a phloem-limited gram-negative bacterium, *Candidatus Liberibacter asiaticus* (CLas). Although there are no HLB-resistant commercial citrus varieties, some resistance or field tolerance to HLB within citrus and citrus relatives has been observed. The objectives of this study were to assess cultivar field tolerance/resistance to HLB compared to sweet orange and to examine the effect of imidacloprid on growth and disease development. To expedite the trial, nursery trees were purchased on rootstock varieties as available. The trial included ‘Hamlin’/Kinkoji’, ‘Hamlin/ Cleo’ (sweet orange), ‘Temple/Cleo’ (tangor), ‘Fallglo/Kinkoji’ (mandarin hybrid), ‘Sugar Belle/SourOrange’ (mandarin hybrid), ‘Tango/Kuharske’ (mandarin), and ‘Ruby Red/Kinkoji’ (grapefruit). A randomized complete block experiment with 10-20 trees per scion/rootstock was established at Ft. Pierce, FL, in 2010. Disease severity was rated on a scale of 0 to 3 (0 = healthy, 1 = pale mottling, 2 = mottle but symmetric, and 3 = blotchy mottle), and growth (height and diameter) of trees was recorded starting in April 2012 and continued on a monthly basis. At each sample time, three leaves were collected from each tree for quantitative real time PCR of CLas and citrus dehydrin. All trees exhibited symptoms of HLB and tested positive for CLas. Imidacloprid was applied quarterly to a subset of trees and significantly increased diameter compared to the untreated trees (P < 0.05) but did not have a significant effect on height, disease severity, or CLas titer levels. No effects of rootstock were observed between ‘Hamlin’ on Kinkoji vs. Cleo. There were significant differences (P < 0.05) in disease severity, diameter, and CLas titer between the seven varieties screened. ‘Fallglo’ had the lowest incidence and ‘Ruby Red’ the highest incidence of distinctive HLB mottling. The highest CLas titer levels in 2012 were observed in November and December, with ‘Sugar Belle’ and ‘Tango’ displaying the highest titer levels (70 and 38 CLas per 1000 citrus cells) while ‘Fallglo’ and ‘Temple’ had the lowest levels (~5 CLas/1000 citrus cells). Despite the high titer levels of ‘SugarBelle’ it had the greatest overall increase...
in diameter, 22.91 cm and was among the healthiest in overall
appearance. Initial results indicate that compared to ‘Hamlin’,
‘Fallglo’ and ‘Temple’ appear to display field resistance to
HLB while ‘SugarBelle’ appears to have significant tolerance.
These trees are not yet bearing, suggesting that production was
compromised in all varieties by the severe HLB pressure at this
site, and commercial value of the observed resistance/tolerance
remains uncertain.

Specified Source(s) of Funding: CRDF

9:15–9:30 AM

Impacts of HLB Disease on Citrus Fruit
Preharvest Drop

Greg McCollum*
USDA–ARS, USHRL, Fort Pierce, FL; greg.mccollum@ars.usda.
gov

Jinhe Bai
USDA–ARS, USHRL, Fort Pierce, FL; Jinhe.Bai@ars.usda.gov

Hong Chen
Huashong Agricultural University, Wuhan; hong.chen@ars.usda.gov

Huanglongbing (HLB) disease is devastating the Florida citrus
industry. HLB was first confirmed in Florida in 2005, by 2010
HLB had been confirmed in every citrus production region in
Florida; current estimates suggest that greater than 75% of all
citrus trees Florida are infected with Candidatus Liberibacter
asiaticus (CLas), presumed causal agent of the disease. The
disease has also been confirmed present in commercial and
dooryard citrus in Texas, and a single dooryard tree in California.
Following initial CLas infection there is a lengthy latent phase
prior to expression of disease symptoms, which eventually result
in loss of productivity, poor fruit and juice quality and eventually
tree death. As disease symptoms escalate there has been a
concomitant increase in preharvest fruit drop which translates
into significant loss of yield. We have initiated experiments to
determine how HLB impacts citrus fruit detachment force (FDF)
(abscession), the ultimate mechanism which leads to fruit drop.
We compared fruit detachment force for HLB-asymptomatic
(AS) and HLB-symptomatic (S) fruit. Fruit detachment force
was determined for ‘Hamlin’ (early season variety) and ‘Valen-
cia’ (late season variety) sweet oranges (Citrus sinensis).
Fruit detachment force was measured with a force gauge using either
a straight pull method (to emulate fruit drop) or with a twisting
method (to emulate hand harvesting). Our results indicate that
FDF differed was significantly lower for S than AS fruit regard-
less of pull method. Rind plugging was significantly greater
for AS fruit than for S fruit when the straight pull method was
used. Although ‘Hamlin’ fruit were sampled late in the harvest
season when the greatest difference in FDF was expected, ini-
tial results with ‘Valencia’ indicate a greater difference in FDF
than for ‘Hamlin’. Our data confirm that FDF is reduced as a
consequence of HLB and that the effect can be seen very early
in fruit development.

Wednesday, July 30, 2014

Marketing and Economics 2

Moderator: Edward Evans; eaevans@ufl.edu

8:00–8:15 AM

Price Signs to the Left of Center Get More
Visual Activity

Bridget K. Behe*
Michigan State University, East Lansing; behe@msu.edu

Jennifer Dennis
Purdue University, West Lafayette, IN; jhdennis@purdue.edu

Charles R. Hall
Texas A&M University, College Station; charliehall@tamu.edu

Hayk Khachatryan
University of Florida, Apopka; hayk@ufl.edu

Ben Campbell
University of Connecticut, Storrs; ben.campbell@uconn.edu

Participants from 6 locations viewed 5 unique plant displays with
3 manipulated signs per display to total 27 total treatment images.
Three signs spanned the back, upper portion of each display
to (a) identify the plants, (b) convey a fabricated horticultural
production method (conventional, energy-saving, sustainable,
or water-saving), and (c) convey price (low, medium, or high).
While identification sign was central to all displays, price and
production method were changed depending on the plant type.
Comparisons were made between the two price sign positions
(left or right) using the SAS GLIMMIX. Signs posted on the
left were more likely to receive the first fixation and had more
fixations compared to those on the right. When price sign location
was further compared by price level, no significant difference
was detected in fixation count, but high and medium prices on
the left side were observed faster than a low price, and all three
were looked at before any level of price if shown in the right side
of the display. Higher prices displayed on the left receive more
visual activity than lower prices or those displayed to the right.

Specified Source(s) of Funding: USDA FSMIP

8:15–8:30 AM

Estimating Market Equilibrium Values of Fruit
Traits for Peach and Sweet Cherry Using Choice
Experiments with Consumers and Producers

Yingzi Li
Washington State University, Pullman; yingzi.li@email.wsu.edu

Chengyan Yue
University of Minnesota, St. Paul; yuechy@umn.edu

R. Karina Gallardo*
Washington State University, Puyallup; karina_gallardo@wsu.edu

Vicki McCracken
Washington State University, Pullman; mccracke@wsu.edu

James Luby
University of Minnesota, St. Paul; lubyx001@umn.edu

Three signs spanned the back, upper portion of each display
to (a) identify the plants, (b) convey a fabricated horticultural
production method (conventional, energy-saving, sustainable,
or water-saving), and (c) convey price (low, medium, or high).
While identification sign was central to all displays, price and
production method were changed depending on the plant type.
Comparisons were made between the two price sign positions
(left or right) using the SAS GLIMMIX. Signs posted on the
left were more likely to receive the first fixation and had more
fixations compared to those on the right. When price sign location
was further compared by price level, no significant difference
was detected in fixation count, but high and medium prices on
the left side were observed faster than a low price, and all three
were looked at before any level of price if shown in the right side
of the display. Higher prices displayed on the left receive more
visual activity than lower prices or those displayed to the right.

Specified Source(s) of Funding: USDA FSMIP

8:15–8:30 AM

Estimating Market Equilibrium Values of Fruit
Traits for Peach and Sweet Cherry Using Choice
Experiments with Consumers and Producers

Yingzi Li
Washington State University, Pullman; yingzi.li@email.wsu.edu

Chengyan Yue
University of Minnesota, St. Paul; yuechy@umn.edu

R. Karina Gallardo*
Washington State University, Puyallup; karina_gallardo@wsu.edu

Vicki McCracken
Washington State University, Pullman; mccracke@wsu.edu

James Luby
University of Minnesota, St. Paul; lubyx001@umn.edu

An asterisk (*) following a name indicates the presenting author.
To meet the dynamic consumer demand, and to keep peach and sweet cherry industries sustainable, innovation through development and commercialization of new cultivars has become an increasingly important strategy. New cultivars with superior performance and market acceptance provide advantages to all parties in the supply chain. We study and compare how consumers and producers value fruit traits differently and synthesize their values of fruit traits in market equilibrium. We conducted choice experiments with consumers and growers using mail-in surveys and online surveys. Mixed logit models were used to estimate consumer and producer willingness to pay for desired peach and sweet cherry traits. Using the mixed logit model estimation results we derive the consumer demand curves and producer supply curves for the traits. The market equilibrium prices and quantities are then identified for the fruit traits.

specified Source(s) of Funding: USDA National Institute of Food and Agriculture Specialty Crop Research Initiative project: RosBREED: Enabling marker-assisted breeding in Rosacae (2009-51181-05808)

8:30–8:45 AM

Assessing the Intensity of Market Competition in the U.S. Papaya Import Market

Edward Evans*
University of Florida, Homestead; eaevans@ufl.edu

Fredy Ballen
University of Florida, Homestead; fredy.ballen@ufl.edu

Papaya is the third most traded tropical fruit, after pineapples and mangoes, respectively. World imports of fresh papayas exceeded 261,000 metric tonnes (t) in 2011, with an import value of $250.82 million. Globally, the United States is the number one papaya importer, and in 2011, accounted for 53.43 percent of the trade, valued at around $79.82 million. The US fresh papaya import market may be characterized as oligopolistic (imperfect competition), whereas Mexico, Belize, and Brazil are the main import suppliers. Mexico plays a dominant role in the US papaya import market; however, market share per se does not necessarily prove Mexican papaya exporters exercise market power for papaya exports in the United States. For instance, Brazil, which exports the Solo cultivar (considered to be of higher quality and a slightly differentiated product), commands a higher price for its produce and, in fact, could be the one exercising the market power. The United States, although not currently a major player in the papaya market, is considering becoming more active within the market, with anticipated increases in supplies coming mainly from Florida. This potential development stems from ongoing research to eradicate the papaya ringspot virus (PRSV) that has severely curtailed production supplies coming from this source. Since success in the market will depend on the extent to which U.S. growers can compete in the market, an understanding of the level of competition that exists in the market is of paramount importance. Hence, the primary objective of this study is to investigate the intensity of the competition that currently exists in this market among the major players. An inverse residual demand model for the three main competitors (Mexico, Belize, and Brazil) is specified and estimated. Results of this analysis offer an interesting insight into the competitive behavior of the three main fresh papaya exporters in the US market. The empirical estimates indicate that over the sample period, imperfect competition was not an issue for the three main fresh papaya exporters to the U.S. market. The findings suggest that the U.S. papaya market is very competitive and is driven by price competition and cultivar characteristics. Because there are no major barriers to entry, Florida growers can do reasonably well in the market as long as they can compete on a price basis.

8:45–9:00 AM

Competitive Behavior in the U.S. Green-skinned Avocado Market

Edward Evans*
University of Florida, Homestead; eaevans@ufl.edu

Fredy Ballen
University of Florida, Homestead; fredy.ballen@ufl.edu

Green-skinned avocados are an important contributor to the agricultural economy of Florida, second only to citrus. In 2011, cash receipts for green-skinned avocados totaled $22 million. At the wholesale end of the market, the Florida avocado industry is worth upwards of $30 million per year. Approximately 80 percent of the crop is sold outside of the state; hence, the industry brings in a substantial amount of “new dollars” to the state, resulting in an overall economic impact of approximately $54 million per annum. Domestic green-skinned avocado production is not enough to satisfy the demand; therefore imports are needed. The U.S. green-skinned avocado import market may be characterized as oligopolistic as it is served by few suppliers: Dominican Republic, Peru, Mexico, and Chile. Dominican Republic has been the main US supplier of green-skinned avocados; in 2012, it supplied about 96 percent of the total imports valued at $15.2 million. Historically, a high market share has been associated with market power; however, as stated by Goldberg and Knetter (1999), a high market share does not necessarily prove a country’s ability to exercise market power. On the other hand, the United States is the major purchaser of green skinned avocados and as such could exercise market power. Whether from the perspective of the seller or buyer, imperfect competition remains an ongoing concern in international agricultural trade, as it may lead to higher consumer prices in the importing country and/or lower producer prices in the supplying country. Given the current market structure of the US green-skinned avocado market, incentives for both the seller and the buyer exist to exercise market power. The purpose of this paper is to simultaneously assess the competitive behavior of the United States and Dominican Republic in the US green-skinned avocado market. The results of our investigation suggest that over the 2003–2012 sample period, imperfect competition was an issue in the U.S. green-skinned avocado market.
Management of irrigation water is extremely important as fresh water continues to be depleted on a global scale and pollution is a big issue. In anticipation of regulatory restrictions, several businesses in New Jersey have implemented systems that disinfect and recycle their irrigation water. A cost analysis of this investment was performed at five businesses in Southern New Jersey. This study compared the disinfection methods at two greenhouses and three nurseries. The disinfection techniques analyzed were ozone, chlorine gas, UV light, and copper. The data for this study were collected during on-site visits where the growers were interviewed. The Rutgers Office of Continuing and Professional Education filmed these interviews to produce educational videos. A partial budget analysis was performed to determine the economic efficiency of this investment. The most efficient disinfection technique could not be determined due to the variability between businesses and the many unquantifiable benefits of recycling water. A rubric was developed to compare the recycling systems to one another, and serve as a tool for growers that are interested in making this investment. A small-scale nursery would likely benefit from a small capital investment in a chlorine gas system; a high-end greenhouse would likely benefit from a large-scale investment in an ozone treatment system. A third option is for growers to reduce their runoff entirely by changing their water management practices. One of the five businesses took this approach and does not recycle, but instead uses drip irrigation and strategic water management to produce negligible runoff. This information was compiled into guidelines with recommendations that will be available to the public, along with the educational videos, to promote learning about new sustainable technologies in the field.

Specified Source(s) of Funding: USDA-NIFA multistate project about new sustainable technologies in the field. The project was supported by the USDA National Institute of Food and Agriculture/Oregon Association of Nurseries, This project was supported by the USDA National Institute of Food and Agriculture, hatch project number MICL02010

Cost Analysis of Recycling Water in Greenhouses
Robin G. Brumfield*
Rutgers University, New Brunswick, NJ; brumfield@aesop.rutgers.edu
Alyssa DeVincentis
Rutgers University, New Brunswick, NJ; ajdevincentis@gmail.com

Radio frequency identification (RFID) tags were used to track bare-root harvested nursery trees at a wholesale nursery, J. Frank Schmidt and Son Inc. (JFS), as they were loaded into transport pallets and to track pallet movement during transport on a flatbed tractor-trailer. Harvested trees were graded by size, tied in bundles, labeled with RFID tags and loaded into wooden pallets in a warehouse. The pallets were 1.22 m x 2.44 m, with walls along the long sides at 1.22 m height and the short side without walls. An Alien ALR 9900 RFID reader was connected to 2 MTI MT262006 and 2 Laird 9025PR antennae. Two antenna layout patterns were used to read the RFID tags and evaluate antenna placement on read success. Three pallet load densities (bundles per pallet) were evaluated. There were 10 trees per bundle for medium and high density loads and 3 or 5 trees per bundle for low density loads. The number of tags read was compared to number of tags used, a manual count by the JFS crew, and a manual count by the research team. Manual miscounts occurred for all pallet densities. No tags were missed by the RFID system for pallets with less than 48 bundles. For pallets with 54 or more bundles, there was an average of 1.5 tags per pallet missed. A total of 841 tags were used between all densities. Accuracy was similar for all methods with 9, 11, and 8 tags missed by the RFID system, JFS crew, and research team, respectively. Antenna location and type affected tag counts with the best results achieved from overhead placement using the MTI antenna. One plastic encased RFID tag was attached to each of two pallets, the pallets placed on a tractor-trailer and driven past an antenna array with the tags on the same side and repeated with the tags on the opposite side of the antennae. One of each antenna was placed at 2 m and 3 m. The antennae placed at 3 m read both pallets for each of 3 passes by the truck while at the 2 m placement only the MTI antenna read one pallet on one pass. The effectiveness of RFID in reading tags in a container yard with the same type of slip-on tags will be evaluated this spring and presented as well.

Specified Source(s) of Funding: J Frank Schmidt Family Charitable Foundation, Oregon Department of Agriculture/Oregon Association of Nurseries, This project was supported by the USDA National Institute of Food and Agriculture, hatch project number MICL02010

Radio frequency identification (RFID) tags were used to track bare-root harvested nursery trees at a wholesale nursery, J. Frank Schmidt and Son Inc. (JFS), as they were loaded into transport pallets and to track pallet movement during transport on a flatbed tractor-trailer. Harvested trees were graded by size, tied in bundles, labeled with RFID tags and loaded into wooden pallets in a warehouse. The pallets were 1.22 m x 2.44 m, with walls along the long sides at 1.22 m height and the short side without walls. An Alien ALR 9900 RFID reader was connected to 2 MTI MT262006 and 2 Laird 9025PR antennae. Two antenna layout patterns were used to read the RFID tags and evaluate antenna placement on read success. Three pallet load densities (bundles per pallet) were evaluated. There were 10 trees per bundle for medium and high density loads and 3 or 5 trees per bundle for low density loads. The number of tags read was compared to number of tags used, a manual count by the JFS crew, and a manual count by the research team. Manual miscounts occurred for all pallet densities. No tags were missed by the RFID system for pallets with less than 48 bundles. For pallets with 54 or more bundles, there was an average of 1.5 tags per pallet missed. A total of 841 tags were used between all densities. Accuracy was similar for all methods with 9, 11, and 8 tags missed by the RFID system, JFS crew, and research team, respectively. Antenna location and type affected tag counts with the best results achieved from overhead placement using the MTI antenna. One plastic encased RFID tag was attached to each of two pallets, the pallets placed on a tractor-trailer and driven past an antenna array with the tags on the same side and repeated with the tags on the opposite side of the antennae. One of each antenna was placed at 2 m and 3 m. The antennae placed at 3 m read both pallets for each of 3 passes by the truck while at the 2 m placement only the MTI antenna read one pallet on one pass. The effectiveness of RFID in reading tags in a container yard with the same type of slip-on tags will be evaluated this spring and presented as well.

Specified Source(s) of Funding: J Frank Schmidt Family Charitable Foundation, Oregon Department of Agriculture/Oregon Association of Nurseries, This project was supported by the USDA National Institute of Food and Agriculture, hatch project number MICL02010

Radio frequency identification (RFID) tags were used to track bare-root harvested nursery trees at a wholesale nursery, J. Frank Schmidt and Son Inc. (JFS), as they were loaded into transport pallets and to track pallet movement during transport on a flatbed tractor-trailer. Harvested trees were graded by size, tied in bundles, labeled with RFID tags and loaded into wooden pallets in a warehouse. The pallets were 1.22 m x 2.44 m, with walls along the long sides at 1.22 m height and the short side without walls. An Alien ALR 9900 RFID reader was connected to 2 MTI MT262006 and 2 Laird 9025PR antennae. Two antenna layout patterns were used to read the RFID tags and evaluate antenna placement on read success. Three pallet load densities (bundles per pallet) were evaluated. There were 10 trees per bundle for medium and high density loads and 3 or 5 trees per bundle for low density loads. The number of tags read was compared to number of tags used, a manual count by the JFS crew, and a manual count by the research team. Manual miscounts occurred for all pallet densities. No tags were missed by the RFID system for pallets with less than 48 bundles. For pallets with 54 or more bundles, there was an average of 1.5 tags per pallet missed. A total of 841 tags were used between all densities. Accuracy was similar for all methods with 9, 11, and 8 tags missed by the RFID system, JFS crew, and research team, respectively. Antenna location and type affected tag counts with the best results achieved from overhead placement using the MTI antenna. One plastic encased RFID tag was attached to each of two pallets, the pallets placed on a tractor-trailer and driven past an antenna array with the tags on the same side and repeated with the tags on the opposite side of the antennae. One of each antenna was placed at 2 m and 3 m. The antennae placed at 3 m read both pallets for each of 3 passes by the truck while at the 2 m placement only the MTI antenna read one pallet on one pass. The effectiveness of RFID in reading tags in a container yard with the same type of slip-on tags will be evaluated this spring and presented as well.

Specified Source(s) of Funding: J Frank Schmidt Family Charitable Foundation, Oregon Department of Agriculture/Oregon Association of Nurseries, This project was supported by the USDA National Institute of Food and Agriculture, hatch project number MICL02010

Radio frequency identification (RFID) tags were used to track bare-root harvested nursery trees at a wholesale nursery, J. Frank Schmidt and Son Inc. (JFS), as they were loaded into transport pallets and to track pallet movement during transport on a flatbed tractor-trailer. Harvested trees were graded by size, tied in bundles, labeled with RFID tags and loaded into wooden pallets in a warehouse. The pallets were 1.22 m x 2.44 m, with walls along the long sides at 1.22 m height and the short side without walls. An Alien ALR 9900 RFID reader was connected to 2 MTI MT262006 and 2 Laird 9025PR antennae. Two antenna layout patterns were used to read the RFID tags and evaluate antenna placement on read success. Three pallet load densities (bundles per pallet) were evaluated. There were 10 trees per bundle for medium and high density loads and 3 or 5 trees per bundle for low density loads. The number of tags read was compared to number of tags used, a manual count by the JFS crew, and a manual count by the research team. Manual miscounts occurred for all pallet densities. No tags were missed by the RFID system for pallets with less than 48 bundles. For pallets with 54 or more bundles, there was an average of 1.5 tags per pallet missed. A total of 841 tags were used between all densities. Accuracy was similar for all methods with 9, 11, and 8 tags missed by the RFID system, JFS crew, and research team, respectively. Antenna location and type affected tag counts with the best results achieved from overhead placement using the MTI antenna. One plastic encased RFID tag was attached to each of two pallets, the pallets placed on a tractor-trailer and driven past an antenna array with the tags on the same side and repeated with the tags on the opposite side of the antennae. One of each antenna was placed at 2 m and 3 m. The antennae placed at 3 m read both pallets for each of 3 passes by the truck while at the 2 m placement only the MTI antenna read one pallet on one pass. The effectiveness of RFID in reading tags in a container yard with the same type of slip-on tags will be evaluated this spring and presented as well.

Specified Source(s) of Funding: J Frank Schmidt Family Charitable Foundation, Oregon Department of Agriculture/Oregon Association of Nurseries, This project was supported by the USDA National Institute of Food and Agriculture, hatch project number MICL02010
assumption that porous sidewalls of fabric containers display more rapid evaporative water loss rate than the industry standard container (black plastic; BP). Research conducted at Colorado State University (Fort Collins, CO) examined evaporative water loss from containers using gravimetric and volumetric soil moisture measurements. The three container types [BP, Root Pouch® (RP) and Smart Pot® (SP)] were initially examined in a greenhouse setting. We found that the fabric containers (RP and SP) lost water more rapidly compared to BP containers. In a second study, plastic-wrapped RP and SP containers behaved similarly to BP containers, suggesting that there is significant water loss through the sidewalls of fabric containers. A third study, conducted outdoors using Viburnum trilobum ‘Compactum’, examined plant growth and quality under varying levels of deficit irrigation [25%, 50%, and 75% of potential evapotranspiration (ET)]. Plants grown in BP containers had significantly greater cumulative ET rates (4700 mL), compared to plants grown in RP (3900 mL) and SP (4200 mL) containers. Plants grown in BP containers displayed delayed wilting and scorching of leaves compared to RP- and SP-grown plants. Following a 16-day dry-down, where no supplemental irrigation was provided, plants grown in BP containers displayed the least amount of drought stress compared to RP and SP. We conclude that plants growing in fabric containers under deficit irrigation exhibit more rapid water loss and earlier symptoms of drought stress than plants growing in BP containers. However, when all containers were irrigated at 100% ET, there were no water use or growth differences among container types.

Specified Source(s) of Funding: Colorado State University De...
Craig Ramsey  
USDA Animal & Plant Health Inspection Service, Fort Collins, CO; craig.l.ramsey@usda.gov

Steven Earl Newman  
Colorado State University, Fort Collins; steven.newman@colostate.edu

Phytophthora ramorum is a major risk to interstate trade of nursery stock. Our work focuses on chemical oxidant chemistry as a disinfectant on nursery grown Camellia japonica species. Disinfection of the plant is crucial, but the impact on plant health and phytotoxic responses are also important. Chlorophyll fluorescence was measured to determine plant stress responses to two oxidant disinfectants, mixed with and without a sarcosinate surfactant. A parameter of fluorescence is Fv/Fm, or maximum fluorescence measured to determine plant stress responses to two oxidant disinfectants, mixed with and without a sarcosinate surfactant. A parameter of fluorescence is Fv/Fm, or maximum quantum efficiency, which is the efficiency of chlorophyll to convert photons into sugars. Data were collected using a Li-Cor 6400 Leaf Chamber Fluorometer (Li-Cor, Lincoln, Neb) to evaluate the potential phytotoxicity of Camellia plans to several formulations of ClO2 and H2O2 that were applied five times at three day application intervals. Maximum quantum efficacy (Fv/Fm) increased when ClO2 and H2O2 were applied with the surfactant sarcosinate to camellia foliage. Also, visual injury of the camellia foliage increased with each subsequent spray application; however, foliar injury did not exceed a marketable threshold for most treatments, until after four or five consecutive spray applications.

9:15–9:30 AM  
**Nitrogen Rate, Irrigation Frequency, and Container Type Affect Plant Growth and Nutrition Uptake of Encore Azalea ‘Chiffon’**

Tongyin Li*  
Mississippi State University, Mississippi State; tl665@msstate.edu

Guihong Bi  
Mississippi State University, Mississippi State; gb250@msstate.edu

Richard L. Harkess  
Mississippi State University, Mississippi State; rharkess@pss.msstate.edu

Geoff Denny  
Mississippi State University, Mississippi State; gcd42@msstate.edu

Xiaojie Zhao  
Mississippi State University, Mississippi State; xz179@msstate.edu

Encore azaleas are popular in the United States because of their multiple blooming seasons and good performance under full sun exposure in the southern region. They are members of the large Rhododendron genus having hundreds of species and varying nutrition requirements. This study was conducted to investigate the influence of nitrogen (N) rates (0, 5, 10, 15, 20 mM N from ammonium nitrate) and irrigation frequency (once or twice per day with the same total amount of water) on growth of Encore azalea plants grown in two types of containers: one is a conventional plastic container (GL 2800, Nursery Supplies® Inc., Chambersburg, PA), and the other one is a paper biocontainer (Western Pulp Products Co., Corvallis, OR). Feasibility of using biodegradable paper containers as an alternative to traditional plastic containers in a one-year production cycle of Encore azalea ‘Chiffon’ was evaluated. Results showed container type significantly influenced plant daily water use (DWU) with plants grown in biocontainers having significantly greater DWU than those in plastic containers. Plants treated with higher nitrogen rates (10, 15, and 20 mM N) and grown in biocontainers had greater plant growth indices, total leaf area, and total root length than those in other treatment combinations. The interaction of irrigation frequency and nitrogen rate influenced flower number. Plants treated with 10 and 20 mM N and irrigated once a day had a significantly greater flower number than those in other treatment combinations. Nutrition levels in plant tissues were also significantly influenced by nitrogen rate and container type.

Wednesday, July 30, 2014  
**Floriculture 1**

Moderator: Alicain S. Carlson; ascarlos@ncsu.edu  
8:00–8:15 AM  
**Potassium Silicate Supplementation Enhances Heat Tolerance of Petunia xhybrida ‘Mitchell Diploid’**

Neil Mattson*  
Cornell University, Ithaca, NY; nsm47@cornell.edu

Michal Moyal Ben Zvi  
Cornell University, Ithaca, NY; mm2443@cornell.edu

Silicon (Si) supplementation to plants has been reported to mitigate several abiotic stresses, including: drought, salinity, extreme temperatures, and heavy metal toxicity. While the beneficial effects of Si have been long documented, obstacles to the realization of the potential of Si in greenhouse crop production include limited knowledge regarding the regulatory pathways underlying Si accumulation by plants and subsequent mode of action. Our objective was to determine if silicon supplementation to Petunia during greenhouse production could ameliorate subsequent response to heat stress. Greenhouse grown petunia plants received either 0 (control), 0.5, or 2 mM Si from potassium silicate supplemented to the standard daily fertilizer regime. Potassium chloride was also supplemented so that all plants received the same amount of potassium. After several weeks plants were moved to controlled environment chambers. Following acclimation to the chambers, plants received 40 °C heat stress treatments for three days followed by a return to 24 °C. Plants were well watered in the chamber experiment. Si treatment led to a visual improvement in plants exposed to heat stress. Plants receiving 2 mM Si exhibited less wilting and leaf yellowing than control plants. With 24 h of heat stress, net photosynthesis (Pn) of control plants was reduced by about 50% while 0.5 and 2 mM Si plants exhibited only a 30% decrease in
Pn. Transpiration (E) of 2 mM Si plants was greater than control plants in response to 24 and 72 h of heat stress. Silicon treated plants did not exhibit a decrease in chlorophyll fluorescence (Fv/Fm) in response to heat stress; whereas for control plants, Fv/Fm decreased from 0.83 prior to stress to 0.45 following 48 hours of stress. Stress induced silicon accumulation (SISA) was observed. Leaf Si concentration prior to heat stress was 78, 352, and 897 mg·kg⁻¹ for 0, 0.5, and 2 mM Si treatments, respectively. Following heat stress, leaf Si concentration had increased by more than two-fold to 208, 1161, and 2360 mg·kg⁻¹ for 0, 0.5, and 2 mM Si treatments, respectively. Our results demonstrate that Si supplementation partially ameliorates 40 °C heat stress in Petunia. Future work should explore the landscape performance of Si-amended greenhouse grown petunias and further explore the mechanisms underlying Si-mediated heat tolerance.

Specified Source(s) of Funding: USDA Hatch, Post-Schenkel Memorial Fund

8:15–8:30 AM

Vase Water Bacteria Isolations and Their Effects on Vase Life of Cut Zinnia elegans

Alicain S. Carlson*
North Carolina State University; ascarlso@ncsu.edu

John M. Dole
North Carolina State University; john_dole@ncsu.edu

Ann G. Matthesse
University of North Carolina, Chapel Hill; matthesse@bio.unc.edu

Research has shown that bacterial growth in vase solutions can lead to stem vasculature blockage causing petal and leaf wilt, bent neck, or similar water stress related symptoms that reduce vase life. However, some species of cut flowers are not negatively affected by high bacteria counts in vase solution. Therefore, controlling the species of bacteria present in the vase solution may be more important than maintaining low microbial population levels. This research isolated and identified ten bacteria species associated with cut Zinnia elegans postharvest and investigated the effects of pure cultures on vase life of cut Zinnia ‘Benary’s Giant Wine’, including: Pseudomonas fulva, Serratia fioraci, Rhizobium radiobacter, Chryseobacterium sp., Pantoea ananatis, Bacillus pumilus, Chryseobacterium daejonense, Brevundimonas sp., Escherichia coli K 12, and Pseudomonas marginalis. Cut Zinnia stems inoculated with P. fulva and E. coli K 12 had significantly greater vase life of 9.5 and 9.4 d, respectively compared to the nutrient broth control, P. marginalis, P. ananatis, and R. radiobacter (7.3, 7.0, 6.9, and 6.8 d, respectively). The deionized (DI) water control had a vase life of 8.6 d. The other bacterial species had an intermediate vase life, which were statistically similar to each other and to the DI water control. There was no significant difference in water uptake, percent incidence of termination criteria, change in vase solution pH and electrical conductivity, and bacteria concentrations in the vase at termination among all treatments. This research shows that bacteria species present in the vase solution have an effect on vase life in addition to number of bacteria. Knowing the effects of different bacteria may lead to novel postharvest treatments.

Specified Source(s) of Funding: Partial funding provided by Smithers Oasis

8:30–8:45 AM

Efficacy of GA4+7 + BA or Commercial Pulsing Solutions on Postharvest Longevity, Quality and Leaf Chlorosis of Cut Lilium and Gladiolus

Iftikhar Ahmad
University of Agriculture, Faisalabad; iahmad3@ncsu.edu

John M. Dole*
North Carolina State University, Raleigh; john_dole@ncsu.edu

Bruno T. Favero
Unesp – Universidade Estadual Paulista, CEP: 18.618-970 - Botucatu - São Paulo; btrevensoli@yahoo.com.br

Effects of pulsing during cold storage with different concentrations of gibberellins (GA4+7) plus benzyladenine (BA; Fresco) or commercial preservatives, Chrysal BVB or Chrysal Bulb Flower Food, were studied on postharvest performance and quality of cut lilies (Lilium L. hybrids) and gladiolus (Gladiolus L. hybrids). Pulsing of cut stems of lilies with GA4+7 + BA at 5 or 10 mg·L⁻¹ or Chrysal BVB for 20 h at 3 ± 1 °C extended the vase life and controlled leaf yellowing of ‘Cobra’ Oriental lily and ‘Cappuccino’ and ‘Dot Com’ Asian lilies. Cut ‘Orange Art’ Asiatic lilies performed best when pulsed with GA4+7 + BA at 10 mg·L⁻¹ or Chrysal BVB. For cut gladiolus, use of GA4+7 + BA at 5 or 10 mg·L⁻¹ extended the vase life of ‘Alice’, ‘Mammoth’, ‘Passion’ and ‘Scarlet’. Chrysal BVB was also effective for vase life extension and controlling leaf chlorosis of gladiolus. However, Chrysal Bulb Flower Food had no effect on vase life extension or lowering leaf yellowing of lilies and was less effective than Chrysal BVB on gladiolus. The former product was intended as a pulse treatment and the latter as a vase solution. Gladiolus cultivars had no leaf yellowing during postharvest handling. In summary, overnight pulsing with GA4+7 + BA or commercial preservative, Chrysal BVB, proved beneficial for vase life extension and inhibiting leaf yellowing and can be used by growers and wholesalers for maintaining quality of cut lilies and gladiolus.

Specified Source(s) of Funding: International Cut Flower Growers Association and J.H. Hill Foundation

8:45–9:00 AM

PGRs Improve the Postharvest Performance, but Not Ethylene Sensitivity, of Potted Ornamental Plants and Plugs

Iftikhar Ahmad
University of Agriculture, Faisalabad; iahmad3@ncsu.edu

John M. Dole*
North Carolina State University, Raleigh; john_dole@ncsu.edu

Brian E. Whipker
North Carolina State University, Raleigh; brian_whipker@ncsu.edu

An asterisk (*) following a name indicates the presenting author.
Oral Presentations

Plant growth regulators (PGRs) are commonly used for growth control of ornamental plants, but may also offer the added benefits of increased postharvest performance and reduced ethylene sensitivity. With an increase in paclobutrazol dose or ancymidol/uniconazole concentration, plant growth (height and diameter, shoot fresh weight, or dry weight) control also increased for all species tested. With the postharvest study, use of 1.0–2.0 mg paclobutrazol per 15.2 cm pot produced 21% to 28% shorter plants with 12% to 15% smaller plant diameter, 13% to 19% less shoot fresh weight, and 15% to 21% less dry weight, and darker green foliage color of potted sunflower (Helianthus annuus L.) than untreated plants. Treatment with 1.0–4.0 mg paclobutrazol per pot delayed first wilting signs by 0.7–1.4 d compared to plants without treatment. Plants subjected to simulated shipping at 15 °C in the dark for 4 d wilted more quickly than plants kept in green house or held at 15 °C for 2 d. For zinnia (Zinnia violacea Cav.), 0.5–1.0 mg paclobutrazol per 11.4 cm pot controlled plant growth, produced dark green foliage, and extended shelf life by delaying first wilting by 2.6–3.9 d and second wilting by 1.4–2.0 d than untreated plants. For marigold (Tagetes erecta L.) and petunia (Petunia x hybrida Vilm.) plugs, 40–80 mg·L⁻¹ ancymidol with a volume of 0.21 L m⁻² as a foliar spray provided ample growth control with greener foliage; however, postharvest longevity was extended only when sprayed with 160 mg·L⁻¹. For postharvest ethylene sensitivity, while the use of paclobutrazol drenches controlled excessive plant growth of both potted cuphea (Cuphea hyssopifolia Kunth) (0, 1.0, 2.0, or 4.0 mg·L⁻¹ per 11.4 cm pot) and petunia (0, 2.0, 4.0, or 8.0 mg·L⁻¹ per 15.2 cm pot), postharvest ethylene sensitivity was unaffected as most flowers absceded from all plants exposed to exogenous ethylene. However, use of uniconazole at 4 mg·L⁻¹ produced shorter plant height with less shoot fresh and dry weight, lowered the number of absceded leaves or flowers when not exposed to ethylene, and improved foliage color of portulaca (Portulaca oleracea L.) plugs treated with 0, 2.0, 4.0, or 8.0 mg·L⁻¹ as a foliar spray. In summary, use of plant growth retardants effectively controlled excessive plant growth and extended shelf life of potted plants and plugs, but had no significant effect on ethylene sensitivity of tested species.

Specified Source(s) of Funding: USDA FNRI

9:00–9:15 AM
Effects of Plant Growth Regulators on Plant Height Control in Purple Firespike (Odontonema callistachyum)

Amir Rezazadeh*
Mississippi State University, starkville, MS; ar1372@msstate.edu
Richard L. Harkess
Mississippi State University, Mississippi State, MS; rharkess@pss.msstate.edu
Geoff Denny
Mississippi State University, Mississippi State; gcd42@msstate.edu

PGR Drenches Control the Growth and Flowering of Potted Eucomis ‘Leia’

Guihong Bi
Mississippi State University, Mississippi State; gbi@pss.msstate.edu
Brian S. Baldwin
Mississippi State University, Mississippi State; bbaldwin@pss.msstate.edu

 Firespike (Odontonema callistachyum) is a tropical ornamental shrub native to Central America. It is considered as a potential potted floriculture crop because of its beautiful crimson and brilliant red tubular flowers and shiny leaves. Five growth regulators, daminozide (Dazide), chlormequat (Cycocel), paclobutrazol (Bonzi), nniconazole (Sumagic), and flurprimidol (Topflor) at different rates and application methods (spray and drench) were tested on their efficacy on plant height control. Treatments were: daminozide spray (2000, 3000, 5000 mg·L⁻¹), chlormequat spray (1000, 2000, 3000 mg·L⁻¹), tank mix of daminozide and chlormequat spray (4500/1500, 3000/1000, 1500/500 mg·L⁻¹), paclobutrazol spray (15 mg·L⁻¹), paclobutrazol drench (10, 15, 20, 30 mg·L⁻¹), uniconazole drench (2.5, 5, 8 mg·L⁻¹), flurprimidol spray (15, 30, 45 mg·L⁻¹), and flurprimidol drench (5, 10, 15 mg·L⁻¹). Plant height, leaf area, and leaf dry weight were recorded at 9 weeks after PGR application. Maximum reduction in height was obtained with uniconazole drench at 8 mg·L⁻¹, resulting in plants 22 cm tall, which were 60.7% shorter than untreated control (56 cm). Plant height was reduced by 56% and 45.7% using paclobutrazol 30 mg·L⁻¹ and flurprimidol 15 mg·L⁻¹ drenches, respectively. Daminozide spray 2000 mg·L⁻¹ and tank mix of daminozide and chlormequat at 4500/1500 mg·L⁻¹ suppressed stem elongation by 20.3% and 18.6%, respectively. Paclobutrazol drenches at 30 mg·L⁻¹ reduced leaf area and leaf dry weight effectively compared with other PGRs. While chlormequat spray at any concentration were ineffective for controlling plant growth. Based on the results of this experiment, highest concentration of uniconazole excessively reduced plant height. Thus, the most attractive potted plants were produced using a drench application of paclobutrazol at 10 or 15 mg·L⁻¹.

9:15–9:30 AM

An asterisk (*) following a name indicates the presenting author.

HortScience 49(9) Supplement—2014 ASHS Annual Conference S183
An asterisk (*) following a name indicates the presenting author.

Anthurium is one of the most prominent flowers in the tropical cut flower industry. Its appeal is in part due to the exceptionally long vase-life seen in some cultivars. Here the link between water relations and vase-life was investigated for three anthurium cultivars: Spirit, Success, and Honduras. Blooms were kept in vases in controlled conditions while regular measurements were made of bloom degradation index (BDI), water uptake, water loss, stomatal conductance (gs), and the relative water content (RWC) of the spathe, the peduncle apex and the peduncle base. Spirit, Success and Honduras took 15, 18 and 36 days respectively to reach end of vase-life. In all three cultivars, end of vase-life occurred at c. 75% spathe RWC. However, there was no relationship between RWC of the peduncle base or apex and degradation for any of the cultivars. This indicated that blockage of the peduncle was not a critical factor in loss of water content in the spathe. Both water uptake and water loss were highest for Spirit, indicating that this may have induced the rapid loss of vase-life in this cultivar. The high water uptake seen in this short vase-life cultivar also suggests that blockage of the peduncle was not the cause of bloom degradation. The water uptake and water loss values for Success and Honduras were initially similar (ranging from 0.3–1.5 g/d/bloom) but Honduras maintained water uptake rates for longer, whilst Success showed an overall decrease in water loss with time. Water retained in the bloom (water loss–water uptake) was compared to BDI for all cultivars.

Although there were some fluctuations, there was a general trend for water loss to exceed water uptake as BDI increased for Spirit and Success. Honduras retained moisture throughout, with water uptake keeping pace with water loss despite a small increase in BDI. Spirit showed the highest value for gs, which likely accounted for its rapid bloom degradation even though this was accompanied by rapid water uptake. Success and Honduras showed similar gs and similar water uptake for most of the study; however success appeared to lose its ability to take up water sooner than Honduras.
index. In conclusion, dry bean sowing dates in the wet season between December and mid-February showed the highest yield potential. Dry and winter season sowing required irrigation to achieve maximum dry bean yield.

10:00–10:15 AM

**Research: The Key to Sustainable Management of Peatlands in Canada**

Stéphanie Boudreau*
CSPMA/APTHQ, Rivière-du-Loup, QC; science@tourbehorticole.com

Because of its incomparable properties, sphagnum peat moss is an important constituent of growing media. It is a natural resource formed by the accumulation of decomposed parts of Sphagnum mosses or other plants that grow in peatlands. Canada is a major producer and exporter of peat for horticultural uses. The Canadian peat industry has funded major restoration research programs over the past 20 years, along with government agencies and academic institutions (e.g. the Peatland Ecology Research Group, www.gret-perg.ulaval.ca). The overall goal of peatland restoration is to re-establish self-regulatory mechanisms that will lead back to naturally functioning peat accumulating ecosystems. The restoration approach (the ‘moss-layer transfer technique’) developed through this extensive research program is based on two main actions: 1) active reintroduction of peat bog plant species, along with various techniques to improve micro-environmental conditions for plant establishment; and 2) rewetting through ditch blocking. Monitoring of restored sites shows that typical bog plants establish within a few years following restoration and the organic matter accumulation returns to values comparable to those of natural systems. The hydrological conditions necessary for moss establishment are improved as the water table rises quickly after ditch blocking. Research also suggests that it takes between 10-20 years to return the annual carbon balance comparable to natural conditions. Other aspects related to the sustainable management of peatlands are also the subject of research, for example: techniques for improving water quality at effluent, cultivation of Sphagnum fibers on a renewable basis, improving knowledge about ‘off-site’ GHG emissions, environmental and social life-cycle analysis of peat, etc. The research outcomes have been incorporated into the policies and practices of the Canadian industry. For example, the industry is engaged with the VeriFlora® Certification Standards and the Sector Specific Annex for Responsible Horticultural Peat Moss Production and Handling. The Certification is intended to identify and encourage responsible production practices and to stimulate continuing improvement in the industry. One requirement of this certification engages the producer to restore all “new” postharvested areas. The industry is now working on its first Social Responsibility Report that highlights the actions taken by the sector toward responsible management and sets the stepping stones for the future. The presentation will summarize the past and current research, as well as the industrial initiatives toward the responsible production and sustainable management of peatlands in Canada.

10:15–10:30 AM

**Scientific Writing: From Concept to Publication for International Audiences**

Robert N. Trigiano*
University of Tennessee, Knoxville; rtrigian@utk.edu

Caula A. Beyl
University of Tennessee, Knoxville; cbeyl@utk.edu

Phillip A. Wadl
University of Tennessee, Knoxville; pwadl@utk.edu

English has become the international language of science, business and education. Competency in written language is necessary for anyone wishing to communicate on a global scale, whether writing for academia, journalism or business. A major reason why research/educational papers are rejected or why international employment is not offered to non-native English speakers is the lack of proficiency in written and oral English skills. Scientific Writing: From Concept to Publication is an intensive course developed for international audiences to improve their English writing and oral communication skills. The course was taught at two universities each in the People’s Republic of China and Germany and one institution in Brazil. The course examined 18 facets of writing/presentation skills during a 15-hour course and involved interactive presentations and extensive student participation with their own materials. Participants were surveyed to assess their level of understanding regarding the 18 topics before and after the course –we did not measure competency in these areas. Regardless of location, students believed that they had a significantly better ($P = 0.05$) understanding of the topics because of the workshop. Although there was variation among locations, the top five highest ranked writing areas with improved understanding were the following: 1. dealing with editors; 2. the peer review process; 3. preparing the manuscript for submission; 4. consulting instructions to authors; and 5. authorship and its implications. There is a demonstrated need for this program and/or programs like it because of the increased emphasis on receiving and accepting submissions from non-native English speakers.

10:30–10:45 AM

**An International Study Abroad Project to Empower Women Farmers in Turkey**

Robin G. Brumfield*
Rutgers University, New Brunswick; brumfield@aesop.rutgers.edu

Burhan Özkan
Akdeniz University, Antalya; bozkan@akdeniz.edu.tr

In May 2013, Akdeniz University partnered with Rutgers, The State University of New Jersey to offer Empowering Turkish Women Farmers, a summer International Service Learning Program through the Rutgers Study Abroad Program. This Study Abroad program expanded on Suzanne’s Project, a pre-existing partnership between Rutgers University and Akdeniz University which was launched in Antalya, Turkey in 2011. The goals of Suzanne’s Project are to train Turkish women
An asterisk (*) following a name indicates the presenting author.

Wednesday, July 30, 2014

**Herbs, Spices, and Medicinal Plants**
Moderator: Lijing Zhou; Lijing_Zhou@ncsu.edu

9:45–10:00 AM

**Preservation Treatments Affect Sensory Quality of Oyster Mushroom**

Itai Mutukwa*
North Dakota State University, Fargo; itai.mutukwa@ndsu.edu

Clifford A. Hall
North Dakota State University, Fargo; clifford.hall@ndsu.edu

Chiwon W. Lee
North Dakota State University, Fargo; chiwon.lee@ndsu.edu

Oyster mushrooms are nutritious, flavorful, and are known to have some medicinal properties. Their production requires low capital investment and minimal expertise and thus they can potentially be a source of nutrition and income in resource limited communities. However, one limiting factor is that oyster mushrooms spoil easily and thus require preservation to extend their shelf life. This study investigated the effect two drying treatments (solar and oven), three blanching treatments (no blanching, water and steam), and four chemical pretreatments (no chemical, lemon juice, vinegar and potassium bisulfite) on oyster mushroom sensory quality. The pretreated dehydrated oyster mushrooms were assessed by a trained panel who rated the mushroom’s flavor, texture and appearance attributes on a 174 mm scale. Mean ratings were calculated and analysis of variance was done using Statistical Analysis System (SAS Inst. 1988) with the use of least significant figures to separate means. Among the un-blanched samples, those that did not receive any chemical pretreatment and those that were pretreated with lemon juice before drying were found to have better appearance, flavor and were more generally acceptable when compared to those with the vinegar and potassium bisulfite treatments. However, when a blanching treatment was included, samples that were treated with potassium bisulfite had superior quality when compared to those treated with lemon juice, vinegar and the control. Solar drying resulted in more browning when compared to oven drying. Water blanching resulted in a more fibrous texture when compared to steam blanching.

Keywords: oyster mushroom, sensory, preservation, chemical pretreatments, blanching

10:00–10:15 AM

**Seed Size Does Not Affect Germination or Vigor of Echinacea angustifolia**

Jennifer Crumley*
North Carolina State University, Mills River; jennifer_crumley@ncsu.edu

Lijing Zhou
North Carolina State University, Mills River; Lijing_Zhou@ncsu.edu

John Balles
Amway Corporation, Lakeview, CA; john.balles@amway.com

Jeanine M. Davis
North Carolina State University, Mills River; jeanine_davis@ncsu.edu

*Echinacea angustifolia* is widely used for its medicinal properties and included in some of the most popular herbal products on the market. The seeds, however, can be challenging to germinate and have been the subject of several studies. Previous research and personal observation suggested that seed size might influence germination. In the fall of 2013 and early spring of 2014, studies were conducted to determine the effect of seed size and seed source on germination and seedling vigor of *Echinacea angustifolia*. Seeds from two commercial seed companies and one private commercial herb farm that saves their own seed were used for comparison. The seeds were separated into three sizes (small = 1.18 mm or less, medium = 2.00 mm, large = 2.36 mm or greater) using standard sieves and sown into a commercial soilless media in 288 cell transplant flats. The experimental design was a split plot with seed source as the main plot and seed size as the subplot, with six replications. Data were collected weekly on germination, average plant height, and average number of leaves. Two germination studies were conducted in petri dishes for approximately two weeks each under a 16-h photoperiod in late summer 2013 and spring 2014 with two and four replica-
tions, respectively. Each was a two-factor completely randomized
design with the same three seed sources and three seed sizes
used in the seedling studies. There were 100 seeds in each dish.
Data were collected approximately every other day, whereupon
germination was considered successful at the emergence of the
radicle from the seed coat. For both the seedling studies and the
petri dish studies, the primary difference was observed between
the seed sources. The private farm seed had significantly lower
germination and seedling vigor compared to the commercial
sources. The slight differences observed in germination based
on seed size were statistically insignificant in both studies. The
small differences observed in the average number of leaves and
average plant height per seed size were also not found to be
significant. Therefore, according to the data collected in these
studies, there is no correlation between germination or seedling
vigor with seed size in Echinacea angustifolia.

Specified Source(s) of Funding: Amway/Nutrilite Corporation

10:15–10:30 AM Influence of Seed Source on Chemical
Composition of Echinacea purpurea and
Echinacea angustifolia Grown as Medicinal
Herbs in Two Environments

Lijing Zhou*
North Carolina State University, Mills River; Lijing_Zhou@ncsu.edu

Jennifer Crumley
North Carolina State University, Mills River; jennifer_crumley@ncsu.edu

John Balles
Amway Corporation, Lakeview, CA; john.balles@amway.com

Jeanine M. Davis
North Carolina State University, Mills River; jeanine_davis@ncsu.edu

Three year field trials were initiated in 2012 in the southern
mountains (Mills River) and upper piedmont (Reidsville) regions
of North Carolina to evaluate the effect of seed source, plant
age, and environment on the phytochemical profile of Echinacea
purpurea (EP) and Echinacea angustifolia (EA). The tops and
roots of these plants are used in a wide variety of commercially
available natural botanical products. At each location there are
two studies, one for each species. Within each species six seed
sources are being compared and plants are being harvested after
one, two, and three years of growth. The aerial parts and roots of
EP, and the roots of EA are dehydrated and extracted for
phytochemical analysis. After one year of growth, significant
differences among EP sources for caftaric acid, cichoric acid,
and total polyphenols in the aerial tops were found in both loca-
tions. EP and EA sources were significantly different for total
polyphenols in the roots in both locations. Significant differences
for total alkamides were found in the roots among EA sources,
but not among EP sources in both locations. EP and EA sources
were significantly different for caftaric acid and chlorogenic
acid, respectively, in the roots from Reidsville, but not from
Mills River. One EA source had significantly higher amounts
of echinacoside and total alkamides in the roots than the other
sources at both locations. The location differences are most likely
due to variations in climate, soil type, and fertility which will
be examined as these studies continue as will the influence of
plant age on the chemical profiles. The results indicate that there
may be potential for some Echinacea sources to provide specific
commercial characteristics and fulfill certain market needs.

Specified Source(s) of Funding: Amway/Nutrilite Corporation

10:30–10:45 AM Four Native Wildflower Species Differ in Their
Seed Yield Response to Irrigation

Erik B.G. Feibert
Oregon State University, Ontario; erik.feibert@oregonstate.edu

Clinton C. Shock*
Oregon State University, Ontario; clinton.shock@oregonstate.edu

Nancy Shaw
Rocky Mountain Research Station, Boise, ID; nshaw@fs.fed.us

Native grasslands and their associated shrubs and wildflowers
have been disappearing from the Great Basin. Seed of native
wildflowers are needed in restoration efforts. Four key char-
acteristic native wildflower species (Eriogonum umbellatum,
Lomatium dissectum, Penstemon speciosus, and Sphaeralcea
grossularifolia) that grow in the same region were established
at the OSU Malheur Experiment Station in 2006 and supplied
with 0, 100, and 200 mm of irrigation per year. Irrigations were
divided in four equal increments from budding to seed set with
four replicates per irrigation rate. The irrigation timings dif-
fered by species. Seed was harvested over multiple years and
optimal irrigation was determined by regression. The four na-
tive wildflower species differed in their response to irrigation.
Lomatium dissectum seed yields were optimized with 140 mm
of irrigation. The E. umbellatum seed yields were optimized
with nearly 200 mm of irrigation in dry years and progressively
less to no irrigation in the wettest year. P. speciosus seed yields
were optimized with 100 to 125 mm of irrigation in dry years
and were reduced by irrigation in wet years. S. grossularifolia
seed yields did not respond to irrigation.

10:45–11:00 AM Comparison of High Tunnel and Field Grown
Ginger Roots for Yield and Quality in Southern
Virginia

Christopher Mullins*
Virginia State University, Petersburg; cmullins@vsu.edu

Ibn-Raqib Rahim
Virginia State University, Petersburg; irah1169@students.vsu.edu

Reza Rafie
Virginia State University, Chester; arafie@vsu.edu

Nationally consumer demand for locally grown fresh fruits and
vegetables are on the rise. In addition, consumers in the U.S are
also considering food products with recognized health benefits.

An asterisk (*) following a name indicates the presenting author.
Ginger (*Zingiber officinale*) has numerous health benefits and is widely accepted in the American food market. In 2009, the United States imported approximately 42,000 metric tons of ginger with a total value of 37.2 million dollars. The consumer demand for locally grown ginger is on the rise and many farmers are taking advantage of the higher prices. While most ginger is grown in high tunnels, no information is available about field grown ginger or comparing ginger production under field to high tunnel conditions. An experiment was conducted to compare the yield and quality of field grown ginger with that of ginger grown under high tunnel conditions. The results showed that ginger can be grown under field conditions in Southern Virginia, however ginger grown in a high tunnel produced higher yield. High tunnel produced ginger averaged 2074 grams per plant in comparison to 866 grams per plant for the field grown ginger. The high tunnel also extended the ginger harvest period from October 8 to December 5 in comparison to October 8 to October 31 for ginger grown in the field.

Specified Source(s) of Funding: Virginia Department of Agriculture and Consumer Services

---

**Wednesday, July 30, 2014**

**Postharvest 1**

Moderator: Jinwook Lee; Jinwook.Lee@ars.usda.gov

10:15–10:30 AM

**Volatile Profile Changes and Visual Appearance of Tomatoes after Low Temperature Storage**

Angelos I. Deltsidis*

University of Florida, Gainesville; adeltsidis@ufl.edu

Poliana C. Spricigo

Universidade Estadual de Campinas/UNICAMP, Campinas; polianaspricigo@yahoo.com.br

Jinhe Bai

USDA–ARS, USHRL, Fort Pierce, FL; Jinhe.Bai@ars.usda.gov

Elizabeth Baldwin

USDA–ARS, USHRL, Ft. Pierce, FL; Liz.Baldwin@ars.usda.gov

Jeffrey K. Brecht

University of Florida/IFAS, Gainesville, FL; jkbrecht@ufl.edu

Chilling injury (CI) is a physiological disorder that occurs at temperatures lower than the chilling threshold. Although low temperatures slow ripening and thus seemingly prolong storage, tomato fruit may never achieve the normal color and aroma that develops when they are stored exclusively at non-chilling temperatures. The irreversible damage that may occur at chilling temperatures potentially renders the fruit unmarketable. Changes in volatiles are an important indicator of CI with the effects occurring before the appearance of external CI symptoms. Some volatile compounds contribute to desirable fresh tomato aroma while others have negative attributes that produce unwanted off-flavors. In this study, ‘Tasti Lee’ tomatoes harvested at the pink ripeness stage were stored at 5, 12.5, or 20 °C, the latter being considered the control (non-chilling) temperature and 12.5 °C the putative chilling threshold temperature. Color (a* value) was measured and appearance was subjectively evaluated daily. Fruit from 5 and 12.5 °C storage were transferred to 20 °C after 5 and 10 days to examine the color and volatile recovery. Fruit were considered fully ripe when the average a* value for a treatment measured at the distal end of the fruit reached a plateau and homogenized tissue samples were then frozen for volatile measurements. Aroma volatiles were analyzed by GC-MS using the SPME headspace method. Tomato fruit stored at 20 °C reached full ripeness in 4 days, fruit stored continuously at 12.5 °C required 14 days, whereas the 5 °C-stored fruit never achieved color values equivalent to fruit from the other two temperatures even after 20 days. On the other hand fruit stored for 5 days at 5 or 12.5 °C all recovered upon transfer to 20 °C and reached similar color values, whereas for fruit transferred after 10 days the 5 °C-stored fruit showed irreversible damage and failed to achieve full red color. Volatile profiles were negatively affected and did not recover after storage for 10 days at either 5 or 12.5 °C. This study contributes to further the understanding of the nature of CI in tomato fruit harvested at a more advanced ripeness stage than is usual for commercial operations as well as quantifying the extent of the CI effect on volatiles that precedes visible injury. The pattern of changes in the aroma volatile profile that occurs in tomato fruit during low temperature storage can be an indicator of the true chilling threshold temperature.

---

**Wednesday, July 30, 2014**

**Interactions Between Atmospheres and Sanitizers and Their Effect on the Quality and Safety of Packaged Fresh-cut Celery (Apium graveolens L.)**

Jaime Gonzalez-Buesa*

Michigan State University, East Lansing; jaimegb@msu.edu

Natalie Page

Michigan State University, East Lansing; pagenata@msu.edu

Chelsea Kaminski

Michigan State University, East Lansing; cnkaminski@ucdavis.edu

Elliott Ryser

Michigan State University, East Lansing; ryser@msu.edu

Randolph Beaudry

Michigan State University, East Lansing; beaudry@msu.edu

Eva Almenar

Michigan State University, East Lansing; ealmenar@msu.edu

Increased consumption of fresh-cut produce has led to the need to explore more sustainable packaging alternatives as well as effective and safe sanitizers that can meet consumer, market, and industry needs. In this study, the effect of combining atmospheres and sanitizers on the quality and safety of packaged fresh-cut celery sticks stored at 7 °C was evaluated. Three different washing treatments consisting of water, XY12 (sodium hypochlorite), or Tsunami 200 (mainly composed of peroxycetic acid) were applied. Polylactic acid bags containing an initial gas composition of air or high oxygen (95% O₂ + 5% N₂) and
polylactic acid snap-fit packages were evaluated. Changes in surface and cut-end color and *Listeria monocytogenes* growth were assessed on the celery sticks throughout 14 d of storage at 7 °C. High oxygen packages and snap-fit packages maintained the initial populations of *L. monocytogenes* during storage, while bags initially containing air promoted their growth. In contrast, the tested sanitizers had no effect on the safety of fresh-cut celery, independent of the selected atmosphere. The in-package gas composition also affected the quality of the celery sticks; bags with an initial gas composition of air proved to be the best packaging choice at maintaining surface and cut-end color while snap-fit packages promoted browning. Sanitizer choice affected the color of fresh-cut celery in snap-fit packages, but not in bags containing air or high oxygen as initial atmospheres. Overall, the high oxygen packages, independently of the sanitizer, showed the best balance of both safety and quality of celery sticks during storage at 7 °C, while traditional snap-fit containers did not help to maintain quality. In conclusion, the gas composition has an impact on the quality of celery sticks, while specific sanitizers can interact with specific atmospheres having a negative effect on the quality of fresh-cut celery.

Specified Source(s) of Funding: Project 2011-51110-31027 from the USDA NIFSI (United States Department of Agriculture’s National Integrated Food Safety Initiative); People Program (Marie Curie Actions) of the European Union’s 7th Framework Program (REA grant agreement nº332201)

10:45–11:00 AM

**Real Time-based Targeted Metabolomic Approach as Risk Assessment Tools for Controlling Superficial Scald in ‘Granny Smith’ Apples during Storage**

Jinwook Lee*
USDA–ARS, Tree Fruit Research Laboratory, Wenatchee, WA; Jinwook.Lee@ars.usda.gov

David Buchanan
USDA–ARS, Tree Fruit Research Laboratory, Wenatchee, WA; David.Buchanan@ars.usda.gov

Rachel Leisso
USDA–ARS, Tree Fruit Research Laboratory, Wenatchee, WA; Rachel.Leisso@ars.usda.gov

James Mattheis
USDA–ARS, Tree Fruit Research Laboratory, Wenatchee, WA; James.Mattheis@ars.usda.gov

Nigel E. Gapper
Cornell University, Ithaca, NY; Neg29@cornell.edu

Christopher B. Watkins
Cornell University, Ithaca, NY; cbw3@cornell.edu

James Giovannoni
USDA–ARS, Boyce Thompson Institute, Ithaca, NY; jjg33@cornell.edu

Maarten Hertog
Katholieke Universiteit Leuven, Heverlee; Maarten.Hertog@biw.kuleuven.be

Bart Nicolaï
Katholieke Universiteit Leuven, Heverlee; Bart.Nicola@biw.kuleuven.be

Jason Johnston
New Zealand Institute for Plant & Food Research Limited, Auckland; Jason.Johnston@plantandfood.co.nz

Robert J. Schaffer
New Zealand Institute for Plant & Food Research Limited, Auckland; robert.schaffer@plantandfood.co.nz

Bruce D. Whitaker
USDA–ARS, Beltsville, MD; Bruce.Whitaker@ars.usda.gov

David R. Rudell
USDA–ARS, Tree Fruit Research Laboratory, Wenatchee, WA; david.rudell@ars.usda.gov

The risk of superficial scald incidence in ‘Granny Smith’ apple ([*Malus sylvestris* (L.) Mill var. *domestica* (Borkh.) Mansf.] fruit during cold or controlled atmosphere (CA) storage increases with increased storage duration and oxygen level during CA storage. The objective of this study was to investigate risk assessment of superficial scald using biomarkers. ‘Granny Smith’ apples were harvested from 4 orchards in Prosser, WA, and held for up to 9 months at 0.5 °C in either air or CA at 0.5 kPa O2 and 1 kPa CO2, or 2 kPa O2 and 1 kPa CO2. Superficial scald began to develop at 3 months in air storage with severity and incidence increasing gradually thereafter. Scald was not detected on fruit stored in 0.5 kPa O2 and 1 kPa CO2 CA. When scald risk was detected at 3 months in both 2 kPa O2 and 1 kPa CO2 chambers, O2 levels were reduced to 0.5 kPa in one of the rooms, reducing final scald incidence at 9 months + 7 days shelf life. Scald first appeared on fruit stored at 2 kPa O2 and 1 kPa CO2 at 6 months storage and increased during 7 days post-storage ripening. The α-Farnesene and conjugated trienol levels were measured using a spectrophotometer correlated with levels of 2,6,10-trimethyldecane-2,7(E),9(E),11-tetraen-6-ol (CTol) and a number of unknown non-polar compounds measured using LC-MS. These compounds are tentatively identified as acyl conjugates of CTol. The identification process is ongoing. We hypothesize that the genesis of these putative conjugates results from further metabolism of CTol once it forms. Results show that risk assessment biomarkers indicate when scald risk is elevated and which storage conditions have the highest risk.

11:00–11:15 AM

**De Novo Fatty Acid Biosynthesis Contributes to Ester Formation in Some, but not All, Fruits**

Randolph Beaudry*
Michigan State University, East Lansing; beaudry@msu.edu

Alejandra Moya
Universidad de Talca, Talca; alemoya@utalca.cl

Gustavo Lobos
Universidad de Talca, Talca; globosp@utalca.cl

Miriam González
Universidad de Talca, Talca; mzgonzal@uc.cl

An asterisk (*) following a name indicates the presenting author.
An asterisk (*) following a name indicates the presenting author.
Effects of Location and Harvest Time on Sensory Properties of Southern Highbush Blueberries

Jessica L. Gilbert*
University of Florida, Gainesville; jessgilb@ufl.edu
Eric Q. Dreyer
University of Florida, Gainesville; dreyer@ufl.edu
Thomas A. Colquhoun
University of Florida, Gainesville; ucntcmel@ufl.edu
Charles A. Sims
University of Florida, Gainesville; csims@ufl.edu
David G. Clark
University of Florida, Gainesville; geranium@ufl.edu
James W. Olmstead
University of Florida, Gainesville; jwolmstead@ufl.edu

Southern highbush blueberry cultivars (SHB, Vaccinium corymbosum L. hybrids) developed through the blueberry breeding program at the University of Florida are the foundation for the Florida blueberry industry. These SHBs are also grown at many other locations throughout the world, including Georgia, California, Chile, Morocco, and Australia. To better understand the variation in human blueberry sensory experiences that may arise from different growing environments, six SHB genotypes (FL06-377, ‘Emerald’, ‘Farthing’, ‘Meadowlark’, ‘Primadonna’, and ‘Scintilla’) grown at three farms at different latitudes in Florida were selected and evaluated by sensory panels for two years. In 2012 and 2013, all genotypes were harvested early, mid, and late-season, from each of the three farms. Eighteen consumer panels (N = 72 to 95, average = 90) were conducted. Panelists rated overall liking, sweetness, sourness, and flavor intensity using general Labeled Magnitude Scales, which allow for improved comparison between panelists and between years. Overall, panelists’ ratings of liking, sweetness, and flavor intensity were not significantly different between 2012 and 2013, although perceived sourness was significantly higher in 2012 than 2013 (Tukey’s HSD, P < 0.05). Fruit from certain genotypes performed significantly differently in the consumer sensory panels when harvested from the three different growing locations. Two genotypes varied in only one sensory aspect between locations: FL06-377 and ‘Scintilla’ varied significantly from location to location for perceived sourness (Tukey’s HSD, P < 0.05). In contrast, ‘Farthing’ varied significantly for all measured sensory characters when harvested from different locations (Tukey’s HSD, P < 0.05). In general, scores for liking, perceived sweetness, and flavor intensity were highest for berries of all genotypes from mid-season harvests, and perceived sourness was lowest at the end of the season (Tukey’s HSD, P < 0.05). From these sensory analyses, it is apparent that location and environment can cause differences in liking, sweetness, sourness, and flavor intensity of clonal SHBs. However, certain genotypes were more tolerant to the environmental effects, resulting in less change in sensory characteristics than others. Thus, it should be possible to select for genotypes with more predictable fruit quality.

Specified Source(s) of Funding: University of Florida Plant Molecular Breeding Initiative

Modeling of Heat Profile in Bulk Storage of Fresh Crop

Mona Shaaban*
Michigan State University, East Lansing; shaabamm@msu.edu
Randolph Beaudry
Michigan State University, East Lansing; beaudry@msu.edu
Bradley Marks
Michigan State University, East Lansing; marksbp@msu.edu
Khaled Yousef
Menoufia University, Menoufia; khyousef@msu.edu

Harvested sugar beet (Beta vulgaris L.) roots are stored in Michigan in large piles and exposed to ambient weather conditions during winter storage period, which generally lasts three to four months. During this time, the air temperature may range from as low as –23 °C to as high as 16 °C. Winter air temperatures are rising in association with long-term trends of increasing global temperatures. Higher air temperatures contribute to increasing respiration and storage decay due to increasing metabolic activities, and give decay organisms optimal conditions to increase biomass. To mitigate the impact of these climatic conditions on the storage of fresh crops, a heat profile model was developed for predicting the temperature distribution of sugar beet storage piles. The developed model was validated using on-farm measurements of temperature and crop condition. The results of this study show that the model accurately predicts the temperature distribution in the storage piles, and its outputs can be used to optimize the storage conditions in order to minimize the decay and maximize the quality of the stored product.

Specified Source(s) of Funding: University of Florida Plant Molecular Breeding Initiative

An asterisk (*) following a name indicates the presenting author.
their growth and aggressiveness. Decay losses can result in losses of 206 g sugar/ton beets/day, which can amount to as much as $1 million dollars per week for the Michigan industry. Thus, it is important to understand the composition of the pile temperatures by developing a model to predict pile temperature based on the history of air temperature, pile age, and pile architecture. We designed a 2D model of the temperature profile of a non-ventilated pile as a function of air speed, direction, relative humidity, and temperature.

Wednesday, July 30, 2014

Plasticulture

Moderator: Ruijun Qin; ruijun.qin@ars.usda.gov

11:15–11:30 AM

Soil Fumigation Applied through Deep Drip Tapes in Totally Impermeable Film Mulched Raised-bed Systems for Strawberry Production

Ruijun Qin*
University of California, Davis; ruijun.qin@ars.usda.gov

Oleg Daugovish
UC-ANR Cooperative Extension, Ventura, CA; odaugovish@ucanr.edu

Suduan Gao
USDA-ARS, Parlier, CA; suduan.gao@ars.usda.gov

Bradley D. Hanson
University of California, Davis; bhanson@ucdavis.edu

James Gerik
USDA-ARS, Parlier, CA; James.Gerik@ars.usda.gov

Husein Ajwa
University of California, Davis at Salinas; haajwa@ucdavis.edu

California strawberry production is highly dependent on soil fumigation through drip tapes buried at shallow depth in polyethylene (PE) mulched raised-beds. However, the high fumigant emission loss is being regulated stringently by government due to human safety and air pollution concerns. Using totally impermeable film (TIF) and applying fumigants deeper may reduce the fumigant emission and improve pest control efficacy, but little information is available regarding the effects of these application strategies in the raised-bed production system. A trial was conducted in a strawberry field at Camarillo, CA to evaluate the distribution, emission, and fate of the fumigants in Pic-Clor 60 EC [a mixture of 56.7% chloropicrin (CP), 37.1% 1,3-dichloropropene (1,3-D), and 6.2% inert ingredients] as affected by application depth, application rate, and film type. The treatments included applying fumigant with full rate (25 gallon/acre) or half rate at shallow depth or at shallow plus deep depths under TIF (TIF/shallow/full; TIF/shallow/half; TIF/deep/full; TIF/deep/half), and a full rate at shallow depth under PE (PE/shallow/full). A non-fumigated control with shallow irrigation and TIF (TIF/shallow/CK) was included for comparison. Results showed that fumigant emissions are primarily through the TIF covered beds and very little fumigant escaped from the furrows between beds. Comparing to past results on fumigant emissions in PE tarped raised-beds, TIF reduced fumigant emission dramatically. In the TIF/shallow/full treatment, the emission peak fluxes were 41.4 and 24.0 ug m⁻² s⁻¹ for 1,3-D and CP respectively, while in the TIF/deep/full treatment, they were only 17.3 and 5.8 ug m⁻² s⁻¹, suggesting that deeper applications can further reduce fumigant emission. At the same application depth, the fumigant concentration under TIF with half rate was found even higher than that under PE with full rate, implying that the use of TIF may allow reduced fumigant rates to achieve pest control comparable to conventional applications. Field observations on the strawberry growth during early stage did not show significant differences among fumigation treatments. However, there is modest yield improvement with the deep drip lines, possibly due to the improved pest control results. The on-going field evaluation is expected to further show the advantage of using deep drip fumigation, especially during the later season as pest reinfestation may occur.

Specified Source(s) of Funding: A grant from the Walmart Foundation and administered by the University of Arkansas System Division of Agriculture Center for Agricultural and Rural Sustainability

11:30–11:45 AM

Row Covers as a Weather Risk Management Tool in Plasticulture Strawberries

Barclay Poling*
North Carolina State University, Raleigh; strawberrydoc@gmail.com

The 2014 winter season in the Mid-South proved to be one of the most challenging winters for management of cold weather extremes since strawberry plasticulture was introduced in this region in the early 1980s. Though temperatures below −20 °C were not experienced this past winter (as occurred in January 1985), many strawberry growing areas in North Carolina experienced temperatures of just below −17.7 °C on 7-Jan-14. Despite plants being fully dormant at the time of this arctic clipper in early January, significant crown injury occurred in both Chandler and Camarosa plants that did not have winter row cover protection. The freeze-injured plantings were about 10 days later in crop ripening in spring 2014 than plantings that had row cover protection. A second ‘arctic clipper’ occurred in the Mid-South over the period of 26-Feb-14 to 1-Mar-14, and minimums were as low as −10 °C in the North Carolina piedmont. At this juncture, the crop had broken dormancy and was in the pre-bloom period. With row cover protection during this second arctic clipper in late February, growers were able to save non-emerged flower buds that were still inside crown, but a high percentage of newly emerged ‘tight’ buds were killed at −10 °C. Under the windborne freeze conditions of 26–27 Feb., a small number of growers attempted a relatively new technique of using sprinkling in conjunction with row covers, and this approach proved to be very successful for saving all flowers buds stages (non-emerged and emerged) as well as the so called ‘popcorn’ flowers and non-emerged and emerged...
stage (just before open blossom). The author will describe a relatively new weather tool called the ‘Row Cover Optimizer’ that provides generally accurate two week weather forecasts for strawberry growers in a 4-state region (VA-NC-SC-TN). With this tool, growers can better anticipate when their row covers may need to be ‘ON’ for freezes, and they are also advised of mid-winter ‘warm up’ periods when covers need to be ‘OFF.’ Whenever average daily temperatures in January are 4 °C to 5 °C above normal, and this happens over a consecutive 2–3 day period, there is greater risk of the crop breaking dormancy underneath the covers. Smaller strawberry plasticulture growers (< 4 ha) with access to family and/or local labor are generally more successful in making timely adjustments in winter row cover usage according to changing weather conditions than are larger growers who depend on a migrant labor force that is unavailable until early spring.

Specified Source(s) of Funding: North Carolina Strawberry Association, Inc.

11:45 AM–12:00 PM

Nitrogen Uptake, Use Efficiency, and Yield in Plasticulture Grown Cabbage

Charles Barrett*
University of Florida, Gainesville; charlesedwardbarrett@gmail.com

Lincoln Zotarelli
University of Florida, Gainesville; lzota@ufl.edu

Lucas Paranhos
University of Florida, Gainesville; lucasgp@ufl.edu

Peter J. Dittmar
University of Florida, Gainesville; pdittmar@ufl.edu

Clyde Fraisse
University of Florida, Gainesville; cfraisse@ufl.edu

John VanSickle
University of Florida, Gainesville; sickle@ufl.edu

Mihai Giurcanu
University of Florida, Gainesville; giurcanu@stat.ufl.edu

Cabbage is an important specialty crop for Florida with a value at over $70 million. Florida cabbage is traditionally grown on bare-ground using seepage irrigation. In recent years interest in alternative production systems that focus on irrigation water and nitrogen fertilizer conservation has grown. Plasticulture or the use of plastic mulch and drip tape has the potential to reduce irrigation water demand and nitrogen consumption by increasing water and nitrogen use efficiencies (WUE and NUE, respectively). A plasticulture system for Florida cabbage production has been developed and is under assessment for commercial use. Cabbage was grown on 1.23-m wide raised beds with black plastic mulch and drip irrigation. The beds were spaced at 2.03 m with four rows of plants with an in-row spacing of 0.25 m for a total of 77,500 plants/ha. Five nitrogen rates (45, 98, 147, 196, 294 kg/ha of N) were tested using a randomized complete-block design. Biomass and plant nitrogen uptake were measured bi-weekly throughout the growing season and NUE was calculated. The application of 147, 196 and 294 kg/ha of N had similar final biomasses and were significantly greater than the 45 and 98 kg/ha of N treatments ($P = 0.0001$). Accordingly, the 45 and 98 kg/ha of N treatments had significantly lower marketable yields (> 2.1 Mg/ha) than all other treatments ($P = 0.0001$). The 294, 196, and 147 kg/ha of N treatments yielded 24.5, 17.2, and 10.4 Mg/ha, respectively and were significantly different from each other. An increase in the N- fertilizer rate applied decreased the apparent NUE. The apparent NUE was 74%, 72%, 58%, and 41% for the n-rate treatments 98, 147, 196, 294 kg/ha of N, respectively. The NUE of 196 kg/ha of N rate was significantly higher than 294 kg/ha of N rate ($P = 0.0001$), but marketable yield for the later was 30% higher than the 196 kg/ha of N.

Specified Source(s) of Funding: USDA/FDACS Specialty Crop Block Grant

12:00–12:15 PM

Effect of Cabbage Planting Dates and Plant Population on Plant Water Use, Biomass Accumulation, and Yield

Lucas Paranhos*
University of Florida, Gainesville; lucasgp@ufl.edu

Lincoln Zotarelli
University of Florida, Gainesville; lzota@ufl.edu

Charles Barrett
University of Florida, Gainesville; charlesedwardbarrett@gmail.com

Gabriel dos Santos
University of Florida, Gainesville; gabriel.p.mol@gmail.com

Rangel de Feijo Almeida
University of Florida, Gainesville; rangel.agronomia@gmail.com

Florida is ranked number two for fresh market cabbage production in the United States, with an economic value of over $70 million per year. Seepage irrigation and broadcast fertilizer application are practices that are very common in cabbage production in Florida. Seepage irrigation has low water use efficiency because it requires a significant withdrawal of water from the aquifer to maintain a high water table to irrigate the crop, and can cause leaching and runoff of nutrients. Drip irrigation provides higher water use efficiency. Although, the plasticulture system that utilizes a combination of drip tape and plastic mulch has been used in several vegetable crops, this system is still under adaptation for Florida cabbage production. The objectives of this project were to evaluate water use efficiency and yield of cabbage grown under plasticulture planted at four dates with tree high density plant populations. The trial was conducted during fall of 2013 in Hastings, FL. Cabbage ‘Bravo’ was grown on 1.22-m wide raised beds with black plastic mulch and two drip tapes. A split plot experimental design was used with randomized complete blocks with four replications. Main plots consisted of three planting dates September, October, and November and subplot treatments were in-row plant spacings 25, 30 and 36
The objective of this study was to determine the effect of fomesafen-preplant on Palmer amaranth control and sweetpotato tolerance, yield and quality. Studies were conducted at the Horticultural Crops Research Station, Clinton, NC, on a sandy loam soil. The experimental design was a randomized complete block with three (2012) or four (2013) replications. Herbicide treatments included fomesafen-preplant alone at 0.20, 0.28, 0.36, 0.42, 0.56, and 0.84 kg ai/ha (kg/ha) or followed by (fb) S-metolachlor at 1.12 kg/ha 7 days after transplanting (DAP), and fomesafen 0.28 kg/ha followed by S-metolachlor at 1.12 kg/ha 14 DAP. Additional treatments included flumioxazin preplant 0.105 kg/ha alone, S-metolachlor 1.12 kg/ha 7 DAP and a sequential treatment of flumioxazin fb S-metolachlor (standard treatment), flumioxazin preplant fb clomazone plus S-metolachlor 7 DAP, clomazone 0.63 kg/ha 7 DAP, and napropamide 2.24 kg/ha 7 DAP. A weedy and weed-free check was included for comparison. ‘Covington’ and ‘Evangeline’ sweetpotato slips were transplanted with a mechanical transplanter. In 2012, Palmer amaranth control 28 DAP was at least 90% from all treatments except clomazone and fomesafen alone at 0.20 kg/ha. At 50 DAP, all sequential treatments of fomesafen fb S-metolachlor provided at least 95% control except the fomesafen at 0.20 and 0.36 kg/ha which provided approximately 80% control. Palmer amaranth control by fomesafen fb S-metolachlor at 14 DAP was 66% which was less than control when fomesafen fb S-metolachlor 7 DAP (96%). In 2013, at 28 DAP all the treatments provided at least 90% Palmer amaranth control except clomazone (51%). The trend was similar at 50 DAP. In both years, Palmer amaranth control from fomesafen at 0.28, 0.36, 0.42, 0.56, and 0.84 kg/ha was similar to treatments including fomesafen fb S-metolachlor 7 DAP and flumioxazin alone or fb S-metolachlor (standard treatment) or fb clomazone plus S-metolachlor. Maximum injury and stunting from fomesafen at 0.36 and 0.20 kg/ha fb S-metolachlor was 16 and 8%, respectively. Marketable yield (Jumbo and No.1 grades) was lower in plots treated with S-metolachlor alone or 0.20 or 0.84 kg/ha fomesafen or clomazone in 2012. In 2013, marketable yield was lower than weed-free treatment from fomesafen fb S-metolachlor 14 DAP or fomesafen at 0.20 or 0.36 kg/ha or clomazone. In both years, all other treatments had similar yield as the weed-free. Overall, fomesafen rates from 0.28 to 0.56 kg/ha alone or in sequential with S-metolachlor provide adequate control of palmer amaranth without causing significant injury and yield reduction in sweetpotato.
An asterisk (*) following a name indicates the presenting author.

**Oral Presentations**

12:15–12:30 PM

**Evaluation of Watermelon Rootstocks for Resistance to Verticillium Wilt in Northwestern Washington State**

Jesse A. Wimer  
Washington State University, Mount Vernon; jesse.wimer@wsu.edu

Carol A. Miles*  
Washington State University, Mount Vernon; milesc@wsu.edu

Debra A. Inglis  
Washington State University, Mount Vernon; dainglis@wsu.edu

Watermelon (*Citrullus lanatus*) grafting is common in areas of the world where production is affected by soilborne diseases. One such disease is Verticillium wilt caused by *V. dahliae*. Watermelon does not have known resistance to this pathogen and chemical control options are limited. Verticillium wilt has the potential to become increasingly problematic for watermelon growers throughout Washington State due to the long-term persistence of the pathogen in the soil. This 2013 study investigated the reactions of 11 commercially available non-grafted rootstocks and 14 non-grafted cucurbit species which have the potential to be used as rootstocks. This study was carried out in a field naturally infested with *Verticillium* sp. Entries were obtained from various seed companies as well as the USDA National Plant Germplasm System (NPGS). One watermelon entry, ‘Crimson Sweet’ grafted onto ‘Shintoza’, and two non-grafted watermelon entries ‘Crimson Sweet’ and ‘Sugar Baby’ also were included. The experiment was arranged as a randomized complete-block design with three replications; transplanting occurred from 12 June to 21 June. Plots were rated for Verticillium wilt severity once per week from 2 Aug. through 18 Sep. ‘Sugar Baby’ and ‘Crimson Sweet’ had the highest relative area under disease progress curve (RAUDPC) values (26.8 and 15.6, respectively), while PI 419060 and ‘Crimson Sweet’ grafted onto ‘Shintoza’ had the lowest RAUDPC values (1.5 and 2.0, respectively). Twenty-one of the entries—10 commercial varieties and 11 germplasm accessions—had RAUDPC values lower than the overall mean (6.6). In addition, 5 commercial varieties and 6 germplasm accessions had RAUDPC values lower than 5, which was identified as a threshold of acceptable sustained disease severity in our study. The mean RAUDPC value for commercial varieties (5.7) was not significantly different from the mean RAUDPC value for germplasm accessions (5.5). One plant per entry was assayed for *V. dahliae* using a stem incubation method. Microsclerotia were observed on all samples except those of PI 181913 ‘Hama No 9 Long’ and ‘Crimson Sweet’ grafted onto ‘Shintoza’. Eighteen Verticillium isolates were obtained and eight were sent to the WSU Molecular Laboratory for species identification. Isolates obtained from ‘Crimson Sweet’, ‘Sugar Baby’ and PI 419060 were identified as *V. dahliae*, while the remaining five were *V. isaacii*. A follow-up greenhouse inoculation study will be conducted using selected rootstock entries and results from both field and greenhouse will be used to designate rootstocks as resistant, tolerant or susceptible to Verticillium wilt.

Specified Source(s) of Funding: Washington State University
A field study was designed to evaluate the growth and development of Lilium hybrids treated with natural full sun (NFS), 50% black shade cloth (BSC) and 50% aluminet shade cloth (ASC). Lily bulbs were planted monthly from April to August in 2013 in raised bed at Stephen F. Austin State University, TX. Lily cultivars were selected from Asiatic, Oriental, Longiflorum-Asiatic (LA) and Longiflorum Oriental (LO) hybrids. Each treatment included ten individual hybrid Lilium cultivars and consisted of ten bulbs per cultivar with three replicates at each planting date. Shade cloth significantly affected plant growth and development. Lily stem length was significantly greater for lilies grown under ASC (47.3 cm) followed by BSC (45.3 cm) and NFS (34.7 cm). Planting date also influenced stem length. Lilies planted in April (50.8 cm) were significantly taller followed by June (42.4 cm), May (42.1 cm), August (39.4), and July (31.8 cm). Days-to-harvest were significantly shortened using ASC (60 days) followed by BSC (62 days) and NFS (64 days). Days-to-harvest was significantly greater for lilies planted in July (68 days) followed by August (62 days), April (62 days), May (61 days) and June (60 days). The number of flower buds per stem was significantly greater for lilies grown under ASC (4.5) when compared to NFS (4.3) and BSC (4.2). Lilies planted in April produced a significant greater numbers of flowers (5.2) followed by August (4.4), May (4.3), June (4.1), and July (3.3).

Specified Source(s) of Funding: University Research Grant, Stephen F. Austin State University

An asterisk (*) following a name indicates the presenting author.
of acute NaCl stress in leaf. The proposed transcriptome can also be used as an excellent tool for biological and bioinformatics in the absence of an available Petunia genome and it is available at the SOL Genomics Network (SGN) http://solgenomics.net. Genes related to regulation of reactive oxygen species, transport, and signal transduction as well as novel and undescribed transcripts were among those most differentially expressed in response to salt stress. Gene Ontology analyses indicated that much of the NaCl damage happened at 24 h inducing genotoxicity, affecting transport and organelles due to the high concentration of Na+ ions. Work is ongoing to examine the root transcriptome response. The candidate genes identified in this study can be applied as markers for breeding or to genetically engineer plants to enhance salt tolerance. The data from this work will enable researchers to perform accurate downstream analysis to further understand the effect of salt stress in both roots and leaves.

Specified Source(s) of Funding: Post-Schenkel Memorial Foundation

2:30–2:45 PM

Preservation of Rare Chrysanthemums at Longwood Gardens

Alan D. Petravich*
Longwood Gardens Inc, Kennett Square, PA; apetravich@longwoodgardens.org

Matthew D. Taylor
Longwood Gardens, Kennett Square, PA; mtaylor@longwoodgardens.org

To insure a world class display of rare chrysanthemums which draws thousands of visitors each year, Longwood Gardens developed procedures to ensure virus-free chrysanthemum stock is preserved on site. Specialty forms of Chrysanthemum x morifolium, such as spider forms and cascades, are not readily available in the trade, and laws prohibit the import of varieties from outside of the United States. Availability of specialty forms is very limited. In some cases the stock is available from only one nursery or public garden. Chrysanthemum Virus B is often wide spread in existing stock. To maintain clean chrysanthemum stock Longwood Gardens created a preservation strategy. Longwood maintains duplicate stock in greenhouses and tissue culture. Each year greenhouse plants are tested for the presence of chrysanthemum virus B. Clean stock is established in tissue culture where it acts as a bank of clean material. If greenhouse stock becomes infected, the tissue culture stock can be rooted out for replacement of infected greenhouse stock. If only infected plants are available a meristem isolation procedure is conducted to eliminate virus. Stock in tissue culture is multiplied each year to supplement greenhouse cuttings for the display crop. To reduce labor, cultures are grown at temperatures between 38 °F and 45 °F Fahrenheit to slow growth rate and need for culture renewal. Cultures grown at room temperature are renewed approximately every six months. Cultures grown under cool temperatures don’t need renewal for at least a year. Each year a third of plants in tissue culture are grown to flowering to verify identity which could have altered from mutations or mislabeling. Using this strategy, Longwood is able to maintain approximately 150 cultivars of rare chrysanthemum, create clean plants for their own use, and in some cases share rare stock with the community.

Specified Source(s) of Funding: The USDA National Institute of Food and Agriculture’s Specialty Crop Research Initiative and Michigan State University’s Project GREEEN
UVB Radiation Affects Intumescence Development in Ornamental Sweet Potato (Ipomoea batatas)

Joshua K. Craver*
Kansas State University, Manhattan; joshuakcraver@gmail.com

Chad T. Miller
Kansas State University, Manhattan; ctmiller@ksu.edu

Kimberly A. Williams
Kansas State University, Manhattan; kwilliam@ksu.edu

Nora Bello
Kansas State University, Manhattan; nbello@ksu.edu

Intumescences are a physiological disorder characterized by hypertrophy and possibly hyperplasia of plant tissue cells. Ultimately, this disorder results in the death of the affected cells. Previous observations and research suggest that the quality and quantity of light to which plants are exposed may be a factor in development of the disorder. The purpose of this study was to assess the preventive effect of UVB radiation on intumescence development in ornamental sweetpotato (Ipomoea batatas). Two sweetpotato cultivars, ‘Blackie’ and ‘Ace of Spades,’ were grown under light treatments consisting of 1) normal glass greenhouse production conditions; 2) supplemental UVB lighting; 3) supplemental UVB lighting with Mylar® sleeves over the lamps to block UVB radiation; and 4) control lighting with full spectrum lamps. Treatments were administered for two weeks, and these runs were repeated twice. The ‘Ace of Spades’ cultivar was highly susceptible to intumescence development, while ‘Blackie’ was much less susceptible to the disorder. For ‘Ace of Spades,’ the addition of UVB radiation significantly reduced the number of leaves affected with intumescences when compared to plants grown under the other light treatments; this UVB effect was not apparent for ‘Blackie’. Further, there was no evidence for reduced plant growth under UVB light in either cultivar, but side effects from the radiation included leaf discoloration and deformities. This study indicates a cultivar-specific effect of UVB light in minimizing intumescence development on ornamental sweetpotato, therefore suggesting a potential genetic component in intumescence susceptibility. These results provide further insight into intumescence occurrence and how to prevent the disorder.

Specified Source(s) of Funding: The Fred C. Gloeckner Foundation, Inc.

Soy-based Biocontainers Allow for Reduced Fertilizer Inputs

Christopher J. Currey*
Iowa State University, Ames; ccurrey@iastate.edu

Kenneth G. McCabe
Iowa State University, Ames; kgmccabe@iastate.edu

In previous research with soy-based bioplastic containers, we found that nitrogen (N), phosphorous (P), and potassium (K) are liberated from the container material during plant production and become available for uptake and assimilation. Therefore, if greenhouse crops are produced in soy-based biocontainers, fertilizer-application strategies may need to be adjusted to account for mineral nutrients released from this type of biocontainer. Our objectives were to quantify the impact of container type and amount of applied mineral nutrients on the growth and mineral nutrient content and concentration in marigold shoots. Seedlings of Tagetes patula L. (marigold) ‘Honeycomb’ were transplanted into one of six container types filled with a commercial soilless substrate of 70% sphagnum peat moss and 30% perlite (by vol.) with no fertilizer (i.e. starter charge). The six container types included a petroleum-plastic container and five types of soy composite (by weight) containers: 1) 50% soy plastic and 50% polyactic acid (PLA); 2) 33% soy plastic and 67% PLA; 3) 30% soy plastic, 60% PLA, and 10% dried distillers grains with solubles (DDGS); 4) 33% soy plastic and 67% polyhydroxyalkanoate (PHA); and 5) a proprietary, protein-based bioplastic material. All containers were molded on the same prototype mold to eliminate confounding effects of container design. Plants were fertilized with one of five fertilizer regimes providing a total of 60, 75, 105, 150, or 300 mg of N from a complete, water-soluble fertilizer (16.6N–5P–16.3K) over six weeks. Shoot N concentration was 45% (300 mg of N) to 313% (60 mg applied N) greater for marigolds grown in biocontainers comprised of soy-PLA bioplastic, but not soy-PHA, compared to those grown in petroleum containers within any given N application. When only 60 mg of N was applied, shoot dry mass of plants grown in soy-PLA containers was 23–68% greater than shoot mass of plants grown in conventional containers of petroleum plastic. However, when 300 mg of N was applied, there were no differences in shoot dry mass between plants grown in petroleum-plastic and bioplastic containers. When 60 mg of N was provided, shoot N content increased from 30 mg for plants grown in petroleum-plastic containers to 227 mg for plants grown in 50%-50% soy-PLA biocontainers, indicating a substantial N release from these soy-based containers. The use of soy-PLA containers in greenhouse crop production will allow producers to reduce the amount of fertilizer input, while still providing adequate mineral nutrients for healthy plant growth.
Use of Sphagnum Moss As a New Growth Medium in Advanced Life Support Systems

Michelle M.P. McKeon-Bennett*
Limerick Institute of Technology, Limerick; michelle.bennett@lit.ie
Raymond M. Wheeler
NASA, Kennedy Space Center, FL; raymond.m.wheeler@nasa.gov
Trevor R. Hodkinson
Trinity College Dublin, Dublin 2; trevor.hodkinson@tcd.ie

Advanced Life Support technologies are used in regenerative life support systems to enable human flight beyond Earth’s atmosphere. On long duration missions such as the establishment of a permanent base on the Moon or Mars, humans will require a continual food, water and air supply. For these flights it is not economical or practical to re-supply elements from Earth, therefore, the development of an integrated energy efficient technology to produce food, purify water, and scrub the air is paramount. Such a technology could for example involve hydroponic systems contributing to water purification, air revitalisation and resource recovery from organic waste, all while operating under restrictions of minimising volume, mass, energy, and labour. This research investigated the use of Sphagnum moss in a hydroponic/resource-recovery system for this purpose. Sphagnum leaves are nerveless, lack vascular tissue and are composed of two main cells, ‘living’ narrow green cells and inflated colorless ‘dead’ cells. The enormous water holding capacity of the plant is attributed to these dead cells. Sphagnum cuspidatum was selected for this investigation, based on its resilience to nutrient and environmental fluctuations. A salad crop trial using lettuce cv. Flandria was initiated and observed for 28 days with the sphagna as the growth medium. Five trays were set up: Rockwool control + ½ Hoagland’s; Sphagna ‘living’ + ½ Hoagland’s; Sphagna ‘dead’ + ½ Hoagland’s; Sphagna ‘living’ + Urine Simulate & Sphagna ‘dead’ + Urine Simulate. The effectiveness of the Sphagna to buffer the lettuce against nutrient overload was measured in both the Hoagland’s and urine simulate tests. The benefit of ‘living’ Sphagna versus ‘dead’ was also determined. Microbial characterization was completed using plate counts and PCR, while elemental analysis was carried out on both the lettuce & sphagna tissue to determine nutrient concentrations. Lettuce in all 4 test trays with Sphagna showed healthy growth and nutrient concentration within the tissue was higher than that observed in the control. The urine simulate test trays, while causing stress to the live sphagna plants, exhibited a higher nutrient load than the Hoagland’s, with some leaf burning of the lettuce evident as the trial proceeded. We found that the ‘dead’ Sphagna plants performed similar to the live Sphana, making it a suitable choice for space flight, as it can be dehydrated before flight to reduce weight and rehydrated for use.

Growth Chambers and Controlled Environments 1
Moderator: Michelle M.P. McKeon-Bennett; michelle.bennett@lit.ie

Oral Presentations

Thursday, July 31, 2014

Use of Sphagnum Moss As a New Growth Medium in Advanced Life Support Systems

Michelle M.P. McKeon-Bennett*
Limerick Institute of Technology, Limerick; michelle.bennett@lit.ie
Raymond M. Wheeler
NASA, Kennedy Space Center, FL; raymond.m.wheeler@nasa.gov
Trevor R. Hodkinson
Trinity College Dublin, Dublin 2; trevor.hodkinson@tcd.ie

Advanced Life Support technologies are used in regenerative life support systems to enable human flight beyond Earth’s atmosphere. On long duration missions such as the establishment of a permanent base on the Moon or Mars, humans will require a continual food, water and air supply. For these flights it is not economical or practical to re-supply elements from Earth, therefore, the development of an integrated energy efficient technology to produce food, purify water, and scrub the air is paramount. Such a technology could for example involve hydroponic systems contributing to water purification, air revitalisation and resource recovery from organic waste, all while operating under restrictions of minimising volume, mass, energy, and labour. This research investigated the use of Sphagnum moss in a hydroponic/resource-recovery system for this purpose. Sphagnum leaves are nerveless, lack vascular tissue and are composed of two main cells, ‘living’ narrow green cells and inflated colorless ‘dead’ cells. The enormous water holding capacity of the plant is attributed to these dead cells. Sphagnum cuspidatum was selected for this investigation, based on its resilience to nutrient and environmental fluctuations. A salad crop trial using lettuce cv. Flandria was initiated and observed for 28 days with the sphagna as the growth medium. Five trays were set up: Rockwool control + ½ Hoagland’s; Sphagna ‘living’ + ½ Hoagland’s; Sphagna ‘dead’ + ½ Hoagland’s; Sphagna ‘living’ + Urine Simulate & Sphagna ‘dead’ + Urine Simulate. The effectiveness of the Sphagna to buffer the lettuce against nutrient overload was measured in both the Hoagland’s and urine simulate tests. The benefit of ‘living’ Sphagna versus ‘dead’ was also determined. Microbial characterization was completed using plate counts and PCR, while elemental analysis was carried out on both the lettuce & sphagna tissue to determine nutrient concentrations. Lettuce in all 4 test trays with Sphagna showed healthy growth and nutrient concentration within the tissue was higher than that observed in the control. The urine simulate test trays, while causing stress to the live sphagna plants, exhibited a higher nutrient load than the Hoagland’s, with some leaf burning of the lettuce evident as the trial proceeded. We found that the ‘dead’ Sphagna plants performed similar to the live Sphana, making it a suitable choice for space flight, as it can be dehydrated before flight to reduce weight and rehydrated for use.

8:15–8:30 AM
Lettuce Growth and Morphology in a Red-rich Low PAR Light Environment in a Greenhouse

Michael B Whalen*
University of Arizona, Tucson; michaelwhalen@email.arizona.edu
Chieri Kubota
University of Arizona, Tucson; ckubota@cals.arizona.edu
Murat Kacira
University of Arizona, Tucson; mkacira@cals.arizona.edu
Wenyue Li
University of Arizona, Tucson; wli@email.arizona.edu
Caitlyn Hall
University of Arizona, Tucson; caitlynahall@gmail.com
Paul Meyer
Abengoa Solar Inc., Lakewood, CO; paul.meyer@solar.abengoa.com

Selective filtration of sunlight has been shown to affect the growth of plants. In this research a side-by-side comparison was done between two greenhouses, a conventional (control) greenhouse covered with double-layer acrylic panels and an experimental greenhouse covered with a glazing that creates a red-rich diffuse light environment while generating electric power through photovoltaic cells integrated into the glazing (Abengoa Solar US Patent pending). Two cultivars of lettuce (Lactuca sativa), ‘Rex’ and ‘Magenta’, were grown hydroponically for 60 days (November 27 to January 26, 2014). Average daily light integral (DLI) over the plant canopy was 9.7 ± 2.1 and 6.5 ± 1.4 mol·m⁻² in the control and experimental greenhouse, respectively. When measured under a clear sky at midday, red (600-700 nm) photon flux over PAR (400–700 nm) was 38.5% and 64.4% and red to blue (400-500nm) photon flux ratio was 1.42 and 2.95 in the control and the experimental greenhouse, respectively. Average day/night temperatures were almost the same (22.8 ± 0.9 °C/17.9 ± 0.4 °C in the control and 23.6 ± 1.2 °C/17.9 ± 0.3 °C in the experimental greenhouse). Despite the lower DLI, initial plant fresh and dry weight in the experimental greenhouse was equal to or significantly greater than in the control, depending on variety. Thirty-three days after seeding (DAS), shoot fresh weight, shoot dry weight, and leaf area were 49%, 31%, and 55% greater, respectively, for ‘Magenta’ in the control greenhouse compared to the same (22.8 ± 0.9 °C/17.9 ± 0.3 °C in the control greenhouse). The enhanced initial growth of lettuce in the experimental greenhouse, despite the low DLI, was presumable due to greater canopy light interception caused by larger leaf area due to altered red-rich light quality. The higher yield in the control greenhouse compared to the experimental greenhouse at the final harvest in comparison to the seeding stage was likely due to canopy closure beginning around 41
Large Plant Growth Chambers: Flying Soon on a Space Station Near You!

Gioia D. Massa*
NASA, Kennedy Space Center, FL; gioia.massa@nasa.gov

Robert C. Morrow
ORBITEC, Madison, WI; morrowr@orbitec.com

Howard G. Levine
NASA Kennedy Space Center, Kennedy Space Center, FL; howard.g.levine@nasa.gov

The International Space Station (ISS) now has platforms for conducting research on horticultural plant species, and those capabilities continue to grow. The ‘Veggie’ vegetable production system will be deployed to the ISS in Spring of 2014 to act as an applied research platform with goals of studying food production in space, providing the crew with a source of fresh food, allowing behavioral health and plant microbiology experimentation, and being a source of recreation and enjoyment for the crew. Veggie was conceived, designed, and constructed by Orbital Technologies Corporation (ORBITEC, Madison, WI). Veggie is the largest plant growth chamber that NASA has flown to date, and is capable of growing a wide array of horticultural crops. It was designed for low energy usage, low launch mass and stowage volume, and minimal crew time requirements.

The Veggie flight hardware consists of a light cap containing red (630 nm), blue (455 nm) and green (530 nm) LEDs. Interfacing with the light cap is an extendable bellows/baseplate secured to the light cap via magnetic closures and stabilized with extensible flexible arms. The baseplate contains vents allowing air from the ISS cabin to be pulled through the plant growth area by a fan in the light cap. The baseplate holds a Veggie root mat reservoir that will supply water to plant pillows attached via elastic cords. Plant pillows are packages of growth media and seeds that will be sent to ISS dry and installed and hydrated on orbit. Pillows can be constructed in various sizes for different plant types. Watering will be via passive wicking from the root mat to the pillows. Science procedures will include photography or videography, plant thinning, pollination, harvesting, microbial sampling, water sampling, etc. Veggie is one of the ISS flight options currently available for research investigations on plants. The Plant Habitat (PH) is being designed and constructed through a NASA–ORBITEC collaboration, and is scheduled to Fly on ISS around 2016. This large plant chamber will control light quality, level, and timing, temperature, CO2, relative humidity, and irrigation, while scrubbing ethylene. Additional monitoring capabilities include leaf temperature sensing and root zone moisture and oxygen sensing. The PH light cap will have red (630 nm), blue (450 nm), green (525 nm), far red (730 nm) and broad spectrum white LEDs. There will be several internal cameras to monitor and record plant growth and operations.
Oral Presentations

9:00–9:15 AM

**A Novel Organic Substrate Based on Hemp (Cannabis sativa) or Flax (Linum usitatissimum) Fibre for Hydroponic Systems**

Stephanus J Rossouw*
McGill University, Montreal, QC; stephanus.rossouw@mcgill.ca

Mark Lefsrud
McGill University, Ste-anne-de-Bellevue, QC; mark.lefsrud@mcgill.ca

Valerie Gravel
McGill University, Ste-anne-de-Bellevue, QC; valerie.gravel@mcgill.ca

New consumer considerations regarding mining impacts and waste disposal issues have highlighted the need to innovate alternative horticultural media. The goal of this study is to determine whether a novel hydroponic substrate based on the bast fibres of hemp (Cannabis sativa) or flax (Linum usitatissimum) could perform comparable with popular existing media. First, physical and chemical properties of hemp- and flax bast fibre were characterized in the laboratory, including effective pore volume, moisture content, moisture holding capacity, saturated hydraulic conductivity, cation exchange capacity, electrical conductivity, and pH. These properties were evaluated as useful indicators of the media’s ability to exchange and store both oxygen and water, as well as to provide information about its chemical nature. In the second part of the study a plant growth trial was conducted to compare the effect of 9 hydroponic media on plant growth parameters. Lettuce (Lactuca sativa var. Buttercrunch) was cultivated for 28 days in a greenhouse for two weeks in a grow chamber, followed by another two weeks in the Plant Research Facility Greenhouse (McGill University, Macdonald campus) using a nutrient film technique (NFT) hydroponic system. Plants were analyzed at two points in time: at germination (days 2-7), and postharvest. At germination we will measure total germination frequency and mean germination time. Following harvest, we will determine shoot biomass (fresh and dry), root biomass (fresh and dry), shoot:root biomass ratio (fresh and dry), moisture content and levels of various nutrients and metabolites were evaluated. Results from this study may potentially lead to a novel hydroponic substrate that is biodegradable, harvested sustainably, and produced from local resources that are frequently (un)underutilized.

Specified Source(s) of Funding: Urban Barns and NSERC

9:30–9:45 AM

**Enrichment of Tissue Iron (Fe) Contents of Leaf Lettuce Grown Hydroponically**

Adeline Bordier
North Dakota State University, Fargo; adeline.bordier@wanadoo.fr

Chiwon W. Lee*
North Dakota State University, Fargo; chiwon.lee@ndsu.edu

This experiment was conducted to enhance tissue concentrations of iron (Fe++) in leaf lettuce (Lactuca sativa cv. Grand Rapids) plants grown hydroponically. The nutrient solution containing the standard macronutrient concentrations (meq/liter: 2 NH₄⁺, 10 NO₃⁻, 4 Ca++, 6 K⁺, 2 Mg²⁺, 2 SO₄²⁻, 2 H₂PO₄⁻) was modified to contain 0.01, 0.01, 0.1, 1, 2, 4 meq/liter Fe++ using iron sulfate (FeSO₄). The concentration of SO₄²⁻ increased from 2 meq/liter to 2.01, 2.1, 3, 4, 6 meq/liter to accommodate the elevated levels of Fe++ in the nutrient treatment solutions. All treatment solutions contained the standard micronutrient concentrations of Hoagland solution. Compared to the control treatment (0.01 meq/liter), the growth of lettuce was reduced when the nutrient solution contained 1 meq/liter or higher Fe++ concentrations. The leaf tissue Fe++ content was elevated linearly (R² = 0.893) as nutrient solution Fe++ levels increased, with the highest tissue Fe++ content (1.53 g/kg, dry weight basis) being achieved when plants were grown with 4 meq/liter Fe++ in the hydroponic solution for 35 days. However, the use of FeSO₄ to increase Fe++ in the nutrient solution has a limitation due to suppression of plant growth on Grand Rapids lettuce, especially when nutrient Fe++ concentrations exceeded 0.1 meq/liter. The possible use of chelated forms of iron in the nutrient solution may be tested as a means of reducing plant toxicity during hydroponic culture.

9:15–9:30 AM

**Evaluation of Colored Shade Cloth on Tomato Production in Oklahoma**

Charles Rohla*
The Samuel Roberts Noble Foundation, Ardmore, OK; ctrohla@noble.org

Will Chaney
The Samuel Roberts Noble Foundation, Ardmore, OK; jwchaney@noble.org

Colored shade cloths have shown a potential to lengthen the growing season of many crops. This study was designed to evaluate three different colors of shade cloth on the production of tomatoes in Oklahoma. Black, red and aluminet shade cloths were compared to a control. There was no significant difference in total production per plant or number of fruit per plant among the treatments. Average weight of fruit grown under black shade cloth was significantly higher than fruit grown under red shade cloth. Black shade cloth increased percent marketable fruit compared to control, while the red shade cloth had a lower percent marketable fruit than the control. Percent grade 1 fruit was lowest under the red shade cloths. All shade cloths declined the maximum temperature observed within the canopy of the plants. With the black shade cloth significantly lower than the red or aluminet for maximum temperature. This study was conducted for two years and there was a significant difference between both years. The data indicates that the black shade cloth increased the performance of the tomato plants over the other control, while the red shade cloth actually decreased average weight and percent marketable fruit.

9:45–9:55 AM

**Evaluation of Colored Shade Cloth on Tomato Production in Arizona**

Margaret W. Johnson
The Samuel Roberts Noble Foundation, Ardmore, OK; mjohnson@noble.org

The use of colored shade cloths has been shown to lengthen the growing season of many crops. This study was designed to evaluate three different colors of shade cloth on the production of tomatoes in Arizona. Black, red and aluminet shade cloths were compared to a control. There was no significant difference in total production per plant or number of fruit per plant among the treatments. Average weight of fruit grown under black shade cloth was significantly higher than fruit grown under red shade cloth. Black shade cloth increased percent marketable fruit compared to control, while the red shade cloth had a lower percent marketable fruit than the control. Percent grade 1 fruit was lowest under the red shade cloths. All shade cloths declined the maximum temperature observed within the canopy of the plants. With the black shade cloth significantly lower than the red or aluminet for maximum temperature. This study was conducted for two years and there was a significant difference between both years. The data indicates that the black shade cloth increased the performance of the tomato plants over the other control, while the red shade cloth actually decreased average weight and percent marketable fruit.
Thursday, July 31, 2014

Postharvest 2
Moderator: Yosef Al Shoffe; Yas24@cornell.edu
8:00–8:15 AM

1-Methylcyclopropene (1-MCP) Effects on Ethylene Biosynthesis in Relation to Flesh Browning of ‘Empire’ Apple Fruit

Mahmoud Saba
Cornell University, Ithaca, NY; mk959@cornell.edu
Nigel E. Gapper
Cornell University, Ithaca, NY; Neg29@cornell.edu
Jacqueline F. Nock
Cornell University, Ithaca, NY; jfn3@cornell.edu
James Giovannoni
USDA–ARS, Boyce Thompson Institute, Ithaca, NY; jjg33@cornell.edu
Christopher B. Watkins*
Cornell University, Ithaca, NY; cbw3@cornell.edu

It has been hypothesized that inhibited ethylene production as a result of storage temperatures such as 0.5 °C, or by 1-methylcyclopropene (1-MCP) treatment at warmer temperatures such as 3-4 oC, is a causal factor in flesh browning of controlled atmosphere (CA) stored ‘Empire’ apples. In this study we have investigated the effects of 1-MCP at storage temperatures of 0.5 °C and 3 °C on ethylene biosynthesis of CA stored fruit. Internal ethylene concentrations (IECs), 1-aminocyclopropane-1-carboxylate (ACC) and malonyl ACC (MACC) concentrations, and activities of ACC synthase (ACS) and ACC oxidase (ACO) in peel and flesh, and gene expression of ACS, ACO and ACC N-malonyl transferase (MT) peel, was assessed. Flesh browning occurred in all treatments except for untreated fruit stored at 3 °C, and this was the only treatment where IECs increased during storage. The most distinct patterns of change were detected in peel tissues; ACS1 expression, ACS activity and ACC concentrations were highest in untreated fruit stored at 3 °C and were lowest in untreated and 1-MCP treated fruit stored at 0.5 °C. However, they increased in a similar fashion in 1-MCP treated fruit stored at 3 °C. ACO1 and ACO2 expression remained low in 1-MCP treated fruit irrespective of storage temperature. MT expression and MACC concentrations increased toward the end of storage. The effects of treatment on ethylene in relation to flesh browning will be discussed.

Specified Source(s) of Funding: NE1336

8:15–8:30 AM

Yield and Postharvest Quality of Tablestock Potato (Solanum tuberosum L.) in Response to Irrigation Method and Harvest Time

Mildred N. Makani*
University of Florida, Gainesville; mmakani@ufl.edu
Steven A. Sargent
University of Florida/IFAS, Gainesville, FL; sasa@ufl.edu

Increased competition for water resources has resulted in the need to evaluate more water use efficient irrigation methods. The harvest quality and storability of two tablestock potato varieties were evaluated for two spring seasons in response to irrigation method and harvest time. ‘Fabula’ and ‘Red LaSoda’ potatoes were irrigated using seepage (SP), surface drip (SD), or sub-surface drip (SSD) irrigation (tape buried 0.05 m below the seed piece). Plant vines were killed off before harvest to promote tuber skin maturation. Tubers were harvested 1 to 3 weeks after vine kill (H1, H2, and H3) and stored for 14 d at 10 °C and 90% to 95% relative humidity. In ‘Fabula’, total yields for SP and SD averaged 26,230 kg·ha⁻¹, while SSD yields were significantly lower at 15,249 kg·ha⁻¹. Soil moisture fluctuations under SP resulted in higher incidences of tuber physiological disorders. At harvest, differences in tuber quality were only observed in the second season, due to prolonged exposure of tubers to wet soils. H1, SSD tubers were 8.4 N firmer than SD tubers. Increased moisture uptake resulted in decreased peel dry matter content (DMC) with increased harvest time. SP tubers had the highest DMC at H2 and H3, compared to those grown with drip. Incomplete skin maturation in H1 tubers made them more susceptible to storage losses. H1 drip tubers were 4.9 N firmer than SP at d 0, with no significant difference by 14 d, due to moisture loss. DMC of H1, SD tubers also increased significantly, from 14.6% to 17.4% due to lower moisture content. Ascorbic acid content (AAC) decreased with increased storage time for all H1 tubers, although drip tubers maintained a higher average of 17.1 mg/100g at 14 d, compared to SP’s 11.8 mg/100g. In ‘Red LaSoda’, although SP produced the highest total yields in both seasons, uneven soil wetting patterns resulted in more physiological disorders. In storage, only during the second season, H1, SSD and H2, SP lost the most fresh weight of 4.1% and 3.8%, respectively, due to immature tuber skins. These results indicate that SD shows potential to improve water use efficiency in ‘Fabula’ potatoes while maintaining high tuber yields and postharvest quality. This was especially true when tubers were harvested 2 to 3 weeks after vine kill. In ‘Red LaSoda’, although SP resulted in higher yields, tubers grown with drip irrigation had comparable quality.

8:30–8:45 AM

Conditioning of ‘Honeycrisp’ Apple to Prevent Injury by Controlled Atmosphere Storage: Testing a Matrix of Temperatures and Exposure Durations

Randolph Beaudry
Michigan State University, East Lansing; beaudry@msu.edu
Diep Tran*
Michigan State University, East Lansing; trandiep@msu.edu

‘Honeycrisp’ apple [Malus sylvestris (L.) Mill. var. domestica
(Borkh.) Mansf.] fruit are susceptible to damage by the low \( O_2 \) and elevated \( CO_2 \) partial pressures in controlled atmosphere (CA) storage. The injury takes the form of small to extensive dark brown lesions in the cortex and lens-shaped openings typical of \( CO_2 \) injury reported for other apple varieties. The browning is somewhat more patchy and less smooth-edged than that of the chilling injury soggy breakdown when viewed in transverse cross section. Previously we have shown that a prestorage conditioning treatment can suppress CA injury. However, the conditioning treatment has not been optimized. To better understand the relationship between the duration of the conditioning treatment and the temperature during conditioning, we exposed ‘Honeycrisp’ fruit from 6 different orchards to combinations of temperature (3, 10, 15, 20 and 25 °C) and conditioning durations (0, 1, 3, 5, and 7 days). After conditioning, fruit were held at 3 °C in CA (3 kPa \( O_2 \) and 3 kPa \( CO_2 \)) for 7 months and subsequently evaluated for CA injury, aroma profile, fruit firmness, °Brix and titratable acids and subjected to a sensory evaluation of degree of ripeness. We found that increasing the conditioning time reduced susceptibility to CA injury at all temperatures. Use of a 10 °C conditioning temperature was not sufficient to reduce injury to acceptable levels. A minimum of 3 days at 20 °C or 25 °C was required to effectively suppress CA injury. Increasing the temperature and duration of the conditioning period tended to increase ripeness-related volatiles, but only the most extreme treatment (7 d at 25 °C) resulted in a discernable advancement in ripeness as determined by a trained panel.

Specified Source(s) of Funding: Michigan Apple Committee and Project GREEEN

8:45–9:00 AM

**Bitter Pit and Soft Scald in ‘Honeycrisp’ during Cold Storage**

Yosef Al Shoffe*
Cornell University, Ithaca, NY; yas24@cornell.edu

Jacqueline F. Nock
Cornell University, Ithaca, NY; jfn3@cornell.edu

Christopher B. Watkins
Cornell University, Ithaca, NY; cbw3@cornell.edu

‘Honeycrisp’ apples grown in six orchards in the Hudson Valley (HV) and twelve orchards in Western New York (WNY) were harvested and stored at 3 °C for up to four months. Bitter pit and soft scald incidence was assessed at monthly intervals. Minerals were analyzed from fruit peel before three weeks of harvest and at harvest. Most bitter pit occurred in fruit from the HV, but wherever present was highest at harvest and during the first month of storage. Soft scald incidence was low, and mainly confined to WNY, but developed only after two months of storage. High correlations were detected between bitter pit and levels of N, P, K, N/Ca, Mg, Mg+N/Ca ratio, Cu and B measured three weeks before harvest, and between bitter pit and Mg/Ca, N, Ca, and Mg+N/Ca at harvest. In a separate experiment, fruit from two WNY orchards were stored directly at 0.5 °C or 3 °C, or after conditioning for 7 days at 10 °C. The highest soft scald and soggy breakdown incidences were measured in fruit stored at 0.5 °C; conditioning reduced the incidence of these disorders but did not prevent them at 0.5 °C. Bitter pit was generally highest in fruit stored at 3 °C, and especially with conditioning. These results will be discussed in relationship to management strategies for ‘Honeycrisp’ apples.

Specified Source(s) of Funding: NY Apple R&D program; NE1336

9:00–9:15 AM

**Humidity-efficient Clamshells to Decrease Moisture Loss and Extend Storage Life of Small Fruits**

Jinhe Bai*
USDA–ARS, USHRL, Ft. Pierce, FL; jinhe.bai@ars.usda.gov

Elizabeth Baldwin
USDA–ARS, USHRL, Fort Pierce, FL; Liz.Baldwin@ars.usda.gov

Anne Plotto
USDA–ARS, USHRL, Fort Pierce, FL; anne.plotto@ars.usda.gov

Xiuxiu Sun
USDA–ARS, USHRL, Ft. Pierce, FL; xiuxiu.sun@ars.usda.gov

Libin Wang
USDA–ARS, USHRL, Ft. Pierce, FL; libin.wang@ars.usda.gov

Zhe Wang
USDA–ARS, USHRL, Ft. Pierce, fl; wangzhejida2008@163.com

Jan Narciso
USDA–ARS, USHRL, Ft. Pierce, FL; jan.narciso@ars.usda.gov

Clark F. Seavert
Oregon State University, Corvallis; clark.seavert@oregonstate.edu

A humidity efficient one-pound clamshell was designed for small fruit packaging. Quality attributes and shelf-life of lychee, sweet cherry, strawberry, blueberry, Chinese bayberry, and loquat fruits packaged in the new clamshells and commercial clamshells were compared during storage at 0 °C, 5 °C, 10 °C, and/or 20 °C. Water loss of fruit in the new clamshells decreased by at least 62%, in comparison to commercial clamshells at all storage temperatures. As a result, fruit in the new clamshells had less surface shriveling and flesh softening (cherry, strawberry and blueberry), stem (cherry) and calyx (strawberry) browning and drying, and pericarp browning (lychee). Oxygen and \( CO_2 \) concentration in both clamshells did not substantially change from the atmosphere, and there was no anaerobic metabolism in the packaged fruits. Blueberries inoculated with a fruit decay organism, *Colletotrichum acutatum*, or non-inoculated, were packaged in the clamshells and stored at 1 °C and 20 °C, and there was no difference in decay incidence despite the higher internal humidity caused by the reduced open areas. The new clamshell extended shelf-life of fruits by an average of 178% in comparison to commercial clamshells. (Some of the material discussed in this abstract and associated manuscript comprises the subject matter of a patent application currently pending with the U.S. Patent and Trademark Office. If you are interested in licensing the technology described herein, please contact Jinhe Bai or Liz
caused by the α-Proteobacteria Candidatus Liberibacter. Huanglongbing (HLB, also known as greening), presumably led to increased incidence of stem end rot in fruit destined for the fresh market because such fruit are typically treated with ethylene to enhance chlorophyll degradation (“degreening”).

9:30–9:45 AM

**High Incidence of Diplodia Infection in HLB Symptomatic Orange Fruit and Its Implication in the Preharvest Fruit Drop**

Wei Zhao*  
USDA–ARS, USHRL, Ft. Pierce, FL; wei.zhao@ars.usda.gov  
Jinhe Bai  
USDA–ARS, USHRL, Ft. Pierce, FL; jinhe.bai@ars.usda.gov  
Greg McCollum  
USDA–ARS, USHRL, Ft. Pierce, FL; Greg.Mccollum@ars.usda.gov  
Elizabeth Baldwin  
USDA–ARS, USHRL, Ft. Pierce, FL; Liz.Baldwin@ars.usda.gov  
Huanglongbing (HLB, also known as greening), presumably caused by the α-Proteobacteria Candidatus Liberibacter, is one of the most devastating diseases of citrus and is currently having significant impact on the Florida citrus industry. In an investigation conducted to identify fungal species in juice from HLB-symptomatic fruit, we found that Diplodia natalensis (Diplodia) was consistently present in HLB-symptomatic fruit (harvested from HLB symptomatic trees), but not in non-symptomatic fruit (harvested from trees showing no symptoms of HLB). Diplodia is the causal organism of citrus stem end rot; the pathogen infects citrus fruit under the calyx, and is associated with cell wall hydrolytic enzymes involved in abscission. Stem end rot caused by Diplodia is rarely seen in fruit on the tree, but typically occurs following harvest and is exacerbated by exposure to ethylene. One symptom of HLB is excessive fruit drop, and as the severity of HLB has increased throughout Florida, preharvest fruit drop has become the most severe ever recorded. Based on the consistent incidence of Diplodia in HLB-affected fruit and the relationship between Diplodia and cell wall hydrolytic enzymes in the calyx abscission zone, we conducted experiments to determine the potential role of Diplodia infection in fruit drop. Based on qPCR analysis using primers specific for the β-tubulin gene of Diplodia, we found a significantly greater incidence of the pathogen in the calyx of HLB-symptomatic fruit than in non-symptomatic fruit (70% and 5%, respectively). Diplodia infection was confirmed by morphology of conidia in isolates from the calyx abscission zone of HLB-symptomatic fruit. Two weeks following exposure to ethylene (10 ppm, 4 days) the incidence of stem end rot in HLB-symptomatic fruit (66.7%) was significantly greater than in non-symptomatic fruit (6.7%). Fruit detachment force for 88% of the HLB-symptomatic fruit was between 0–20 N, whereas for non-symptomatic fruit, detachment force was 30–45 N. Ethylene production from non-HLB-symptomatic was below the limit of detection, however, ethylene production was detected from 60% of symptomatic fruit. Fruit detachment force was negatively correlated with Diplodia titer ($R^2=0.79$), and positively correlated with ethylene production ($R^2=0.70$), suggesting that Diplodia infection may contribute to the HLB-associated preharvest fruit drop. In addition to the potential impact on fruit drop, an increase in Diplodia infection could lead to increased incidence of stem end rot in fruit destined for the fresh market because such fruit are typically treated with ethylene to enhance chlorophyll degradation (“degreening”).

9:45–9:60 AM

**Effects on Fruit Quality**

Adrian D. Berry  
University of Florida/IFAS, Gainesville; adberry@ufl.edu  
Steven A. Sargent  
University of Florida/IFAS, Gainesville; sasa@ufl.edu  
Marcelo A.G. Carnelossi*  
Federal University of Sergipe, Aracaju; magcarnelossi@oi.com.br  

Blueberry is widely produced in the USA and around the world. Fruits are harvested fully ripe and, as such, are highly perishable. One strategy to maintain fruit quality during commercial handling is rapid cooling. Currently blueberries are forced-air cooled for 60 to 90 min to 2 to 3 °C pulp temperature. Hydrocooling is an effective cooling method widely used for many crops such as peach, cherry, avocado, mango, sweetcorn, and carrot. Hydrocooling is also a potential cooling method for blueberry. The objective of this work was to compare the cooling efficiency of forced-air cooling (FA) with hydrocooling (HY) and with hydrocooling plus forced-air cooling (HY+FA) and the effects on blueberry fruit quality. ‘Emerald’ and ‘Farthing’ (Vaccinium coribosum) are widely grown southern highbush cultivars released from the University of Florida breeding program. ‘Emerald’ is a vigorous, high-yielding cultivar with large fruit and good shipping quality. ‘Farthing’ has high quality, with dark peel color and exceptionally firm texture. ‘Emerald’ and ‘Farthing’ blueberries were commercially harvested and cooled using the three methods. FA was accomplished in a small-scale unit within a cold room with air maintained at 1 °C; there was 15.2 mm pressure drop across the plenum during a 27-minute treatment period. For HY, fruits in clamshells (125 g) were immersed in chlorinated ice-water (200 ppm free Cl-1) for 3 minutes. For HY+FA, following HY the clamshells were transferred to FA for 30 minutes. After cooling treatments, the clamshells were stored at 1 °C for 21 d and the fruit quality, weight gain/loss, appearance, freshness, firmness, bloom, anthocyanin content, soluble solids content, pH, titratable acidity, decay and bruising were determined weekly. ‘Emerald’ was more sensitive to HY than ‘Farthing’, where several fruit from the former showed skin breaks. The initial firmness for ‘Farthing’ was 3.5 N for all treatments and decreased to 2.9 N after 21 d while for ‘Emerald’ the initial firmness was 2.7 N and decreased to 2.4 N during

---

An asterisk (*) following a name indicates the presenting author.
Bruising in Avocado (Persea americana M.) ‘HASS’ Supply Chains in Queensland Australia: Ripener to Retailer

Muhammad S. Mazhar*
University of Queensland, Gatton Qld; sohail@uq.edu.au

Daryl C. Joyce
University of Queensland, Gatton Qld; d.joyce@uq.edu.au

Ray J. Collins
University of Queensland, Gatton Qld; ray.collins@uq.edu.au

The avocado fruit cv. Hass supply chains in Queensland Australia are designed and practiced to meet the quality standards demanded by the consumers. The industry players implement a whole of the supply chain system, equipped with systems to ensure that the fruit quality delivered to their buyer is the same what they receive from their supplier, up until the retail. The quality losses at each stage in the supply chain are recorded for continuous improvements in the system. However, the quantitative losses, in terms of flesh bruising have never been documented in the ‘through the supply chain’ context. The incidence and severity of flesh bruising in ripening avocado fruit cv. Hass, as it travelled through the supply chain, has been described in this paper. The objective of this research was to identify where and how much flesh bruising does occur at different stages in the supply chain, from the ripener to the retailer. Fruit samples at serial sampling points (ripening arrival, ripener dispatch, distribution centre arrival, distribution centre dispatch, retail store arrival, and the retail display) along the supply chain were collected and destructive bruising assessment was conducted after 48 h. The results of two consecutive years of research established that the flesh bruising increased as the fruit travelled through the supply chain and it reached at maximum level at the retail display, which was significantly higher than at the previous sampling point. Based on the findings of this experiment, critical points in the supply chains contributing to bruising the avocado fruit cv. Hass have been identified. Further research is recommended to quantify the incidence of bruising in cv. Hass due to the handling practices of shoppers and consumers.
An asterisk (*) following a name indicates the presenting author.

Thursday, July 31, 2014

8:15–8:30 AM

**A Case Study Evaluation of Edible Plants Curriculum Implemented in an Elementary School**

Leila Anne Graves*
Colorado State University, Fort Collins; gravesleila35@gmail.com

Chad T. Miller*
Colorado State University, Fort Collins; ctmiller@colostate.edu

Meena Balgopal
Colorado State University, Fort Collins; Meena.Balgopal@colostate.edu

The main purpose of this study was to describe elementary teachers’ attitudes and perceptions toward plant science. The secondary purpose was to create an edible plant curriculum as a vehicle for integrating STEM and 21st Century skills into Common Core Content. Results indicate that teachers and STEM coordinators did find the curriculum to be effective in teaching the interdisciplinary standard-based and inquiry based content and skills targeted. Additionally, the curriculum development process produced a hybrid design framework that facilitated the creation of life science content as a vehicle for integrating STEM into common core content. However, several significant barriers will need to be overcome with regard to the teachers’, STEM coordinators’ and administrators’ perception that plant science and nutrition literacy are “special” content activities versus important STEM content.

8:30–8:45 AM

**Do High School Students Who Participate in State FFA Career Development Events Matriculate at the Host University? A Case Study with Horticulture CDEs at Kansas State University**

Chad T. Miller*
Kansas State University, Manhattan; ctmiller@ksu.edu

Kimberly A. Williams
Kansas State University, Manhattan; kwilliam@ksu.edu

In recent years, many Horticulture departments around the United States have been concerned with recruiting and retaining an adequate number of students. One potential opportunity for recruitment is horticulture FFA Career Development Events (CDEs). Annually, hundreds of high school students travel to a state’s land-grant university to compete in state-level CDEs that are often coordinated by faculty with teaching and extension appointments in horticultural disciplines. For each of the past 14 years (1999 to 2012), over 100 students have participated annually in the state-level nursery and floriculture CDEs held at Kansas State University, totaling 1,462 participants. Using the rosters from these two CDEs, we referenced the university student information database to determine whether the high school students who participated as FFA horticulture CDE contestants ultimately matriculated to Kansas State University. We investigated whether each FFACDE participant was accepted to K-State; enrolled at K-State; the degree program enrolled in; and whether the student graduated, among other factors. We found that just over half (51.7%) of these former FFA horticulture CDE contestants were accepted to K-State, with 32.1% matriculating at the university. Of those who matriculated, 57.8% enrolled in the College of Agriculture and of these, 18.5% majored in horticulture. This means that of the total number of students who participated in the FFA CDEs, 3.4% majored in horticulture. These results suggest that FFA CDEs have the potential to serve as a valuable recruitment tool and that organizers should create experiences that expose students to career opportunities associated with horticultural disciplines.

8:45–9:00 AM

**Evaluating Difficult Plant Science Concepts in an Introductory Horticulture Course Using Conceptual Maps as Assessment Tools**

Kathryn S. Orvis*
Purdue University, West Lafayette, IN; orvis@purdue.edu

Cecilia Espinoza Morales
Purdue University, West Lafayette, IN; cespino@purdue.edu

Large, introductory horticulture courses are often populated with non-science majors that are taking those courses to fulfill science requirements. These students can struggle with difficult, complex plant science concepts; common examples include photosynthesis and respiration. Previous research has shown that one of the key issues with these misconceptions is that students grapple with comprehension of the relationship between photosynthesis and respiration in plants. Conceptual maps are a teaching tool that illustrate the relationship between concepts, and can be also used to detect common misconceptions retained by students. Therefore concept maps have the potential to not only help detect commonly held misconceptions, but can also help provide scaffolding that can address and remediate mistaken understandings. Utilizing a constructivist approach, a semi-structured conceptual map was developed as an assessment tool to detect commonly held misconceptions about photosynthesis and respiration in an introductory horticulture course at a U.S. Land Grant University. Results indicate that students’ misconceptions associated with photosynthesis and respiration in that course are: (1) photosynthesis gives energy; (2) plants use CO₂ during respiration; (3) respiration reaction is opposite to photosynthesis; (4) respiration happens in the dark and photosynthesis in the light; (5) the goal of photosynthesis and respiration is produced energy to keep the plant alive.

9:00–9:15 AM

**Multicultural Student Perspectives on a Study Abroad Course in Costa Rica**

Kevin D. Gibson*
Purdue University, West Lafayette, IN; kgibson@purdue.edu

An asterisk (*) following a name indicates the presenting author.
Enrollment in study abroad has increased substantially during the last few decades; however, minority participation in study abroad has not kept pace with this growth. To address this need, we delivered a synchronously taught undergraduate course on sustainable agriculture to students at Haskell Indian Nations University and at Purdue University for three semesters from 2010 to 2012. Following the preparatory course, students from both universities participated in a two-week field trip to Costa Rica. An online questionnaire with both Likert-style and open-ended questions was administered in 2013 to assess student perceptions of the course. Despite differences in backgrounds, the Haskell and and Purdue students did not differ in their positive assessment of the course. Our experience suggests that study abroad programs can be developed and offered through partnerships between tribal colleges and universities and predominately white institutions that provide substantial benefits to students at both institutions.

9:15–9:30 AM

Service Learning Program Changes Perspectives and Impacts Professional Skills

Cynthia Haynes*
Iowa State University, Ames; chaynes@iastate.edu

Kevin Duerfeldt
Iowa State University, Ames; kduerf@iastate.edu

The EARTH (Education and Resiliency Through Horticulture) program is a service learning, school gardening partnership between Iowa State University, (ISU), Ames Iowa and Giff Hill School (GHS), St. John, U.S. Virgin Islands. Each semester, 2-4 ISU students spend 8-12 weeks at GHS teaching horticulture, environmental science, and culinary arts. In addition to semester-long internships, ISU students have participated in the EARTH program through a weeklong faculty lead study abroad course Educating Youth Through Horticulture (Hort 282). Students in Hort 282 prepare lesson plans and practice teaching youth including youth at GHS over spring break. Twenty-three undergraduate students, who participated with the EARTH program either as an intern or through Hort 282, were surveyed to record their beliefs on how the EARTH program has impacted their perceptions of sustainability and personal and professional skills. Twenty-one students responded (91% response rate) to the 27-question survey administered in March 2013. Ninety-five percent of students agreed or strongly agreed that they learned a lot about conserving resources. Almost 81% agreed or strongly agreed that they practice sustainability more often at home, and 85% agreed or strongly agreed that they look for ways to limit wasteful uses of resources like water. Some student comments include: “I have a better idea of conservation and how important resources are…”, “It has emphasized the meaning of ‘place-based’…That is something that I can apply to my personal life and profession…”. The majority of students agreed or strongly agreed that they were challenged to: 1) use critical thinking skills to solve problems (99%); 2) work better with others (80%); and 3) learn more about teaching and educating youth (95%). All students agreed or strongly agreed that they developed new or expanded personal and professional capabilities. Several students commented that the EARTH program helped in “…solidifying where I could see myself in 5 to 10 years”. One student responded: “I am now getting a Masters in Education. This program is part of the reason I made that decision.” In addition, several students responded that the EARTH program experience helped them become “…more accepting of different values and cultures.” These results support student comments from exit interviews. Overall, a study abroad and service learning experience like the EARTH program provides a valuable experiences that impact students’ perceptions of the world and provide them an opportunity to develop and practice personal and professional skills.

9:30–9:45 AM

Socratic, Traditional, and Experiential Instructional Methods for Adult Learners Enrolled in a Plant Production Extension Program

Brian J. Pearson*
University of Florida, Mid-Florida Research and Education Center, Apopka; bpearson@ufl.edu

Liz A. Felter
Univeristy of Florida IFAS Extension, Orlando; lfelter@ufl.edu

Juanita Popenoe
University of Florida IFAS Extension, Tavares; jpopene@ufl.edu

Matthew C. Lollar
Univeristy of Florida IFAS Extension, Sanford; mlollar@seminolecountyfl.gov

Gul S. Ali
University of Florida, Mid-Florida Research and Education Center, Apopka; gsali@ufl.edu

The traditional lecture-based instructional method is a foundational style used almost universally in conventional classroom instruction and professional extension courses (John et al., 2007). Although this method is effective for a wide range of audiences, its overuse or misapplication can result in poor achievement of learning outcomes (Caudron, 2000). The Socratic and experiential learning methods use a student-centered learning approach that is effective for development of critical thought and problem solving proficiencies that may be more appropriate for adult learners enrolled in extension programs (Parkinson and Ekachai, 2002). A six-week plant production extension short course was developed and delivered in Spring 2014 at the Mid-Florida Research and Education Center using a mixture of Socratic, traditional, and experiential instructional methods. At the start
of the course, 85% of students stated a preference for a mixture of instructional methods. Behavioral changes documented with pre- and post-tests demonstrated high achievement of learning outcomes when a mixture of instructional methods was used. At the conclusion of the course, students maintained strong support of mixed instructional methods. Results support continued use of a variety of instructional methods for adult learners enrolled in extension programs.

9:45–10:00 AM

**Extending Research Impacts to a General Audience via Video: The Good, The Bad, and The Ugly**

Robert Wilson*
University of Arizona Cooperative Extension, Yuma; Rcw@email.arizona.edu

Kurt D. Nolte
University of Arizona, Yuma; knolte@ag.arizona.edu

Rosa Kim Bevington
University of Arizona Cooperative Extension, Yuma; rosa@cals.arizona.edu

Since 2012, we have used social media as a means to deliver grower friendly bilingual content in the area of fresh produce safety. We have learned, that there are marked differences between videos, which can distract the user from a message. This presentation attempts to provide five key recommendations or reminders on creating outreach videos that generate the greatest impact. 1) **Voice Composition**—What not to do: Avoid someone speaking in monotone voice, it creates a dull video and makes it seem unexciting. Recommended—It is always important to ensure that the narrator has a full, clear voice. The goal is to inform and excite the listener, so therefore it’s suggested that the speaker be excited, positive and passionate about their topic. 2) **Appearance**—What not to do: If your video is about finances or something of a professional matter, then dressing casually in a t-shirt is NOT acceptable. Inappropriate attire could distract the viewer, and the content of your video can possibly not be taking seriously. Recommended—Dress appropriately, Viewers typically respect a speaker who appears friendly, inviting, and that they fully understand the content being presented. 3) **Understanding Content and Delivery**—What not to do: Avoid not being confident in what you say or being unknowledgeable of the content. Having too many “um’s” and “uh’s” can really hurt the quality of the presentation. Recommended—Avoid long winded phrases, and instead, keep the points short and to the point. 4) **Physical Presence**—What not to do: Slouching or leaning in a peculiar way is not attractive to most viewers, and once the viewer witnesses something unusual, they can easily be distracted and lose focus on hearing and understanding the content. Recommended—Be firm in the way you stand so that you come off as confident to viewers, and avoid standing statuesque. 5) It is recommended to interact with the camera, and demonstrate ordinary body movements. Involving an audience with clear and logical content is the ultimate achievement when creating a video that has high impact value. By providing video outreach materials with few distractions and with an understandable message, the audience will better utilize the information that the video is intended to achieve.

Specified Source(s) of Funding: Improving the Safety and Postharvest Quality of Field Grown Organic Leafy Greens: Assessment of Good Production Practices Along the Farm to Fork Continuum

---

**Thursday, July 31, 2014**

**Vegetable Crops Management 3**

Moderator: Danielle D. Treadwell; ddtreadw@ufl.edu

8:00–8:15 AM

**Plant Functional Diversity Leads to Increased Yields in a Low-input Organic Intercropping System**

Jose G. Franco*
Texas A&M University, College Station; franjo@tamu.edu

Stephen R. King
Millican Farms, Millican, TX; srking@tamu.edu

Joseph Masabni
Texas A&M University, College Station; jmasabni@tamu.edu

David Briske
Texas A&M University, College Station; dbriske@tamu.edu

Astrid Volder
University of California, Davis; a-volder@tamu.edu

In multispecies systems, facilitation and complementarity can offset some of the negative effects of interspecies competition. This can lead to more efficient use of resources by the plant community as a whole, resulting in an increase in productivity. Overyielding, a phenomenon whereby plant production in mixture exceeds that of production in monoculture, has been attributed to complementary use of resources by different plant functional types. Different combinations of peanut, watermelon, okra, cowpea and pepper in single crop and various intercropping combinations were investigated in a low-input organic system in Texas. Each species was selected to perform a specific function within the system. Results from land equivalent ratio (LER) and per plant production calculations show that the intercropping combination with peanut, watermelon and okra (Wpwo) and peanut, watermelon, okra and cowpea (Wpwo) consistently overyielded and performed the best overall in both 2011 and 2012. Planting dates were adjusted in 2012 based on observations from 2011. This did not, however, alter LER values between years as LER’s were 1.17 for both combinations in 2011 and 1.20, respectively, in 2012. Changes in planting dates resulted in a reversal of dominance between watermelon and okra between years. In 2011 when watermelon was the dominant crop, per plant production was highest in the...
Evaluation of Tomato Yellow Leaf Curl Virus Resistant (TYLCV-R) Varieties and Advanced Breeding Lines in Florida

Crystal A. Snodgrass*  
UF/IFAS Manatee County Extension, Palmetto, FL; crys21@ufl.edu

Monica Ozores-Hampton  
University of Florida, Southwest Florida Research and Education Center, Immokalee; ozores@ufl.edu

Florida ranks second nationally in production of fresh market tomatoes (Solanum lycopersicum) with 29,000 acres and a value of 267 million in the 2012 season. TYLCV is transmitted by sweetpotato whitefly (Bemisia tabaci) and contributes significantly to yield losses due to flower abortion. Controlling whitefly, maintaining a tomato free period and tomato TYLCV-R varieties are currently the tools available to lower the negative impacts on yields. The objective of this study was to evaluate TYLCV-R varieties and advanced breeding lines on disease incidence, fruit yield, and postharvest fruit quality. The trial included 10 TYLCV-R varieties and advanced breeding lines plus a susceptible control (‘FL 47’) planted on 8 Feb. 2012 under polyethylene black mulch with drip irrigation in Duette, FL. Plants were 20 inches apart and beds were 36 inches wide at 6 ft. bed spacing (center to center). Tomatoes were harvested twice on 2 May and 16 May 2012. Data collection consisted of TYLCV severity and yield of X-large, large, medium and unmarketable fruit and unmarketable (zippers, cracks, scratches, odd shaped fruit and blossom end scars). Ten tomatoes fruit per plot were collected and evaluated for postharvest quality including fruit firmness (by fruit deformation) and color (1–6 scale, 1 = green, 6 = red). Weather was cool to warm with a total of 3.8 inches of rainfall. TYLCV pressure was low with 2.5% in ‘FL47’. At first harvest there we no differences between the TYLCV-R and ‘FL47’ in X-large fruit and total marketable yield. Total X-large fruit and season marketable yield (all harvests and sizes combined) was similar for all TYLCV-R varieties, except XTM 0211 and K55 which were significantly lower than ‘Fl47’. Several TYLCV-R varieties produced a high percentage of unmarketable fruit due to zippering and off shapes compared to ‘FL47’. However, several TYLCV-R varieties had higher firmness and better color than ‘FL47’. Based on yield and postharvest quality, there are several TYLCV-R varieties and advanced breeding lines with acceptable horticultural characteristics available in tomato growers, but the trial should be repeated in higher TYLCV pressure.

Enhanced Forage Production from Triticale and Triticale–Pea Mixtures

Kurt D. Nolte*  
University of Arizona, Yuma; knolte@ag.arizona.edu

Nancy A. Elliott  
Elliott Plant Breeding, Yuma, AZ; elliottbp@yahoo.com

The desert regions of the lower Colorado River Valley is home to over 300,000 acres of winter vegetables. While most producers in the region typically produce a spring winter wheat, melon or cotton crop following winter vegetable harvest, many seek alternative cropping schemes that fit within the winter vegetable rotation. And, although alfalfa is the single most important field crop grown along the Colorado River, many desert southwest alfalfa producers either graze sheep on slow growing alfalfa fields or let them lie inactive during the 4 month winter period. Intercropping field peas with cereal grains for forage has great potential for winter production in the desert areas as the protein benefits of peas in pea/cereal mixtures has been shown to produce better quality silage than cereals alone in the upper Midwest and Canada. A spring triticale variety (Companion) and two winter triticale varieties (Blizzard and Wintersiris) were grown in small plot trials either alone or intercropped with a forage pea (var. Mittry) to test the notion that pea/cereal intercropping may have certain advantages when grown for livestock feed. In mixed crop treatments, peas represented an average of 22% of the seeds present at seeding. Following the first harvest, yields of intercropped triticale/pea were not significantly different from the cereal alone, but both out yielded alfalfa grown alone during the same time frame by over 4.2-fold. Although forage peas did not significantly enhance the Relative Forage Value (RFV) of pea/cereal mixtures, intercropping produced results that were similar to that of alfalfa alone. The success of these intercrops seems to be highly dependent on the seeding rates for both crops. From our preliminary results, when peas form at least 20% of the sown mixture (by weight), we found crude protein in the harvested forage to be 2 to 4 percentage points higher than with pure cereals. Acid detergent fiber (ADF) content did not vary significantly between mixtures and pure cereals, but neutral detergent fiber levels are 2 to 4.5 percentage points lower in mixtures, resulting in a higher feed intake potential.

Specified Source(s) of Funding: Improving the Safety and Postharvest Quality of Field Grown Organic Leafy Greens: Assessment of Good Production Practices Along the Farm to Fork Continuum

An asterisk (*) following a name indicates the presenting author.
Evaluation of Summer Cover Crops Sorghum [Sudangrass Sorghum Bicolor L. (Moench) \times Sorghum sudanense)] and Pigeon Pea (Cajanus cajan L.) Management on Fall Cabbage (Brassica oleracea L. ‘Capitata’)

Danielle D. Treadwell*
University of Florida, Gainesville; ddtreadw@ufl.edu

Dakson Sanon
University of Florida, Gainesville; sdakson@hotmail.com

Lincoln Zotarelli
University of Florida, Gainesville; lzota@ufl.edu

In Haiti and other tropical systems, pigeon pea is a valuable rotational crop. As a first step to evaluate the potential for pigeon pea to be used for multiple purposes in low-external input vegetable systems, this study was conducted to identify the cover crop planting scheme and termination management strategy associated with the greatest cabbage yield and quality when as a rotational cover crop prior to cabbage. The experiment was conducted in Live Oak, Florida at the UF-IFAS North Florida Research and Education Center-Suwannee Valley in 2011 and 2012. Treatments were arranged in a split split-plot design and replicated four times. Main effects included four cover crop (CC) treatments: pigeon pea (PP); sorghum Sudangrass (SS); PP and SS biculture (SP); and no cover crop (control). Cover crop plots were equally split in week four after CC emergence with two NT treatments. subplot was equally split again prior to cabbage transplanting. Cover crops were mowed and soil-incorporated (CT) or rolled (NT) with a roller-crimper (sub-subplots). Data from cover crop biomass, weed biomass, cabbage yield and yield parameters were analyzed using repeated measures analysis (PROC GLIMMIX, SAS V. 9.3, SAS Institute Inc., Cary, NC) in order to determine main effects of cover crops planting, fertilizer, and tillage management as well as their possible interactions. Tillage approach, rather than cover crop planting scheme was more important to cabbage yield. The greatest cabbage yield and marketable yield were 54 and 38 tons/ha, respectively in fall 2011 and 38 and 17 tons/ha, respectively in fall 2012. Yields obtained in general from CT plots were greater (P ≤ 0.05) than NT plots in both years likely due to a greater occurrence of broadleaf weeds in NT treatments.

Specified Source(s) of Funding: USAID WINNER

Broccoli (Brassica oleracea) Yields and Size of Flowering Head as Affected by Planting Distance

Peter Germishuizen*
Quality Produce LLC, Tifton, GA; peter@1st-in-quality.com

Juan Carlos Diaz-Perez
University of Georgia, Tifton; jcdiaz@uga.edu

Pablo Navia
Quality Produce LLC, Tifton, GA; pablo@qualityproducellc.com

Jesus Bautista
University of Georgia, Tifton; jesusb@uga.edu

Broccoli (Brassica oleracea) produces a large flowering head that is used as a vegetable. It is rich in vitamin C, fiber, and anticancer compounds. Size of broccoli head is an important quality attribute. Broccoli crowns (diameter = 6.4 to 12.8 cm) have a higher market price compared to bunched broccoli. The objective was to determine the impact of planting distance on broccoli yield and size of broccoli flowering head. Broccoli ‘Emerald Crown’ was planted on bare soil on three rows per bed (1.8-m centers) on 7 Nov. 2013. Plants were thinned to the following planting distances within the row: 15, 19, 25, 38 and 76 cm. Plants were harvested on 7 Feb. 2014, when plants had high number of crown florets. Broccoli flowering heads were graded as marketable (crows or bunched) and culls, according to U.S. grading standards. Above-ground plant biomass increased with increasing planting density. Yield of broccoli crowns increased with planting distance reaching a maximum at 25 cm; there was no augment in yield of crowns with further increments in planting density above 25 cm. Total broccoli yield also increased with increasing planting density reaching a maximum at 25 cm and decreased with further increments in planting density. Weight

Large Bed Vegetable Cropping Systems Enhance Productivity and Water Conservation

Kurt D. Nolte*
University of Arizona, Yuma; knolte@ag.arizona.edu

Recently, a number of lettuce (Lactuca sativa L) producers in the desert southwest have shown interest in using a wide (2 m) bed system relative to the conventional practice of growing the crop on a more narrow (1 m) bed system. A field study was conducted during the 2010-2012 winter growing season to evaluate bed size and three irrigation methods for romaine and iceberg lettuce. The trial included solid-set sprinkler and subsurface drip plots, each managed by Et replacement, and furrow irrigation applied when available soil water was depleted by 40%. When compared to drip, 60% and 41% more water was applied to lettuce grown with either sprinklers or furrow, respectively. Naked romaine or romaine hearts grew equally well in either narrow or wide bed systems. However, sprinkler irrigated romaine produced slightly lighter heads (3%) and hearts (10%) relative to drip irrigated romaine. Iceberg lettuce, harvested as either a wrapped or cored head (bulk for salad processing) weighed 17% greater when grown in narrow beds relative to wide beds. Irrigation method was equally striking with drip irrigated iceberg outperforming both furrow and sprinkler by as much as 16%. In fact, sprinkler irrigated iceberg produced heads which were either 7% (wrapped) or 15% (cored) lighter when compared to iceberg grown under drip regardless of bed configuration. The results from this study demonstrate a great potential for water conservation and field productivity by producing romaine lettuce on large beds.

Large Bed Vegetable Cropping Systems Enhance Productivity and Water Conservation

Kurt D. Nolte*
University of Arizona, Yuma; knolte@ag.arizona.edu

Recently, a number of lettuce (Lactuca sativa L) producers in the desert southwest have shown interest in using a wide (2 m) bed system relative to the conventional practice of growing the crop on a more narrow (1 m) bed system. A field study was conducted during the 2010-2012 winter growing season to evaluate bed size and three irrigation methods for romaine and iceberg lettuce. The trial included solid-set sprinkler and subsurface drip plots, each managed by Et replacement, and furrow irrigation applied when available soil water was depleted by 40%. When compared to drip, 60% and 41% more water was applied to lettuce grown with either sprinklers or furrow, respectively. Naked romaine or romaine hearts grew equally well in either narrow or wide bed systems. However, sprinkler irrigated romaine produced slightly lighter heads (3%) and hearts (10%) relative to drip irrigated romaine. Iceberg lettuce, harvested as either a wrapped or cored head (bulk for salad processing) weighed 17% greater when grown in narrow beds relative to wide beds. Irrigation method was equally striking with drip irrigated iceberg outperforming both furrow and sprinkler by as much as 16%. In fact, sprinkler irrigated iceberg produced heads which were either 7% (wrapped) or 15% (cored) lighter when compared to iceberg grown under drip regardless of bed configuration. The results from this study demonstrate a great potential for water conservation and field productivity by producing romaine lettuce on large beds.
of individual crowns increased quadratically with increasing planting density. Thus, planting distance had a strong effect on both total marketable yield and broccoli size of both crowns and bunched broccoli.

9:30–9:45 AM

**Maximizing Plant Density Affects Broccoli Yield and Quality**

Brian Ward*
Clemson University, Charleston, SC; bw@clemson.edu

Mark W. Farnham
USDA–ARS, Charleston, SC; mark.farnham@ars.usda.gov

Powell Smith
Clemson University, Lexington; jpsmith@clemson.edu

Zach Stansell
USDA–ARS, Charleston; Zachary.Stansell@ars.usda.gov

Susan James
Clemson University, Lexington; sjames2@clemson.edu

Increased demand for fresh market bunch broccoli (*Brassica oleracea* L. var. italica) has led to increased production along the United States east coast. Maximizing broccoli yields is a primary concern for quickly expanding southeastern commercial markets. This broccoli plant density study was carried out over two years using a hybrid cultivar ‘Emerald Crown’ on a commercial farm in Summerton, S.C. and at Clemson Coastal Research and Education Center in Charleston, SC, to determine maximum yields and quality under three environments with the primary focus on within row spacing of 10.2 cm, 15.2 cm and 20.3 cm and between row spacing of 30.5 cm. Results from this study suggest that increased plant density of 10.2 cm within row spacing significantly increases overall yields/ha over the 15.2 and 20.3 cm spacing respectively, despite inter-row competition for resources. Overall quality affected by plant density trends toward marginal significance with increased overall quality at lower plant densities. Ultimately, increased plant density of 10.2 cm within row spacing is recommended for maximum yields regardless of environment with little effect on overall quality.

9:45–10:00 AM

**Using Grower Friendly, Web-based Mapping to Share Field Isolations within a Global Agricultural Community**

Kurt D. Nolte*
University of Arizona, Yuma; knolte@ag.arizona.edu

Rosa Kim Bevington
University of Arizona Cooperative Extension, Yuma; rosa@cals.arizona.edu

Greater emphasis has been placed on the interplay between computerized agricultural mapping and crop production since the integration of GPS/GIS became mainstream in the late 1990’s. In addition, interfacing agriculture and the web has provided a new dynamic involving production practices, data management, networking, communication and information gathering.

Hybrid seed production requires certain field isolations and/or setbacks to prevent the pollen cross-contamination as a result of bees possibly making multiple field visits. For a number of years, vegetable seed producers in Yuma, Arizona utilized a large paper map of growing regions to indicate field locations, which were made transparently available to all seed producers. With the onset of web-based mapping, the University of Arizona–Yuma, in collaboration with area vegetable seed producers, utilized the Google Maps Engine Lite mapping website to develop a mapping system which allows for a grower friendly platform to identify field isolations. While not necessarily required, we converted a large flat screen, wall-mounted television into a touch screen using an overlay frame. This allowed the operator to enter map locations, and visually network with other users. The system is flexible enough to allow for the categorization of crops, establishing buffer zones, and entering data through the web at the convenience of cellular phone or desktop computer connections. The resulting maps are made immediately available throughout the globe. This presentation will provide a system overview, and review the necessary technical aspects so that participants can incorporate the scheme into their own research or Cooperative Extension programs.

---

**Thursday, July 31, 2014**

**Crop Physiology**

Moderator: S. Kaan Kurtural; kkurtural@csufresno.edu

10:00–10:15 AM

**The Effect of Small Interval Wavelengths Using LEDs on Photosynthetic Rates of Tomato Plants**

Bo-sen Wu*
McGill University, Ste-Anne-de-Bellevue, QC; bo-sen.wu@mail.mcgill.ca

Konstantin Daive
McGill University, Ste-Anne-de-Bellevue, QC; konstantin.daive@mail.mcgill.ca

Most Tahera Naznin
McGill University, Ste-Anne-de-Bellevue, QC; most.naznin@mail.mcgill.ca

Mark Lefsrud
McGill University, Ste-anne-de-Bellevue, QC; mark.lefsrud@mail.mcgill.ca

Light emitting diodes (LEDs) offer great advantages, which include a long lifetime (> 10,000 h), small size, low thermal output, and adjustable light intensity, over conventional light sources (e.g. incandescent, fluorescent, high pressure sodium). Moreover, LEDs can have very narrow wavelengths (~30 nm) and are easily adjusted for irradiance level. Therefore, these advantages make LEDs perfect for exploring and investigating plant responses to different light conditions including different photoperiods, irradiance or wavelengths while coupling with specific equipment. The object of this research was to investigate
the photosynthetically active radiation (PAR) curve of tomato plant using narrow spectrum LEDs under controlled conditions. The experiment focused on a specific wavelength range (600−700 nm) at a light intensity of 30 and 60 µmol·m−2·s−1 with a small bandwidth (~5 nm). The results from this study provide precise information on the impact that specific wavelengths of light have on plant growth and will be used to optimize LED arrays for maximum plant production.

10:15–10:30 AM
**Response of CO₂ Exchange Pattern and Chlorophyll Fluorescence Property in *Dendrobium Officinale* to Drought Stress and Rewatering**

Dongxian He*
China Agricultural University, Beijing; he_dongxian@hotmail.com

Zejin Zhang
China Agricultural University, Beijing; zhangzej127@163.com

Genhua Niu
Texas A&M AgriLife Research Center at El Paso; gniu@tamu.edu

Rongfu Gao
Beijing Forestry University, Beijing; gaorf@bjfu.edu.cn

*Dendrobium officinale* is a facultative crassulacean acid metabolism (CAM) plant showing the photosynthetic pattern in CAM, C3 and concomitance of CAM and C3. The specific environmental stress is known to change photosynthetic pathway from CAM to C3 pattern or from C3 to CAM pattern in some facultative CAM plants but is not clear for *D. officinale*. In this study, influences of drought stress on CO₂ exchange pattern and chlorophyll fluorescence characteristics of *D. officinale* were studied for photosynthetic pathway switching. After plants were well-watered, irrigation was withheld for 12 days before rewatered and measurements were continued for another 6 days. The net CO₂ exchange rates of *D. officinale* plants were continuously measured by a continuous photosynthesis measurement system for 18 days and the chlorophyll fluorescence parameters were measured by steady-state chlorophyll fluorescence measurement system on day 1, day 12, and day 18. The percentage of CO₂ exchanges observed during the dark period in the total daily CO₂ exchanges increased as the drought stress increased, but decreased again as the plants were rewatered. PIABS in photosynthetic performance index of *D. officinale* leaves under drought stress on day 12 decreased 31%, compared to that without drought stress. These results indicate that the CO₂ exchange pattern of *D. officinale* changed from concomitance of CAM and C3 to CAM pattern by drought stress and reversed from CAM pattern to concomitance of CAM and C3 by rewatering. The drought stress can induce a recoverable damage to photosystem II and the photosynthetic pathway switch to CAM pattern in *D. officinale*.

Specified Source(s) of Funding: National Natural Science Foundation of China (Grant No. 31372089)
Mist Cooling to Delay Bloom and Prevent Frost Damage—Old Idea, New Technology

Ishara Rijal*
Michigan State University, East Lansing; rijalish@msu.edu
James A. Flore
Michigan State University, East Lansing; flore@msu.edu
Jeffrey A. Andresen
Michigan State University, East Lansing; andresen@msu.edu

Recent shifts in temperature and seasonality have significantly impacted commercial fruit production in the Great Lakes region. Michigan’s tart cherry and apple production in 2012 was reduced by about 90% and 88%, respectively, compared to the previous year’s production due to a series of spring freeze events that followed an abnormally warm temperature in March. Bud development is driven by the localized accumulation of heat units once endo-dormancy has been satisfied. Evaporative cooling with water prior to the onset of growth has been used in the past (mid 1970s and early 1980s) to delay early development of flowers; one to three week delay was observed. However, related problems (more disease, poor fruit set, and large applications of water) reduced its potential for commercial use. This study re-examines mist-cooling to delay bloom by bringing together three new or refined technologies: application of water by mist via new pesticide application system called solid set canopy delivery system (SSCD), modern weather sensing and control systems, and evaporative cooling application based on changes in temperature and humidity. The study aims to identify the timing and discharge rate of mist applications necessary to delay early vegetative stages by suppressing the temperature of cherry and apple buds. In 2013, SSCD system was set up at three different locations in Michigan on sweet cherries, and apples to test the feasibility of the system. The study consisted of three different treatments: no misting, misting from the first week in April until first flower (May 7), and misting from the first week in April through full bloom (May 15). Misting delayed the bloom by 7–10 days in both cherry and apples depending on the variety and treatment compared with the control. The total rate of mist application was of 11–14 cm/ha, which is 75% less than application rates reported in previous studies. No significant difference was seen in fruit set, disease, size, color, firmness and sweetness among the treatments. This approach is expected to directly increase the economic viability and sustainability of the region’s fruit industry by reducing the vulnerability of freeze damage.

Daily Water Use of Tomato Plants as Affected by Environmental Conditions and Plant Age

Alexander G. Litvin*
University of Georgia, Athens; alitvin@uga.edu
Marc van Iersel
University of Georgia, Athens; mvanier@uga.edu
Anish Malladi
University of Georgia, Athens; malladi@uga.edu

Daily water use (DWU) by plants is affected by the size of the plants as well as the environmental conditions to which they are exposed. As plants grow, DWU increase as well. Environmental conditions, such as daily light integral (DLI) and vapor pressure deficit (VPD), can also affect DWU. We measured DWU of young ‘Moneymaker’ tomatoes and environmental conditions in the fall of 2013, to quantify their effects on DWU. Plants were grown from seed in 15-cm pots filled with a peat-perlite substrate in a greenhouse for 53 d. Irrigation was controlled by a datalogger, which maintained the substrate moisture levels at 35% (v/v). Plants were irrigated as needed and the datalogger recorded how much water was applied each day, as well as environmental conditions. Stepwise selection was used to describe DWU as a function of plant age and environmental conditions. Plant age and the interaction between age and VPD accurately described daily water use of the plants ($r^2 = 0.95$, $P < 0.0001$). DWU by tomato plants generally increased over time, and peaked at 425 mL/plant. However, DWU during the last 20 d of the study fluctuated by over 200 mL/plant. These fluctuations were correlated with changes in VPD, emphasizing the impact of environmental conditions on plant water use. Our findings describe how fluctuations in environmental conditions affect DWU by plants through the early phase of their lifecycle. This information can help growers better schedule irrigation and reduce the negative consequences of over- or under watering.
controlled release fertilizer (CRF) and Jack’s 21–5–20 constant liquid fertilizer (CLF) applied at 100 ppm N. The granular fertilizers and CRF were incorporated into the substrate at the rate of 400 mg L\(^{-1}\) N. Four week old seedlings of tomato (*Solanum lycopersicum*) ‘Celebrity’ were transplanted into 10 cm containers in growth chambers with average daily temperatures of 10 °C, 15 °C, or 20 °C. Fluorescent lights provided 300 µmol m\(^{-2}\) s\(^{-1}\) for 16 h daily. The CLF treatment was applied at each irrigation event, whereas no added fertilizer was given to the granular organic and Osmocote treatments. After 6 weeks the plants were destructively harvested for plant quality measurements and tissue nutrient analysis. At 10 °C and 15 °C root dry weight (DW) did not differ based on fertilizer treatment. At 20 °C, root DW with vermicompost was smaller than the CLF treatment. At 10 °C shoot DW was very low and did not differ based on fertilizer treatment. At 15 °C shoot DW of vermicompost plants was significantly smaller than CLF and CRF, but the other organic fertilizers performed comparably to conventional fertilizers. At 20 °C shoot DW was greatest for CLF, least for vermicompost, and medium-sized for the other organic fertilizers and CRF. Our results indicate that vermicompost might be best used as a complementary fertilizer source for tomato; whereas the other organic granular fertilizers can be used as a substitute for CRF at 20 °C and a substitute for WSF and CRF at 15 °C. Leachate analysis is being used to determine nutrient leaching patterns. This will be combined with tissue and substrate analysis to develop a nitrogen budget for each fertilizer.

Specified Source(s) of Funding: USDA NRCS CIG

**10:30–10:45 AM**

**Does Position in the Canopy Affect Fruit Bud and Berry Development in Highbush Blueberry?**

Khalid Almutairi*
Oregon State University, Corvallis; almutaik@onid.oregonstate.edu
Bernadine C. Strik
Oregon State University, Corvallis; bernadine.strik@oregonstate.edu
David Bryla
USDA-ARS, Corvallis, OR; david.bryla@ars.usda.gov

The study was conducted in a 7-year-old field of certified organic highbush blueberry. Plants were grown on raised beds, and treatments included ‘Duke’ and ‘Liberty’ plants mulched with weed mat or compost topped with sawdust and fertilized with feather meal or fish emulsion. One-year-old fruiting laterals, ranging from 0.5–0.7 m, were randomly-selected at three heights (top, middle, and bottom) on the east and west side of the plants. The third flower bud from distal end of each lateral was tagged, and bud, flower, and fruit development were monitored through fruit harvest. Fruit harvest occurred 8–9 d after the fruit were fully blue and ranged from 2–5 July 2012 and 26 June–3 July 2013 in ‘Duke’ and from 1–20 Aug. 2012 and 17 July–7 Aug. 2013 in ‘Liberty’. Proportionally more fruit buds occurred on upper laterals than on lower laterals [1:2, 2:1, 2:1 (‘Duke’); 1:2, 1:1, 1:1 (‘Liberty’)]. Bud swell and bud break dates were not affected by cultivar or lateral position, but ‘Duke’ reached the early pink stage before ‘Liberty’. ‘Duke’ produced 6–8 and ‘Liberty’ produced 7–9 flowers/bud. Fruit set was high and averaged 95% in both cultivars. However, 10% to 20% of the flowers aborted or remained relatively small in ‘Liberty’. Laterals in the upper canopy were larger (+65 cm) and had a greater diameter (4–5 mm in ‘Duke’ and 2–3 mm in Liberty) than those in the lower canopy (35–45 cm long and 2–3 and 1.5–2 mm diameter in ‘Duke’ and ‘Liberty’, respectively). The first shoot flush produced only vegetative buds while the second and third flushes produced vegetative and flower buds. Fruit ripening was more uniform within clusters in ‘Duke’ than in ‘Liberty’, and average fruit diameter was similar among harvests in ‘Duke’ but decreased by 25–40% between the first and last harvest in ‘Liberty’. Fruit ripening was faster and berries were larger at harvest in clusters on partially-shaded laterals than in those on completely-shaded laterals. The berries matured 3–5 d earlier on the east side of the canopy than on the west side. The first fruit coloring stage in 2012 started in the upper east laterals in plants fertilized with fish emulsion and mulched with weed mat in ‘Duke’ and sawdust + compost in ‘Liberty’. The results suggest that more pruning on the lower part of the canopy will result in larger fruit at harvest than uniform pruning of the canopy.

10:45–11:00 AM

**Summer Sorghum Cover Crop Reduces Fall Lettuce Growth and Yield**

William B. Evans*
Mississippi State University, Crystal Springs; wbe1@ra.msstate.edu
Sarah Reynolds
Mississippi State University, Gulfport; s.red.reynolds@gmail.com
Robert Williams
LSU AgCenter, Baton Rouge, LA; rwilliams@agcenter.lsu.edu
Anna Horton
Mississippi State University, Crystal Springs; amh461@msstate.edu
Carl Motsenbocker
LSU AgCenter, Baton Rouge, LA; cmots@lsu.edu

As part of the third year of a summer cover crop study for fall organic vegetable production in the U.S. Gulf States, leaf lettuce (*Lactuca sativa L.*) was grown in Baton Rouge, LA, and Crystal Springs, MS, following summer cover crops. In this third year of a study, four cover crops were raised for during summer 2013: sorghum-sudan (*Sorghum × drummondii* var. Southland Honey Pasture hybrid), sesame (*Sesamum indicum* L. var. sesame), sunn hemp (*Crotalaria juncea* L. var. sunn hemp), and a sesame/sunn hemp blend. After cover crop incorporation in September, lettuce was transplanted at 12 inch spacing onto raised beds 30 to 35 days after the cover crops were flail mowed and incorporated. Prior to transplanting, four rates of broadcast, incorporated composted chicken (*Gallus gallus*) broiler litter compost were superimposed on each cover crop plot as part of a split plot arrangement. The litter was incorporated and the soil cultivated to form narrow, raised rows 42 inches apart.

An asterisk (*) following a name indicates the presenting author.
Four week-old lettuce transplants were set into these rows 12 inches apart and watered in. At both locations, lettuce growth appeared to be impaired when grown after sorghum-sudan within the first two weeks after transplanting. This retarded growth continued through harvest. Increasing rates of CBL helped lettuce to partially overcome the negative effects of the sorghum-sudan but not completely. Almost no marketable lettuce was harvested from sorghum-sudan plots. Sorghum-sudan has well known allelopathic properties and this study provided very sound, regionally-specific evidence of this allelopathy. It also provided significant local educational opportunities for growers and others that might be considering using sorghum sudan as a summer cover crop for lettuce and perhaps other fall vegetable crops.

Specified Source(s) of Funding: Southern SARE
11:00–11:15 AM

Biological Control and Exclusion of Brown Marmorated Stink Bug in Organic Crops
Mary A. Rogers*
University of Minnesota, St. Paul; roge0168@umn.edu
Jennifer Moore
University of Tennessee, Knoxville; croker@utk.edu
Jim Walgenbach
North Carolina State University, Mills River; jim_walgenbach@ncsu.edu
Ricardo Bessin
University of Kentucky, Lexington.; rbessin@uky.edu
Anne Nielslen
Rutgers, Bridgeton, NJ; nielsen@AESOP.Rutgers.edu
Annette L. Wszelaki
University of Tennessee, Knoxville; anmettw@utk.edu

The Brown Marmorated Stink Bug (BMSB) (*Halyomorpha halys*) is an invasive species pest first introduced to the United States in the mid-1990s. It has since been detected in 40 states, and is one of the most devastating pests of the Mid-Atlantic region in the last 50 years. The diverse host range of BMSB includes tree fruit, small fruits, vegetables, and row crops. Management of BMSB in organic systems is particularly challenging and pest management options are limited. Pest management in organic production systems emphasizes biological control and cultural methods to exclude pests or reduce their damage. The potential for biological control and mesh barrier screens to mitigate damage by BMSB are being investigated in Tennessee as part of a multi-state project to study whole farm organic management of this invasive pest. Here we report on the results obtained in the first year of this study. Sentinel and natural-laid BMSB egg masses were observed for parasitism and predation by natural enemies on organic bell peppers, corn, and soybean. Parasitism rates ranged from 1% to 16%, and predation rates ranged from 2% to 30%, showing that biological control may help reduce BMSB. The mesh barrier study was performed on bell peppers, and treatments included 1/6", 1/8" and fine mesh screens, compared to a no-screen control. The fine mesh screens increased yield and marketable fruit by reducing BMSB damage and reducing sunscald of peppers. Mesh barrier screens can be re-used from year to year and have potential to exclude BMSB and improve marketable yields in organic vegetables in an integrated pest management system.

Specified Source(s) of Funding: USDA–NIFA: 2012-51300-20097

11:15–11:30 AM

Impact of Liquid Fertilizers on Plant Growth, Yield, Fruit Quality, and Fertigation Management in an Organic Processing Blackberry Production System
Javier Fernandez-Salvador*
Oregon State University, Corvallis; avifernandezs80@gmail.com
Bernadine C. Strik
Oregon State University, Corvallis; strikb@hort.oregonstate.edu
David Bryla
USDA–ARS, Corvallis, OR; david.bryla@ars.usda.gov

The impact of organic fertilizer source on the growth, fruit quality and yield of blackberry (*Rubus* L. subgenus Rubus Watson) cultivars (‘Marion’ and ‘Black Diamond’) grown in machine-harvested, organic production systems for the processed market was evaluated from 2011-2013. The planting was established in spring 2010 using approved practices for organic production and was certified in 2012. Plants were irrigated using a drip line under a porous landscape fabric (weed mat) installed for weed management. Two sources of liquid fertilizer were evaluated: 1) a corn steep liquor and fish waste digestion (2.5–2.5–1.5); and 2) fish solubles and molasses blend (4–0–2). Fertilizers were applied by fertigation through the drip system at rates of 56 kg·ha⁻¹ N per year in 2011–12 and 90 kg·ha⁻¹ N in 2013. The impact of fertigation on drip system performance was evaluated with two maintenance options, “flushing” and “no flushing” of the drip lines. Total yield differed among years, while fruit soluble solid concentration and firmness, and floricane biomass dry weight at pruning were affected by year x cultivar. ‘Black Diamond’ had greater total yield and average fruit weight than ‘Marion’, but produced the most unmarketable fruit. There was no effect of fertilizer source on yield, fruit quality, primocane length, or floricanes/plant in any year, with the exception of fruit weight, which was greater with corn than with fish. ‘Marion’ had a greater floricane biomass when fertilized with fish than with corn. Soil nutrients were within the recommended range, except for B, which was below recommended levels; and only soil nitrate-N was affected by fertilizer source, which was greater with corn than with fish in ‘Black Diamond’, but there was no effect in ‘Marion’. Primocane leaf nutrient concentrations were within recommended levels for all nutrients, except for Ca and B which were below recommended standards in both cultivars. Primocane leaf K and Zn concentrations were greater with fish than with corn. There was no fertilizer source or maintenance effect on emitter flow rate of the drip system in either year. However, flow rates decreased an average of 4.5% in the first year.
and 19% in the second year. Overall, there were no differences between the fertilizers on plant growth, yield, or fruit quality, and both fertilizers were suitable for planting establishment.

Thursday, July 31, 2014

Public Horticulture
Moderator: E. Thomas Smiley; tsmiley@bartlettlab.com

10:15–10:30 AM
A Novel Approach to Vertical Gardening: An Inexpensive Vertical Growing Structure
Hilary Omega Heath*
Auburn University, Auburn, AL; hzh0032@auburn.edu
Donald J. Eakes
Auburn University, Auburn, AL; eakesdj@auburn.edu
Carolyn W. Robinson
Auburn University, Auburn, AL; cwr0001@auburn.edu
J. David Williams
Auburn University, Auburn, AL; willi09@auburn.edu
Ann W. Fleener
Auburn University, Auburn, AL; awf0001@auburn.edu

The use of vertical structures for gardening is a sustainable method for growing fresh produce. Vertical structures require smaller production areas, provide readily-available fresh, local produce on a larger scale, and can be quite versatile when compared to traditional gardening methods. This work looks at the design and construction of an inexpensive, A-frame vertical growing structure with the goal of creating a more profitable, economical, and sustainable method for growing plants. The A-frame vertical structure is constructed from simple, readily available, inexpensive, and durable materials. Each structure consists of: 2” x 4” x 8’ and 1” x 4” x 8’ treated wood boards, galvanized steel carriage bolts, nuts and washers, metal cattle fencing, fencing staples, and galvanized steel nails. The estimated cost to build one A-frame vertical structure is $57.56. The structure provides staples, and galvanized steel nails. The estimated cost to build one A-frame vertical structures is $57.56. The structure provides staples, and galvanized steel nails. The estimated cost to build one A-frame vertical structures is $57.56.

Today’s college students are living in a digital age, but how closely do recruitment efforts in horticulture target these students? The last time recruitment studies in horticulture were published was 10–20 years ago, so this data does not accurately depict the students of today. Trends in recruitment need to be re-evaluated based on influential factors prompting them into the field and re-established this identity to better define them. These students play a vital role in supplying the job market in the Green Industry, which is in high demand according to industry. This study was conducted via a survey given to current students who attended PLANET’S 2014 Student Career Days with the objective was multifaceted, with one portion being to identify influential factors in a student’s decision to pursue a career in the field of horticulture. The results show prior experience in gardening played a large role as well as talking with a parent or relative in students’ decision to pursue a degree in horticulture. It was also determined that 41% of students were another major prior to horticulture and may give rise to additional areas of recruitment. These results will provide both academia and industry in horticulture vital information in enhancing the efforts of recruitment and securing the necessary supply of students for the job openings ahead in the Green Industry.

10:45–11:00 AM
Creating Butterfly Gardens Across Louisiana through Enhanced Extension Agent Training
Kathryn Fontenot*
LSU AgCenter, Baton Rouge, LA; kkfontenot@agcenter.lsu.edu
Alan Morgan
LSU AgCenter, Baton Rouge, LA; amorgan@agcenter.lsu.edu
Allen Owings
LSU AgCenter, Hammond, LA; aowings@agcenter.lsu.edu

County extension agents are constantly under pressure to increase contact numbers. Limited state and federal funding reduce possibilities for new horticulture programming and make maintaining existing programming difficult. An internal innovation grant was received to host an agent training with a butterfly garden focus. The agent training focused on information on butterfly anatomy, butterfly eating habits and host plant and nectar plant selection for southern gardens. Agents were also provided with three lessons related to growing a butterfly garden. Lessons were matched with state educational benchmarks and could be used with elementary-aged students and older students with slight modifications. Lesson topics included: plant propagation of butterfly plants, butterfly life–cycles, and but-
Internships in public horticulture allow the unique opportunity for future leaders to learn in an immersive environment while gaining hands-on practical work experience. This valuable experience is gaining in popularity as a prerequisite for full time employment in our industry. In 2012, an electronic survey was distributed in partnership with the American Public Gardens Association (APGA) and the Public Horticulture Working Group of ASHS to evaluate internship programs in public horticulture.

An asterisk (*) following a name indicates the presenting author.
Cumulation of bioactive compounds, with antioxidant activity and phytochemical content increasing as the season progressed. Antioxidant activity was significantly and positively correlated ($P > 0.01$) with accumulation of both flavonoids ($r = 0.83$) and total phenolics ($r = 0.77$). Improved knowledge of nutritional quality existing in modern peach germplasm will facilitate development of new peach cultivars with increased bioactive composition, thereby providing tastier and healthier food choices for consumers.

Specified Source(s) of Funding: USDA and South Carolina Department of Agriculture

10:30–10:45 AM

**Comprehensive Genotyping of the Peach Collection at the National Clonal Germplasm Repository in Davis**

Ksenija Gasic*
Clemson University, Clemson, SC; kgasic@clemson.edu

Bradley Rauh
Clemson University, Clemson, SC; brauh@clemson.edu

C.E. Wells
Clemson University, Clemson, SC; cewells@clemson.edu

Douglas G. Bielenberg
Clemson University, Clemson, SC; dbielen@clemson.edu

John E. Preece
USDA–ARS, Davis, CA; John.Preece@ars.usda.gov

We used genotyping by sequencing (GBS), a low-cost, high-throughput sequencing technology to genotype 333 *Prunus* accessions, preserved at the *Prunus* collection of the National Clonal Germplasm Repository (NCGR) in Davis, California. The *Prunus* collection is the second largest in this genebank with more than 90 taxa and in excess of 1600 accessions of *Prunus* spp that includes almonds, apricots, cherries, peaches and plums. The accessions genotyped here consist of heirlooms (old cultivars never patented, or off patent), landraces, breeder’s lines, and wild relatives of the peach from all over the world. Majority of accessions belonged to *Prunus persica* (84%), with 10% of them being wild relatives (*P. mira, P. davidiana, and P. ferganensis*) and 6% categorized as hybrids between peach and other related species and *Prunus* spp. The method produced on average 1 million sequence reads per accession, with majority of the accessions having more than 500,000 reads. We identified 18,008 single-nucleotide polymorphism (SNP) markers, present in at least ≥ 80% of analyzed accessions distributed across the entire genome. These genomic data will serve as a resource for breeders seeking to develop peach cultivars that will meet the challenge of changing climates, markets, and horticultural practices. The use of these SNP markers for conservation, management and utilization of the NCGR collection as well as for genome-wide association studies (GWAS) in combination with phenotypic data available through Germplasm Resources Information Network (GRIN) will be discussed.

Specified Source(s) of Funding: USDA–ARS

---

An asterisk (*) following a name indicates the presenting author.
**Oral Presentations**

10:45–11:00 AM

**From Population to Association Genetic Analyses in Prunus umbellata Elliot, Can GBS Do It All? — A Comparison of SSR and SNP Markers**

Dario J. Chavez*
University of Georgia, Griffin; dchavez@uga.edu

Stuart F. McDaniel
University of Florida, Gainesville; stuartmcdaniel@ufl.edu

Adam C. Payton
University of Florida, Gainesville; acpayton@ufl.edu

Thomas G. Beckman
USDA–ARS, Byron, GA; tom.beckman@ars.usda.gov

José Chaparro
University of Florida, Gainesville; jaguey58@ufl.edu

Prunus umbellata is a diploid plum species native to the Southern United States with a wide geographic range and adaptation to different soils and environments. Other species native to the Southern U.S. include *P. americana* Marsh., *P. angustifolia* Marsh., and *P. geniculata* Harper. The objective of this research was to evaluate *P. umbellata* as a model plant for the identification of genomic regions associated with dormancy response. A total of 48 genotypes: 42 of *P. umbellata* ranging from central Georgia to south Florida, 2 of *P. americana*, 2 of *P. angustifolia*, and 2 of *P. geniculata*, were fingerprinted using 41 SSRs distributed across the peach genome (~15-25 cM). Similarly, genotype-by-sequencing (GBS) was used to identify SNPs across the genome of 48 multiplexed genotypes using Illumina HiSeq® 2000 system. GBS produced up to 175 million reads in one flow cell lane, yielding approximately 40 Gb of data, with a filtered 101 million reads and an average of 2.1 million reads per genotype. SNP markers were detected using Stacks software and ranged from 30,411 markers (6x depth) for at least 33 genotypes (r = 0.7 or 70% of genotypes required to process a locus) to 487 markers (6x depth) for all genotypes (r = 1.0 or 100% of genotypes required to process a locus). Genetic diversity and population structure results based on SSR and SNP markers (using different depth coverage and r values) were comparable. SSR and SNPs markers allowed the identification of hybrid genotypes among species. Similarly, these markers were used to identify genomic regions associated with dormancy response.

11:00–11:15 AM

**Genetic Relationship of Peach [Prunus persica (L.) Batsch] Cultivars using SSR Markers and Correlation between SSR Markers and Morphological Characteristics**

Jee-Hwa Hong*
Korea Seed & Variety Service, Suwon; hongjh19@korea.kr

Won-Heum Park
Gyeongsangbuk-do Agricultural Technology Administration, Cheongdo-gun; pwh9107@korea.kr

Seung-In Yi
Korea Seed & Variety Service, Anyang-si; seedin@korea.kr

Yong-Sham Kwon
Korea Seed & Variety Service, Suwon; yskwon3@korea.kr

Doo-Hwan Kim
Konkuk University, Seoul; kimdh@konkuk.ac.kr

Peach [Prunus persica (L.) Batsch] is a member of the Rosaceae and a temperate fruit crop. Seventy-three peach cultivars have been registered at the Korea Seed & Variety Service for Plant Variety Protection. Simple sequence repeat (SSR) markers are very suitable for genetic relationship and cultivar identification through automatic detection system. The 189 SSR primers designed previously were used to identify peach cultivars. Out of the 189 SSR primers, 74 SSR markers were polymorphic in 9 cultivars. Out of 74 SSR markers, 30 markers were observed reproducibility and band clearance. These 30 SSR markers were applied for constructing DNA profile database of 174 peach cultivars through automatic detection system. A total of 124 polymorphic amplified fragments were obtained by 30 markers, and two to ten SSR alleles were detected for each locus with an average of 4.1 alleles per locus. Average polymorphism information content (PIC) was 0.465, ranging from 0.033 to 0.753. Genetic distance ranged from 0.36 to 1.00 in the 174 cultivars. Totally 115 cultivars were identified by 30 markers, and fifty-nine cultivars consisting of 23 groups showed 100% similarity in genetic distance. A total of 32 peach cultivars randomly selected according to the genetic similarity ratio were scored for 11 distinctness, uniformity, and stability (DUS) characteristics from the test guidelines prescribed by Korea Seed & Variety Service. The correlation coefficient (r) was 0.722 between the 30 SSR markers and morphological traits distance, which is the highest value ever reported. These SSR markers may be useful for selecting the most similar comparative cultivar to the candidate cultivar in DUS examination and protection of plant breeders’ rights.

11:15–11:30 AM

**Genetic Diversity and Distribution within Cultivated Gene Pools of Chionanthus retusus (Oleaceae) in the United States**

Richard T. Olsen*
USDA–ARS U.S. National Arboretum, Beltsville, MD; richard.olsen@ars.usda.gov

Timothy A. Rinehart
USDA–ARS SHL, Poplarville, MS; tim.rinehart@ars.usda.gov

Joseph H Kirkbride
USDA–ARS-USNA-FNPRU, Washington, DC; joseph.kirkbride@ars.usda.gov

The chinese fringe tree (*Chionanthus retusus* Lindl. & Paxton) has a broad distribution in China with disjunct populations found in Korea, Japan, and Taiwan. Although introduced to the United States on several occasions from different sources and provenances, the extent to which these introductions were established in cultivation, and their contribution to the cur-
rent cultivated C. retusus-genepool is unknown. Genomic simple sequence repeat (SSR) markers were used to screen a broad sampling of C. retusus from commercial nurseries and botanical collections to assess genetic diversity and structure. Seventy-one SSR loci tested were highly polymorphic across 63 accessions of C. retusus. The mean number of alleles per loci and mean polymorphic information content was 8.7 and 0.61, respectively. The mean observed heterozygosity (0.35) was low relative to mean expected heterozygosity (0.64). Nineteen loci (26.7%) deviated significantly from Hardy Weinberg equilibrium and the mean frequency of null alleles was 0.33. Low observed heterozygosity and disequilibrium are indicative of the narrow genetic base for the initial introductions of C. retusus and subsequent inbreeding and clonal propagation. Distance and cluster analyses are congruent, and the resulting population clusters (K = 7) are supported by collection and provenance data. Commercially available C. retusus consists primarily of three populations. The largest and most diverse population originates from northeastern China, and includes historical introductions and their progeny augmented with new Chinese-sourced commercial seed. The second population is based on the original Japanese introduction in 1901, exhibits low diversity, and is essentially derived from the cultivar Arnold’s Promise. The third population originated from a small initial Taiwanese introduction and is widely cultivated in hardiness zone 7 and south. The southern ecotype previously identified in the literature is associated only with material from Taiwan, and is represented primarily by the cultivar China Snow. The newly introduced cultivar, Tokyo Tower, is genetically similar to a fourth population from Tsushima Island, Japan, which had not previously contributed to the cultivated gene pool. Additional populations from China and Korea are only represented in botanical collections. Therefore, American plant breeders have additional, though limited, genetic diversity available for the development of novel C. retusus cultivars.

11:30–11:45 AM

Polyplody as a Potential Erythrina Gall Wasp Management Strategy

Ken W. Leonhardt*
University of Hawaii, Honolulu; leonhardt@hawaii.edu

The erythrina gall wasp (EGW; Quadrastichus erythrinae Kim) was first collected in Hawaii in 2005 on Erythrina variegata L., a then popular landscape species. It quickly spread to all islands causing severe damage to the native Erythrina sandwicensis Degener as well as most introduced species. E. variegata ‘Tropic Coral’, a fastigiate form was widely used as a windbreak for crop protection and soil and water conservation. However, today it is nowhere to be found. Galls on leaves, petioles and stems are induced by the larvae of the tiny EGW. Larvae develop within plant tissues, causing the formation of galls on leaves, petioles and stems. Leaves curl and become massively deformed while petioles and stems become swollen. Heavy infestations cause defoliation and death of trees. Thousands of trees have been killed by this pest. Polyploid individuals of E. variegata show a high level of tolerance to the EGW, while in the same plot diploid individuals are destroyed or nearly destroyed. The induction of polyploidy in EGW-susceptible Erythrina variegata may be a strategy to return this species and its cultivar ‘Tropic Coral’ to cultivation in Hawaii and other areas where this pest is a problem.

11:45 AM–12:00 PM

Genetic Characterization of Coffea arabica ‘Geisha’ from Panama and Ethiopia

Sarada Krishnan*
Denver Botanic Gardens, Denver, CO; krishnas@botanicgardens.org

Willem Boot
Boot Coffee, Mill Valley, CA; willem@bootcoffee.com

Coffee is an important agricultural commodity contributing significantly to the economies of many developing countries. Of the 125 species of Coffea, the two main commercial species used in the production of the beverage are C. arabica L. (Arabica coffee) and C. canephora A. Froehner (robusta coffee). Arabica coffee accounts for about 70% of the total coffee production. The Geisha variety (C. arabica var. Geisha) was first discovered in the forested mountains of western Ethiopia in 1930s in the provinces of Maji and Goldiha. It was first brought to Panama from Costa Rica in 1963 after journeying through Tanzania, Kenya and Costa Rica. Displaying unique flavor profiles, larger bean size and other phenotypic differences from other C. arabica varieties, this variety also exhibits resistance to coffee leaf rust (Hemileia vastatrix Berkeley and Broome). The specific research objective of this study was to understand the genetic differences between the Geisha coffee grown in Panama and that from the original forests in Ethiopia using Inter Simple Sequence Repeats (ISSRs).

Thursday, July 31, 2014

Ornamentals/Landscape and Turf

Moderator: Matt Lenhardt; lenhardt@ufl.edu

10:15–10:30 AM

Turf Fertilization Effects on Nitrogen Status of Kentucky Bluegrass and ‘Autumn Blaze’ Maple Growing in a Mixed Landscape

Alison Stoven O’Connor
Colorado State University, Fort Collins; astoven@larimer.org

Anthony J. Koski*
Colorado State University, Fort Collins; tony.koski@colostate.edu

Daniel K. Struve
Ohio State University, Columbus; struve.1@osu.edu

Ken Kawamura
Town of Windsor, Windsor, CO; kkawamura@windsorgov.com

James E. Klett
Colorado State University, Fort Collins; jim.klett@colostate.edu

It is commonly assumed that trees growing in a lawn receive sufficient nitrogen (N) from lawn fertilization. However, few
researchers have examined the effect of N lawn fertilization on N levels of trees growing in urban landscapes. In this study, we applied nitrogen at a rate of 48.8 (LN) or 195.2 (HN) kg N per hectare (1 or 4 pounds N per 1000 square feet) to separate tree medians containing Kentucky bluegrass (Poa pratensis L.) turf and 15-year-old Autumn Blaze maple (Acer xfreemanii ‘Jeffersred’). Nitrogen was applied in May 2013 using a 35N–0P–8.3K fertilizer (28.35% urea nitrogen from polymer-coated urea). Grass clippings and tree leaf samples are collected biweekly (June–September), dried, ground, weighed and analyzed for total N. Tree stem growth rate was measured by examining marked branch increments monthly. Dark green color index (DGCI) and calculated SPAD were measured biweekly. As expected, the HN fertility rate stimulated consistently greater turf clipping yields throughout the growing season than what was observed with the LN fertility rate. Tree growth rate was unaffected by fertility treatment. Tree leaf N concentration and dark green color index (DGCI) was also unaffected by N fertility in the first year of this study.

Specified Source(s) of Funding: Colorado State University Agrium Advanced Technologies Rocky Mountain Regional Turfgrass Association

10:30–10:45 AM

Characterization of Warm-season Turfgrasses Against Drought
Quurrat-ul-Ain Farooq*
University of Punjab, Lahore; anniepk_elegant@yahoo.com

Turfgrasses are important ground covers used aesthetic and environment amelioration. Study of drought resistance is important for selection of suitable varieties. The study was conducted to investigate the assess drought resistance among different warm season turfgrass varieties viz. Bermuda grass (Dacca), Zoysia grass, Tifway and Tiffany. The treatments were applied, i.e. well watered (control), drought stress (irrigation was withheld and soil was allowed to dry by continually maintaining un-watered for 15 days and 30 days). Leaf area, shoot length, root length, and chlorophyll content were measured. Dacca retains maximum leaf area at three observed drought levels. In comparison to other varieties Dacca maintained maximum shoot length and root length at different drought levels. Minimum total chlorophyll content alteration found in Dacca >Tiffany >Zoysia. While Tifway prone to maximum alteration in total chlorophyll content. In present study it was observed that among four selected warm-season turfgrasses Dacca had maximum resistance, whereas Tifway was most sensitive against applied drought levels.

10:45–11:00 AM

Irrigation Effects on Growth and Visual Quality of Three Ornamental Grass Species
Jane Rozum
Colorado State University, Fort Collins; jane.rozum@colostate.edu
James E. Klett*
Colorado State University, Fort Collins; jim.klett@colostate.edu

Ornamental grasses have become ubiquitous in the landscape and are popular with consumers and industry professionals because of their favorable low-input cultural characteristics. These characteristics include low water and nutrient requirements, decreased maintenance, fast growth and few disease and insect problems. A study conducted at Colorado State University (Fort Collins, CO) examined the effects of four irrigation levels [0, 25, 50 and 100% of potential evapotranspiration (ET)] on growth and visual quality of three species of ornamental grasses (Panicum virgatum ‘Rotstrahlbusch’, Schizachyrium scoparium ‘Blaze’ and Calamagrostis brachytricha). Averaged across species, maximum plant height and width was observed at the 25% irrigation level. We found that plant dry weight increased as irrigation level increased from 0% to 50% of ET, but there was a decrease in total plant dry weight at 100% of ET. This indicates that watering these species of ornamental grasses at 100% ET may be detrimental to growth and plant quality. The greatest drought stress, as measured by leaf water potential, was found with the more mesic species C. brachytricha. Averaged across species, leaf water potential was more negative (greatest drought stress) at 0% of ET and the least amount of stress was observed at 50 and 100% of ET. At the conclusion of the study, visual ratings of plant form, floral impact and landscape impact were highest at the 25% of ET irrigation level. Our research with these three species in Colorado suggests that irrigation at 25% of ET produces the healthiest plants, with greater height, width, dry weight and visual impact in the landscape. This agrees with anecdotal observations that ornamental grasses will perform better in a landscape with limited irrigation and other inputs.

11:00–11:15 AM

My Brevard Yard: Residential Education for the Protection of the Indian River Lagoon
Matt Lenhardt*
UF/IFAS Extension Brevard County, Cocoa, FL; lenhardt@ufl.edu
Sally A. Scalera
UF IFAS Extension Brevard County, Cocoa, FL; sasc@ufl.edu

The Indian River Lagoon contains the most diverse ecosystem in the continental United States. Years of nutrient loading and pollution from septic systems, fertilizers, and storm-water runoff have contributed to the IRL’s impaired status. In Florida, landscape professionals are required to have a license to apply fertilizer, whereas homeowners require no such education. Realizing the need for homeowner education, UF/IFAS Brevard County Extension horticulture agents adapted the Green Industries Best Management Practices training to develop My Brevard Yard, a creative approach to teach homeowners how to apply fertilizer and irrigate their properties in an environmentally sound way. My Brevard Yard consists of a one-hour classroom and “hands-on” workshop plus an optional site visit. Collaboration with local municipalities helps promote the workshops in their local communities. Five My Brevard Yard workshops with 64 participants have been held. Pre- and post-tests indicated a 23.4% knowledge gain in topics such as proper walking speed
for applying fertilizer, the recommended amount of slow release nitrogen for turfgrass, and the importance of using a soil test to develop a fertilization program. The My Brevard Yard workshops and site visits were designed to capture a variety of practice changes. These changes can range from applying the recommended amount of fertilizer, applying fertilizer at the correct time, and using proper irrigation practices. The adoption of various practices, multiplied by a large number of residents, can result in the improved health of the Indian River Lagoon.

11:15–11:30 AM

**Green Beer & Brew: Using Themed-styled Trainings to Increase Participation and Knowledge Gain**

Matt Lenhardt*

UF/IFAS Extension Brevard County, Cocoa, FL; lenhardt@ufl.edu

Karen M. Stauderman

University of Florida, DeLand; kstauderman@ufl.edu

Volusia County has many licensed landscape pesticide applicators. Each year, license holders seek Continued Education Units (CEUs) to increase industry knowledge and maintain their state certification. Many traditional education programs used by County Extension offices are often conventional and routine, resulting in declining classroom attendance or landscape professionals obtaining CEUs online. Therefore, increasing classroom participation and stimulating learning will require engaging classroom educational methods and enhanced marketing efforts. Two pesticide training classes were offered having Halloween and St. Paddy’s Day themes. Marketing efforts included Facebook, email list serves, websites, and print media. County agents instructed in costume themed attire, offered holiday décor and food, and used theme-styled educational presentations to increase knowledge gain. Same day class survey results indicated that 69% of participants would be more likely to attend themed-style trainings in the future. A three-month follow-up survey indicated that 87% of participants indicated the theme-styled presentations helped them learn the subject matter better than non-themed presentations and reduced overall pesticide usage by 11%. Theme-styled educational programming is an effective way to draw audiences that may not attend traditional classroom settings. As a result, audiences expressed learning gains, pesticide usage reduction and monetary savings.

11:30–11:45 AM

**Irrigation Contractors in Georgia Offer Many Systems and Many Prices**

Ellen Bauske*

University of Georgia, Griffin; ebauske@uga.edu

Clint Waltz

University of Georgia, Griffin; cwaltz@uga.edu

Kathy Nguyen

Cobb County Water System, Marietta, GA; Kathy.Nguyen@cobbcounty.org

A residential landscape plan was developed and drawn to scale. The landscape included 465 m² of turfgrass, an 84 m² tree island and 45 m² of woody ornamentals. Thirty-one irrigation contractors were asked to bid on the installation of an irrigation system for the landscape and 11 bids were received. Five of the contractors were WaterSense® (WS) partners. Seven participating contractors were Irrigation Association (IA) certified. The bids ranged from a high of $3,480 to a low of $1,530 with an average bid price of $2,417. WS partner bids with an average cost of $2,297, were slightly lower than non-partner bids, which averaged $2,517 (no statistical difference $P = 0.05$). The seven IA certified contractors (average = $2,549) tended to charge more than the four non-certified contractors (average = $2,188), though the difference was not statistically significant. Some of the bids suggested practices that would increase water use. For instance, two bids did not use drip irrigation on the woody ornamentals. Another bid watered the tree island, noting that installation would be less expensive if the tree island was watered with turfgrass areas. One contractor suggested eliminating the rain shutoff devise to save money (this is a violation of state law). Six contractors included WS labeled smart controllers in the bids, only two of these contractors were WS partners. One bid provided no information regarding the controller and four bids provided no information about nozzles, heads or drip equipment. Only one bid provided water saving, equipment upgrade options for the consumer, yet did not specify that the upgrades would reduce water use. Many consumers must pay for water the irrigation system uses as well as installation costs. Ongoing water costs may quickly eclipse the cost of the installation. Results suggest contractors may be able to distinguish their bids and sell upgrades by including estimated water costs in bids and conversation.

11:45 AM–12:00 PM

**Container Type Affects Landscape Establishment and Growth of Chanticleer Pear**

Alison Stoven O’Connor*

Colorado State University, Fort Collins; astoven@larimer.org

James E. Klett

Colorado State University, Fort Collins; jim.klett@colostate.edu

Anthony J. Koski

Colorado State University, Fort Collins; tony.koski@colostate.edu

Above-ground container nursery production makes up more than 50% of the $26 billion woody plant nursery industry in the United States. Circling and/or malformed roots, a common problem with container-grown plant material, can negatively impact plant health and stability both in the nursery and landscape after transplanting. Roots deflected in plastic containers grow in many directions, including up, down or around the root ball; some roots may “kink” 180 degrees and go back the way they grew from, causing constrictions and circling roots. Research has found that fabric containers have fewer circling/girdling roots compared to those grown in other smooth-sided containers. Long-term survival of trees planted into the landscape

An asterisk (*) following a name indicates the presenting author.
may be influenced by the container in which they are grown. Malformed roots that begin with container production can lead to tree instability and possible failure. Our research, conducted at Colorado State University (Fort Collins, Colo.), examined container effects on *Pyrus calleryana* ‘Glen’s Form’ (Chanticleer®) establishment for three years following transplanting. The three container types were the industry standard black plastic (BP), and Root Pouch® (RP) and Smart Pot® (SP). Trees were grown in the nursery one season and then planted into the landscape. We found no container effects on above-ground growth (height, caliper, leaf area, leaf and shoot dry weight) in 2011, 2012 and 2013. Container type significantly affected root dry weight, root re-growth, and fine root development. Trees grown in BP containers had the greatest root dry weight, yet BP-grown trees had the least amount of root re-growth beyond the original root ball after three years (29%), compared to RP- (35%) and SP-grown (37.3%) trees. There was greater fine root development for the two fabric containers (RP and SP) compared to BP containers. This suggests that three years following planting, container type still directly affects root establishment and development. Our research found that fabric containers resulted in trees with a more natural, lateral branching root system compared to trees grown in BP containers. Further, above-ground growth may not indicate if a tree’s root system has established correctly. Based on our study, if long-term growth and plant health is a priority for growers, tree care professionals and homeowners, then fabric containers should be considered as alternatives to black plastic containers.

Specified Source(s) of Funding: Colorado State University Department of Horticulture and Landscape Architecture, Colorado Department of Agriculture, Colorado Agricultural Experiment Station, and the Colorado Nursery Research and Education Foundation

12:00–12:15 PM

**Performance of Elm Taxa in Auburn, AL**

Hanna J. Pettus*
Auburn University, Auburn, AL; hjp0001@auburn.edu

Adam F. Newby
Auburn University, Auburn, AL; newbyaf@auburn.edu

Carolyn W. Robinson
Auburn University, Auburn, AL; cwrobinson@auburn.edu

Jeff L. Sibley
Auburn University, Auburn, AL; sibleje@auburn.edu

American elms (*Ulmus americana* L.) once lined Midwestern and New England towns until the late 1950s. At that time, 80% of elms across the country had been diagnosed with Dutch elm disease and were removed. This created a need to find genetically diverse elms, and began many researchers’ work on finding species and/or hybrids that would have increased resistance to Dutch elm disease. As part of their efforts, Colorado State University coordinated a multi-state effort to evaluate elm cultivars in different climates and hardness zones, also known as the National elm trial. Auburn University joined this trial in 2007, with the purpose to evaluate growth, horticultural tolerance, and insect, disease, and stress tolerance. There have been many trials throughout the United States, but those in the Southeast have not been completed or at least reported. These characteristics need to be evaluated before recommendations on specific cultivars most suitable for the region can be reported to producers and the landscape industry. In the Auburn University trial, a total of 19 cultivars were planted. Eighteen cultivars were replicated five times, and one cultivar was replicated ten times, equaling a total of 105 trees. No herbicides, pesticides, or supplemental irrigation were used. Data collected includes height, trunk diameter (at 12”), crown width, crown shape, fall foliage color, date of fall foliage color onset, duration of fall foliage, disease incidence and severity, and insect incidence and severity. In the fall of 2013, *Ulmus* ‘Morton Red Tip’ had the greatest height (19.1 ft. and caliper (4.55). *U. ‘Patriot’, U. parvifolia ‘BSNUPF’, *U. americana ‘Princeton’, and *U. Morton Stalwart’ were among the tallest cultivars. *U. americana ‘Homestead’, U. americana Lewis and Clark’, *U. parvifolia ‘Emet I’, ‘U. Morton Stalwart’, and *U. New Horizon’ were cultivars with a trunk diameter of greater than 3.5 inches. *U. propinqua ‘JSF-Bieberich’, *U. parvifolia ‘Emet I’, ‘U. Morton Plainsman’, and ‘U. Morton Triumph’ were among the shortest cultivars with heights equal to or less than 12 ft. *U. Morton Triumph’, *U. americana ‘Princeton’, *U. propinqua ‘JSF-Bieberich’, and *U. Morton Plainsman’ had the smallest trunks with diameters less than 2.5 in. This data will be useful in creating recommendations for elm cultivar selection in the Southeastern U.S.

**Thursday, July 31, 2014**

**Viticulture and Small Fruits 2**

Moderator: Sonet Van Zyl; svanzyl@csufresno.edu

11:30–11:45 AM

**Transcriptional Changes of Anthocyanin Metabolism during Fruit Ripening in Highbush Blueberry (Vaccinium corymbosum L.)**

Sun Woo Chung*
Seoul National University, Seoul; jsw599@gmail.com

Duk Jun Yu
Seoul National University, Seoul; dukjunyu@hanmail.net

Min Kyo Chun
Seoul National University, Seoul; alsry88@snu.ac.kr

Hee Jae Lee
Seoul National University, Seoul; heejlee@snu.ac.kr

Transcriptional changes of anthocyanin metabolism during fruit ripening were examined based on the gene expression and metabolite profiling in ‘Bluecrop’ highbush blueberry. Fruits were categorized into mature green, veraison, and dark blue stages. Genes involved in anthocyanin metabolism were identified in the fruit transcriptome analyzed by using RNA-Seq. Transcriptional changes of these genes were investigated by differentially expressed genes. Total anthocyanin content was determined by...
pH differential method using UV/Vis spectrophotometer and anthocyanin aglycon content was determined by high performance liquid chromatography. Individual anthocyanins were profiled by liquid chromatography-mass spectrometry. Of 38,025 contigs, 33 genes involved in anthocyanin metabolism were identified. Anthocyanins were glucosylated and/or methylated by 8 transferase genes during fruit ripening. Gene expression involved in anthocyanin metabolism was correlated with the increase of anthocyanin content during fruit ripening. A total of 18 anthocyanins composed of cyanidin, delphinidin, malvidin, peonidin, and petunidin were identified at dark blue stage. These results provide information to understand anthocyanin metabolism during fruit ripening in highbush blueberry.

Specified Source(s) of Funding: This work was supported by Korea Science and Engineering Foundation (KOSEF) grant founded by the Korea government (MEST) (NO.2013R1A1A2011925)

11:45 AM–12:00 PM

Comparative Analysis of Polyphenolic Content and Gene Expression Patterns of Key Flavonoid Biosynthetic Genes in Fragaria Species Color Mutants

Sutapa Roy*
University of Kentucky, Lexington; sutaparoy09@gmail.com

Douglas Archbold
University of Kentucky, Lexington; darchbol@uky.edu

Strawberries are a rich source of polyphenols which contribute to berry color and flavor and have been shown to lower the risk of chronic diseases such as cancer and cardiovascular disease when consumed. While there is a considerable body of work on the polyphenolic composition of commercial strawberry (Fragaria x ananassa Duch.), less information is available concerning polyphenols in Fragaria vesca, or Alpine strawberry, now considered a model system for the Rosaceae family. To provide insight into metabolic flux through the complex, branched flavonoid biosynthetic pathway, the identity and quantity of the major phenolic-derived anthocyanins, flavonols, flavan-3-ols, hydroxycinnamic acids, and ellagic acid (EA)-derived compounds, and expression patterns of key flavonoid biosynthetic genes, of red cultivars versus white mutants of F. vesca and F. xananassa were compared. Polyphenolic compounds of ripe berries were identified and quantified in six cultivars of F. vesca, 5 white and 1 red, and two cultivars of F. xananassa, 1 white and 1 red, by high performance liquid chromatography coupled with electrospray ionization mass spectrometry in both positive and negative ion modes. Six anthocyanins were identified, though not in all genotypes. There was more pelargonidin-3-glucoside than cyanidin-3-glucoside in red F. xananassa, while the opposite was true for red F. vesca. The white genotypes of both species had very low anthocyanin levels. Twenty-one other phenolic-derived compounds were identified. Among the flavonols, quercetin-3-glucoronide and kaempferol-3-glucoside were the most abundant in both F. vesca and F. xananassa, with more in the latter. Flavan-3-ols were present in dimeric forms of catechin and epicatechin with consistently high amounts in the all of the white cultivars of both species. Total hydroxycinnamic acids were generally the least abundant across species and genotypes. Total content of free EA and its conjugated forms, EA pentoside, methyl EA pentoside, and EA hexoside, were generally higher in white versus red F. vesca, and red versus white F. xananassa. Galloyl bis HHDP hexose and HHDP galloyl hexoside were the most common ellagitannins in both species though no clear species or genotype differences were evident. Transcriptional analyses of the flavonoid biosynthetic genes revealed correlations with the final concentrations of polyphenolic groups in red and white F. vesca, especially the differential expression patterns of dihydroflavonol-4-reductase, anthocyanidin synthase, and UDP-glucose-flavonoid-3-O-glucosyltransferase genes. These results will be discussed in terms of final metabolite pools.

12:00–12:15 PM

The Effects of Foliar Potassium Applications on Table Grape Quality

Sonet Van Zyl*
California State University, Fresno; svanzyl@csufresno.edu

Si Jie Zhu
California State University, Fresno; zsj1101@mail.fresnostate.edu

Xiaofan Zhao
California State University, Fresno; zhaoxiaofan@mail.fresnostate.edu

About 99% of all U.S. grown table grapes come from California and over 100 million boxes were shipped to over 60 countries in 2012. Potassium (K) is the most abundant nutrient in mature grapes and has a significant effect on increasing fruit quality compounds. Foliar K applications are often used since soil K is not always sufficiently translocated for optimum crop quality. In 2013 two foliar applications were made using either water or 1.3 g/L of K at veraison and three weeks later at California State University, Fresno. Samples were collected weekly until harvest. Soluble solids content, berry K content, juice pH and titratable acidity were measured at each sampling. Berry firmness, diameter, weight and color were also measured at harvest. Potassium caused significant increases in soluble solids in both cultivars including increased berry K content, firmness and color intensity, while berry size and firmness decreased significantly. Foliar K applications after veraison appear to be a promising approach to obtain earlier harvest. In addition, five different K salt solutions were tested. The salts included K bicarbonate, K phosphate, K phosphite, K sorbate, and a commercial potassium product Metalosate® K. These products were applied at the onset of veraison and again three weeks later to clusters of ‘Sweet Scarlet’ and ‘Scarlet Royal’ table grapes. Per liter, the solutions contained 1.3 g of K and 0.3 g of surfactant B1956. The clusters were immersed for 10 seconds into the solutions. Five berries from each sample cluster were collected weekly for three weeks and soluble solids and K concentrations were determined. The fourth and final sample consisted of 20 berries per cluster and in addition to soluble solids, berry color, firmness,
An asterisk (*) following a name indicates the presenting author.

HortScience 49(9) Supplement—2014 ASHS Annual Conference  S225

berry size, and juice pH and acid content were determined. The soluble solids of untreated ‘Scarlet Royal’ and ‘Sweet Scarlet’ berries were significantly lower than the Metalosate® K treated berries. Responses from K bicarbonate and K sorbate applications were similar. The three potassium applications that increased soluble solids: 1) did not alter berry color; 2) generally reduced berry firmness; 3) reduced the size of ‘Scarlet Royal’ berries but not those of ‘Sweet Scarlet’; and 4) did not alter acid content or pH. Results indicate that the application of these salts could be used to increase soluble solids to facilitate earlier harvest, or to mature a larger crop on the vines.

Specified Source(s) of Funding: California Table Grape Commission

12:15–12:30 PM

**Fruit Quality of Pierce’s Disease Resistant 87.5% *Vitis vinifera* Selections**

Elina D. Coneva*
Auburn University, Auburn, AL; edc0001@auburn.edu

James A. Pitts
Alabama Agriculture Experiment Station, Clanton, AL; pittsja@auburn.edu

Three recently developed Pierce’s disease (PD) resistant 87.5% *V. vinifera* selections from the U.C.-Davis grape breeding program, namely ‘502-10’, ‘502-01’, and ‘501-12’, were planted at the Chilton Research and Extension Center (CREC) near Clanton, Alabama in 2010 to evaluate their fruit quality characteristics and their field PD resistance in a high PD risk zone. The experimental vineyard is a RCBD with 6 blocks and 5 vines per block. Vines are trained to a vertical shoot positioning trellis system. The first commercial crop was produced in 2012. Fruit quality data collection continued in 2013. Our results suggest selection ‘502-10’ had the lowest pruning weight of 2.1 kg/vine, while ‘501-12’ had the highest (2.3 kg). Selection ‘502-10’ matured early in the season, while ‘501-12’ ripened late. The selections differed in total yield per vine with the late maturing ‘501-12’ producing the largest crop of 8.1 kg/vine. ‘502-10’ and ‘501-01’ also produced very good yield. Selection ‘501-12’ had the largest number of clusters per vine – 89, while ‘502-10’ had 33 clusters per vine on average. Early-season selection ‘502-10’ had the largest cluster weight of 210 g, while mid-season selection ‘502-01’ produced the largest size berries. Late season selection ‘501-12’ had the sweetest berries with soluble solids content of 24.2%. The preliminary results of our study are very encouraging. Further research is needed to fully assess the fruit quality of newly introduced *V. vinifera* selections in multiple years.

Specified Source(s) of Funding: Washington State Concord Grape Research Council

Thursday, July 31, 2014

**Nursery Crops 2**

Moderator: Andrew R. King; aking@tamu.edu

1:45–2:00 PM

**Influence of Provenance on Acute Drought Tolerance of Four Native Texas Groundcover Species**

Andrew R. King*
Texas A&M University, College Station; aking@tamu.edu

Michael A. Arnold
Texas A&M University, College Station; ma-arnold@tamu.edu

Charles R. Hall
Texas A&M University, College Station; charliehall@tamu.edu

H. Brent Pemberton
Texas A&M AgriLife Res & Ext Center, Overton; b-pemberton@tamu.edu

Marco A. Palma
Texas A&M University, Dept. Agricultural Economics, College Station; mapalma@ag.tamu.edu

Sean T. Carver
Texas A&M University, College Station; scarver@neo.tamu.edu

From previous selection efforts, four promising native groundcovers were identified; *Erigeron procumbens* (Houst. ex Mill.) G.L. Nesom., *Mimosa strigillosa* Torr. & A. Gray, *Oenothera drummondii* Hook. and *Phyla nodiflora* (L.) Greene. Plants were collected from an area ranging from south Texas to northwestern...
An asterisk (*) following a name indicates the presenting author.

Louisiana and were selected on the basis of ornamental potential and observed stress tolerances. *Trachelospermum asiaticum* (Siebold & Zucc.) Nakai and *Sphagneticola trilobata* (L.) Pruski were included as comparison species from the nursery trade. Studies were designed to estimate the overall drought tolerance of each species. Three genotypes were chosen to represent the most southwestern, central, and northeastern provenances collected. Plants were grown in a peat moss and pine bark-based substrate (MetroMix 900). Acute drought was imposed by the total cessation of irrigation once plants were established in 2.51-L containers. A completely randomized design (CRD) was installed with five replicates of each of the four native species, three provenances per native species, and a single commercial genotype of the two comparison groundcovers. Volumetric water content (VWC) measurements and xylem water potentials were measured throughout the experiment. A provenance was harvested when two of the five representatives exhibited shoot damage beyond a tolerable level to market the plants. Total time until harvest ranged from 9 d for *S. trilobata* to 72 d for *T. asiaticum* while the *M. strigillosa* provenances remained longer than the other native materials (a mean of 29d). Significant interactions (P ≤ 0.05) among date of measurement and provenances were observed for mid-day water potentials and the recovery from mid-day to pre-dawn measurements. *T. asiaticum* and *S. trilobata* exhibited water potentials no lower than –0.3 MPa while potentials as negative as –3.45 MPa were observed in a provenance of *P. nodiflora* (TX32) at harvest. The VWC at harvest was significantly different among species and provenances. All *E. procumbens* and *P. nodiflora* provenances were harvested with at least 10% VWC remaining while all *O. drummondii* were harvested with less than 7% VWC remaining. *Mimosa strigillosa* provenances from the central and southwestern regions of the collection area were harvested with 4.76 and 4.5% VWC remaining in the substrate, respectively, while substrates supporting the provenance from northwestern Louisiana held 10.68% VWC suggesting differential acute water stress tolerances among these taxa. Taxa such as *M. strigillosa* appeared to survive by tolerating water deficits in the substrate, whereas *T. asiaticum* appeared to survive by limiting water losses thus conserving substrate moisture.

2:00–2:15 PM

**Elongation of Hibiscus acetosella ‘Panama Red’ in Well-watered and Water-stressed Conditions**

Amanda Bayer*
University of Georgia, Athens; bayer10@uga.edu
John M. Ruter
University of Georgia, Athens; ruter@uga.edu
Marc van Iersel
University of Georgia, Athens; mvanier@uga.edu

Controlling the elongation of ornamental plants is commonly needed for shipping and aesthetic purposes. Plant growth regulators are typically used to do this; however drought stress can also limit elongation. Many growers are reluctant to expose their plants to drought stress because they do not want it to negatively affect overall plant quality. Knowing how and when stem elongation is affected by water availability will help to increase our understanding of how elongation can be controlled without reducing plant quality. Hibiscus acetosella rooted cuttings were grown in a growth chamber with 12 hours of light at 25 °C. Two plants of similar size were used for each run of the experiment to compare growth under well-watered and water-stressed conditions. Plants were kept well watered for the first four days of the study, after which one plant remained well-watered while the other was allowed to become water-stressed over the remaining eight to sixteen days. Time lapse photography was used to compare the diurnal patterns of elongation over the course of the experiment. Evapotranspiration and substrate water status were measured using load cells and soil moisture sensors. Over the course of the 12–20 d runs, the increase in plant height, number of internodes, and number of leaves of drought-stressed plants was 34%, 30%, and 55% less than for the well-watered plants. Under well watered conditions, plant height increased by approximately 10% per day, but this decreased to 5% within three days of the start of the water stress. The well-watered plants had more visible internodes; however average length of visible internodes were similar for both the well-watered and water-stressed plants. We hypothesize that the difference in the number of visible internodes between well-watered and drought-stressed is due to un-elongated internodes near the growing point of the water-stressed plants. Stem elongation was greatest at night, when evapotranspiration was lowest, suggesting that elongation is greatest at night due to rehydration and increasing turgor pressure of the plant. The results of this study show that controlling stem elongation and growth of plants is possible via irrigation management. Further manipulation of irrigation timing and substrate moisture will provide additional information about controlling plant growth via irrigation.

Specified Source(s) of Funding: USDA–NIFA, SCRI (award no. 2009-51181-05768)

2:15–2:30 PM

**Investigating Alternative Pathogen Management through Sensor-driven Irrigation**

Andrew Ristvey*
University of Maryland, Queen Anne; aristvey@umd.edu
Bruk Belayneh
University of Maryland, College Park; belayneh@umd.edu
James Zazanis
University of Maryland, College Park; jameszazanis@gmail.com
Justine Beaulieu
University of Maryland, College Park; jbeauli1@gmail.com
Yilmaz Balci
University of Maryland, College Park; ybalci@umd.edu
John D. Lea-Cox
University of Maryland, Queen Anne; jlc@umd.edu

Substrate pathogen management is important in greenhouse and
container nursery operations, particularly if irrigation water is being recycled for re-use. Often times, fungicides are used as a preventative cultural practice even if recycled water is treated. Routine fungicide applications are expensive, can encourage chemical resistance and can be environmentally unsound. We hypothesize that we can reduce the need for preventative fungicides, by irrigating based on daily plant water use, and creating an antagonistic environment for pathogen movement. We conducted a replicated study in a commercial container-nursery in Maryland using precision irrigation management, based on soil-moisture volumetric water content (VWC) data. Three irrigation strategies, namely time-based (TB), set-point based (SP) and set-point + interrupted (SPI) were applied to two Rhododendron species (R. catawbiense and R. chinoides). Half (24) of the plants in each of ten replicate blocks per irrigation treatment were inoculated with Phytophthora cinnamomi from samples bulked in the lab. Substrate VWC content from ten 10-HS sensors (Decagon Devices, Inc. Pullman WA) in each treatment were continuously monitored and logged by a combination of EM50R (monitoring) and nR5 (control) nodes (Decagon Devices), that transmitted data to a computer located in the nursery office. The data were downloaded and visualized using Sensorweb (Carnegie Mellon) software. Remote access to the data and control node settings is accessed over the internet through a browser. Irrigation in the SP and SPI treatments was monitored and controlled through the sensor system which applied irrigation according to the VWC set-point. The TB irrigation irrigated 4-6 times per day (adjusted seasonally) for 40 seconds per irrigation. Water-use volumes were recorded for each irrigation treatment throughout the study using flow meters. Plants each species were destructively harvested at the beginning of the experiment in July 2013; thirty-six randomly selected plants (18 inoculated, 18 non-inoculated) were destructively harvested in November; Canopy volume and shoot extension were measured three times during summer and fall 2013. Roots and substrate samples were taken to assess infection rates at the same times. Irrigation water applications were significantly lower for SP and SPI treatments compared to TB irrigation. Average shoot mass and leaf area, although not significant between treatments after six months, were higher for both SP and SPI treatments, compared to TB irrigation. Shoot dry mass and leaf area also averaged higher for non-inoculated vs. inoculated plants, indicating that these differences might become significant by the next harvest in June, 2014.

2:30–2:45 PM
Isolating Crown Rot Disease Organisms in a Nursery Production System
Carla Proano*
  LSU AgCenter, Baton Rouge, LA; CHerrera@agcenter.lsu.edu
Edward Bush
  LSU AgCenter, Baton Rouge, LA; ebush@agcenter.lsu.edu
Jeff Kuehny
  LSU AgCenter, Baton Rouge, LA; jkuehny@lsu.edu

Major production plant losses up to 20% in ‘Big Blue’ liriope container production have been measured in nurseries. Crown rot was suspected of causing these losses due to plant mortality. The objective of this project was to isolate, culture, and confirm the causal organisms responsible for the crown rot symptoms of liriope. Initially, pathogens from diseased tissue of infected plants were cultured for research purposes. Phytophthora palmivora (PP) and Fusarium oxyssporum (FO) (liriope leaf and crown rot) were isolated and cultured. ARCB design with 6 blocks consisting and four disease treatments [no inoculation (control), PP, FO, and PP+FO] were established. Disease free ‘Big Blue’ liriope plants were grown in a covered greenhouse and established for 6 weeks prior to inoculation in 10.2-cm plastic containers filled with a fertilized soilless medium. Within 6 weeks symptoms occurred within the PP and PP+FO treatments. A characteristic leaf yellowing and eventual browning of leaves followed by foliage being easily separated from the crown was observed. Also, sunken root lesions were observed in symptomatic and some asymptomatic plants. Fusarium oxyssporum symptoms occurred later after 8 to 12 weeks of inoculation. These symptoms were characterized by a golden yellow color and stunted growth for both FO and PP+FO plants. Plant infection rates were slightly lower than some reported field infection levels, however PP and FO cultures were isolated and confirmed for both organisms using Koch’ postulates. Both pathogens were reisolated from the new host and shown to be the same as the originally inoculated pathogen.

2:45–3:00 PM
Solute Transport Through a Pine Bark Substrate
Tyler C. Hoskins
  Virginia Tech, Virginia Beach; tylerh86@vt.edu
Jeb S. Fields*
  Virginia Tech, Virginia Beach; jsfields@vt.edu
James S. Owen
  Virginia Tech, Virginia Beach; jsowenn@vt.edu
Julie Brindley
  Virginia Tech, Virginia Beach; jbrindley@vt.edu
Alexander X. Niemiera
  Virginia Tech, Blacksburg, VA; niemiera@vt.edu

High fertilizer application rates, frequent irrigation and relatively low substrate nutrient retention can lead to increased nutrient leaching in containerized crop production. However, little is known about how individual mineral nutrient ions travel through pine bark (PB; Pinus taeda L.) substrate during irrigation events. Developing this knowledge may lead to improved management practices that reduce fertilizer leaching. A study was conducted to characterize the fundamental principles of how solutes are transported through a column of PB under saturated and unsaturated conditions. In this study, effluent was collected after being passed through the column of bark during the application
of fertilizer solution and subsequent flush with deionized (DI) water. Effluent electrical conductivity (EC) and the concentration of individual ions (nitrate, phosphate, and potassium) were used to develop breakthrough curves (BTC), which depict the change in relative effluent solute concentration (C/Co; where C = effluent concentration and Co = input solution concentration). For both the saturated and unsaturated treatments, effluent EC increased during the application of fertilizer solution, and decreased during DI water application at lower effluent volumes than predicted by the piston flow model, which theorizes that effluent solute concentration will change upon the displacement of one pore volume (PV). This effect was more pronounced for the unsaturated treatment. For example, the center of the EC BTC (C/Co = 0.5) during fertilizer application occurs at ≈ 0.85 PV and 0.65 PV for the saturated and unsaturated treatment, respectively. Furthermore, the BTC during the DI flush was centered at ≈ 0.80 PV and 0.60 PV after beginning DI water application for the saturated and unsaturated treatments, respectively. Nitrate and phosphate (anions) BTCs mimicked that of EC. However, the intensity of the potassium (cation) BTC during fertilizer application was considerably reduced apparently due to interaction with PB cation exchange sites and the calcium and magnesium residing on those sites from dolomitic lime additions. The speed in which the fertilizer solution moved through and was flushed from the columns was likely a result of the preference for solute to flow through macropores over micropores. These results demonstrate the relative quickness and ease which nutrients can move through and leach from a PB substrate under saturated and unsaturated conditions and demonstrate a potential source of inefficiency in fertilizer management. The research presented herein is a stepping-stone that will assist researchers to better understand and manage solute transport in a soilless substrate during irrigations.

Thursday, July 31, 2014

Viticulture and Small Fruits 2

Moderator: Zilfina Rubio Ames; zrubioames@ufl.edu

1:45–2:00 PM

Effect of Timing and Severity of Summer Pruning on Vegetative and Reproductive Traits of Southern Highbush Blueberry

Alisson Pacheco Kovaleski*
University of Florida, Gainesville; apkovaleski@ufl.edu

Jeffrey G. Williamson
University of Florida, Gainesville; jgrw@ufl.edu

Rebecca L. Darnell
University of Florida, Gainesville; rld@ufl.edu

Summer pruning is a major practice for blueberry management, but research-based recommendations are lacking in the southeastern United States. The objective of this study is to determine the effects of timing and severity of summer pruning on vegetative and reproductive growth in ‘Jewel’ and ‘Emerald’ southern highbush blueberry. Mature plants of both cultivars were subjected to the following treatments for three years: 1) control = no pruning; 2) control = detailed hand pruning; 3) pruning = 30% of existing foliage in early June (30% June); 4) pruning = 30% of existing foliage in mid-June (30% July); and 5) pruning = 30% of existing foliage in early June followed by shoot tipping in mid-July (30% June+tip); and 6) pruning 60% of existing foliage in early June, followed by shoot tipping in mid-June (60% June+tip). Regrowth volume of the non-pruned plants decreased significantly from the first to third year in ‘Jewel’, while regrowth in the other treatments either increased or was similar between years. In ‘Emerald’, there was also a trend toward reduction of regrowth volume in the non-pruned control (P = 0.058). Flower bud number per shoot decreased in non-pruned plants of both cultivars. In ‘Jewel’, hand-pruned and 30% July also showed this reduction in number of flower buds per shoot. Total flower bud number per plant was not affected by treatments in ‘Emerald’; however, in ‘Jewel’ total flower buds per plant decreased in non-pruned plants from 2012 to 2013. There were no effects of pruning on yield or yield distribution during the season in ‘Emerald’. However, 60% June+tip increased the average berry weight early in the season compared to non-pruned and 30% July treatments. In ‘Jewel’, yield was greater in 30% June+tip compared to non-pruned, hand-pruned and 60% June+tip treatments. The 60% June+tip treatment also shifted the highest yielding period from late April to early and late May in 2013, a trend that was also observed in 2012. Late pruning (30% July) did not reduce or shift yield in either cultivar. Data indicate that summer pruning, regardless of timing or severity, is beneficial for vegetative growth in both cultivars. There was no pronounced effect of pruning treatments on reproductive traits for ‘Emerald’. For ‘Jewel’, early moderate pruning followed by tipping promoted high, early yields with large berries.

Specified Source(s) of Funding: Florida Blueberry Growers Association and USDA Specialty Crops Block Grant Program

2:00–2:15 PM

Productivity of Pruned and Unpruned ‘Triple Crown’ Blackberry Plants on the Rotating Cross-arm Trellis System

Fumiomi Takeda*
USDA–ARS, Kearneysville, WV; Fumi.Takeda@ars.usda.gov

Ann Rose
USDA–ARS, Kearneysville, WV; ann.rose@ars.usda.gov

In 2012 and 2013, mature ‘Triple Crown’ blackberry plants were trained on the rotating cross-arm trellis (RCA) trellis. By the end of the summer, as many as 30 lateral canes with lengths > 3.5 m had developed on three primocanes that had been bent at a 0.50-m height. In winter, the lateral canes were pruned back to 1.5 m lengths or left un-pruned to determine the effect of lateral cane length on budbreak, fruit cluster number, fruit number per cluster, fruit weight, and yield. On a plant basis, pruned and unpruned plants possessed 36 and 54 m of cane length and 706 and 932 nodes, respectively. Pruned lateral canes had node numbers...
that were only 60% of unpruned lateral canes, but 68% of buds developed a flowering shoot compared to only 32% of nodes on unpruned laterals. Shortening the lateral canes to 1.5 m did not result in reduction of plant yield, fruit number, or fruit weight. The results indicated that pruning lateral canes to 1.5 m length was advantageous for blackberries trained on the RCA trellis.

Specified Source(s) of Funding: USDA–ARS and Driscoll Strawberry Associates

2:15–2:30 PM

The Effect of Shoot and Cluster Thinning on Vine Performance and Fruit Quality of ‘Blanc Du Bois’

Zilfina Rubio Ames*
University of Florida, Gainesville; zrubioames@ufl.edu

Mercy A. Olmstead
University of Florida, Gainesville; mercyl1@ufl.edu

‘Blanc Du Bois’ is a hybrid bunch grape released by the University of Florida in 1987. It has excellent resistance to Pierce’s Disease caused by Xylella fastidiosa and is cultivated in the southeastern United States. It has good fruit quality for wine production and several wineries have won awards with wines made from this variety. However, there is a lack of information on the optimal horticultural practices to maximize fruit quality in a subtropical climate. Thus, the objective of this project is to optimize vine vigor and fruit quality of ‘Blanc Du Bois’ through shoot thinning (ST) and manipulation of cropload (CP). Five-year-old vines of ‘Blanc Du Bois’ were shoot thinned at the end of March, when shoots were about 10 cm long or between stages 12 to 15 on the modified Eichorn–Lorenz scale. In May when berries were pea-sized (7 mm), cluster thinning was applied, leaving one cluster (CP1), two clusters (CP2) or three clusters (CP3) per shoot. The experiment was established in a randomized complete block, with no shoot thinning (NST) and three clusters per shoot (CP3) serving as a control. During the growing season, shoot length, leaf area, and photosynthesis were measured. Vines were harvested in July for fruit quality measurements [total soluble sugars (°Brix), pH, titratable acidity] and vine performance (yield per vine, cluster weight, berry number, and weight). No significant differences were found in the interaction between shoot thinning and cluster thinning; however, significant differences were found with shoot thinning and cluster thinning alone. Yield per vine increased in vines that were not shot thinned with the highest cropload (CP3) when compared to CP1. No significant differences were found between CP2 and CP3. Shoot thinning significantly affected pH, with ST resulting in lower pH. Cluster thinning increased Brix, with CP1 (lowest cropload) resulting in higher °Brix, followed by CP2 and CP3; however there was no difference between CP2 and CP3. No significant effects were found on vine measurements. Although there was no effect from the interaction of shoot thinning and cluster thinning, there was an increase in fruit quality when shoot thinning or cropload management was applied.

Specified Source(s) of Funding: Florida Viticulture Advisory Committee, Florida Department of Agriculture and Consumer Services

2:30–2:45 PM

Syrah Cultivar Under Mechanical Canopy Management

S. Kaa Kurkutural*
California State University, Fresno; kkurtural@csufresno.edu

Geoffrey Dervishian
California State University, Fresno; gdervishian@csufresno.edu

A trial in the San Joaquin Valley of California investigated how the interaction of pruning systems and mechanical shoot thinning affected canopy performance, yield components, fruit phenolic composition at harvest, and production efficiency of a procumbent cultivar in a warm climate grape-growing region. Two pruning systems and three shoot thinning treatments were arranged factorially in a randomized complete-block design with four replications. The pruning methods were applied by either handpruning to a target of 25 nodes/m or mechanically hedging and retaining a 100-mm spur height. The shoot density treatments were applied mechanically at a modified Eichhorn–Lorenz scale, stage 17 to retain 40 or 45 shoots/m of a row, or left unthinned. The contribution of count shoots to total shoots increased when mechanical box pruning replaced spur pruning. The contribution of percent count shoots to total shoots was greatest with 40 shoots/m and unthinned treatments. The percent photosynthetically active radiation (PAR) transmission and percent canopy gaps increased with mechanical box pruning and also with the decrease in shoot density per meter of row.

Berry and cluster size decreased with mechanical box pruning application. However, because mechanically box-pruned vines carried more clusters, the yield per meter of row increased. There was a quadratic response to shoot thinning where berry skin phenolics, anthocyanins, and tannins decreased with the 45 shoots/m treatment when compared with 40 shoots/m and unthinned treatments. Pruning weight per meter of row and leaf area-to fruit ratio decreased, whereas Ravaz Index (kg yield/kg pruning weight) increased with mechanical box pruning. Shoot thinning treatments did not affect pruning weight per meter of row or leaf area-to-fruit ratio. Increasing amount of PAR and percent canopy gaps by shoot thinning resulted in vegetative compensation from a sparsely populated grapevine canopy, thereby negating its purported effects. The 40 and 45 shoots/m treatments repopulated the canopy rapidly with non-count shoots thereby increasing the pruning weight per meter of row at the end of the season. In the absence of a physiological response, shoot thinning in a procumbent cultivar is not recommended. Mechanically box pruning to a 100-mm spur height and slowing down vegetative growth by irrigating to 50% of daily evapotranspiration (ETo) variance between fruit set and veraison have resulted in a Ravaz Index window (5 to 10 kg·kg⁻¹) and is recommended for procumbent red wine grape cultivars for the region with similar or better berry skin phenolic accumulation than spur-pruned vines.

An asterisk (*) following a name indicates the presenting author.
2:45–3:00 PM

Chemical Removal of Primary Inflorescence and Mature Leaves to Force Vine Regrowth and Fruiting in a Warmer Region for Winegrape Production

Sanliang Gu
California State University, Fresno; sanliang@csufresno.edu

Tian Tian*
California State University, Fresno; tiantian90@mail.fresnostate.edu

Muming Cao
California State University, Fresno; caomuming79@126.com

Geoffrey Dervishian
California State University, Fresno; gdervishian@csufresno.edu

S. Kaan Kurtural
California State University, Fresno; kkurtural@csufresno.edu

Previous research has demonstrated that grapevines can be forced to regrow while fruit ripening is shifted to the cooler portion of the growing season improving winegrape fruit quality in warm regions. In order to force vine regrowth, shoot tips, primary clusters, leaves, and laterals need to be removed, requiring a significant amount of labor if it is conducted manually. In order to reduce or eliminate the reliance for manual labor, nitrogen fertilizers including NH₄NO₃, (NH₄)₂SO₄, NH₄Cl, Ca(NO₃)₂, KNO₃, urea, and UAN-32 were screened in 2012 and 2013 at 4, 8, 12, 16, and 20 g/L N with a surfactant containing 0.005% polyalkyleneoxide-modified polydimethylsiloxane. Primary inflorescences, mature leaves, young leaves, and shoot tips were dipped into fertilizer solutions at either flower separation, full bloom, or after fruit set. The NH₄NO₃, (NH₄)₂SO₄, NH₄Cl, Ca(NO₃)₂, KNO₃, urea, and UAN-32 were screened in 2012 and 2013 at 4, 8, 12, 16, and 20 g/L N with a surfactant containing 0.005% polyalkyleneoxide-modified polydimethylsiloxane. Primary inflorescences, mature leaves, young leaves, and shoot tips were dipped into fertilizer solutions at either flower separation, full bloom, or after fruit set. The NH₄NO₃, (NH₄)₂SO₄, NH₄Cl, Ca(NO₃)₂, KNO₃, urea, and UAN-32 were ineffective after fruit set. KNO₃, urea, and UAN-32 were ineffective at all stages. Greater degree of necrosis was observed on inflorescences, young leaves, and shoot tips than on mature leaves at both flower separation and full bloom. The most effective fertilizers, NH₄NO₃, (NH₄)₂SO₄, and NH₄Cl, were then further evaluated in 2013 for the optimal application rate by spraying into the forcing zone of the developing canopy at full bloom. Growing shoots were hedged to 6 nodes and all remaining primary clusters, leaves, and laterals were removed by hand at pea-sized berry stage to force vine regrowth and fruiting. (NH₄)₂SO₄ at 30 g/L N and NH₄Cl at 20 g/L N were the most effective, resulting in the greatest degree of necrosis of inflorescence and mature leaves, the greatest amount of hedge weight, the greatest number of forced shoots and wine regrowth, and the greatest number of forced clusters and the highest yield of forced crop. No severe injury was observed on the remaining portion of growing shoots. The experiments demonstrated the potential of nitrogen fertilizers in chemical removal of primary inflorescences and mature leaves and optimized the application rate and timing to reduce the labor requirement for crop forcing. It seems possible to force vines by chemically removing the primary inflorescences with nitrogen fertilizers before full bloom, and then mechanically hedging the growing shoots and removing the leaves and laterals at the time of forcing.

Specified Source(s) of Funding: California State University Agricultural Research Institute
Evaluation and Classification of Bioplastic Plant Containers

James Schrader
Iowa State University, Ames; jschrade@iastate.edu

Kenneth McCabe
Iowa State University, Ames; kgmccabe@iastate.edu

Gowrishankar Srinivasan
Iowa State University, Ames; srigshan@iastate.edu

David Grewell
Iowa State University, Ames; dgrewell@iastate.edu

Kyle Haubrich
Iowa State University, Ames; haubrich@iastate.edu

Samy Madbouly
Iowa State University, Ames; madbouly@iastate.edu

Heidi Kratsch
University of Nevada Cooperative Extension, Reno; kratschh@unce.unr.edu

Christopher Currey
Iowa State University, Ames; ccurrey@iastate.edu

William Graves*
Iowa State University, Ames; graves@iastate.edu

More than 750,000 metric tons of petroleum-based plastics are consumed annually by the greenhouse and nursery industries in the United States for single-use plant containers. This extensive use of petroleum-based materials is an obstacle to sustainability because they are non-renewable, non-biodegradable, and about 98% of used containers are disposed in landfills. Bioplastics have potential for use in plant containers that fulfill the functional advantages of conventional plastic but are made of renewable materials that have much lower environmental footprints. In 2012 and 2013, we created 46 novel biocontainers (35 injection-molded bioplastics or biocomposites and 11 bioplastic-coated fiber containers). We evaluated container materials for cost, processability, and biodegradability in soil, and evaluated the prototype containers, along with other commercially available biocontainers, in greenhouse, nursery, and landscape trials. Greenhouse and nursery evaluations demonstrated that many of the injection-molded bioplastics function as well or better than petroleum plastics for crop containers. Soy-based bioplastic containers released plant-available nutrients and improved root-system morphology during crop production. Adding bio-based fibers to form injection-molded biocomposite containers reduced the cost of containers and improved the processability, function, and degradation of the bioplastic materials. Coating fiber containers with bioplastics improved water-use efficiency during crop production and resulted in containers similar to those made from petroleum-based plastics in durability and function. Many of the bioplastics and biocomposites degraded over 50% during two years in the landscape, suggesting that containers made of these materials could end their life cycles as degraded organic matter in soil, instead of entering the solid waste stream. Based on results of these trials, we classified the biocontainers into three categories: 1) containers biodegradable in soil within one to two years; 2) containers not degradable in soil, but degradable by composting; and 3) exceptional or durable containers that can be recycled, or will be carbon-negative if landfilled. Biocontainers from any of these categories constitute an improvement in sustainability with regard to the container material. Containers from category 1 have potential to reduce or eliminate the problems related to disposal of used containers, and containers from category 3 could provide an improvement in sustainability while providing nearly identical function to that of petroleum-based plastic and requiring little or no change in cultural practices. Soy-based containers from categories 1 and 2 provide additional functions beyond those of petroleum plastic by supplying intrinsic fertilizer and improving root systems.

Effects of Reduced Phosphorus on Plant Growth and Flowering of Lantana

Hye-Ji Kim*
University of Hawaii at Manoa, Honolulu; hkim2@hawaii.edu

Xinxin Li
University of Hawaii at Manoa, Honolulu; lixinxin0476@163.com

The application of phosphorous (P) fertilizer is an integral part of greenhouse and nursery crop production, however, overapplication of P above the crop needs is a common practice, leading to higher production costs and higher risk for P runoff and leaching to the environment. This study was conducted to determine optimum concentration of P which helps maximize crop quality and minimize environmental impact. Rooted cuttings of Lantana camara ‘New Gold’ were grown with complete nutrient solutions containing 1, 3, 5, 10, 20, or 30 mg·L⁻¹ P, and plant growth and flowering characteristics were recorded for 8 weeks. Plants were harvested at 3 weeks and 8 weeks for shoot and root analysis. The P contents were determined from different parts of plants and phosphorus use efficiency (PUE) was calculated as the amount of biomass produced per gram of P taken up by the plant. P promoted plant growth from the first week after transplanting. In general, plant size and the numbers of branches and leaves increased with higher P. However, plants grown with lower P were more compact, and flowered at the same time as the ones grown with higher P and produced the same number of flowers per unit area. Flower size was not significantly different when the P level was higher than 10 mg·L⁻¹. Similarly, root length, surface area, and volume increased as P level increased, however, the root-to-shoot ratio significantly decreased with higher P. Although higher P application increased P content, plant tissues, particularly in flowers, plant had greater PUE when grown with lower P ranging from 3 to 10 mg·L⁻¹. Our results demonstrate that reduced P application does not cause major negative impacts on the growth and flowering of Lantana and, in fact, it may be useful to sustainably control the size of plants with stronger roots.
An asterisk (*) following a name indicates the presenting author.

**Thursday, July 31, 2014**

**2:30–2:45 PM**

**Involvement of Calcium and Boron in the Development of Brown Spots on the Leaves of Oncidium Sharry Baby**

Hye-Ji Kim*

University of Hawaii at Manoa, Honolulu; hkim2@hawaii.edu

The development of brown spots has been recognized as a significant problem which occurs on the leaves of *Oncidium* Sharry Baby. The causes of brown spots are still not clear, yet some evidence suggests that it may be related to environmental conditions and cultural practices during production. Our previous results showed that the occurrence of brown spots depends on the size of plants, and is strongly associated with high growing temperature. This study was conducted to determine physiological and nutritional differences in plants grown at different temperature schemes. The 6-month-old plugs of *Onc.* Sharry Baby ‘Red Fantasy’ were obtained from a commercial orchid nursery, and planted in a pot filled with two parts coarse perlite, one part coconut husk chip and one part coarse peat. All plants were placed in a growth chamber maintained at day/night temperatures of 30/25 °C, 25/20 °C, or 20/15 °C with a 12-h day, 60% RH, and 200 μmol·m⁻²·s⁻¹ photosynthetically active radiation (PAR), and fertigated based on current farm practices. Our results showed that higher temperatures induced an initial vigorous growth, and therefore, plants were taller and produced more leaves, and continued to grow faster than the ones grown at the low temperature. The development of high-temperature-induced brown spots occurred within a month, and the number continued to increase, especially at the highest temperature. Once formed, the size of brown spots gradually increased over time. Leaf discs were taken from the lower and upper part of the leaves of the plants at the end of the experimental period, and nutrient analysis was conducted. Plants grown at the highest temperature have significantly lower calcium (Ca) content but significantly higher boron (B) content in the upper leaves, while the Ca and B contents were not different in the lower leaves. Potassium content was maintained lower in the upper leaves regardless of growing temperature. There were no significant differences in other nutrient elements. Our results suggest that the contents of Ca and B in the upper leaves are associated with the high-temperature-induced brown spot development in Oncidium Sharry Baby. The interaction between calcium and boron may play a key role in the development of brown spots.

**2:45–3:00 PM**

**Quantifying the Effects of Preharvest Calcium Nutrition on the Toning of Unrooted Cuttings**

Uttara C. Samarakoon*

School of Agricultural, Forest, and Environmental Sciences, Clemson University, Clemson, SC; usamara@clemson.edu

Jim Faust

School of Agricultural, Forest, and Environmental Sciences, Clemson University, Clemson, SC; jfaust@clemson.edu

The causes of brown spots are still not clear, yet some evidence suggests that it may be related to environmental conditions and cultural practices during production. Our previous results showed that the occurrence of brown spots depends on the size of plants, and is strongly associated with high growing temperature. This study was conducted to determine physiological and nutritional differences in plants grown at different temperature schemes. The 6-month-old plugs of *Onc.* Sharry Baby ‘Red Fantasy’ were obtained from a commercial orchid nursery, and planted in a pot filled with two parts coarse perlite, one part coconut husk chip and one part coarse peat. All plants were placed in a growth chamber maintained at day/night temperatures of 30/25 °C, 25/20 °C, or 20/15 °C with a 12-h day, 60% RH, and 200 μmol·m⁻²·s⁻¹ photosynthetically active radiation (PAR), and fertigated based on current farm practices. Our results showed that higher temperatures induced an initial vigorous growth, and therefore, plants were taller and produced more leaves, and continued to grow faster than the ones grown at the low temperature. The development of high-temperature-induced brown spots occurred within a month, and the number continued to increase, especially at the highest temperature. Once formed, the size of brown spots gradually increased over time. Leaf discs were taken from the lower and upper part of the leaves of the plants at the end of the experimental period, and nutrient analysis was conducted. Plants grown at the highest temperature have significantly lower calcium (Ca) content but significantly higher boron (B) content in the upper leaves, while the Ca and B contents were not different in the lower leaves. Potassium content was maintained lower in the upper leaves regardless of growing temperature. There were no significant differences in other nutrient elements. Our results suggest that the contents of Ca and B in the upper leaves are associated with the high-temperature-induced brown spot development in Oncidium Sharry Baby. The interaction between calcium and boron may play a key role in the development of brown spots.

**3:00–3:15 PM**

**Plant Species Effects on Acidity or Basicity of Hydroponic Solutions**

Ryan W. Dickson*

University of Florida, Gainesville; rdickson@ufl.edu

Paul R. Fisher

University of Florida, Gainesville; pfisher@ufl.edu

The relationship between solution-ph change and plant cation/anion uptake was quantified for three floriculture species (*Pelargonium x hortorum*, *Impatiens walleriana*, and *Petunia x hybrida*). Plants were grown in complete hydroponic nutrient solutions that contained 0%, 10%, or 20% ammonium-N with the remainder of N supplied as nitrate. The solution-ph in each hydroponic vessel replicate was maintained between 5.5...
and 6.5 and titrated back to initial solution-pH (6.0) after 7
days using HCl and NaOH. Specific nutrient uptake by plants
was determined by depletion from the nutrient solution after 7
days, and net acidity or basicity was determined by additions
of acid (HCL) or base (NaOH) during solution-pH correction.
Ion uptake and net acid or base addition were converted to
milli-equivalents (meq) for comparisons. There was a close 1:1
relationship between net cation or anion uptake and net acidity
or basicity, (meq acidity of the solution = 0.962±0.195*(net
meq of cations – anions taken up) + 0.140±0.478; adjusted-R²
= 0.739) over all species and solution types, which indicated a
strong correlation between solution-pH change and net cation-
anion uptake. The largest difference between species occurred in
the 0% ammonium solution, where Petunia produced the most
base, followed by Impatiens, and then Pelargonium. All three
species responded to increased ammonium concentration with
increased total cation uptake and solution acidity. However, in the
20% ammonium solution all species produced similar net acid
after 7 days. Ammonium uptake was preferred over nitrate, and
the ratio of ammonium to nitrate nitrogen supplied in solution
greatly influenced solution acidity or basicity. Both Impatiens
and Petunia depleted nearly all ammonium within 7 days which
probably affected final net acidity or basicity measurements.
Understanding species acidity-basicity potentials has practical
applications in commercial floriculture for matching fertilizer
type to plant species. Additional trials evaluating nutrient up-
take over time, over wider ammonium to nitrate ratios, and in
soilless substrate are necessary to characterize species effects
on solution-pH.

Specified Source(s) of Funding: Floriculture Research Alliance

Thursday, July 31, 2014

**Plant Biotechnology 3**
Moderator: Kedong Da; kda@ialr.org

1:45–2:00 PM

**Building the Genomic Infrastructure in Black Raspberry**

Douglas Bryant*
Donald Danforth Plant Science Center, St. Louis, MO; dbryant@danforthcenter.org

Jill M. Bushakra
USDA–ARS, NCGR, Corvallis, OR; jill.bushakra@ars.usda.gov

Michael Dossett
B.C. Blueberry Council (in partnership with Agriculture and Agri-
Food Canada), Pacific Agri-Food Research Centre, Agassiz, BC;
Michael.Dossett@agr.gc.ca

Kelly Vining
Oregon State University, Corvallis; Kelly.Vining@oregonstate.edu

Sergei Filichkin
Oregon State University, Corvallis; filichks@onid.orst.edu

Jerry Weiland
USDA–ARS, HCRU, Corvallis, OR; jerry.weiland@ars.usda.gov

Jungmin Lee
USDA–ARS, HCRL, Parma, ID; Jungmin.Lee@ars.usda.gov

Chad E. Finn
USDA–ARS, HCRU, Corvallis, OR; Chad.finn@ars.usda.gov

Nahla Bassil
USDA–ARS, NCGR, Corvallis, OR; Nahla.Bassil@ars.usda.gov

Todd Mockler
Donald Danforth Plant Science Center, St. Louis, MO; tmockler@danforthcenter.org

Cultivar improvement of black raspberry (*Rubus occidentalis*
L.) has been stagnant for the past 75 years, with only a handful
of new releases to date. The most commonly grown elite culti-
vars are susceptible to aphid-transmitted viruses and soil-borne
pathogens that lead to a rapid decline in plant health necessitat-
ing frequent stand replacement by the growers. Recent research
supporting the anti-cancer effects of black raspberries has led to
a resurgence of interest in this fruit and a renewal of breeding
efforts. Genomic tools we are developing will be applied to
the identification of quantitative trait loci and alleles important
for breeding objectives regionally and nationally. We applied
high-throughput genome sequencing of a highly homozygous
accession to generate 2,200 scaffolds of approximately 240
Mbp, with 353 kbp N50, and 0.06% per-basepair variation. We
employed genotyping by sequencing on the full-sibling popula-
tion ORUS 4305 (~115 progeny) to generate more than 900 single
nucleotide polymorphic (SNP) markers to construct a linkage
map. The consensus linkage map consists of seven linkage
groups spanning 613.1 cM with the longest group spanning 101.7
cM with 103 markers (G1) and the shortest spanning 77.6 cm
with 61 markers (G7). The linkage map was used to place over
50% of the genomic sequence into linkage groups. In addition,
RNA-seq data from seven replicated libraries of five tissue types
were assembled by de novo and reference-guided approaches,
forming the basis for our empirically-based structural annotation
(~26,000 transcription units). The ORUS 4305 population and a
second population (ORUS 4304, 192 progeny) are being evalu-
ated across production regions for a number of economically
important traits. The genomic data and the phenotype informa-
tion will be used to develop markers to assist plant breeders in
parent selection with the goal of developing cultivars that satisfy
the demands of the growers and the marketplace, adding to the
sustainability and profitability of the industry.

2:00–2:15 PM

**Somatic Embryogenesis and Histological Analysis of Zelkova schneideriana**

Xiaoling Jin
Central South University of Forestry and Technology, Changsha;
jxl0716@hotmail.com

Youping Sun
Hunan Academy of Forestry, changsha; sypyp79@gmail.com

Xijun Hu
Central South University of Forestry and Technology, Changsha;
huxj0801@1.26.com

An asterisk (*) following a name indicates the presenting author.
Zelkova schneideriana Hand.-Mazz. is a high-value timber plant and popular landscape species in China. It is an endangered species due to over-harvesting and inefficient propagation systems. Immature zygotic embryos from a 20-year-old tree were cultured on Murashige and Skoog’s (MS) medium containing 2.0 mg·L⁻¹ 6-benzylaminopurine (BA), and 51% of explants induced embryogenic calluses. The white friable nodular callus was subcultured on MS medium supplemented with 1.0 mg·L⁻¹ BA and 1.0 mg·L⁻¹ α-naphthaleneacetic acid (NAA) to regenerate somatic embryos and the conversion rate was 36.7%. Somatic embryos successfully germinated on MS medium without plant growth regulators. Histological analysis revealed that somatic embryogenesis of Z. schneideriana included single embryogenetic cell, multicellular proembryo, globular, heart and cotyledonary embryo. These results were similar to other Ulmaceae species. Somatic embryogenesis could be used for production of synthetic seeds and regeneration of transgenic plants.

2:15–2:30 PM
Production of Three New Grapefruit Cybrids to Improve Citrus Canker Resistance

Ahmad A. Omar*
University of Florida, Lake Alfred; omar71@ufl.edu
Aditi Satpute
University of Florida, Lake Alfred; aditi148.satpute@gmail.com
Mayara Murata
University of Florida, Gainesville; mayara.murata.13@ufl.edu
Christine D. Chase
University of Florida, Gainesville; cdchase@ufl.edu
Jude W. Grosser
University of Florida/IFAS, Lake Alfred; jgrosser@ufl.edu

The production of cybrids, combining nucleus of a species with alien cytoplasmic organelles, is a valuable method used for improvement of various crops. Moreover, this technology considers a non-GMO biotechnology strategy. In citrus, Cybrid plants can be produced as a by-product of somatic fusion. Several citrus cybrids have been created by somatic hybridization. Through the cell fusion between nucellar callus cells Meiwa kumquat, Fortunella crassifolia Swingle (believed to contain a gene(s) for canker resistance) and mesophyll cells in three Citrus combinations of commercial grapefruit (Marsh grapefruit, Citrus paradisi Macfadyen, Flame grapefruit, Citrus paradisi Macfadyen, and N11-11 somaclone grapefruit), we obtained and regenerated putative cybrid-like grapefruit plants resembling mesophyll parent. The mtDNA analysis is underway to confirm that the generated clones that resembled mesophyll parents has identical mtDNA fragment patterns to those of the nuclear callus parent. The results from this test will confirm that these regenerated clones resembling mesophyll parents are cybrids. The confirmed generated cybrids will be propagated for greenhouse and field disease resistance assays. Those plants may have a great potential to improve citrus canker residence in commercial grapefruit varieties.

2:30–2:45 PM
Growing Media Amended with Beneficial Microorganisms to Improve Growth Stimulation and Plant Protection

Rémi Naasz
Premier Tech Horticulture, Rivière-du-Loup, QC; naar@premiertech.com
Ed Bloodnick
Premier Tech Horticulture, Quakertown, PA; bloe@premiertech.com
Troy Buechel*
Premier Tech Horticulture, Quakertown, PA; but@premiertech.com

Plant diseases are a major cause of yield losses and ecosystem instability worldwide. Use of chemical pesticides to protect crop against plant pathogens has been increasing along with the intensification of production over the last decades. Nevertheless agrochemicals are often considered as one of the major pollution source of ground and surface water inducing depletion of freshwater. Beneficial microorganisms can offer a sustainable and efficient alternative to chemical pesticides used in agriculture. Extensive experiments have been done by Premier Tech Horticulture over the last years to select and combine different biocontrol agents use to protect plants against the major greenhouse diseases caused by Pythium sp., Rhizoctonia sp., Fusarium sp., Phytophthora sp., and Sclerotinia sp. Consequently, Bacillus subtilis, Bacillus pumilus, and Mycorrhizae were amended in PRO-MIX® peat based growing medium. The aim of this communication is to present the most recent results supporting plant growth promotion and plant disease suppression effect of these different beneficial microorganisms. Several experiments were conducted on vegetables (tomato, lettuce, cucumber, and pepper) and ornamental plants (celosia, geranium, pancy, petunia, begonia, and vinca). Data obtained in these studies demonstrated that in absence of biocontrol agents, the shoot and root weight of plants were negatively affected by pathogens infestation. In case of disease presence, the health of the root and shoot systems was the most important parameter. The presence of beneficial microorganisms in the substrates results in the best fresh or dry root and shoots systems.

2:45–3:00 PM
Oriental Lily Tissue Culture Somatic Embryogenesis

Kedong Da*
The Institute for Advanced Learning and Research, Danville, VA; kda@ialr.org
Samantha Smith
The Institute for Advanced Learning and Research, Danville, VA; samantha.smith@ialr.org

An asterisk (*) following a name indicates the presenting author.
Oriental lilies (Lilium) are famous for their extremely fragrant, very large, outward-facing, flattened flowers. They are widely used for landscaping and indoor decoration, and are very easy to grow. Three famous varieties are raspberry spotting Muscadet, red Stargazer and white Casa Blanca. Oriental lilies bloom from mid-summer through early fall and grow very well in USDA Zones 4–9. We have tested different explant regeneration systems with oriental lily ‘Muscadet’ and established an efficient somatic embryogenesis system using in vitro bulb scale explants. Somatic embryos developed directly from near end of the explant, with a mean number of 3 somatic embryos obtained per explant. Regenerated somatic embryos were matured on plantlet strength medium after 30 days. The well-developed plantlets were directly transplanted to peat moss:perlite:vermiculite (1:1:1) soil and kept under moisture in the greenhouse for acclimatization, a 100% survival rate was obtained after 25 days of acclimatization.

3:00–3:15 PM

**Development and Optimization of Nicotiana benthamiana Seed Production for Biopharmaceutical Applications**

Joey Norikane  
Fraunhofer USA, Newark, DE; joey.norikane@fhcmb.org

Rebecca Snow*  
Fraunhofer USA, Center for Molecular Biotechnology, Newark, DE; rebecca.snow@fhcmb.org

David Wienner  
Fraunhofer USA, Center for Molecular Biotechnology, Newark, DE; david.wienner@fhcmb.org

Ryan Dayton  
Fraunhofer USA, Newark, DE; ryan.dayton@fhcmb.org

Central to the plant-based pharmaceutical production are the plants, and more specifically the plants seeds. Food and Drug Administration (FDA) regulators have multiple questions, e.g., what is the source of the seeds, how are the seeds multiplied, what testing is conducted to ensure the seeds are viable and virus-free, among other questions. To address these concerns during the scale-up process from the laboratory bench to the pilot plant capacity, Nicotiana benthamiana (USDA PI555478) seeds were acquired from the USDA Nicotiana Germplasm Collection (Raleigh, North Carolina USA). These seeds were multiplied in a controlled environment, but seed yields and germination rates were low. The early seed production efforts were resource limited, i.e., space and environment, which impacted seed yield and quality. Later, a dedicated seed production area was developed with metal halide lighting (500–700 µmol·m⁻²·s⁻¹) and temperature control (26°C to 28 °C). Nutrient content and irrigation methods were optimized in the seed production area which increased average seed yields from 5.0 ± 1.8 g/plant to 48.1 ± 11.6 g/plant. Maximum single plant seed harvests increased from 9.4 g/plant to 74.6 g/plant. Postharvest processing protocols were developed to ensure seed quality, consistency, and viability, which are particularly important at large scale with automated equipment. Harvested seeds were sieved and germination tests were conducted according to size. As the environmental conditions and cultivation methods were optimized, seed size distribution trended toward larger seeds, where the 500, 425, and 355 µm sieve sizes shifted from 3.6, 62.5, and 32.0% to 45.8, 48.4, and 4.6%, respectively. Larger seed sizes had higher germination rates where seeds from the 500 and 425 µm sieve sizes germinated at a rate of 99.6% and 99.2%, respectively. Seeds from the 355 µm sieve size germinated at an 84.2% rate and the germination rates for smaller seeds (< 355 µm) were less. The improvements in seed production environment and cultivation methods have yielded higher quality seeds with satisfactory germination rates. These are two critical aspects for seeds supplying the manufacturing of a plant-based biopharmaceutical product.

Thursday, July 31, 2014

**Environmental Stress Physiology**

Moderator: Aparna Krishnamurthy; aparna.k@ufl.edu

1:45–2:00 PM

**Controlled Mechanical Wounding Applied on Leaves during Preharvest As an Innovative Way to Increase the Levels of Bioactive Phytochemical in Fruits**

Facundo Ibanez*  
Texas A&M University, College Station; facundoibanez@neo.tamu.edu

Gustavo Gimenez  
National Institute for Agricultural Research, Las Piedras, Canelones; ggimenez@inia.org.uy

Leonardo Lombardini  
Texas A&M University, College Station; l-lombardini@tamu.edu

Luis Cisneros-Zevallos  
Texas A&M University, College Station; lcsnero@tamu.edu

Biotic and abiotic stresses like wounding and herbivores induce changes in plant metabolism. Wounded tissues induce the production of phenylpropanoid secondary metabolites as a local response, and also as a systemic response in the same organ type (e.g. leaves). The importance of phytochemicals for human health has lead the study of pre and postharvest factors that influence the production of bioactive phenylpropanoids. In this study, a preharvest leaf wounding was applied to measure the effects on production of bioactive compounds on fruits. The experiment was conducted on strawberry (advanced selection LBM10.3) subjected to two levels of mechanical wounding applied on completely developed leaves, 7–12 days before harvest time. The fruits were evaluated after harvest for quality parameters (color, soluble solids, firmness, and fresh weight).
Overexpression of Glutaredoxins in Transgenic Rice to Improve High Temperature Stress Tolerance

Aparna Krishnamurthy*
University of Florida, Gainesville; aparna.k@ufl.edu

Bala Rathinasabapathi
University of Florida, Gainesville; brath@ufl.edu

Glutaredoxins (Grx) are small heat stable proteins. They protect cellular proteins from damage by reactive oxygen species by reducing disulfide bridges and glutathione adducts in proteins. In this study we used biotechnological tools to understand the functions of Grxs in plant tolerance to heat stress. We overexpressed (OE) Grx cDNA from fern Pteris vittata (PvGrx5) or Arabidopsis (AtGrxCp or At5G18600) as independent events in Oryza sativa cv. Nipponbare using agrobacterium-mediated transformation. Transgene expression was verified in stable T2 lines by semi-quantitative RT-PCR. Protein extracts from GRX OE lines had significantly higher Grx activity compared to those from the vector control lines. The Grx OE lines were evaluated for high temperature stress tolerance by exposing the seedlings to 37°C and 45°C at germination and V3-V4 stages of plant growth, respectively. The cotyledon length in PvGrx5 OE lines under heat stress were > 67% of control compared to 23% in wildtype. There was no or less inhibition of shoot growth in PvGrx5 OE lines compared to higher inhibition in control lines. The PvGrx5 and AtGrxCp OE lines showed significantly less protein oxidation following heat stress treatments. Measurement of photosynthetic efficiency showed that the PvGrx5 OE lines had significantly higher PSII efficiency under heat stressed conditions than the control lines. Together these results indicate that PvGrx5 overexpression in rice could be used to improved thermotolerance at various vegetative stages of plant growth.

Specified Source(s) of Funding: CPBR Inc., BASF Plant Sciences and Univ. of Florida

Mitigation of Stress Induced by Salinity and Nickel in Pea (Pisum sativum L.) by Exogenous Application of Synthetic Proline and Proline-enriched Lolium perenne (L.) Leaf Extract

Muhammad Adnan Shahid*
Department of Horticulture, University of Sargodha, Pakistan; dr.mas@uos.edu.pk

Rashad M. Balal
Department of Horticulture, University of Sargodha, Pakistan; uaf_rashad@yahoo.com

M.M. Javaid
Department of Agronomy, University of Sargodha, Pakistan; mmansoorjavaid@gmail.com

Muhammad Anjum Aquel
Department of Entomology, University of Sargodha, Pakistan; anjum_ento@uos.edu.pk

Tahira Abbas
Department of Horticulture, University of Sargodha, Pakistan; tara_9872004@yahoo.com

Neil Mattson
Cornell University, Ithaca, NY; nsm47@cornell.edu

Shahidul Islam
University of Arkansas, Pine Bluff; islam@uapb.edu

The plants of pea (Pisum sativum L.) were grown under NaCl and/or NiCl₂ stress, to evaluate whether pure proline and proline-enriched Lolium perenne (L.) leaf extract could efficaciously mitigate the drastic effects of nickel and salinity stress on pea. Both stress factors (salinity and nickel) significantly inhibited growth, chlorophyll contents, photosynthetic activity, stomatal conductance, intercellular carbon dioxide (CO₂) level, number of stomata, stomatal size, water-use efficiency, relative water content (RWC), and the membrane stability index (MSI). However, the proline and glycine betaine contents in leaves and roots, lipid peroxidation, electrolyte leakage, and activities of antioxidant enzymes (superoxide dismutase, peroxidase, catalase, ascorbate peroxidase, guaiacol peroxidase, and glutathione reductase) were significantly increased. Exogenously applied proline and L. perenne (LP) leaf extracts significantly overcame the nickel and/or salinity-induced toxic effects on growth, RWC, and various photosynthetic attributes. However, follow-up treatment with proline and LP leaf extract detoxified the stress caused by NiCl₂ and/or NaCl, by suppressing lipid peroxidation and electrolyte leakage, accelerating the antioxidant activities, and improving the MSI, leaf/root proline, and glycine betaine contents. Natural proline (LP leaf extract) proved to be better than pure proline for improving growth, gas exchange parameters, proline, glycine betaine, RWC, and antioxidant activities. As LP leaf extract was enriched with a substantial amount of proline along with many other essential nutrients, it was found to be as efficacious as pure proline in ameliorating growth, some major physiological attributes, and...
non-enzymatic and enzymatic antioxidant activities in the pea, under nickel and/or salinity stress. Thus, it could be used as an alternative inexpensive source of proline, to be used as a mitigating agent for safeguarding plants against the deleterious effects of nickel and/or salinity stress.

Specified Source(s) of Funding: Higher Education Commission of Pakistan

2:30–2:45 PM

**Foliar Spray of Phyto-extracts Supplemented with Silicon: An Efficacious Strategy to Extenuate the Salinity-induced Deleterious Effects in Pea (*Pisum sativum* L.)**

Rashad M. Balal  
Department of Horticulture, University of Sargodha, Pakistan; uaf_rashad@yahoo.com

Muhammad Mumtaz Khan  
Sultan Kabos University Musqat, Musqat; mumtaz59pk@hotmail.com

Muhammad Adnan Shahid*  
Department of Horticulture, University of Sargodha, Pakistan; dr.mas@uos.edu.pk

Tahira Abbass  
Department of Horticulture, University of Sargodha, Pakistan; tara_9872004@yahoo.com

Muhammad Anjum Aquel  
Department of Entomology, University of Sargodha, Pakistan; anjum_ento@uos.edu.pk

M.M. Javaid  
Department of Agronomy, University of Sargodha, Pakistan; mmansoorjavaid@gmail.com

Neil Mattson  
Cornell University, Ithaca, NY; nsm47@cornell.edu

A pot culture study was conducted to assess the ameliorative effect of silicon, *Melia azedarach* leaf extract and sugar beet root extract, each applied individually or in different combinations, against the salinity-induced detrimental effects in pea (*Pisum sativum* L.). Salinity markedly inhibited the growth, photosynthetic activity, stomatal conductance, stomatal size, transpiration rate, water use efficiency, green pigments, total phenol contents, membrane stability index and productivity. However, lipid peroxidation, electrolyte leakage, H2O2 content and antioxidant activities i.e., superoxide dismutase, peroxidase, catalase, ascorbate peroxidase, guaiacol peroxidase and glutathione reductase, leaf free proline and glycinebetaine contents were significantly enhanced by salinity. But exogenously applied Si and phyto-extracts markedly alleviated the salinity-induced drastic effects on growth, gas exchange attributes and productivity. However silicon, *M. azedarach* leaf and sugarbeet root-extracts in various combinations proved to be better than their individual sprays on salt-stressed pea plants. Both phyto-extracts supplemented with silicon gave highly salinity mitigating effect by markedly improving growth, gas exchange attributes, enzymatic activities, osmolytes and yield. While, phyto-extracts and Si suppressed the lipid peroxidation, electrolyte leakage and H2O2 content, by strengthening the enzymatic and non-enzymatic (proline and glycinebetaine) antioxidant defense system. The phyto-extracts and Si application also checked the root/leaf sodium and chloride contents, however improved the silicon contents. Thus, it can be concluded that exogenous application of silicon in combination with phyto-extracts of *M. azedarach* and sugar beet is highly effective ameliorative approach to alleviate the salinity-induced hazardous effects in plants especially in pea, grown under saline regime.

Specified Source(s) of Funding: Higher Education Commission of Pakistan

---

2:45–3:00 PM

**Growth and Physiological Responses of Cotton Genotypes to Controlled Drought Using an Automated Irrigation System**

Yingping Sun*  
Texas A&M AgriLife Research Center at El Paso; sypyp79@gmail.com

Genhua Niu  
Texas A&M AgriLife Research Center at El Paso; gniu@tamu.edu

Jinfa Zhang  
New Mexico State University, Las Cruces; jinzhang@nmsu.edu

Cotton (*Gossypium hirsutum* L.) is an economically important crop with multiple uses as fiber, biofuel, food, and medicine. In this study, a breeding line with potential drought tolerance, ‘Q1735-4’, developed by New Mexico State University from a cross of ‘Acala 1517-99’ and ‘Pima Phy 76’, together with its parents were grown in a greenhouse. The plants were characterized for growth and physiological responses to varying substrate volumetric water contents (θ = volume of water/volume of substrate) maintained by using an automated irrigation system with soil moisture sensors. Substrate was maintained for nine weeks at four θ levels, i.e., 0.15, 0.25, 0.35, and 0.45 L·L−1. The results showed that, as θ decreased, total dry weight (DW), stem diameter, and leaf area were decreased linearly for ‘Pima Phy 76’ and ‘Q1735-4’, but quadratically for ‘Acala 1517-99’. However, the reduction varied among genotypes. As θ decreased from 0.45 to 0.25, the total DW of ‘Acala 1517-99’, ‘Pima Phy 76’, and ‘Q1735-4’ was decreased by 59.2%, 55.6%, and 15.1%; stem diameter was reduced by 33.4%, 28.1%, and 22.1%; leaf area was decreased by 70.9%, 65.8%, and 34.7%; and plant height was reduced by 39.2%, 32.5%, and 23.7%, respectively. As θ further decreased to 0.15, the growth reduction in ‘Q1735-1’ and ‘Acala 1517-99’ was similar but lower than ‘Pima Phy 76’. In conclusion, the growth and development of the three cotton genotypes were negatively impacted by the reduction of water content in substrate. ‘Q1735-4’ was more tolerant to drought than its parents ‘Acala 1517-99’ and ‘Pima Phy 76’.

---

An asterisk (*) following a name indicates the presenting author.
Climate Drivers of Crop Carbon Gain and Water Use in Apple Between Western and Eastern States
Soo-Hyung Kim*
University of Washington, Seattle; soohkim@uw.edu
D. Michael Glenn
USDA Appalachian Fruit Research Station, Kearneysville, WV; michael.glenn@ars.usda.gov

Apple is cultivated under various climatic conditions in many parts of the world. Better understanding of how climate factors affect crop growth and productivity at different locations will improve our ability to optimize crop selection, management strategies, and resource use. The objective of this work was to apply a process-based apple canopy model 1) to identify what and how climatic factors limit crop biomass accumulation and water use at multiple locations in the states of Washington, California, and West Virginia, and 2) to evaluate how these climate factors influence crop radiation use efficiency (RUE) and water use efficiency (WUE) in apple. Our results indicate that temperature is a dominant factor limiting biomass gain when compared across the locations while VPD was predominantly dictating crop water use during the growing season. Crop RUE and WUE were strongly correlated with each other while VPD showed highly negative correlation with both RUE and WUE across all locations examined. Locations in western WA were found to have both higher RUE and WUE than other locations examined in this study. Locations with higher diffuse light fraction (e.g., WV and western WA) tended to have greater RUE than other locations but its positive effects on RUE and WUE were negated by low total radiation and high temperatures in WV. Our results provide effective means and useful insights to disentangle the complex relationships between canopy carbon gain, water use, and climate factors that are site-specific.

Growth Chambers and Controlled Environments 2
Moderator: Shuyang Zhen; syzhen@uga.edu

3:00–3:15 PM
Blue Light Dose-response of Growth and Morphology of Cucumber Seedlings Under Different Blue and Red Photon Flux Ratios Using LEDs
Ricardo Hernández*
University of Arizona, Tucson; ricahdez@email.arizona.edu
Chieri Kubota
University of Arizona, Tucson; ckubota@ag.arizona.edu

With the continuous increase of light emitting diodes (LEDs) energy-to-photon conversion efficiencies, LEDs have become a viable light source for the production of transplants under closed-type conditions. The objective of this experiment was to evaluate different blue and red photon flux (PF) ratios using LEDs for the production of cucumber seedlings (Cucumis sativus). Cucumber seedlings (cv. Cumlaude) were grown in a growth chamber until the second true leaf stage with 100 μmol·m⁻²·s⁻¹ photosynthetic photon flux of LED lighting, 18-
hour photoperiod, 25 °C temperature, and ambient CO₂. The treatments consisted of blue-red (B-R) PF ratios of 0B-100R, 10B-90R, 30B-70R, 50B-50R, 75B-25R, 100B-0R, and one blue-green-red PF ratio of 20B-28G-52R. Peak wavelengths were 455 nm and 661 nm for the blue and red LEDs, respectively in the B-R ratio treatments and 473 nm, 532 nm, 660 nm for the blue, green, and red LEDs, respectively in the B-G-R treatment. Seeds were germinated under darkness and transferred to treatments after radicle emergence (24h). Hypocotyl length decreased with the increase of blue light percent up to 75B-25R; however, 100B-0R showed the longest hypocotyl of all the treatments. Hypocotyl length was 70% greater in the 0B-100R treatment and 80% greater in the 100B-0R treatment compared to the 75B-25B treatment. Chlorophyll concentration increased with the increase of the percentage of blue light except for 100B-0R, which had significantly lower chlorophyll concentration than 50B-50R, and 75B-25R. Cucumber shoot fresh and dry mass decreased with the increase of the percentage of blue light except for the two monochromatic treatments; 0B-100R had the smallest and 100B-0R had the greatest shoot dry and fresh mass of all the treatments. Net photosynthetic rate (Pn) was not different between 10B-90R, 30B-70R, 50B-50R, 75B-25R, and 100B-0R; however, Pn was significantly lower in 0B-100R and 20B-28G-52R than 10B-90R, 30B-70R, and 100B-0R. The optimal spectrum for the growth of cucumber transplants under artificial light will need to be selected based on grower preferences. For example, the 100B-0R treatment had the highest growth rate of all the treatments; however, the long hypocotyl is not preferred by growers. The most compact cucumber transplant were in 75B-25R, but they had the smallest shoot dry mass. An adequate compromise may be 10B-90R since it had a good growth rate and an acceptable plant height. More research is needed to find the optimal spectrum for the growth and development of cucumber transplants under artificial lighting.

2:15–2:30 PM  
**Chlorophyll Fluorescence of Three Species with Different Light Requirements: A Tool to Optimize Supplemental Lighting Efficiency?**  
Shuyang Zhen*  
University of Georgia, Athens; syzhen@uga.edu  
Marc van Iersel  
University of Georgia, Athens; mvanier@uga.edu  
Rhuanito Soranz Ferrarezi  
University of Georgia, Athens; rhuanito@terra.com.br

Supplemental lighting is commonly used in greenhouse production to increase plant photosynthetic rate, thus increasing crop yield and shortening the production cycle. As electrical consumption of lighting increases the production cost, more energy-efficient lighting sources, such as light-emitting diodes (LEDs), have increased in popularity. Another way to improve energy use efficiency is to provide plants with the optimal level of photosynthetically active radiation (PAR) at which plants utilize PAR most efficiently to produce biomass. However, this approach has received little attention. To understand how efficiently different species utilize PAR, mature plants of sweet potato (*Ipomoea batatas* ‘Desana Lime’, a high light plant), lettuce (*Lactuca sativa* ‘Green Ice’, a medium light plant), and pothos (*Epipremnum aureum*, a shade-tolerant plant) were exposed to gradually increasing PAR in a growth chamber equipped with dimmable LEDs. Chlorophyll fluorescence analysis was used to estimate how the quantum efficiency of photosystem II (ΦPSII), linear electron transport rate (ETR), and non-photochemical quenching (NPQ, i.e. dissipation of excessive PAR as heat) of the three species change when PAR gradually increases from 0 to 1000 µmol·m⁻²·s⁻¹. ΦPSII of all three species decreased with increasing PAR. In contrast, ETR, which is often strongly positively correlated with carbon fixation, increased with increasing PAR. All three species had similar ΦPSII and ETR under relatively low light (PAR < 200 µmol·m⁻²·s⁻¹). However, as PAR further increased, sweet potato consistently had higher ΦPSII and ETR than pothos (intermediate) and lettuce (lowest) when exposed to the same light level, suggesting that sweet potato has a greater light use efficiency under higher light. There was little increase in the ETR of pothos and lettuce above a PAR > 500 µmol·m⁻²·s⁻¹, while ETR of sweet potato was still not light saturated at a PAR of 900 µmol·m⁻²·s⁻¹. NPQ of lettuce increased most rapidly with increasing PAR, indicating inefficient use of the absorbed PAR, with much of the absorbed light energy being converted into heat at higher PAR. We hope to use chlorophyll fluorescence measurements, especially ETR, as a simple and reliable measure to develop a bio-feedback system which can automatically adjust the intensity of the LED lighting to the level at which plants most efficiently use the PAR to fix carbon.

2:30–2:45 PM  
**Comparing Supplemental and Sole-source Lighting for Bedding Plant Seedling Production**  
Wesley Randall*  
Purdue University, West Lafayette, IN; wrandal@purdue.edu  
Roberto G. Lopez  
Purdue University, West Lafayette, IN; rglopez@purdue.edu

In order to produce uniform and high-quality annual bedding plant seedlings or plugs in late winter through early spring, supplemental lighting (SL) must be used to maintain a photosynthetic daily light integral (DLI) of 10 to 12 mol·m⁻²·d⁻¹. The objectives of this study were to: 1) quantify bedding plant seedling quality under greenhouse SL from light-emitting diodes (LEDs), high-pressure sodium lamps (HPS), or plasma lamps (PL); 2) quantify seedling quality under sole-source LED lighting in a growth room environment; and, 3) compare seedlings grown under a DLI of ≈10.5 mol·m⁻²·d⁻¹ from ambient solar light plus SL or sole-source lighting to those grown under ambient solar light. Upon hypocotyl emergence, seedlings of *Catharanthus roseus*, *Impatiens walleriana*, *Petunia × hybrida*, and *Tagetes patula* were placed under ambient solar light plus SL delivering a photosynthetic photon flux (PPF) of 70 µmol·m⁻²·s⁻¹ in the greenhouse for 16-h or under sole-source lighting plus SL delivering a photosynthetic photon flux (PPF) of 70 µmol·m⁻²·s⁻¹ in the greenhouse for 16-h or under sole-source lighting.
light delivering a PPF of 185 µmol·m−2·s−1 in a growth room for 16-h. Supplement light treatments consisted of HPS, PL, and LED arrays providing a red:blue light ratio of 87:13, and sole-source light treatments were made up of LED arrays providing a red:blue light ratio of 87:13 or 70:30. Stem elongation of Pelargonium and Petunia seedlings decreased by 18% and 69%, respectively, for plants grown under sole-source LEDs providing 70:30 red:blue light, and Tagetes decreased by 13% for plants grown under sole-source LEDs providing 87:13 red:blue light, compared to ambient solar light. Root dry mass of Petunia seedlings grown under sole-source LEDs providing 70:30 red:blue light increased by 127% compared to those under the ambient control. The quality index, a quantitative measurement of quality, increased by 157% and 132% for Impatiens and Pelargonium, respectively, for plants grown under sole-source LEDs providing 70:30 red:blue light, compared to the ambient control. These results indicate that annual bedding plant seedlings grown under controlled environments with LED sole-source lighting are generally of higher quality than seedlings grown in a traditional greenhouse with or without SL.

Specified Source(s) of Funding: Specialty Crop Research Initiative award no. 2010-51181-21369

2:45–3:00 PM

End-of-Production Supplemental Lighting from Red and Blue Light-emitting Diodes Increases Leaf Pigments of Lactuca sativa L. ‘Cherokee’ and ‘Vulcan’ in the Greenhouse

W. Garrett Owen*
Purdue University, West Lafayette, IN; owenw@purdue.edu

Roberto G. Lopez
Purdue University, West Lafayette, IN; rglopez@purdue.edu

Under low-light greenhouse conditions, such as those found in northern latitudes, the foliage of red-leaf lettuce (Lactuca sativa L.) varieties is often green and not aesthetically appealing to consumers. Our objective was to quantify the effect of end-of-production supplemental lighting (SL) of different intensities and sources on foliage color of two red leaf lettuce cultivars, ‘Cherokee’ and ‘Vulcan’. Plants were grown for 5 weeks at 20 ºC and under a daily light integral (DLI) of 8.3 mol·m−2·d−1. Two weeks prior to being marketable, plants were placed at 18 ºC and under an ambient DLI of 6 mol·m−2·d−1 and provided with a 16-h photoperiod from low-intensity LED lamps providing 4.5 µmol·m−2·s−1 (control), or 16-h of SL from high-pressure sodium (HPS) lamps providing 70 µmol·m−2·s−1, or high-intensity LED arrays providing 25, 50, or 100 µmol·m−2·s−1 blue light, 100 µmol·m−2·s−1 red light, or 100 µmol·m−2·s−1 50:50 (%) red:blue light. Chromametric and relative chlorophyll content (SPAD) values of ‘Cherokee’ and ‘Vulcan’ foliage were significantly different among all treatments after 3, 5, 7, and 14 days of SL. For example, after 14 days ‘Cherokee’ and ‘Vulcan’ plants grown under 100 µmol·m−2·s−1 red:blue light were the darkest in color with an L* (lightness) value of 31.01 and 33.97, respectively. Chromametric a* (change from green to red) and b* (change from yellow to blue) values increased with 100 µmol·m−2·s−1 red, blue, or combination of red:blue light. Chromametric a* and b* values of ‘Cherokee’ were 4.61 and –1.63 and 3.42 and –1.33 when plants grown under 100 µmol·m−2·s−1 red:blue and blue light, respectively. Under the same lighting treatments, chromametric a* and b* values of ‘Vulcan’ were 4.46 and 11.11 and 5.15 and 12.08, respectively. Our data suggests that as little as 7 days of end-of-production SL of 100 µmol·m−2·s−1 red:blue or blue LED light promotes enhanced red pigmentation of L. sativa ‘Cherokee’ and ‘Vulcan’ foliage when the crop is grown under a low greenhouse DLI.

Specified Source(s) of Funding: USDA NIFA Specialty Crop Research Initiative award no. 2010-51181-21369

3:00–3:15 PM

Effects of LED Interlighting on Plant Growth, Fruit Yield, Quality, and Energy Use Efficiency in Greenhouse Mini-cucumber Production

Xiuming Hao*
Agriculture and Agri-Food Canada, Harrow, ON; xiuming.hao@agr.gc.ca

JingMing Zheng
Agriculture and Agri-Food Canada, Harrow, ON; jingming.zheng@agr.gc.ca

Celeste Little
Agriculture and Agri-Food Canada, Harrow, ON; celeste.little@agr.gc.ca

Shalin Khosla
Ontario Ministry of Agriculture, Food and Rural Affairs, Harrow, ON; Shalin.Khosla@ontario.ca

Year round greenhouse vegetable production with artificial lighting in northern regions is capital and energy intensive. To be successful, the lighting system and crop management must be optimized to maximize light and energy use efficiency. Interlighting, applying the supplemental light within crop canopy, could improve light distribution and interception within canopy and thus increase crop yield and light use efficiency. However, the high bulb temperature with the standard HPS (high pressure sodium lamps) has prevented its use as interlighting in the popular twin-row greenhouse vegetable cultivation system (with small row width). Light emitting diodes (LEDs) have low bulb temperature, making it a good light system for interlighting. Therefore, this study was conducted to evaluate the effects of GreenPower LED inter-lighting module (114W, 220 µmol output, 2.47 m long) recently developed by Philips on plant growth, fruit yield and quality, and light and energy use efficiency in greenhouse mini-cucumber production. Two experiments were conducted in 6 greenhouse compartments during winter 2011–12. Experiment one evaluated single LED inter-lighting module per twin-row (36.7 µmol·m−2·s−1) without or with top HPS lamps (hanged above the crop canopy, 165 µmol·m−2·s−1 just above the plant head). To determine if high plant density (canopy coverage) can improve the response to LED inter-lighting, 2 plant densities (2.8 and 3.6 plants/m²) were used in the experiment. Experiment two

An asterisk (*) following a name indicates the presenting author.
evaluated two LED inter-lighting modules (73.4 μmol·m⁻²·s⁻¹) per twin-row without or with top HPS lamps (120 μmol·m⁻²·s⁻¹). LED inter-lighting improved fruit color, number, weight and size. The LED inter-lighting allowed a higher percentage of light emitted by the light sources reached the canopy and had a higher light use efficiency than the top HPS calculated based on total light output from the light sources. However, the light use efficiency was similar when calculated based on the light emitted by the light sources reached the canopy and had an improved response to LED inter-lighting the canopy when compared to top HPS. Higher plant density improved the response of mini-cucumbers to LED inter-lighting and further increased light use efficiency, and the response to LED inter-lighting appeared to be slightly better under lower top HPS lighting (120 μmol·m⁻²·s⁻¹). Therefore, the response of mini-cucumbers to LED inter-lighting can be optimized by using proper crop management and top/interlight ratio. The LED inter-lighting module achieved higher energy use efficiency than the top HPS in both experiments.

3:15–3:30 PM

Determine the Effect of Different Ratios of Red and Blue LED Light on Commercial Plants Production

Most Tahera Naznin*

McGill University, Ste-anne-de-Bellevue, QC; most.naznin@mail.mcgill.ca

Valerie Gravel

McGill University, Ste-anne-de-Bellevue, QC; valerie.gravel@mcgill.ca

Mark Lefsrud

McGill University, Ste-anne-de-Bellevue, QC; mark.lefsrud@mcgill.ca

Greenhouses in northern latitudes must compensate for the attenuation in total light availability especially during the prolonged winter with short daylight hours, where supplemental artificial lighting is required in order to maintain a consistent crop yield throughout the year. Conventional greenhouse lighting systems utilize broad-spectrum light sources, such as high pressure sodium (HPS) or fluorescent lamps. These lamps were tailored for human vision and therefore are not ideally suited for plant growth. LEDs can be selected to target the wavelengths absorbed by plants, enabling the growers to customize the wavelengths of light required to maximize production and limit wavelengths that do not significantly impact plant growth. Plant response to light from the red and blue spectra has been documented extensively. The purpose of this study was to determine which combination of red and blue LED light ratio was optimum for plant production. In this study three red to blue ratio levels (5:1, 10:1 and 19:1) compared to 100% red led the plants of significant commercial importance to the greenhouse horticultural industry were used as subjects, namely lettuce, spinach, basil, tomato, pepper and strawberry. Seedlings were cultured in a growth chamber at 25 °C/–2.5 °C, ambient CO₂, and a 16 hour light, 8 hour dark photoperiod under fluorescent light. Seeds were germinated and two weeks seedlings were planted in one inch rockwool cubes in trays for soilless hydroponic culture with half-strength Hoagland’s solution and transplanted in LED light chamber. Leafy vegetables were harvested after 4 weeks and fruiting crops were harvested after four months of transplant. Fruit and flower numbers were counted at two weeks intervals and at final harvest. The fresh biomass harvested (aerial and fruit) was dried according to the ASABE standard (2007), with a temperature of 65 °C for no less than 72 hours and subsequently weighed. One representative ripe fruit was collected from each plant during the final harvest, freeze-dried, and stored at –80 °C for future fruit quality measurements. Among the four treatments of light, the 5:1 ratio of red to blue LED was found superior. The lowest significant growth (number of flower, fruit, fresh mass, dry mass) was observed in 100% red LED. This research will facilitate the improved selection of LEDs for commercial control environment production.

3:30–3:45 PM

Determination of the Effect of Red and Blue Ratios of LED Light on Plant Photosynthesis

Michael Schwalb

McGill University, Ste-anne-de-Bellevue, QC; mschwalb1@gmail.com

Most Tahera Naznin*

McGill University, Ste-anne-de-Bellevue, QC; most.naznin@mail.mcgill.ca

Mark Lefsrud

McGill University, Ste-anne-de-Bellevue, QC; mark.lefsrud@mcgill.ca

Light emitting diodes (LEDs) are an emerging versatile artificial light source offering many advantages over conventional artificial light sources. This could eventually allow determination of the ideal light emission spectrum for optimal plant growth, allowing for lighting system designs tailored to optimize plant growth while minimizing associated energy costs. A combination of blue and red wavebands can result in higher photosynthetic activity and better photomorphogenetic characteristics than red or blue alone. Red light is important in the development of the photosystem complex and morphogenesis through the mutation of phytochrome apparatus while blue has been identified as affecting chlorophyll concentrations, photomorphogenesis and stomatal openings. The objective of this research is to measure the photosynthetic response of lettuce and petunia to varying red and blue ratios with and without background broadband radiation. In this experiment, the photosynthetic response of lettuce (Lactuca sativa) and petunia (Petunia hybrida) seedlings to varying 1:10, 1:5, 1:1, 2:1, 3:1, 4:1, 5:1, 6:1, 7:1, 8:1, 9:1, 10:1, 11:1, 12:1, 13:1, 14:1, 15:1, 20:1, 25:1, 30:1, 50:1, and 100:1 ratios of red (660 nm) and blue (435 nm) (r:b) was measured with and without background broadband HPS radiation. Irradiance and spectral distribution measurements were made using a spectroradiometer (PS-300, Apogee Instruments, Utah, USA).
Logan, Utah) with a converging lens and optical fiber aperture to minimize sampling error due to critical angle losses. The plants were tested at an LED irradiance level of 24.4 W m⁻² or approximately 115 μmol·m⁻²·s⁻¹. Background broadband radiation was achieved with a standard HPS bulb (Lucalox, 400 W, GE, Fairfield, CT) which provided a consistent irradiance level of 24.4 W m⁻² for the test set-up. Photosynthetic measurements were obtained with a portable LICOR (Licior, Lincoln, NE) LI-6400XT portable photosynthesis system and exposing the seedlings to varying red to blue ratios. With and without background radiation, the optimum photosynthesis range occurred within the r:b range of 5:1 to 15:1 except for petunia without background radiation for which the maximum occurred at 50:1. The addition of background radiation slightly altered the ratio at which peak photosynthesis rates occurred for lettuce. For every plant, with the addition of background radiation, the r:b resulted in maximum photosynthetic activity was consistently lower than the r:b without background radiation.

Thursday, July 31, 2014

Vegetable Breeding

Moderator: Charlene Margaret Grahn; charlene.grahn@wsu.edu

1:45–2:00 PM
Screening the USDA Lettuce Germplasm Collection for Rapid Germination Rate Under Cold Conditions

Charlene Margaret Grahn*
Washington State University, Mount Vernon; charlene.grahn@wsu.edu

Chris Benedict
Washington State University Whatcom County Extension, Bellingham; chrisbenedict@wsu.edu

Carol A. Miles
Washington State University, Mount Vernon; milesc@wsu.edu

Barbara Hellier
USDA–ARS, Western Regional Plant Introduction Station, Pullman, WA; bhellier@wsu.edu

Quick emergence of seedlings has long been the goal of agronomists and horticulturists in order to maximize uniform emergence and weed competitiveness in direct-seeded crops. Exposure of seed to low temperatures after seeding can increase the time for germination, which leads to increased days to maturity as well as increased potential for weed pressure. For a crop that is densely planted for early harvest, such as baby-leaf salad greens, rapid and uniform seed emergence is essential. Soil temperature during the shoulder seasons in Northwest Washington averages 10 °C in spring and 12 °C in fall. Rapid germination and growth under cool soil conditions enable growers to produce lettuce (Lactuca sativa) in the extended season and can increase economic competitiveness of the crop in regions outside its current range of production. The USDA National Plant Germplasm System (NPGS) lettuce collection has not been screened for rapid germination under cold conditions. In this study, 103 lettuce accessions [53 cos (romaine) and 50 leaf-type] from the NPGS collection, maintained at the Western Region Plant Introduction Station, Pullman, WA, were evaluated for germination at 5 °C. Three replicates of 50 seeds each per accession were placed randomly in a germination chamber on a 12–12 (day–night) cycle (fluorescent light) and screened for percentage of germination after 7 and 10 days. There was a significant difference among accessions ($P < 0.001$) in percent seeds germinated at 5 °C after 7 and 10 days. Overall, an average of 60% of seeds germinated after 7 d and 96% germinated after 10 d. Cos types had a significantly higher percent germination after 7 d than leaf types on average (62% and 58%, respectively; $P = 0.0107$). 4 of the 5 accessions with the highest percentage of germinated seedlings were cos types: PI 140394 (cos), PI 171665-1 (cos), PI 169509-4 (cos), PI 278072 (cos), and PI 344367-1 (leaf). The seed of accessions tested was either black-brown or white. Accessions with black-brown seed were found to have a significantly higher percent of germination after 7 days at 5 °C than white-seeded accessions (61% and 59%, respectively; $P = 0.0097$). Accessions with shortest germination time under cold temperatures have the potential to be used for the development of lettuce cultivars better suited to low-temperature extended season production. Field trials under cold soil temperatures should be performed to further assess the ability of these accessions to germinate rapidly under cold soils.

Specified Source(s) of Funding: WSU CAHNRS ARC Emerging Research Issues

2:00–2:15 PM
Using Regional Broccoli Trial Data to Select Experimental Hybrids for Input into Advanced Yield Trials

Mark W. Farnham*
USDA–ARS, Charleston, SC; mark.farnham@ars.usda.gov

Zachary Stansell
USDA–ARS, Charleston, SC; zachary.stansell@ars.usda.gov

Phillip Griffiths
Cornell University, Geneva, NY; pdg8@cornell.edu

Jeanine M. Davis
North Carolina State University, Mills River; jeanine_davis@ncsu.edu

Mark Hutton
Univ. of Maine, Monmouth; mark.hutton@maine.edu

Thomas Björkman
Cornell University, Geneva, NY; tbl@cornell.edu

A large amount of phenotypic trait data are being generated in regional trials that are implemented as part of the Specialty Crop Research Initiative (SCRI) project entitled “Establishing an Eastern Broccoli Industry”. These data are used to identify the best entries in the trials for inclusion in subsequent and more expansive evaluations. Hybrids entered into the trialing system that are grown in the first phase and then selected for advancement...
Oral Presentations

Colorful and Nutritious Vegetable Genetic Resources in the USDA/ARS National Plant Germplasm System
Jinguo Hu*
USDA–ARS, Western Regional Plant Introduction Station, Pullman, WA; Jinguo.Hu@ars.usda.gov

The USDA/ARS National Plant Germplasm System (NPGS) curates a wide spectrum of plant genetic resources, not only for preserving that biodiversity, but also for making them accessible to researchers and breeders for improving crop productivity in the United States and around the world. Approximately 19% of the current NPGS holdings of 564,738 accessions are vegetable crops and their wild relatives. As of March 5, 2014, there were 87,000 available vegetable accessions managed by the NPGS’s four Regional Plant Introduction Stations and two crop-specific sites. The North Central Regional Plant Introduction Station in Ames, IA, is responsible for curating carrot, cilantro, parsley, cucumber, pumpkin, squash, cantaloupe, honeydew, horned melon, spinach, chicory, and endive. The Northeast Regional Plant Introduction Station in Geneva, NY, curates tomato, onion, celery, winter melon, winter squash, cabbage, bok choy, broccoli, cauliflower, turnip, mustard, collard, kale, and radish. The Southern Regional Plant Introduction Station in Griffin, GA, curates warm season food legumes (black eye pea, mung bean, black gram, asparagus bean, lablab or hyacinth bean, horsegram, catjung, and Jerusalem pea), sweet and hot peppers, eggplants, okra, sunset hibiscus, watermelon, butternut squash, tropical pumpkin, bottle gourd, calabash cushaw, chayote, and malabar spinach. The Western Regional Plant Introduction Station in Pullman, WA, curates Phaseolus beans (dry bean, tepary bean, scarlet runner bean, lima bean, and snap bean), cool season food legumes (garden pea, snow pea, sugar snap pea, chickpea, lentil, faba bean, and fenugreek), lettuce, garlic, leek, chives, Chinese chives, salsify, table beet, leaf beet, chard, and rhubarb. The National Potato Collection in Sturgeon Bay, WI, curates germplasm of potatoes and related wild species, and the University of California-Davis C.M. Rick Tomato Genetics Resource Center curates the genetic stocks and wild relatives of tomato. These diverse collections contain crops belonging to 16 plant families, and represent most of the plant species consumed by humans as vegetables. The preceding NPGS sites also manage the associated information (passport data and limited evaluation data) through the Internet-based GRIN data base, which is updated regularly. These vegetable genetic resources play a pivotal role in supplying critical raw materials for both basic and applied research, for genetically-improving existing vegetable crops, and for developing regionally-adapted varieties to diversify human diets.

Specified Source(s) of Funding: USDA–ARS CRIS Project 5438-21000-026-00D

2:15–2:30 PM
Inheritance of Immature Tomato Fruit Shoulder Color Phenotypes and Their Effect on Yellow Shoulder Disorder and Soluble Solids Content of Ripe Tomatoes
Matthew R. Mattia*
University of Florida/IFAS, Wimauma; mrmattia@ufl.edu
John W. Scott
University of Florida/IFAS, Wimauma; jwsc@ufl.edu

A recent Science article reported increased soluble solids in tomatoes (Solanum lycopersicum L.) with dark green shoulders (U+ gene) compared to an isogenic line with uniform green shoulder (u gene). Tomato breeders have generally been developing cultivars with uniform shoulders because they are less likely to be susceptible to yellow shoulder disorder (YSD) than cultivars with dark green shoulders. YSD is a hard, yellow or green area on the shoulder of tomato fruit exposed to the sun that does not turn red at maturity. Lines with dark green (U+), uniform green (u), uniform gray-green (ug), apple green, medium green, and pale green immature fruit shoulder colors were crossed in all combinations to produce University of Florida, Fort Pierce, and F2 populations. Parents, University of Florida, Fort Pierce, and F2’s were planted in the field in completely randomized block designs over three seasons to compare YSD incidence and soluble solids content for each phenotype. Plants were visually phenotyped for shoulder color then shoulders were measured with a colorimeter. The u and ug genes were confirmed to be separate loci and recessive to U+. Apple green, pale green, and uniform green (u) are alleles at the same locus where apple green is dominant to both uniform and pale green and uniform green is dominant to pale green. Plants with dark green shoulders had higher incidence of YSD than plants of the other phenotypes which were not different from each other. Apple green fruit color was not significantly different from either the uniform or pale green. A recent Science article reported increased soluble solids in tomatoes (Solanum lycopersicum L.) with dark green shoulders (U+ gene) compared to an isogenic line with uniform green shoulder (u gene). Tomato breeders have generally been developing cultivars with uniform shoulders because they are less likely to be susceptible to yellow shoulder disorder (YSD) than cultivars with dark green shoulders. YSD is a hard, yellow or green area on the shoulder of tomato fruit exposed to the sun that does not turn red at maturity. Lines with dark green (U+), uniform green (u), uniform gray-green (ug), apple green, medium green, and pale green immature fruit shoulder colors were crossed in all combinations to produce University of Florida, Fort Pierce, and F2 populations. Parents, University of Florida, Fort Pierce, and F2’s were planted in the field in completely randomized block designs over three seasons to compare YSD incidence and soluble solids content for each phenotype. Plants were visually phenotyped for shoulder color then shoulders were measured with a colorimeter. The u and ug genes were confirmed to be separate loci and recessive to U+. Apple green, pale green, and uniform green (u) are alleles at the same locus where apple green is dominant to both uniform and pale green and uniform green is dominant to pale green. Plants with dark green shoulders had higher incidence of YSD than plants of the other phenotypes which were not different from each other. Apple green fruit color was not significantly different from either the uniform or pale green.
showed significantly higher soluble solids in two of the three seasons. There was no significant differences in soluble solids between any of the other phenotypes.

2:45–3:00 PM

**Molecular Breeding in Cowpea**

Ainong Shi*

University of Arkansas, Fayetteville; ashi@uark.edu

Blair Buckley

LSU AgCenter, Bossier City, LA; bbuckley@agctr.lsu.edu

John R. Clark

University of Arkansas, Fayetteville; jrclark@uark.edu

Dennis Motes

University of Arkansas, Fayetteville; dmotes@uark.edu

Beiquan Mou

USDA–ARS, Salinas, CA; beiquan.mou@ars.usda.gov

David Hensley

University of Arkansas, Fayetteville; dhensley@uark.edu

Noelle A. Barkley

University of Arkansas, Fayetteville; elle.barkley@ars.usda.gov

Molecular Breeding in Cowpea

Cowpea (*Vigna unguiculata* L. Walp.) (2n = 2x = 22) is an important and often a staple annual legume widely grown in Africa, Latin America, Southeast Asia, and the southern United States. It is chiefly used as a fresh or dry grain or vegetable crop for food, and can also be used as animal fodder. The objective of this project was to build a Genotyping by Sequencing (GBS) and Single Nucleotide Polymorphism (SNP) platform for molecular breeding in cowpea and to merge molecular and classical breeding to expedite genetic gain and development of new cowpea cultivars. The molecular approach includes the discovery of genome-wide SNP through GBS, analysis of genetic diversity for world-wide accessions, conducting of genome-wide association, and the identification of SNP markers associated with morphologic and agronomic traits, disease resistance, and seed quality through marker-assisted and genome-wide selection. It is expected that more than 30,000 SNPs will be discovered from 1,000 world-wide cowpea lines through GBS. Genetic diversity is being analyzed in these 1,000 cowpea lines. Genome-wide association is being conducted for morphologic traits such as plant habit, dry pod color, pod placement, mature seed pattern, seed coat color, seed pattern color, flower color, seed protein and sugar contents. Further, agronomic traits such as grain (seed) yield, 100-seed weight and seed size, along with abiotic (disease and pest) resistance/tolerance to cowpea wilt (*Fusarium oxysporum* f. sp. *tracheiphilum*), cowpea mosaic virus (CPMV), bacterial blight (*Xanthomonas axonopodis* pv. *vignicola*), cowpea aphid, iron deficiency chlorosis (IDC), and low phosphorus uptake efficiency are being studied for associations. SNP markers are also being identified for these traits. This research will provide breeders a tool to select for these traits through marker-assisted selection in a cowpea breeding program.

3:00–3:15 PM

**Screening of Tomato (*Solanum lycopersicum L.*) Lines for Bacterial Spot (*Xanthomonas Species*) Resistance**

Krishna Bhattacharai*

North Carolina State University, Mills River; kbhatta@ncsu.edu

Frank J. Louws

North Carolina State University, Raleigh; frank_louws@ncsu.edu

John D. Williamson

North Carolina State University, Raleigh; john_williamson@ncsu.edu

Diip R. Panthee

North Carolina State University, Mills River; dilip_panthee@ncsu.edu

Bacterial spot (BS), caused by four species of *Xanthomonas* in tomato (*Solanum lycopersicum L.*), is challenging to manage by chemical methods under favorable environmental conditions. Development of resistant genotypes is a desirable solution to limit losses. A total of 64 genotypes were planted in the field at the Mountain Horticultural Crops Research and Extension Center (MHCREC), NC in a randomized complete-block design with two replications consisting of six plants per plot. The genotypes were inoculated with a local and prevalent strain of *Xanthomonas* and phenotypic data on foliar disease severity was scored using the Horsfall-Barratt (HB) scale and on fruit incidence. Foliar severity ranged from 0% to over 75% defoliation and fruit incidence ranged from 0% to 100% and these traits were not correlated. The response of tomato genotypes for *Xanthomonas*-specific pathogen associated molecular pattern (PAMP) molecules in production of reactive oxygen species (ROS) was also scored for these lines. A luminol-based assay was conducted to measure the ROS by using four bacterial flagellin and one cold shock protein (CSP) peptides. In addition, observations were taken for seven morphological characters including vegetative and reproductive growth stages. Based on the principal component analysis (PCA), six principal components explained 83% of total morphological variability. Cluster analysis resulted into three major clusters of which one consists of genotypes NC946, NC50-7, IRAT-L3 and Hawaii 7997 which produced high ROS when *Xanthomonas*-specific flagellin was used in luminol-based assay. These genotypes could be useful in developing BS resistance in breeding programs.

3:15–3:30 PM

**SSR Discovery in Common Dandelion (*Taraxacum officinale*) from EST Sequence Databases**

Jianbing Ma*

University of Arkansas, Fayetteville; jxm044@uark.edu

Databases

An asterisk (*) following a name indicates the presenting author.
Oral Presentations

Michael R. Evans
University of Arkansas, Fayetteville; mrevans@uark.edu
Beiquan Mou
USDA–ARS, Salinas, CA; beiquan.mou@ars.usda.gov
Dennis Motes
University of Arkansas, Fayetteville; dmotes@uark.edu
Jessica Chitwood
University of Arkansas, Fayetteville; jchitwo@email.uark.edu
Haizheng Xiong
University of Arkansas, Fayetteville; heixiazi2006@sina.com
Ainong Shi
University of Arkansas, Fayetteville; ashi@uark.edu

Microsatellites or SSRs (simple sequence repeats) are short tandem duplications randomly distributed in eukaryotic genomes. SSR markers derived from genomic sequences have greatly improved marker assisted selection (MAS) for plant breeding. Database screening provides the most readily available approach to search SSRs. The availability of expressed sequence tags (ESTs) in the public databases has resulted in the development of the genomic markers named EST-derived SSR (EST-SSR) markers. Generally, traditional markers used in genetic diversity study are derived from the non-coding regions of the genome. However, EST-SSR markers detect the true functional region of the genome thus determine the genetic diversity of the coding regions of the genome. The objective of this study was to discover SSRs in the EST database that are available in NCBI for common dandelion (Taraxacum officinale). SSRLocator, Blast2Go and DNASTAR were used for data mining. As a result, there were 6,283 non-redundant EST (NR-EST) sequences from 41,295 redundant EST sequences. Only 572 NR-EST (9.1%) sequences contained SSR and a total of 607 SSRs with different motifs were found in T. officinale EST sequences. Within these EST-SSRs, 52.2%, 21.6%, and 23.2% showed monomeric, dimeric and trimeric motifs, respectively. Only about 3% of these sequences showed tetrameric, pentameric and hexameric SSR motifs. PCR primers were designed for the 607 SSRs and virtual-PCR was simulated using SSRLocator. In addition, these NR-EST containing SSRs were categorized based on Gene Ontology (GN) regarding molecular function, biological processes and cellular components. Validation of SSR primers is in progress using five different T. officinale collections. This study provides the preliminary bioinformatics information for MAS using SSR markers in dandelion breeding.

3:30–3:45 PM
Inheritance of Resistance to Basil Downy Mildew (Peronospora belbahrii)

Robert Pyne*
Rutgers University, New Brunswick; rpyne97@gmail.com

Adolfin Koroch
Borough of Manhattan Community College, New York, NY; akoroch@bmcc.cuny.edu
James E. Simon
Rutgers University, New Brunswick, NJ; jimsimon@rci.rutgers.edu

Sweet basil (Ocimum basilicum) is among the most important culinary herbs in the United States. Downy mildew caused by the oomycete Peronospora belbahrii has negatively impacted sweet basil production worldwide. All O. basilicum varieties screened to date are highly susceptible to basil downy mildew, while other species including O. americanum and O. x citriodorum provide resistance and tolerance, respectively. Basil accession RU329 was identified as resistant to downy mildew in field and greenhouse screenings. Pedigree information for this accession is unavailable, but it is sexually compatible with O. basilicum and the F1 generation is completely fertile. The objective of this study was to determine the mode of inheritance for resistance to downy mildew in basil using the previously unreported resistant parent RU329. Downy mildew susceptible inbred line SB22 (P1) was crossed with RU329 (P2), after two generations of inbreeding, to produce segregating generations. The total number of plants evaluated per generation was 12 per parent, 12 per University of Florida, Fort Pierce, 12 per reciprocal University of Florida, Fort Pierce, 300 F2 and 181 backcross. Field ratings were made on three dates at the Rutgers Research and Extension Center (RAREC) in Bridgeton, NJ, during the 2013 growing season. A disease severity index (DSI) corresponding to the estimated percentage of sporulating leaf area was generated per single plant using a five-point scale (0–4). Disease severity varied among rating dates and was greatest at the second rating, 33 days after planting, in which all susceptible SB22 parent and check plants received the highest possible disease rating (DSI = 1.0; SE = 0.0). RU329 parent exhibited full resistance (DSI = 0.0; SE = 0.0). Differences between reciprocal generations were not significant, suggesting no maternal effects and allowing these generations to be pooled. A mixed effects analysis of variance showed significant differences (P > 0.0001) among generations, demonstrating genetic variation. DSI for the RU329 x SB22 population demonstrated a skewed distribution toward resistance among segregating F2 and backcross generations. Chi-square for goodness of fit was used to test observed ratios of resistant, intermediate and susceptible disease response classes against expected ratios for multiple gene models. Results suggest a dominant, complementary two-gene model in both the F2 (\(\chi^2 = 5.71; P < 0.05\)) and BC1P1 (\(\chi^2 = 3.00; P < 0.05\)). This is the first study to provide genetic information with respect to mechanism of resistance to basil downy mildew. Results demonstrate that resistance is highly heritable, which implies a strong potential for genetic gain through plant breeding.

An asterisk (*) following a name indicates the presenting author.

HortScience 49(9) Supplement—2014 ASHS Annual Conference S245
Citrus Crops

(311) Inheritance of Resistance to *Elsinoe fawcettii* (Citrus Scab) in Citrus

Rachel Odom *
University of Florida, Gainesville; ctigress@ufl.edu

José Chaparro
University of Florida, Gainesville; jaguey@ufl.edu

The fresh citrus industry in Florida is currently under strong pressure from diseases such as citrus greening (HLB) and cancer. While Citrus scab does not pose as severe a threat to the citrus industry as HLB, it does represent a challenge to fresh fruit producers. Citrus scab disease, characterized by the production of hardened scab like lesions on the leaves, fruit and stems of susceptible cultivars, is caused by the fungus *Elsinoe fawcettii*. This disease has a significant impact on the external quality of fresh fruit cultivars such as ‘Temple’, ‘Murcott’, and ‘Grapefruit’. ‘Clementine’ a popular seedless mandarin grown in Mediterranean climates is highly susceptible to the disease and cannot be cultivated commercially in Florida. Current control methods consist of fungicides, which represent an additional cost to growers attempting to produce fresh market fruit. *E. fawcettii* has also been reported to develop genetic resistance to fungicides. Therefore, the development of high quality mandarin cultivars with genetic resistance to scab disease would represent a significant contribution to the viability of fresh market citrus production in Florida. Segregating F1 populations of ‘Fallglo’ sour orange, pummelo x sour orange, and ‘Minneola’ x sour orange were generated to study the inheritance of citrus scab resistance. Trees were planted at Gainesville, Florida in 2006 at a spacing of 0.8 meters within the row and 4.6 meters between rows. Trees were irrigated with overhead irrigation as needed. Populations were evaluated twice per year for two years using a 0 to 3 disease rating scale. Evaluation scores were determined based on scab lesions on the leaves, fruit and stems of the entire viewable plant under field infection conditions. Preliminary data showing the segregation of the resistance phenotype and initial conclusions on the inheritance mechanism of this phenotype will be presented.

(312) Production and Characterization of Transgenic Citrus Plants Carrying p35 Anti-apoptotic Gene

Vladimir Orbovic *
University of Florida-IFAS-CREC, Lake Alfred; orbovic@ufl.edu

Milica Calovic
University of Florida/IFAS, Lake Alfred, FL; milica@ufl.edu

Manjul Dutt
University of Florida/IFAS, Lake Alfred, FL; manjul@ufl.edu

The baculovirus gene p35 is known to be a negative regulator of apoptosis. Transgenic plants of Carrizo citrange rootstock cultivar [*Citrus sinensis* (L.) Osbeck x *Poncirus trifoliata* (L.) Raf.] expressing the p35 gene were produced. Two transgenic lines (P35-2 and P35-4) contained one copy of the p35 gene in their genomes, and line P35-1 contained two copies of the p35 gene. In all experiments performed in this study, we used clonal plants that were propagated from original transgenic plants and the wild-type through rooting of stem explants. When grown in the absence of stress-inducing factors, transgenic plants did not appear to be phenotypically different from the wild-type plants except for the P35-4 line which was observed to contain 10% less stomata on the abaxial side of the leaves. Leaf senescence on detached branches was significantly slower in all three transgenic lines compared to the wild-type. Etephone treatment demonstrated that transgenic lines were still sensitive to ethylene although leaf abscission from detached branches of P35-2 and P35-4 lines occurred at a slower rate while abscission of leaves from wild-type and P35-1 line was not significantly different. Contrary to our observations on leaf senescence, treatment of leaf explants with increasing concentrations of the herbicide Paraquat, resulted in a similar decay of chlorophyll A in all tested lines. Girdling of plant stems, besides other effects, also caused some root loss in all tested lines. However, the loss was less pronounced in P35-2 and P35-4 lines. Interestingly, the roots of P35-2 line maintained high levels of starch 78 days after being girdled. Response of citrus plants to stem girdling is similar to symptoms of infection with the greening-causing bacteria (Las). Slower rate of root decay following the stem girdling suggests that some of transgenic lines may be able to attenuate the death of root following the infection with Las and we are currently producing more clonal plants to test this hypothesis.

(313) Mature Citrus Transformation to Combat Diseases in Florida

Gary Barthe
University of Florida/IFAS, Lake Alfred, FL; gba@ufl.edu

Pedro Gonzalez-Blanco
University of Florida/IFAS, Lake Alfred, FL; pcgo@ufl.edu

Edgardo J. Etxeberria
University of Florida/IFAS, Lake Alfred, FL; etxeber@ufl.edu

Jude W. Grosser
University of Florida/IFAS, Lake Alfred, FL; jgrosser@ufl.edu

The fresh citrus industry in Florida is currently under strong pressure from diseases such as citrus greening (HLB) and cancer. While Citrus scab does not pose as severe a threat to the citrus industry as HLB, it does represent a significant contribution to the viability of fresh market citrus cultivars with genetic resistance to scab disease would represent a significant contribution to the viability of fresh market citrus production in Florida. Segregating F1 populations of ‘Fallglo’ sour orange, pummelo x sour orange, and ‘Minneola’ x sour orange were generated to study the inheritance of citrus scab resistance. Trees were planted at Gainesville, Florida in 2006 at a spacing of 0.8 meters within the row and 4.6 meters between rows. Trees were irrigated with overhead irrigation as needed. Populations were evaluated twice per year for two years using a 0 to 3 disease rating scale. Evaluation scores were determined based on scab lesions on the leaves, fruit and stems of the entire viewable plant under field infection conditions. Preliminary data showing the segregation of the resistance phenotype and initial conclusions on the inheritance mechanism of this phenotype will be presented.
19 months after the transformation event was produced. This independent events. Some of the mature transgenics flowered performed to determine copy number of the transgenes in the plants were identified by PCR, NPTII immunostrip tests and marker and GUS or GFP reporter genes, respectively. Transgenic pCambia 2301 or pTLAB21, containing the nptII selectable to the Florida citrus industry. Scion cultivars were transformed -enables genetic improvement and the early flowering and fruiting of scion. The Agrobacterium transformation protocol was adapted to scion sweet orange cultivars ′Valencia′, ′Hamlin′, and ′Pineapple′, and ′Ray Ruby′ grapefruit, which are important to the Florida citrus industry. Scion cultivars were transformed with Agrobacterium strain EHA 105 harboring binary vectors, pcambia 2301 or pTLAB21, containing the nptII selectable marker and GUS or GFP reporter genes, respectively. Transgenic plants were identified by PCR, NPTII immunostrip tests and GUS staining or GFP fluorescence. Southern blots are being high among the prioritized breeding goals for mandarin (Citrus reticulata Blanco). Given long seedling juvenility, large tree size, and associated costs in citrus breeding, trait-associated marker development and marker-assisted selection could potentially lead to a more expeditious and economical approach to these challenges. The objectives of this project were to construct high-density mandarin genetic maps and to identify single nucleotide polymorphism (SNP) markers associated with fruit flavors, colors, as well as other fruit quality traits, using an Illumina GoldenGate assay containing 1,536 BAC end sequence-associated SNPs and a population of 116 ′Fortune′ x ′Murcott′ F1, hybrids generated in the University of Florida Citrus Research and Education Center (UF-CREC) breeding program. These fruit quality traits, including fruit size and weight, seed number, juice percentage, flavedo and juice colors, sugar and acids, and juice flavors, were investigated in 2011 and 2012 harvest season. The integrated mandarin genetic map consisted of 752 SNPs on 380 marker sites, spanning 1306 cM on nine linkage groups. The SNPs sequences were blasted and aligned to the Clementine genome, and most genome sequences showed high identities between these mandarin hybrids and Clementine. The coverage of the integrated genetic map on the Clementine genome varied among nine scaffolds from 82% of scaffold 2 to 98.8% of scaffold 4. A total of 42 QTLs were identified, with 18 of them being stable over samplings and mapped as major QTLs. Multiple QTLs in a genome region on linkage group 4 were detected for flavedo color space value L, a, b, a/b, and juice color space value a, a/b through samplings. Carotenoid biosynthetic pathway genes pds1 and ccd4 were found within this genome region. Identification of QTLs for flavors is in process. QTLs are being validated in other mandarins. Several candidate genes are being under analysis.

(314) Development of Molecular Markers for Fresh Mandarin Flavors and Colors Using a High-throughput Goldengate Assay

Yuan Yu*
University of Florida, IFAS-Horticultural Sciences, Lake Alfred; yymmzyz@ufl.edu

Chunxian Chen
USDA–ARS, SEFTNRL, Byron, GA; Chunxian.Chen@ars.usda.gov

Jinhe Bai
USDA–ARS, USHRL, Fort Pierce, FL; Jinhe.Bai@ars.usda.gov

Anne Plotto
USDA–ARS, USHRL, Fort Pierce, FL; anne.plotto@ars.usda.gov

Elizabeth Baldwin
USDA–ARS, USHRL, Fort Pierce, FL; Liz.Baldwin@ars.usda.gov

Fred Gmitter
University of Florida, IFAS-CREC, Lake Alfred; fgmitter@ufl.edu

Volatile aromatics and carotenoids are the two major interrelated chemical components that determine citrus fruit flavors and colors. Improvement in seedlessness, flavor and color ranks high among the prioritized breeding goals for mandarin (Citrus reticulata Blanco). Given long seedling juvenility, large tree size, and associated costs in citrus breeding, trait-associated marker development and marker-assisted selection could potentially lead to a more expeditious and economical approach to these challenges. The objectives of this project were to construct high-density mandarin genetic maps and to identify single nucleotide polymorphism (SNP) markers associated with fruit flavors, colors, as well as other fruit quality traits, using an Illumina GoldenGate assay containing 1,536 BAC end sequence-associated SNPs and a population of 116 ′Fortune′ x ′Murcott′ F1, hybrids generated in the University of Florida Citrus Research and Education Center (UF-CREC) breeding program. These fruit quality traits, including fruit size and weight, seed number, juice percentage, flavedo and juice colors, sugar and acids, and juice flavors, were investigated in 2011 and 2012 harvest season. The integrated mandarin genetic map consisted of 752 SNPs on 380 marker sites, spanning 1306 cM on nine linkage groups. The SNPs sequences were blasted and aligned to the Clementine genome, and most genome sequences showed high identities between these mandarin hybrids and Clementine. The coverage of the integrated genetic map on the Clementine genome varied among nine scaffolds from 82% of scaffold 2 to 98.8% of scaffold 4. A total of 42 QTLs were identified, with 18 of them being stable over samplings and mapped as major QTLs. Multiple QTLs in a genome region on linkage group 4 were detected for flavedo color space value L, a, b, a/b, and juice color space value a, a/b through samplings. Carotenoid biosynthetic pathway genes pds1 and ccd4 were found within this genome region. Identification of QTLs for flavors is in process. QTLs are being validated in other mandarins. Several candidate genes are being under analysis.

Monday, July 28, 2014

Genetics and Germplasm 1

(201) Analysis of Ploidy, Genetic Diversity and Speciation of the Genus Aronia

Samuel G. Obae*
Stevenson University, Stevenson, MD; sobae@stevenson.edu

Mark H. Brand
Univ of Connecticut, Storrs; mark.brand@uconn.edu

Aronia is an ornamental genus with white spring flowers, red or black fruit, orange-red fall color and easy culture. Black fruited Aronia is also increasingly grown as a nutraceutical fruit crop. Great potential exists to improve ornamental and fruiting Aronia germplasm through breeding. Wild Aronia genotypes from across the native range were collected and subjected to flow cytometry and amplified fragment length polymorphism (AFLP) analysis to better understand ploidy, genetic relatedness of accessions and speciation within the genus. Eight primer combinations used generated a total of 667 fragments of which 77.8% were polymorphic. Jaccard’s similarity coefficient among accessions ranged from 0.42 to 1. Cluster analysis of the AFLP data using unweighed pair group method with arithmetic mean (UPGMA) grouped accessions into different taxonomic groups including mitschurinii, prunifolia, arbutifolia, diploid melanocarpa, tetraploid melanocarpa, and a distinct group of tetraploid melanocarpa accessions from the southern extreme of its range. These southern, black fruited, glabrous genotypes...
may represent a new species of Aronia. Diploid melanocarpa accessions were all from New England states, while melanocarpa found outside of New England were all tetraploid and mostly originating from states bordering the Great Lakes. Arbutifolia and prunifolia accessions were tetraploid. A single triploid prunifolia and melanocarpa accession were also identified. The large-fruited, large-leaved accessions, typical of those used in commercial fruit production, all grouped as mitshurinii, further confirming the intergeneric hybrid nature of this taxa and the need to separate it from melanocarpa taxonomically.

Specified Source(s) of Funding: SARE Program-USDA-NIFA, Project# LNE09-281

(202) Assessment of Genetic Diversity of Sweetpotato (Ipomoea batatas L.) In Puerto Rico

Dimuth Siritunga*
University of Puerto Rico, Mayaguez; dimuths@hotmail.com

Lorraine Rodriguez
University of Puerto Rico, Mayaguez; lorraine1069@gmail.com

Sweetpotato (SP) is the seventh most important food crop after maize, wheat, rice, barley, potato and cassava. Due to its many agricultural advantages, such as adaptability to different environmental conditions and its nutritional value, research endeavors in sweetpotato are increasing. SP in Puerto Rico (PR) is poorly understood and there is a need to assess its diversity, especially since most are cultivated and maintained by farmers. A total of 155 samples were analyzed with 23 SSR markers using a fluorescent PCR technique. As a comparison we included known SP varieties from PR and the USDA SP germplasm collection. The analysis revealed a total of 205 alleles, with an average of 8.9 alleles. Overall average Ho (0.637) was high across populations while measurements of Ht (0.731) revealed a large genetic diversity throughout the populations. Two main clusters were depicted using UPGMA clustering method. Cluster I contained 19 unknown accessions from across the island while cluster II had the majority of unknown samples as well as the known accessions from PR and USDA. Cluster II was subdivided into 4 smaller sub-clusters. We conclude that there is a high level of genetic diversity across PR which can be related to genetic makeup of SP, the ability to be vegetatively propagated, human intervention and the outcrossing nature of SP. High levels of genetic diversity found in PR and the history of domestication and dispersal of SP makes it an extremely valuable resource that needs to be protected and further studied.

(203) Black Raspberry Fruit Composition from Seedling Populations Planted at Multiple Locations

Penelope Perkins-Veazie*
North Carolina State University, Kannapolis; penelope_perkins@ncsu.edu

Gina Fernandez
North Carolina State University, Raleigh; gina_fernandez@ncsu.edu

Christine M. Bradish
North Carolina State University, Raleigh; cmbradis@ncsu.edu

Guoying Ma
North Carolina State University, Kannapolis; gma@ncsu.edu

Joseph C. Scheerens
Ohio State Univ-ORADC, Wooster; scheerens.1@osu.edu

Courtney A. Weber
Cornell University, Geneva, NY; caw34@cornell.edu

Chad E. Finn
USDA-ARS, HCRU, Corvallis, OR; chad.finn@ars.usda.gov

Nahla Bassil
USDA-ARS, NCGR, Corvallis, OR; nahla.bassil@ars.usda.gov

Jill M. Bushakra
USDA-ARS, NCGR, Corvallis, OR; jill.bushakra@ars.usda.gov

As part of a USDA NIFA-SCRI grant, black raspberry seedlings were planted in multiple locations in the U.S. to establish suitable germplasm for expanded processed and fresh market production. Fruit were harvested from Ohio, New York, Oregon and North Carolina. Total anthocyanin, phenolic content, soluble solids, and titratable acidity were determined for 72 sets of seedlings from the four locations. Soluble solids content ranged from 9.2% to 10.8% and titratable acidity from 0.93% to 1.30% malic acid. Total anthocyanins ranged from 330 to 610 mg/100 g cyanidin 3-glucoside equivalents and 315 to 364 mg/100 g gallic acid equivalents. Fruit from New York were higher in total anthocyanin and phenolic content than those from North Carolina or Ohio. North Carolina fruit averaged 46.2% glucose, 53.5% fructose, and 0.3% sucrose. Data from this first harvest year had a strong negative correlation of acidity to total anthocyanin and phenolic content. Fruit from the Oregon location were consistently less acid and higher in total anthocyanin and phenolic content than those from the other locations.

(204) Morphological Characterization of Soursop (Annona muricata L.) Germplasm Cultivated in Colima, Mexico

Jesús Alberto Ortiz-López
Universidad de Colima, Tecomán, Colima; jess_ortilop@hotmail.com

Jaime Molina-Ochoa*
Universidad de Colima, Coordinación General de Investigación Científica, Tecomán, Colima; jmolina18@hotmail.com

Miguel Ángel Manzanilla-Ramírez
Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias, Tecomán, Colima; manzanilla.miguel@inifap.gob.mx

Luis Martín Hernández-Fuentes
Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias, Apartado Postal 100; hernandez.luismartin@inifap.gob.mx

John E. Foster
University of Nebraska, Lincoln; jfoster@unl.edu

Soursop (Annona muricata L.) is tropical fruit tree species belonging to the family Annonaceae. It is an underutilized tropical fruit tree species...
species in Mexico; it is mostly confined to small orchards or home gardens. Despite the importance of soursop, the collection, morphological characterization and improvement of its germplasm is reduced in Mexico. The objective of this study was to identify morphological variation of the varieties cultivated in Colima, Mexico. Orchards located in the municipality of Tecoman, Colima were sampled. Fruit random samples were collected from three representative soursop orchards. Fifteen fruit morphological characters were recorded, and the data were analyzed by ANOVA, and mean characters were separated by Tukey test \( (P \leq 0.05) \). Statistical differences were obtained for most of the fruit characters evaluated. Significant morphological variation was observed between varieties. Three varieties were well distinguished, the local variety called criollo, the Costa Rica variety and their hybrids. Accessions MZ1, MZ2 and MZ4 exhibited the highest fruit weights, an agronomic trait well desired by the soursop growers.

(205) Characterization of Naturalized Cacao Populations in Puerto Rico

Stephanie Cosme  
University of Puerto Rico, Mayaguez; stephanie.cosme@upr.edu

Brian Irish*  
USDA–ARS, TARS, Mayaguez; brian.irish@ars.usda.gov

Taras Oleksyk  
University of Puerto Rico, Mayaguez; dna.lab@upr.edu

Dapeng Zhang  
USDA–ARS, Beltsville, MD; ZhangD@ba.ars.usda.gov

Ricardo Goenaga  
USDA–ARS, Mayaguez; ricardo.goenaga@ars.usda.gov

Native to the headwaters of the Amazon River, cacao (Theobroma cacao L.) is an important agricultural tree crop produced in tropical regions around the world. Its raw product, the ‘beans’, is the source for the multi-billion dollar chocolate industry. The USDA–ARS Tropical Agriculture Research Station in Mayaguez, PR maintains a diverse, replicated field cacao collection consisting of close to 200 clonally propagated accessions. Although no large scale commercial production exists on the island today, Puerto Rico has a long history of cacao introduction and production. Based on anecdotal information, historical publications and data presented here, ‘old’ (>100 years) naturalized cacao trees can be found throughout the island. In addition, and based on preliminary evidence, many of the cacao trees appeared to belong to the ‘Criollo’ genetic background with unique morphological pod features and characteristic white colored beans. To confirm preliminary findings and in order to assess genetic relationships between naturalized trees and existing cacao in the TARS collection, a collection leaf samples from close to 160 trees from diverse regions on the island was carried out. DNAs from collected leaves were screened with 48 EST-derived SNP markers which had been previously assessed for their allelic range and informativeness in assessing genetic diversity in cacao germplasm. Analysis of the SNP data supported initial findings and showed that a large number of trees sampled indeed belonged to the ‘Criollo’ genetic background. In addition, other unique genetic backgrounds including trees belonging to Upper Amazon populations, Amelonado, Trinitario and hybrids among these germplasm groups were identified. The results revealed a high level of allelic and genotype diversity in the cacao samples collected from Puerto Rico. Furthermore, during sample collecting trips several trees with important agronomic traits (e.g., large pods with many large seed) were located. A subset of Criollo-background trees, as well as those with agronomic potential, are being collected and propagated to fill gaps in genetic diversity coverage in the existing TARS collection and for further evaluation.

(206) Pedigree Relationships in the University of Florida Southern Highbush Blueberry Germplasm

Catherine Cellon*  
University of Florida, Gainesville; catherinecellon@ufl.edu

Rodrigo Amadeu  
University of Florida, Gainesville; rodrigo.amadeu@usp.br

Patricio Munoz  
University of Florida, Gainesville; pmdelvalle@gmail.com

James W. Olmstead  
University of Florida, Gainesville; jwolmstead@ufl.edu

The blueberry breeding program at the University of Florida (UF) currently uses a phenotypic recurrent selection strategy for trait improvement. This results in overall genetic improvement of the population, but gains are typically slow with the selection cycle ranging from 10 to 15 years. Choosing superior parents at an earlier stage could result in improved gain from selection, especially for low heritability traits. Best linear unbiased prediction (BLUP) analysis is being used with great success in the animal breeding industry for parental selection. BLUP analysis uses available pedigree information to estimate additive breeding values which can be used to more effectively select parents. We used pedigree information dating back to 1909 to construct an A-matrix that described the genetic relationship of the UF blueberry breeding program germplasm. However, the current A-matrix model assumes disomic inheritance and doesn’t account for double reduction, which is a common phenomenon in autotetraploid species. To determine the level of double reduction, several A-matrices were constructed assuming disomic and tetrasomic inheritance. Using these matrices, we identified the most frequent genotypes in pedigrees, estimated inbreeding coefficient, and calculated the proportion of double reduction.

The mean value of the A-matrix diagonal was 1.052, when assuming a tetraploid model with no double reduction, which indicates the presence of inbreeding in the population. The three individuals most represented in the germplasm were Earliblue, Windsor, and E-30. This was the same across all matrices. The two models estimated different amounts of inbreeding, but the individuals with the highest level of inbreeding were the same in both models. We are collecting phenotypic data for a range of traits and populations to fit a BLUP model comparing vari-
ous levels of double reduction. These analyses are necessary to enable BLUP analysis and the use of genome-wide prediction models for blueberry breeding.

Specified Source(s) of Funding: University of Florida Blueberry Breeding Program

(207) The Phylogeny of the North American Plums (Prunus Species)

Dario J. Chavez*
University of Georgia, Griffin; dchavez@uga.edu
José Chaparro
University of Florida, Gainesville; jaguey58@ufl.edu

The genus *Prunus* L. constitutes approximately 200 species distributed worldwide. Plums, cherries, almonds, apricots, and peaches belong to this genus. North America is a center of diversity for the genus *Prunus*. The phylogeny of the North American plums has been previously studied using chloroplast DNA (cpDNA) and internal transcribed spacer regions (ITS) sequences. However, phylogenetic studies based solely on cpDNA information could be biased due to hybridization among *Prunus* species. The objective of this research was to use nuclear markers and cpDNA to recognize possible incongruence events and to improve the knowledge of the phylogenetic relationships of these species. The University of Florida Stone Fruit Breeding and Genetics Program in collaboration with the National Germplasm Repository and USDA–ARS (Project No. 5306-21000-018-00D) collected and identified 408 accessions of 35 taxa from the wild. Approximately 62 amplicons representing cpDNA, and enzyme, branching and dormancy related genes, were sequenced and studied for a core collection of 13 species representing section *Prunocerasus*. Out of those, trnH-psbA, PGI, MAX4, AXR1, and LFY amplicons, were identified as having the highest frequency of potentially informative characters and the phylogenetic signal across samples within subgenus *Prunus* section Prunocerasus. A total of 105 accessions (out of the 408) representing 35 taxa, with approximately 2-3 accessions per species, were used to study the phylogeny of the North American plums using trnH-psbA, PGI, MAX4, AXR1, and LFY amplicons. Subgenus *Prunus* section Prunocerasus was represented by 14 taxa, commonly accepted as North American plums. Other groups within genus *Prunus* were represented by an additional 21 species: sect. Armeniaca (2), sect. Penarmeniaca (3), sect. *Prunus* (1), sect. Microcerasus (1) in subgenus *Prunus*; subgenus Emplectocladus (1); sect. Cerasus (5) and sect. Laurocerasus (3) in subgenus Cerasus; and subgenus Amygdalus (5) (USDA–ARS and GRIN taxonomic classifications). The use of nuclear markers improved the support for some species relationships and identified novel species relationships. Several sources of incongruence between cpDNA and nuclear genes were identified. Three major clades within section Prunocerasus were identified: the Sand clade, the American clade, and the Chickasaw clade. The Sand clade was constituted by *P. texana* and *P. geniculata*. The American clade was composed by *P. americana*, *P. alleghaniensis*, *P. mexicana*, *P. hortulana*, and *P. rivularis*. The Chickasaw clade was formed by *P. angustifolia*, *P. gracilis*, *P. maritima*, *P. munsoniana*, *P. nigra*, and *P. umbellata*.

Specified Source(s) of Funding: USDA–ARS Project No. 5306-21000-018-00D and the Stone Fruit Breeding and Genetics Program at University of Florida

Monday, July 28, 2014

Nursery Crops

(082) Measuring the Effect of Hand Protection on Worker Effort When Moving Small Container Plants

Scott Langlois*
Mississippi State University, Poplarville; slanglois@ra.msstate.edu

Manual laborers working in various segments of the agriculture industry are subjected, due to the nature of the work, to various job related hazards. The leading causes for these injuries are musculoskeletal disorders (MSD). Generally, these MSDs are categorized into one of several classes; lifting heavy loads, repeated bending/stooping or repetitive hand work. We can find potential causes of these three injury classes in many nursery/greenhouse processes. The manual movement of small container grown plants requires significant stooping and can cause fatigue, specifically in arm and shoulder areas. This study was conducted to ascertain the level at which particular forearm and shoulder muscles were used during small container movement processes while wearing different levels of hand protection. The sizes of containers included in the study were one and three gallon; based on the prevalence of these two common pot sizes at nurseries specializing in small (less than seven gallon) container production. Typically, these containerized plants are moved multiple times during their life cycle at a nursery. Glove use by workers during these container movement processes is inconsistent and the style of glove chosen varies greatly. Four different levels of hand protection (no glove, thin nitrile, leather and a grip-assist glove) were combined with three different weighted container combinations (single one gallon pot in each hand, single three gallon pot in each hand and double one gal pots in each hand). Surface Electromyography (EMG) readings were taken at 12 different muscle locations on the forearms and shoulders of study participants while performing normal container moves. Each container move was made from ground level to a trailer/wagon height at a distance of 20 feet. Mean and peak EMG readings were compared across the treatments to identify significant differences in muscle activation. Reduced muscle activation would mean that the worker is expending less energy and may correlate with reduced fatigue over time. Post trial psychometric surveys were administered to gauge worker preference and perception of glove impact compared to actual EMG readings. Results showed a correlation between glove preference and reduced muscle activity. Study participants generally preferred a thinner or grip-assist glove for most of the container movement scenarios. The thicker glove resulted in muscle use levels aligned with worker perception of an increased effort requirement across most container combinations.

An asterisk (*) following a name indicates the presenting author.

Monday, July 28, 2014
(083) Improving Spray Quality and Disease Control with a Laser-guided Air-assisted Sprayer for Multi-row Nursery Production

Diana Cochran  
University of Tennessee, Knoxville; dcocrrl1@utk.edu

Amy F. Fulcher*  
University of Tennessee, Knoxville; afulcher@utk.edu

Heping Zhu  
USDA–ARS, Wooster, OH; heping.zhu@ars.usda.gov

In Tennessee, nursery producers often maximize production areas by planting 4 or more rows in a block. While this increases the production area it can affect pesticide spray deposition quality and pest control. Nursery producers can choose from many sprayer types depending on target application. Typically, air-assisted sprayers are preferred when applying fungicides and insecticides to field crops. Conventional air-assisted sprayers can be used if there are no concerns for excess pesticide use and/or drift; however, this is increasingly not the case as negative effects of non-point source pollution have become more widely recognized and pesticide costs have increased. The objective of this experiment was to compare spray coverage, spray drift reduction and powdery mildew control in multi-row nursery blocks between a newly developed air-assisted sprayer guided with a laser scanning sensor, which was designed to control spray outputs to match canopy structures and greatly reduce pesticide application volume, and a conventional Tifone Storm 1500 air-assisted sprayer. The experiment was conducted at Walker Nursery, Morrison, TN. Prior to initiation of the experiment early symptoms of powdery mildew were scouted weekly. At the first sight of symptoms, Cornus florida ‘Cherokee Princess’ trees were rated and spray comparison tests were initiated. On day of application, 2 sets (1 set = 2 cards back to back) of water sensitive cards were placed in 5 trees per replication per treatment (n = 120 cards); one set was used to record spray drift and the second was used to document spray coverage. The experiments were conducted using a randomized complete-block design. Percent spray coverage was 43.5%, 30.7%, and 17.4% in trees sprayed using the conventional sprayer compared with 15%, 10.7%, and 5.5% coverage from the laser-guided sprayer, for the three spray dates. Drift created by the conventional sprayer was greater than drift from the laser-guided sprayer at each application date. Overall, powdery mildew ratings were not different with the exception of the third week following the first application. Powdery mildew was generally no different on trees in the interior of the block from exterior rows indicating the sprayers penetrated the interior of the block equally well. Younger leaves had lower levels of powdery mildew than the oldest leaves for the first 7 weeks of the study. These results indicate that growers with multi-row production blocks can potentially benefit from laser-guided technology by reducing pesticide use and spray drift without sacrificing plant quality.

(084) Impact of Cyclic Irrigation Timing on Plant Growth and Daily Water Use in Eastern

Redbud Grown in a Pot–in–Pot Container Nursery

Susmitha Nambuthiri  
University of Kentucky, Lexington; ssnamb2@uky.edu

Robert L. Geneve*  
University of Kentucky, Lexington; rgeneve@uky.edu

Dewayne L. Ingram  
University of Kentucky, Lexington; dingram@uky.edu

Current best management practices recommend single irrigation to occur during early morning hours to reduce drift and evaporative loss of water for container grown nursery plants. A pot-in-pot (PIP) study was conducted at the University of Kentucky Horticulture Research Farm in Lexington, KY to evaluate optimal timing of daily cyclic irrigation in eastern redbud (Cercis canadensis ‘Forest Pansy’) growth and daily water use. Liners were grown in either 7-gallon or 15-gallon containers filled with 85% pine bark: 15% peat (vol/vol) in PIP systems in a completely randomized experiment design. Substrate moisture content was continuously monitored using EC5 (Decagon, IL) moisture sensors inserted into three representative containers per irrigation treatment. Irrigation was scheduled to replace 100% daily water use applied in three equal amounts and applied at the following times: cyclic irrigation starting at (i) 7, 8, and 9 am; (ii) 12, 1, and 2 pm; or (iii) at 5, 6, and 7 pm. Water use was approximately double in plants grown in 15-gal containers compared to 7-gal containers. The timing of cyclic irrigation impacted total and daily use in 7-gal, but not 15-gal containers. In the 7-gal containers, the least amount of water was used in the 7AM cyclic irrigation schedule. Containers required greater irrigation volumes when irrigation was scheduled at noon (19%) and at 4PM (5%) compared to the 7AM irrigation. Plant physiological measurements as well as plant water status were collected just before the start of cyclic irrigation event and it varied on an average from about 9 μmol·m·2·s-1 of CO₂ in the morning to 11 μmol·m·2·s-1 of CO₂ in the noon and to 13 μmol·m·2·s-1 of CO₂ in the afternoon irrespective of irrigation timing. Sap flow varied from about 23 cm/hr in the morning and to 54 cm/hr in the afternoon for plants grown under various irrigation treatments. Leaf water potential became more negative as day progresses irrespective of cyclic irrigation timing as observed right before the morning (~7 kPa), noon (~16 kPa) and afternoon irrigation (~22 kPa) events. The study highlights the water savings under sensor based cyclic irrigation and that when water is not limiting, environmental variables such as air temperature, relative humidity and solar radiation are more closely coupled to changes in plant physiological characteristics and water status.

(085) Growth and Root Characteristics of Trees in Three Northern Nursery Production Systems

Catherine Neal*  
University of New Hampshire, Durham; cathy.neal@unh.edu

Amy Papineau  
University of New Hampshire, Boscawen; amy.papineau@unh.edu

In three northern nursery production systems in New Hampshire, Maine, and Vermont, the use of sensor-based cyclic irrigation (SCIR) was compared with conventional irrigation (CIR) for planted container-grown small trees. Two nursery production systems in New Hampshire used both 3-gal, 7-gal, and 15-gal systems, while a third nursery site in central Vermont only used 3-gal and 7-gal systems. Irrigation schedules were based on sensor outputs to match canopy structure and reduce pesticide and water use. Percent water use was double in the 7-gal and triple in the 15-gal container compared with 3-gal containers. The timing of cyclic irrigation impacted total and daily use in the 7-gal, but not 15-gal containers. In the 7-gal container, the least amount of water was used in the 7 AM cyclic irrigation schedule. Liners were grown in either 3-gal, 7-gal, 15-gal containers filled with 85% pine bark: 15% peat (vol/vol) in PIP systems in a completely randomized experiment design. Substrate moisture content was continuously monitored using EC5 (Decagon, IL) moisture sensors inserted into three representative containers per irrigation treatment. Irrigation was scheduled to replace 100% daily water use applied in three equal amounts and applied at the following times: cyclic irrigation starting at (i) 7, 8, and 9 am; (ii) 12, 1, and 2 pm; or (iii) at 5, 6, and 7 pm. Water use was approximately double in plants grown in 15-gal containers compared to 7-gal containers. The timing of cyclic irrigation impacted total and daily use in 7-gal, but not 15-gal containers. In the 7-gal containers, the least amount of water was used in the 7 AM cyclic irrigation schedule. Containers required greater irrigation volumes when irrigation was scheduled at noon (19%) and at 4PM (5%) compared to the 7 AM irrigation. Plant physiological measurements as well as plant water status were collected just before the start of cyclic irrigation event and it varied on an average from about 9 μmol·m·2·s-1 of CO₂ in the morning to 11 μmol·m·2·s-1 of CO₂ in the noon and to 13 μmol·m·2·s-1 of CO₂ in the afternoon irrespective of irrigation timing. Sap flow varied from about 23 cm/hr in the morning and to 54 cm/hr in the afternoon for plants grown under various irrigation treatments. Leaf water potential became more negative as day progresses irrespective of cyclic irrigation timing as observed right before the morning (~7 kPa), noon (~16 kPa) and afternoon irrigation (~22 kPa) events. The study highlights the water savings under sensor based cyclic irrigation and that when water is not limiting, environmental variables such as air temperature, relative humidity and solar radiation are more closely coupled to changes in plant physiological characteristics and water status.

An asterisk (*) following a name indicates the presenting author.
Three tree species (Betula nigra, Quercus bicolor, and Malus ‘Prairie Fire’) were grown for two seasons from bare root stock in field, below-ground fabric container (FC), and pot-in-pot (PiP) production systems in USDA hardiness zone 5b. Increase in height and trunk caliper were nsd between production systems except for Betula nigra, where FC and PiP trees were smaller than field-grown trees. Root defects (circling, descending, bent roots) were minimal in field trees and most severe in PiP trees. Clean roots were separated into fine, small, medium and large size classes by diameter and dried at 38 °C to 48 °C. Total root biomass was nsd between production methods for Malus and Quercus. Root mass was significantly greater and the root:shoot ratio was greater in PiP than field or FC for Betula. Multivariate logistic regressions were used to compare root class proportions. PiP trees of all three species of had significantly greater proportions of small roots and less medium and large roots than the other treatments. Differences between FC and field grown trees were nsd for Quercus. Betula had a greater proportion of root mass in small to medium roots in FC compared to field, but FC Malus had a greater proportion of root mass in large roots compared to field.

Specified Source(s) of Funding: USDA-NIFA and the NH AgExpt. Station provided funding for this research

(086) Container Plant Species Water Use

Tom Yeager*
University of Florida, Gainesville; yeagert@ufl.edu

Jeff Million
University of Florida, Gainesville; jmillion@ufl.edu

Irrigation Best Management Practices for container plant production indicate that plant species should be grouped according to water needs. Current recommended grouping is primarily based on opinions from producers. Objective comparisons in water usage between species are often confounded by variable plant sizes and container spacings that existed during measurements. The objective of this research was to compare ET rates of plant species with containers spaced to achieve full canopy coverage. We evaluated uniform and marketable-sized plants grown in trade #3 (approximately 10-L) containers filled with pine bark-based substrates at nurseries in Florida and Virginia. The plant species tested included Ilex cornuta ‘Burfordii Nana’, Loropetalum chinense var. rubrum ‘Burgundy’, Podocarpus macrophyllus, Raphiolepis indica ‘Alba’, Rhododendron sp. ‘Conversation Piece’, Rosa sp. Sunrosa® Pink, and Viburnum odoratissimum in Florida and Berberis thunbergii f. atropurpurea ‘Rose Glow’, Gardenia jasminoides ‘Frostproof’, Hydrangea paniculata Pinkie Winky™, Rhododendron sp. ‘Girard’s Crimson’, Spiraea japonica ‘Tracy’ (Double Play® Big Bang), and Weigela florida Wine & Roses® in Virginia. Nineteen plants of each species were arranged in an offset pattern (hexagonal) and spaced to achieve full canopy coverage of the production area. Seven interior plants were weighed after irrigation and again 24 hours later. ET (cm) on an area basis was calculated as the difference between the wet and dry weights (cm³) divided by the area allotted each container (cm²). In Florida, ET ranged from 0.77 cm for Podocarpus to 1.22 cm for Viburnum and ET of Viburnum greatly exceeded the ET of the other six species. In Virginia, ET ranged from 0.74 cm for Rhododendron to 1.15 cm for Berberis and ET of Berberis greatly exceeded the ET of the other five species. Excluding Berberis and Viburnum, differences in ET of 0.16 and 0.31 cm were determined for species tested in Virginia and Florida, respectively. These differences are probably not significant considering the overhead sprinkler distribution uniformity and a common daily application rate of 0.8–1.0 cm.

Specified Source(s) of Funding: Center for Applied Nursery Research and Florida Nursery, Growers and Landscape Association

(087) Root Zone Temperatures and Growth Responses of River Birch (Betula nigra) in Five Above-ground Pot Production Systems

Amy Papineau*
University of New Hampshire, Boscawen; amy.papineau@unh.edu

Catherine Neal
University of New Hampshire, Durham; cathy.neal@unh.edu

River Birch (Betula nigra) were grown for 29 months from bare root stock in five above-ground pot production systems in USDA hardiness zone 5b. Six randomized replicates of clumped birches were grown in each pot type: standard black plastic (SO), black fabric with porous fabric bottom (SP), white fabric with nonporous fabric bottom (RT), black plastic mesh with porous fabric bottom (RBK), black plastic mesh with solid plastic bottom (RBS). Pots were left in the field over winter with no additional protection. Root zone temperatures were logged every 30 minutes in two pots of each type; sensors were placed 4” deep and 1” inside the pot wall in the southwest direction. SO experienced the most extreme high root zone temperatures, accumulating 140 hours above 40.6 °C while SP logged no hours above the same threshold. RBK and RBS logged the most cold root zone temperatures, accumulating an average of 76 hours below –12.2 °C while SP logged only 16 hours below –12.2 °C. Average daily temperature fluctuations were most extreme in black plastic pots (SO, RBK, RBS) with a maximum daily fluctuation of 46.0°C and average daily fluctuation of 14.4 °C, compared to black and white fabric pots (SP, RT) with a maximum daily fluctuation of 29.3 °C and an average daily fluctuation of 9.2 °C. Increases in tree height were significantly different with SP and RBK having greater increases than RBS and RT. Total stem calipers at termination were significantly different, with SP and RBK larger than RBS. At termination, top fresh and dry weights were significantly greater for SP and RBK than RT and RBS. SO trees were intermediate for all growth responses. SP had few visible root defects when removed from the container but air-spading exposed sub-surface defects and there was no difference between SP, RT, and RBS in final root calipers.
(088) Early Rooting Response of Choke Cherry Seedlings to a Commercial Extract of the Marine Alga Ascophyllum nodosum

Jeffrey E. MacDonald
Natural Resources Canada, Canadian Forest Service–Atlantic Forestry Centre, Fredericton, NB; jomacdon@nrcan.gc.ca

Elizabeth Mills
Natural Resources Canada, Canadian Forest Service–Atlantic Forestry Centre, Fredericton, NB; elmills@nrcan.gc.ca

Will Neily*
Acadian Seaplants Ltd., Cornwallis, NS; wneily@acadian.ca

Choke cherry (Prunus virginiana L.) is an ecologically important species in the reclamation of Canada’s oil sands because of its extensive lateral root system that readily suckers and thus quickly creates dense thickets. Consequently, choke cherry provides rapid site occupancy that re-establishes nutrient cycling and prevents erosion, as well as providing food, shelter, and nesting for wildlife. Our goal is to increase root growth after spring planting on reclamation sites by improving seedling root system quality. As increased rooting during seedling establishment has been reported in various horticultural nursery crops treated with Ascophyllum nodosum (L.) Le Jolis extract (ANE), we hypothesized that ANE applications would create a well-developed root system in young choke cherry seedlings. We present results from the initial phase of the study here. The objective of this phase was to determine whether and, at what rate, ANE would increase rooting in choke cherry seedlings during the establishment phase of containerized culture. We transplanted germinants from two Alberta seedlots, arising from a study to improve germination of choke cherry seed, to individual cells of the Ray Leach “Cone-tainer” Single Cell System filled with 1:1 peat:vermiculite media. Trays with cells were placed in a Conviron walk-in chamber maintained at 25 °C / 20 °C (day/night) under a 16-h photoperiod at a relative humidity of 85%. After a 2-week acclimation period to chamber conditions, we applied ANE in deionized water twice at the following rates: 0 ml/L, 0.25 ml/L, 0.5 ml/L, 1.0 ml/L, and 2.0 ml/L. Two irrigations with dechlorinated water separated the ANE applications. One week after the second application, we harvested seedlings and washed roots free of media. Then, we counted secondary and tertiary roots and measured lengths of secondary roots. Root system morphology of both seedlots was affected by ANE application, but there were seedlot differences. For the seedlot that was more responsive to ANE, secondary roots were longer and tertiary roots were more numerous in response to the 0.25- and 0.5-ml/L rates compared with 0.0- and 1.0-ml/L rates. Although the 2.0 ml/L rate increased the number of secondary roots compared with the other rates, they were shorter and lacked tertiary roots.

(089) Changes in Chemical and Physical Properties of Soilless Potting Mixes Amended with Composted Dairy Manure of Varying Maturities

Anne J. Knerr
University of Idaho, Moscow, ID; jenny.knerr@wsu.edu

Robert R. Tripepi*
University of Idaho, Moscow, ID; btripepi@uidaho.edu

Horticultural grade bark and peat moss traditionally comprise the primary components of soilless potting mixes used for nursery stock production, but due to their increased costs and questions of renewability, growers have shown interest in using composted dairy manure as a medium component. To address concerns about its suitability, dairy manure was collected during 9 months of composting, with samples taken at 10 days (0), 3, 6, and 9 months. Soilless potting mixes consisting of bark (90, 60, or 30% softwood bark by volume) and sand (10% for each mix) were amended with 0%, 30%, or 60% compost, respectively, and these three media were made for each age of composted manure. Initial physical and chemical properties of these different potting mixes were determined. Initial air capacity of the mixes was unaffected by the amount of compost in the mix, regardless of the compost maturity. In contrast, initial water-holding capacity and total porosity were significantly affected by the amount of compost added, but remained within or very close to the acceptable ranges for a growth medium. Initial available K, P, B, extractable Cl, NO₃, N, and SO₄-S increased from 1.2-fold to 43-fold, depending on the nutrient and age of the compost. Initial electrical conductivity (EC) of the mixes increased from ~ 2.2 dS·m⁻¹ in control mixes to ~ 25 dS·m⁻¹ in the 60% compost amended mixes for the 3, 6, and 9 month composts. Initial pH of the mixes containing 60% compost also averaged ~ 8.1 for these three ages of compost. In contrast, initial C:N ratios of control mixes was ~71, whereas the mean initial C:N ratios of 60% compost media made with 3, 6, or 9 month composts was ~ 17.6. These results indicated that dairy manure composted 3, 6, or 9 months can have minimal effects on potting mix physical properties but can drastically increase mineral levels and alter salt and pH properties of the mixes, depending on the amount of compost added to the mix.

Specified Source(s) of Funding: United Dairymen of Idaho, Idaho Department of Agriculture, and Idaho Agricultural Experiment Station

(090) In Vitro Propagation, Not Plant Growth Regulators or Pruning, Increases Branch Number, Canopy Density, and Visual Plant Quality in Clethra alnifolia ‘Hummingbird’

Whitney M. Yeary
University of Tennessee, Knoxville; wmcnutt1@utk.edu

Amy F. Fulcher*
University of Tennessee, Knoxville; afulcher@utk.edu

Woody ornamental plants are more marketable when plants have...
symmetrical, well-branched canopies. Pruning or plant growth regulators (PGRs) are often used to modify growth and increase branching and canopy density. However, pruning is time consuming, labor-intensive, and expensive and PGRs do not always perform consistently. Some evidence supports that in vitro propagation (IVP) produces plants with denser canopies than cutting-propagated (CP) plants. The purpose of this study was to determine if pruning, PGRs or IVP produced the most well-branched, symmetrical canopies. Augeo® (dikegulac sodium) at 800-ppm, Configure® (benzyladenine) at 600 ppm, Topflor® (flurprimidol) at 150 ppm, water or a pruning treatment were applied to both CP and IVP Clethra alnifolia ‘Hummingbird’. Symmetry, branch number, density (branch number per unit of height), phytotoxicity, and quality were assessed. Experiments were conducted using a completely randomized design with 10 single plant replications. No treatment improved symmetry of any plant species. Pruning and, in general, PGRs were ineffective at increasing branch number, density, or plant quality. IVP clethra had 92% and 78% more branches and were 100% and 81% denser than CP plants at the initiation of the study in 2012 and 2013, respectively. At 12 WAT, IVP plants continued to have more branches by 51% and 39% and were denser by 58% and 41% in 2012 and 2013, respectively. Phytotoxicity symptoms were observed on Augeo-treated plants at 2 weeks after treatment (WAT), but by 4 WAT, phytotoxicity symptoms were not detected. IVP plants had a higher quality than CP plants by 74% and 18% in 2012 and 2013, respectively. Growers who purchase IVP clethra instead of cuttings, may acquire dense, well-branched, high quality plants with no inputs, and thus less cost. IVP, not PGRs or pruning, increases branch number, canopy density, and visual plant quality in Clethra alnifolia ‘Hummingbird’.

Specified Source(s) of Funding: University of Tennessee Institute of Agriculture, IR-4

(091) Characterizing Spray Penetration Following Insecticide Application in Dense and Sparse Oakleaf Hydrangea ‘Alice’

Amy F. Fulcher*
University of Tennessee, Knoxville; afulcher@utk.edu
Whitney M. Yeary
University of Tennessee, Knoxville; wmcnutt1@utk.edu
Heping Zhu
USDA–ARS, Wooster, OH; heping.zhu@ars.usda.gov

Nursery crop producers often rely on pesticides to manage arthropod pests. However, cultural practices can influence plant architecture which may, in turn, affect pesticide penetration and pest control. The objectives of this study were to examine spray penetration in dense and sparse canopies and assess if canopy density affects beneficial insect survival following insecticide application with the goal of better understanding the implication of canopy density on pest management for select container-grown plants. To characterize spray penetration, water sensitive cards were placed on the exterior, middle and interior of oakleaf hydrangea ‘Alice’ (Hydrangea quercifolia ‘Alice’) plants with dense or sparse canopies. The exterior position served as a check to ensure that both canopy types received the same amount of coverage. Water was applied with a CO₂ sprayer and cards were analyzed for percent coverage and droplet density using DepositScan software. These results were compared to the outside control to get the percentage of the maximum coverage and droplet density received. The dense and sparse middle positions only received 2% and 17% coverage, respectively, of the total coverage applied. The interiors received 1% and 5% coverage of the maximum, respectively. In the dense canopy, middle and interior coverage was not different, but in the sparse canopy, the interior positions received 71% less coverage of the maximum than the middle position, making the interior more protected from spray than the exterior. Percent of maximum droplet density paralleled that of coverage. The middle positions received 3% and 26% of the maximum for dense and sparse canopies, respectively, and the interior positions received 3% and 14% of the maximum. Again, the middle and interior position of dense hydrangea canopies were not different; however the sparse interior received 46% less droplet density of the maximum than the sparse middle and was not different than the dense middle and interior. In this study, spray coverage in the interior of plants was low regardless of plant architecture indicating that the interior of a plant may not be sufficiently penetrated for adequate arthropod control but may serve as a refugium for beneficial insects.

Specified Source(s) of Funding: University of Tennessee Institute of Agriculture

(092) Development of Shoot Architecture of Ligustrum japonicum Thunb. in Response to Soil Moisture

Dilma Daniela Silva
University of Florida, MREC, Apopka; dilma@ufl.edu
Richard C. Beeson*
University of Florida, Apopka; rbeeson@ufl.edu

Bud outgrowth dynamics and their implications for shoot architecture were examined in plants under well-irrigated (SC) and water-limitation (LC) conditions. Plants of Ligustrum japonicum from 11.4 L containers were transplanted into elevated rhizotrons. Treatments consisted of two irrigation frequencies, once a week for 10 minutes (12 L of water, long wet/dry cycle - LC) and every other day for 5 minutes (6 L of water, short wet/dry cycle - SC), with 12 replications each. Growth of shoots was monitored weekly. Plants were not pruned. Neoformed buds had limited sensitivity to dormancy, while preformed buds required more than one growing season to outgrow naturally. First spring shoot flush was mostly due to lateral bud outgrowth, while latter flushes had prominent contributions of neoformed apex bud outgrowth. First-order terminal branches had mainly determinate growth. First-order lateral branches had increased...
occurrence of indeterminate growth. Water limitation influenced shoot architecture by enhancing apical dominance. Lateral branching was diminished 51% in LC plants compared with SC plants. As plants adapted to imposed stress by additional root growth, indeterminate growth was triggered more often in meristematic regions of terminal buds. Old buds burst more frequently than the newly formed apex lateral bud of stressed plants after substantial root growth. Plants under SC had relatively uniform and compact canopies, while plants under LC had considerably less new branches, which were mostly excessively long that would require pruning.

**Physical and Chemical Properties of Peat-based Substrate as Affected by Volcanic Cinder Amendment**

Archana Pant  
University of Hawaii at Manoa, Honolulu; apant@hawaii.edu  
Hye-Ji Kim*  
University of Hawaii at Manoa, Honolulu; hkim2@hawaii.edu

Utilizing locally available materials to create potting mix is vital for sustainable production of ornamental crops. Volcanic cinder is the most commonly used substrate in Hawaii because it is inexpensive, inert and highly porous, and thus provides good drainage for plants. Experiment was conducted to characterize the physical and chemical properties of the substrates formulated by blending either 0%, 25%, 40%, 50%, 60%, 75%, or 100% (by volume) volcanic cinder and peat-moss as compared to commercial potting mix (75% peat-moss and 25% perlite). All substrates containing cinder had higher bulk density than that of 100% peat-moss (0.14 g/cm³) or commercial potting mix (0.12 g/cm³). The bulk density increased with higher percentages of cinder ranging from 0.22 g/cm³ with 25% cinder to 0.43 g/cm³ with 100% cinder. Total porosity was high in both 100% peat-moss (74%) and commercial potting mix (65%) compared to the substrates formulated with cinder, and significantly decreased with higher percentages of cinder. The water holding capacities of both 100% peat-moss (53%) and commercial potting mix (52%) were high compared to the substrates created with cinder, and higher percentages of cinder significantly decreased water holding capacity. Air-filled porosity was high in 100% cinder (33%) followed by 100% peat-moss (21%), while it was similar for the substrate with 25% cinder (14%) and commercial potting mix (13%). Electrical conductivity (EC) was higher in commercial potting mix compared to 100% peat-moss and decreased when higher percentages of cinder were mixed. Similarly, the pH was also higher in potting mix (5.23) compared to 100% peat-moss (4.09), but increased with higher percentages of cinder. These results suggest that inclusion of cinder in the substrate may provide optimum water holding capacity, better drainage and air-filled pore space as did perlite in commercial potting mix. The proper ratio of cinder to peat-moss should be determined based on the irrigation and drainage requirements of the specific crop.
We evaluated the poultry litter pyrolysis co-product biochar as a potential phosphorus (P) fertilizer source and overall soil amendment for the Mid-Atlantic’s fresh market tomato industry. Mid-Atlantic soils utilized for vegetable production are typically sandy loam soils with low organic matter, low water holding capacity, and a low cation exchange capacity. After pyrolysis, any concerns regarding bacterial contamination in growing fresh vegetables is eliminated and biochar retains high concentrations of P, nitrogen (N), and potassium (K). We tested biochar in a 2 P source (biochar and inorganic P fertilizer) × 3 P rate (biochar at 8,961, 17,922, and 26,884 kg·ha⁻¹) factorial arrangement in a randomized complete-block design using alpha = 0.10. Yield and aboveground biomass production were used for treatment comparison. In 2011, marketable tomato yield increased as biochar rate increased. However, salt injury reduced yields and plant biomass in 2012. Farmers need to consider quality of biochar when selecting soil amendment products. More research needs to be completed to fully understand the potentials and problems with using co-products in the marketplace and Mid-Atlantic crop productions systems.

Specified Source(s) of Funding: National Fish and Wildlife Foundation

**Effects of No-tillage and Improved Fertilizer Management on Corn Yield and Soil N₂O Emission in Middle Tennessee**

Qi Deng
Tennessee State University, Nashville; qdeng@tnstate.edu

Dafeng Hui*
Tennessee State University, Nashville; dhui@tnstate.edu

Junming Wang
Center of Atmospheric Science, Illinois State Water Survey, University of Illinois at Urbana-Champaign; wangjim@illinois.edu

Tigist Jima
Tennessee State University, Nashville; fiametat@yahoo.com

Stephen Iwuozo
Tennessee State University, Nashville; siwuozo@my.tnstate.edu

Chih-Li Yu
College of Agriculture, Human and Natural Sciences, Tennessee State University, Nashville; e390701@gmail.com

David Smart
University of California, Davis, CA; drsmart@ucdavis.edu

Suping Zhou
Tennessee State University, Nashville; zsuping@tnstate.edu

Chandra Reddy
Tennessee State University, Nashville; creddy@tnstate.edu

Sam Dennis
Tennessee State University, Nashville; sdennis@tnstate.edu

While the use of no-tillage and improved fertilizer management are proposed as effective ways to enhance corn yield and reduce greenhouse gas emission, their effects remain controversial and the related influencing factors are not well understood. We conducted a field experiment to study the responses of corn yield and N₂O emission to various management practices in middle Tennessee. The management practices include no-tillage + regular applications of urea ammonium nitrate (NT-urea); no-tillage + regular applications of urea + denitrification inhibitor (NT-inhibitor); no-tillage + regular applications of urea + biochar (NT-biochar); no-tillage + 20% applications of urea + chicken litter (NT-litter), no-tillage + split applications of urea (NT-split); and conventional tillage + regular applications of urea as a control (CT-urea). Fertilizer equivalent to 217 kg·ha⁻¹ of N was applied to each of the experimental plots. The experiment used a randomized complete block design with six replications. Results showed that fertilizer management had no significantly effect on corn yield. However, no-tillage (NT-urea) significantly increased corn yield—by 47%—over the conventional tillage (CT-urea). Corn yield tends to be positively related to water filled pore space (WFPS) and negatively related to soil inorganic N (NH₄⁺-N and NO₃⁻-N) across all treatments. Soil N₂O emission was significantly influenced by no-tillage and fertilizer management. The highest cumulative N₂O release from soil occurred in the CT-urea (20.55 kg·ha⁻¹ of N₂O), which was significantly higher than those in the NT-urea (12.92 kg·ha⁻¹ of N₂O) and NT-litter (12.31 kg·ha⁻¹ of N₂O) treatments, and much higher than those in the NT-inhibitor (6.85 kg·ha⁻¹ of N₂O), NT-biochar (4.25 kg·ha⁻¹ of N₂O) and NT-split (8.66 kg·ha⁻¹ of N₂O) treatments. Significant exponential relationships between N₂O emission rate and WFPS were detected in all treatments. Variation in N₂O emission among the treatments was positively correlated with its moisture sensitivity. The emission of N₂O at yield scale showed similar patterns as the N₂O emission. It was the highest in the CT-urea (2.51 kg/ton of N₂O), relatively low in the NT-inhibitor (1.00 kg/ton of N₂O) and NT-biochar (0.87 kg/ton of N₂O), and intermediate in the NT-split (1.47 kg/ton of N₂O), NT-urea (1.97 kg/ton of N₂O) and NT-litter (1.47 kg/ton of N₂O) treatments. Our results indicated that the use of no-tillage and improved fertilizer management could enhance corn yield due to soil water conservation, reduce N₂O emission by decreasing its moisture sensitivity, and ultimately reduce yield-scaled N₂O emission.

Specified Source(s) of Funding: USDA-Capacity Building Grant (2011-38821-30971) and Evans-Allen grants

**Camellia oleifera Abel Utilized Phosphorus from Aluminum-bound Phosphate**

Jun Yuan*
Hunan Provincial Cooperative Innovation Center of Non-wood Forest Cultivation and Utilization, Changsha; yuanjunchina@126.com

Xiaofeng Tan
Key Laboratory of Cultivation and Protection for Non-Wood Forest Trees, Ministry of Education, Central South University of Forestry and Technology, Hunan 410004; tanxiaofeng@126.com

Donglin Zhang
University of Georgia, Athens; donglin@uga.edu

Camellia oleifera Abel (oiltea) is an important woody plant for its edible oil production and has been utilized in South China.

An asterisk (*) following a name indicates the presenting author.
for more than 2300 years. In these regions, the typical soil is red clay and soil P mainly presents in a form of aluminium-bound phosphate (Al-P) and whether or not the Al-P is uptaken by oil tea is unknown. Our study had found that phosphorus deficiency significantly induced the secretion of oxalic, formic, malic and citric acids from roots. Root exudates enhanced the mobilization of plant-unavailable phosphorus in red clay and Al-P. Simulation test of phosphorus activation showed that all induced organic acids could release phosphorus from Al-P effectively and citric acid was the highest. Applications of Al-P increased the available phosphorus in rhizosphere soil significantly as Ca-P did. The seedling height, diameter at ground level, and edible oil yield increased and root/shoot ratio decreased significantly by Ca-P and Al-P treatments. Ca-P and Al-P applications increased Fv/Fm, Fv'/Fm', yield and qP. These results indicated that Al-P could be effectively utilized by oil tea plants and should be the source of available plant P under regular acid red clay. 

Specified Source(s) of Funding: Hunan Major Projects of Science and Technology (2013FJ1006) and Talent Introduction Foundation of Central South University of Forestry & Technology(2013RJ002).

(285) Influence of the Composition and Nitrogen Concentration of Fertilizer Solution on the Growth and Tissue Nutrient Content of ‘Goha’ Strawberry

Jong Myung Choi
Chungnam National University, Daejeon; choi1324@cnu.ac.kr
Hei Soo Lee
Chungnam National University, Daejeon; gyflsn@hanmail.net
Chiwon W. Lee*
North Dakota State University, Fargo; chiwon.lee@ndsu.edu

The influence of the fertilizer type and nitrogen (N) concentrations of the nutrient solution on the growth of ‘Goha’ strawberry mother plants during the vegetative propagation phase. Cold-treated mother plants at the 3 true-leaf stage were transplanted into flower pots (volume 1,600 ml) containing peat moss+perlite (7:3, v/v). Plants were fertilized with nutrient solutions containing 100 or 200 mg-L⁻¹ N, each prepared with acid fertilizer (AF), neutral fertilizer (NF), and basic fertilizer (BF). Tissue nutrient contents of mother plants were analyzed after 100 days of fertilization. Root substrate solutions were analyzed in every two weeks during the 100-day experimental period. Growth of mother plants measured after 100 days of fertilization was better when they were treated with BF than with NF or AF. Fresh and dry weights of plants grown with 200 mg-L⁻¹ N in BF contained highest tissue contents of Ca (0.37%) and Mg (0.34%) respectively, while plants grown with 200 mg-L⁻¹ N in BF contained highest tissue contents of Ca (0.37%) and Mg (0.34%) on a dry weight basis.

Specified Source(s) of Funding: Rural Development Administration, Republic of Korea

(286) Steel Slag Affects pH and Si Content of Container Substrates

James Altland*
USDA–ARS, MWA ATRU, Wooster, OH; james.altland@ars.usda.gov
Wendy Zellner
USDA–ARS, Toledo, OH; wendy.zellner@ars.usda.gov

A substrate representing a typical greenhouse potting mix was prepared using 85% sphagnum peat and 15% perlite. The substrate was filled into 10 cm wide containers. A pulverized steel slag (SS) from a basic oxygen furnace, and dolomitic limestone (DL) were amended to the base substrate at a rate of 0, 2.4, 4.8, or 7.2 kg/m³. Pots were planted with a single sunflower (Helianthus annuus ‘Pacino Gold’) plug. All containers were fertilized at each irrigation event with a complete commercial fertilizer (including micronutrients) at a rate of 100 mg/L. N. Substrate pH was measured weekly using the pour-thru method for 6 weeks. At the conclusion of the experiment, sunflower shoot dry mass and foliar nutrient composition was determined with a Thermo Iris Intrepid ICP-OES. Substrate pH response to SS and DL amendments were fit to exponential curves, which differed for the two amendment type. Exponential response curves for DL increased rapidly then leveled off with a maximum pH of 6.5 with 7.2 kg/m³ DL. In contrast, pH in SS-amended substrates increased more gradually over the range of applied rates but reached a higher pH of 6.9 with 7.2 kg/m³. Foliar Si in control sunflowers averaged 684 mg/kg Si, while those amended with DL contained 1180 mg/kg Si with no differences across DL rate. Sunflower amended with SS contained 8900 to 14,700 mg/kg Si over the range of applied rates. Steel slag can adjust pH of peat-based substrates, although the response curves differ from dolomitic lime. Steel slag has the additional benefit of supplying high rates of plant-available Si.

(287) The Characteristic of Seasonal Nitrogen Absorption and Distribution in Pear Trees from N Fertilizers Applied at Different Growing Stages

Haibo Jiang
Nanjing Agricultural University, Nanjing; 2010103129@njau.edu.cn
Caixia Dong*
Nanjing Agricultural University, Nanjing; cxdong@njau.edu.cn
Yangchun Xu
Nanjing Agricultural University, Nanjing; ycxu@njau.edu.cn
Peng Zhao
Nanjing Agricultural University, Nanjing; 2012103122@njau.edu.cn

An asterisk (*) following a name indicates the presenting author.
A field trial was carried out to study the seasonal nitrogen (N) uptake and distribution in 8-year-old pear trees using labeled N fertilizer. The trees were treated with equal amounts of labeled N [(15NH4)2SO4] at three different stages, i.e., (1) one month after fruit harvest (post harvest fertilization, PHF, mid-October, 2011), (2) one month before budding (before budding fertilization, BBF, early April, 2012), and (3) one month before fruit harvest (fruit enlargement fertilization, FEF, early August, 2012). The N concentration and N abundance were determined in the flowers, leaves, fruits, roots, phloem and xylem of one-year-old or perennial branches, and the trunk. We found that the 15N derived from PHF (Ndff) was mainly located in the root (6.13%), while only trace amounts of 15N occurred in other organs when determined one month before budding. However, 15N increased to 8.62 Ndff % in roots when determined during the fruit enlargement period, which is 54.5% higher than that derived from BBF. During the same period, the N concentration in perennial organs was reduced by 8.9% to 64.7%, which might be due to the growth and development of new organs. However, also during this period, the distribution of 15N derived from PHF was significantly increased in the leaves and fruit, and in the phloem and xylem of branches and the trunk. Compared with PHF, BBF resulted in a reduced amount of 15N in all organs. Compared with the roots, leaves, and xylem of one-year-old perennial branches, the 15N derived from PHF and BBF was mainly distributed in the growing fruit, while that derived from FEF was mainly present in the phloem of one-year-old branches and buds, indicating that FEF application mainly resulted in an increase in the storage of N for the next season’s budding, flowering, and young fruit development, but not for fruit growth in the current season. Thus, we propose that the growth of fruit depends on the amount of N stored in perennial organs, the newly absorbed N from budding to fruit enlargement, during which N absorbed from PHF was significantly higher than that from BBF, and the recycling of N from the roots, leaves, and xylem to the fruit during the period from fruit enlargement to maturation. PHF appears to have a greater impact on the fruit than does BBF.

Specified Source(s) of Funding: China Agriculture Research System (CARS-29-15)

(288) Quantification of Nutrients Lost during Annual Pruning, Leaf Abscission, and Fruit Harvest in Pear Trees

Qiaowei Chen
Nanjing Agricultural University, Nanjing; qiaowei78@njau.edu.cn
Shuo Wang
Nanjing Agricultural University, Nanjing; 201203121@njau.edu.cn
Jie Wang
Nanjing Agricultural University, Nanjing; 496036640@qq.com
Yangchun Xu
Nanjing Agricultural University, Nanjing; yc_xu@njau.edu.cn

Caixia Dong*
Nanjing Agricultural University, Nanjing; cxdong@njau.edu.cn

To investigate the amount of mineral nutrients lost from mature pear trees, we determined the nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), and magnesium (Mg) content in the pruned branches of various ages, fallen leaves, and mature fruit of four varieties (Huangguan, Lvbaoshi, Yuanhuang, and Yali) of 15-year-old pear trees growing in the same orchard. Furthermore, we calculated the weight of the pruned branches and fallen leaves, and the total fruit weight per tree. The nutrient abundance ranged from Ca > N > K > Mg > P in the pruned branches and fallen leaves of all four varieties, whereas it ranged from K > N > P > Ca > Mg in the fruit. The N, K, and P contents decreased with increasing age of the pruned branches. The Ca and Mg contents in the fallen leaves were about 58% and 100% higher than in the pruned branches, but 44-fold and 6-fold that of the fruit. The annual loss of N, P, K, Ca, and Mg from pear trees by pruning, leaf abscission, and fruit harvest was 241.4, 26.3, 117.6, 435.1, and 36.4 kg/hm², respectively, of which 37~78% was due to pruning. The percentage of N, Ca, and Mg lost through fallen leaves was higher than that lost through fruit, being around 15~46% in fallen leaves and 6~16%, 0.9~1.2%, and 5.7~8.7% in fruit, respectively. However, the loss of P and K through fallen leaves was less than through fruit, which was around 6~24% and 22~38%, respectively. Amongst the varieties tested, Lvbaoshi trees exhibited the greatest loss in nutrients through pruning, leaf abscission, and fruit harvest, with the exception of Yali, which lost more N, K, Ca, and Mg through falling leaves than did Lvbaoshi. Therefore, there is great variation in the amount of mineral nutrients lost from different varieties of pear tree during the growth season, and fertilizers should be flexibly applied in accordance with this variation.

Specified Source(s) of Funding: Special Fund for Agro-scientific Research in the Public Interest (201203013)

(289) Mineral Composition of Macronutrients in Shoots of Blackberry Plants Under Nutritional Deficiencies

Filipe Bittencourt Machado Souza*
Clemson University, Clemson; fbitten@clemson.edu

Rafael Pio
Universidade Federal de Lavras, Lavras/MG; rafaelpio@hotmail.com

Gregory L. Reighard
Clemson University, Clemson; grghrd@clemson.edu

Viviane Amaral Toledo Coelho
Universidade Federal de Lavras, Lavras/MG; vivianeatec@yahoo.com.br

Caio Morais de Alcântara Barbosa
Universidade Federal de Lavras, Lavras/MG; caio_seven@yahoo.com.br

This study investigated the mineral nutrition of the blackberry plants under Brazil environmental conditions. The goal was to evaluate the effect of single macronutrient omissions in the
nutritional status of blackberry (Rubus sp.). Blackberry plants ('Brazos' cultivar) were propagated by cuttings. After 3 months, the cuttings were transferred to a Hoagland and Arnon solution culture, which was initiated with 10% of ionic force (i.e., adaptation period), with constant aeration. The experiment was conducted in a controlled environment (glasshouse) in a completely randomized design with nine treatments corresponding to a complete Hoagland and Arnon solution (i.e., control) and individual omission (i.e., minus) of either N, P, K, Ca, Mg, S, B, or Fe with three replicates. The plants were harvested and the plant height and stem diameter at the base were recorded. After harvest the plants were separated into shoots and roots. The plants tissues were dried at 70 °C and then they were weighed and ground, and then the dried plant samples were analyzed. The blackberry plants with the lowest nitrogen concentrations were the treatments -N, -P, and -S. For phosphorus concentration, the smallest values were in the plants with the nitrogen omission. The highest potassium concentrations were observed in the treatments -Ca and -Mg while the highest calcium concentration was in the treatment -N. For magnesium concentration, the highest values were found in plants with omissions of N and K. The highest values of sulfur concentrations were observed in plants grown with no K, Ca, B, or Fe. The omission of nutrients caused changes in the nutritional status of blackberry. The concentrations of macronutrients found in the control treatment were (g·kg⁻¹): N 11.40, P 1.38, K 9.38, Ca 5.70, Mg 2.3, and S 1.46. The decreasing order of nutrient content in the shoots was N > K > Ca > Mg > S > P.

Monday, July 28, 2014

Postharvest 1

(001) DA Meter Readings and Chlorophyll Content on the Blushed and Unblushed Sides of Nine Apple Cultivars

Xingfeng Shao*
Cornell University, Ithaca, NY; Xs233@cornell.edu
Yosef Al Shoffe
Cornell University, Ithaca, NY; Yas24@cornell.edu
Franziska C. Doerflinger
Cornell University, Ithaca, NY; fcd26@cornell.edu
Haiyan Gao
Cornell University, Ithaca, NY; Hg346@cornell.edu
Jacqueline F. Nock
Cornell University, Ithaca, NY; jfn3@cornell.edu
Christopher B. Watkins
Cornell University, Ithaca, NY; cbw3@cornell.edu

The DA meter is a non-destructive method to determine chlorophyll content of fruit, and may have utility as an additional harvest index for apple fruit. In this study, IDA and chlorophyll concentration of blushed and unblushed skins of ‘SnapDragon’, ‘RubyFrost’, ‘Cortland’, ‘Fuji’, ‘Honeycrisp’, ‘Jonagold’, ‘Mutsu’, ‘RedMax McIntosh’ and ‘Redcord’ was measured. With the exception of ‘Mutsu’ and ‘Fuji’, more than half of the fruit of each cultivar had IDA values that were higher on the blushed side compared with the unblushed side. IDA values correlated with chlorophyll a and total chlorophyll but not chlorophyll b. The correlation between IDA and chlorophyll a was greater on the blushed side of the fruit in six of the cultivars. The average IDA value for each fruit was associated with internal ethylene concentration and starch index in fruit of some cultivars. In summary, the difference in IDA values and their relationship with chlorophyll levels from the blushed and unblushed side of the fruit can be significant and is cultivar dependent. IDA values may relate to harvest maturity, but its usefulness across orchard lots requires further investigation.

Specified Source(s) of Funding: Experiment Station federal formula funds, Project No. 2013-14-483: Non-destructive measurement of apple maturity; NY Apple R&D program

(002) Effects of Antitranspirants on Enhancing Temporary Drought Tolerance in Bedding Plants

Suejin Park*
West Virginia University, Morgantown, WV; separk@mix.wvu.edu
Sarah A. Mills
West Virginia University, Morgantown, WV; smills7@mix.wvu.edu
Youyoun Moon
West Virginia University, Morgantown, WV; youyoun.moon@mail.wvu.edu
Nicole L. Waterland
West Virginia University, Morgantown, WV; nicole.waterland@mail.wvu.edu

Bedding plants are often exposed to drought stress during shipping and retailing due to unexpected high temperatures and irregular irrigation. Such stresses reduce the quality and marketability of bedding plants. To prevent damage chemicals known as antitranspirants can be applied to the crops prior to shipping or retailing. Antitranspirants temporarily increase tolerance to drought stress by either physically blocking stomata or physiologically inducing stomatal closure to prevent water loss through transpiration. Physical antitranspirants containing polymers, resins, or waxes cover the stomata when sprayed on the leaves. Physiological antitranspirants induce stomatal closure by Sugar Alcohol-based Compounds (SACs) or abscisic acid (ABA), a phytohormone. However, little is known about the effectiveness of commercially available antitranspirants on enhancing drought tolerance of bedding plants. Two physical antitranspirants, β-pinene polymer (βP) and vinyl-acrylic polymer (VP), and four physiological antitranspirants, three SACs and a biologically active form of ABA (s-ABA) were applied to Begonia semperflorens, Impatiens hawkeri, Impatiens walleriana, Pelargonium x hortorum, two cultivars of Petunia ×hybrida, two cultivars of Tagetes erecta, and Tagetes patula.

Physical antitranspirants were sprayed and the physiological antitranspirants were drenched at a half (0.5X), equal to (1X), or twice (2X) the manufacturer’s recommended rate. s-ABA delayed
visual wilting symptoms and extended shelf life of all species and cultivars tested except for geranium. βP-treated T. erecta showed increased shelf life by 1.2 d. Longer shelf lives were observed when higher concentrations (2X) of antitranspirants were applied, compared to 0.5X and 1X, as shown in I. walleriana and P. ×hybrida treated with s-ABA at 2X, and in T. erecta treated with βP at 2X, respectively. Application of antitranspirants at 1X was conducted independently to measure leaf gas exchange in I. hawkeri, P. ×hortorum, and P. ×hybrida. The s-ABA reduced stomatal conductance within 4 h after application, resulting in reduction of water loss and extension of shelf life. The βP also appeared to block stomata within 4 h of application and caused reduced stomatal conductance in I. hawkeri and P. ×hybrida. The efficacy of βP was, however, less than that of s-ABA. Our data showed that VP and SACs had little or no effect on relieving drought stress symptoms and s-ABA was the most effective in closing stomata and enhancing temporary drought tolerance.

(003) Effects of Modified Atmospheres Packaging, Oxygen Permeable Films and Storage Temperatures on the Quality of Minimally Processed Jicama (Pachyrhizus erosus)

Ana Caren Rivera Rangel*
Universidad Autónoma de Querétaro, Querétaro; any_815@hotmail.com

Ma Estela Vázquez-Barrios
Universidad Autónoma de Querétaro, Querétaro; tita_evb@yahoo.com

Dulce Rivera Pastrana
Universidad Autónoma de Querétaro, Querétaro; dulcereriverap@gmail.com

María Sofía Arvizu-Medrano
Universidad Autónoma de Querétaro, Querétaro; sofiarome@yahoo.com.mx

Rossana Saavedra-García
Universidad Autónoma de Querétaro, Querétaro; rossy_3015@hotmail.com

Edmundo Mercado-Silva
Universidad Autónoma de Querétaro, Querétaro; mercasilva20@yahoo.com.mx

The effects of modified atmosphere packaging (MAP), O₂-permeable films and storage temperature on the quality of minimally processed jicama roots were studied. Fresh-cut jicama was prepared by manual peeling and automatic slicing, packed in regular air and modified atmosphere (~4% CO₂ in Air). The products were packed in four types of films with different oxygen transmission rate (OTR). Microbiological, physicochemical and sensory analyses were performed for jicama packed during 12 and 16 days stored at 10 and 5 °C, respectively. Storage temperature significantly influenced the fresh-cut jicama quality, those samples stored at 5 °C had better appearance than those stored at 10 °C. However mesophilic aerobic bacteria (MAB) and lactic acid bacteria (LAB) growth were observed in all treatments; fresh-cut jicama stored at 5 °C for 8 days reached a microbial growth population by 6 to 7 log ufc·g⁻¹ and 7 to 8 log ufc·g⁻¹ for MAB and LAB respectively. In headspace, CO₂ concentration increased and O₂ decreased faster at 10 than 5 °C. After 12 days at 5 °C, the CO₂ concentration in the MAP and regular air packages averaged 33%, 21%, 36%, and 11% and the O₂ concentration decreased from ~21% to 1%, 2%, 3% and 4%, for 381, 3875, 5100 and >5000 cc/m²/day OTR package, respectively. The texture measurements decreased in both atmospheres, showing a significant softening. Minimal processed jicama stored at 5 °C and under MAP condition, the membrane integrity was maintained to a greater extent than under regular air. Hue value tended to increase during storage in all applications. In conclusions, fresh-cut pieces packed and stored at 10 °C had lower visual quality, crispiness and higher CO₂ levels accumulation during 12 days of storage than those stored at 5 °C, and according to sensory results its acceptability is limited to less than 8 days mainly for normal air atmosphere application. OTR packaging film of 381 cc/m²-day could be suggested for better preservation of minimally processed jicama for 8 days stored at 5 °C.

(004) Application of 1-MCP and Plastic Film Packaging for Extending Shelf Life of Cluster Type Tomatoes

Geon Ho Bak
Chung-Ang University, Anseong-si; ghbak3@gmail.com

NaRae Han*
Chung-Ang University, Anseong-si; nawrae29@naver.com

Jongkee Kim
Chung-Ang University, Anseong-si; jkkim@cau.ac.kr

In an effort to determine an optimum stage of harvest of cluster tomato cultivars ripening characteristics was compared. Days to reach breaker stage in ‘Aranca’ was observed in 49.0, whereas 51.8 in ‘Campari’ and 54.5 in ‘Amoroso’. Based on days taken for each cluster to reach from B to RR, ‘Aranca’ exhibited the fastest ripening, showing 4.3 days, whereas 7.4 and 7.6 days for ‘Amoroso’ and ‘Campari’, respectively. On the contrary, days taken for a single cluster to reach RR was 4.8 for ‘Campari’, 6.3 days for ‘Amoroso’ and 7.3 for ‘Aranca’, indicating that ‘Campari’ be superior to maintain uniformity in color development among fruits in a single cluster. But fruit setting shape was ununiformed on ‘Campari’. To investigate effects of several postharvest treatment in cluster type tomatoes 1-MCP and three types of film, PE, PP, and OPP (40 μm) were applied and an evaluation of the quality factor, gas composition and activities of cell-wall degrading enzyme PG and cellulose during storage at 10 °C. Only a lower level in ethylene production, a significant delay of tissue softening and of weight loss, fruit detachment force was manifested by 1-MCP and film treatment. However, little difference was observed in changes of total soluble solids content from the fruit treated with film, 1-MCP and air. Abscission was observed at joint in all film treated fruit. Knuckle detachment force of film treated fruit was decrease

An asterisk (*) following a name indicates the presenting author.

S260 HortScience 49(9) Supplement—2014 ASHS Annual Conference
at 2 days after storage, the activities of PG and cellulose were increased at 1 and 0 days, respectively. However the activity of both PG and cellulose maintained low during storage at 1-MCP treated fruit.

Specified Source(s) of Funding: This research was supported by Bio-industry Technology Development Program, Ministry of Agriculture, Food and Rural Affairs

Effect of Wax Coatings on Postharvest Quality and Shelf Life of Mango (Mangifera indica L.) cv. ‘Manila’

Dalia Vázquez-Celestino
Universidad Autónoma de Querétaro; dalia_vac@hotmail.com

Humberto Ramos
Universidad Autónoma de Querétaro; huraso@live.com.mx

Edmundo Mercado-Silva
Universidad Autónoma de Querétaro; mercasilva20@yahoo.com.mx

Ma Estela Vázquez-Barrios
Universidad Autónoma de Querétaro; tita_evb@yahoo.com

Dulce M. Rivera-Pastrana
Universidad Autónoma de Querétaro; dulceriverap@gmail.com

Rossanna Saavedra-García*
Universidad Autónoma de Querétaro; rossy_3015@hotmail.com

Mango (Mangifera indica L.) is considered as one of the favorite fruits in the world due to its attractive color, delicious taste, pleasant fragrance and nutritional value. Mexico is the sixth biggest producer and first exporter to USA market with Tommy Atkins, Haden, Ataulfo, Keitt and Kent varieties. However, the Manila variety (the second more important variety in Mexico) does not be included in the market exportation because of high weight and firmness loss. This variety has a high sensory quality and is preferred by consumers. However, due to its accelerated ripening process and high metabolic activity its shelf life is short. An alternative to resolve this problem is the use of wax coatings as an alternative to prevent weight loss and maintain firmness mango fruit, allowing it to maintain quality during postharvest handling and increase its shelf life. The aim of this study was to evaluate the effect of two wax coatings on postharvest quality and shelf life of mango cv. ‘Manila’. A sample of 250 fruits harvested at □ ripeness maturity were treated at 53 °C for 6 min (to anthracnose control), after that, the fruits were waxed with two types of waxes “Charol Mango®” (fatty acids, sucrose, and polypropylene glycol) (W1) and “Saltillo®” (W2) (carnauba and candelilla wax), another set was maintained as control. The fruits were stored for 22 days at 13 °C and transferences from 13 °C to 20 °C. At 15 days of storage, the firmness was higher in fruits treated with W1 (18N) compared with control (8N) and W2 (9N). At the end of storage, 22 days, at 13 °C, the fruits treated with W1 had less weight loss (5.5%) compared with control (17%) and W2 (15.5%) and had better visual quality. The application of wax coating with W1 can be an alternative to avoid dehydration and wilting in mango ‘Manila’.

(005) Effect of Wax Coatings on Postharvest Quality and Shelf Life of Mango (Mangifera indica L.) cv. ‘Manila’

(006) Postharvest Heated Fungicide Treatments to Control Citrus Black Spot (Guignardia citricarpa) on Citrus Fruits

Jiaqi Yan*
University of Florida, Fort Pierce.; yanj@ufl.edu

Pamela D. Roberts
University of Florida, Immokalee; pdr@ufl.edu

Megan M. Dewdney
University of Florida, Lake Alfred; mmwdewdney@ufl.edu

Cuifeng Hu
University of Florida, Fort Pierce; cuifenghu@ufl.edu

Macelynia Hossain
University of Florida, Fort Pierce; mahossai@ufl.edu

Mark A. Ritenour
University of Florida, Fort Pierce; ritenour@ufl.edu

Citrus black spot (CBS), caused by Guignardia citricarpa, is an invasive fungal disease that was first identified March 2010 in Florida and is spreading slowly. Although a USDA pest risk assessment determined that citrus fruit is not a good vector for the disease, lesions may develop on fruit after harvest and can be considered as a grade-lowering defect by receivers. Postharvest fungicides have been evaluated to control postharvest CBS symptom development, but with limited success. Heated fungicide solutions have been shown to enhance control of postharvest decay or allow lower fungicide concentrations to be used. Heat treatments can also induce resistance to disease and physiological disorders. The current preliminary experiment tested the effectiveness of dipping fruits from CBS-infected Valencia orange trees for 30 seconds into one of seven commercial postharvest fungicides. Solutions were at 25 °C or 50 °C. No preharvest fungicides were used on the trees in the field. After harvest, the fruits were sorted into two groups (non-symptomatic and symptomatic fruits) and evaluated separately. All fungicides were tested at commercial concentrations and controls were kept at 25 °C, with 80% relative humidity, 3 ppm ethylene, and continuous light to speed lesion appearance. Fourteen days after treatment, there was no significant reduction in lesion development on fruit that already showed CBS symptoms at harvest. However, fruits dipped in azoxystrobin or thiabendazole tended to develop 37% and 27%, respectively, fewer lesions during storage than the control. On fruit that were asymptomatic at harvest, all fungicide treatments significantly inhibited subsequent lesion appearance during storage. Compared to control fruit, thiabendazole, azoxystrobin, phosphorous acid, pyrimethanil, imazalil, fludioxonil, and sodium o-phenylphenate (SOPP) reduced the number of fruit lesions by 71%, 42%, 38%, 34%, 30%, 29%, and 17%, respectively. Heated solutions enhanced the efficiency of azoxystrobin and fludioxonil by 58% and 27%, respectively. Heated water alone also inhibited lesion appearance compared to control, decreasing the number of lesions on fruits by 28%. Future tests will provide more information and details for practical application.
(007) Microbial Biocontrol of Postharvest Papaya Diseases
Robert E. Paull*
University of Hawaii at Manoa, Honolulu; paull@hawaii.edu
Nancy Jung Chen
University of Hawaii at Manoa, Honolulu; jungc@hawaii.edu
Papaya fruit postharvest losses of up to 75% have been reported to Hawaii shippers by mainland USA wholesalers and retailers. These losses are associated with postharvest disease, often associated with storing color-break fruit for more than three weeks at temperatures of 10 °C or lower temperatures and mechanical injury. Postharvest disease has been controlled by hot water dips, hot water spray treatments and fungicides. Microorganisms were isolated from papaya fruit surface and evaluated for their ability to control postharvest disease by their actions as antagonistic microorganisms to the disease carrying microorganisms. Postharvest disease incidence varied with season. A greater incidence of anthracnose occurred during cool season while stem end rot was more prevalent in the warm season. Anthracnose usually developed after one week at (22 °C) and stem end rot developed at a slower rate after 10 days. Three yeast isolates that had biological activity against anthracnose were tested in vivo on papaya fruit. Half the treated and inoculated fruit were stored at 10 °C for 10 days before ripening at ambient temperature. In addition to the three yeast isolates, 0.5% thyme oil, 1.5% medium molecular weight chitosan and wax were also tested. Application time of the yeast isolates influenced the effectiveness their antagonist activity. All three yeast isolates tested, #581, #961 and #1061 showed antagonistic activity against anthracnose when applied one day after pathogen inoculation in papaya ripened at ambient temperature. However, when the papaya were stored at 10 °C before ripening, only yeast isolate #1061 was effective in reducing the anthracnose development.

Specified Source(s) of Funding: USDA–ARS Cooperative Agreement, USAID-HortCRSP

(008) Modulation of 1-MCP Efficacy in Mango and Papaya Fruit by Quarantine Hot Water Treatment
Jorge A. Osuna-Garcia
INIFAP-Santiago, Nayarit; osuna.jorgealberto@inifap.gob.mx
Jeffrey K. Brecht*
University of Florida/IFAS, Gainesville; jkbrecht@ufl.edu
Donald J. Huber
IFAS, University of Florida, Gainesville; djhuber@ufl.edu
James H. Lee
University of Florida, Gainesville; jhleej@ufl.edu
Kim Cordasco
University of Florida, Gainesville; cordasco@ufl.edu
Md. Golam Ferdous Chowdhury
University of Florida, Gainesville; mchowdhury@ufl.edu
Our research with ‘Kent’ and ‘Keitt’ mango has shown that aqueous 1-MCP provides a moderate delay of ripening but had a negative interaction with quarantine hot water treatment (46.1 °C, 90 min.). Fruit treated with aqueous 1-MCP before or after heating developed fair to poor external appearance. By contrast, fruit treated with aqueous 1-MCP without heating showed delayed ripening without adverse effect. The objective of this study was to determine the physiological processes involved in the response of unheated and heated mango and papaya fruit to 1-MCP. 1-MCP sorption in whole or fresh-cut fruit was determined by enclosing mango or papaya fruit or tissue in plastic containers of 6.7 L that were sealed and injected with 20 µL·L⁻¹ gaseous 1-MCP. 1-MCP depletion was monitored over 6 h using gas chromatography. For 1-MCP ingress in intact papaya, single fruit were placed in similar containers and gaseous 1-MCP injected at 20 µL·L⁻¹. At selected intervals jars were opened and fruit immediately immersed in plastic bins containing 10 L diH₂O. Samples of internal atmosphere were taken by syringe from the apical, middle and basal tissues, and from the cavity of the immersed fruit. 1-MCP concentration was measured using gas chromatography. Internal gaseous 1-MCP in quarantine hot water treated (48.0 °C for 75 min) or untreated intact papaya fruit treated with aqueous 1-MCP was monitored in a similar manner. ‘Kent’ and ‘Keitt’ mangos showed different patterns of 1-MCP sorption, but 1-MCP sorption trends were similar for heated and unheated mangos. Moreover, the 1-MCP sorption rate of fresh-cut ‘Keitt’ fruit was 2-fold higher than that of whole fruit. With respect to papaya, no significant differences in gaseous 1-MCP sorption were noted between heated and unheated whole fruit, but significant differences were found for fresh-cut tissue from heated and unheated fruit. Heated fresh-cut tissue adsorbed more 1-MCP than unheated fresh cut tissue. Significant differences were also found in papaya for gaseous 1-MCP exposure time: the longer the exposure time, the higher the gaseous 1-MCP. Finally, with relation to experiments measuring the ingress of aqueous 1-MCP in papaya fruit, no significant differences were found between heated and unheated fruit, 1 or 5 min dipping time, or sampling regions (apical, middle, basal, or cavity). However, significant differences were detected between 1 mg·L⁻¹ and 3 mg·L⁻¹ 1-MCP in the experiment conducted in January, but not in the experiment conducted in December.

Specified Source(s) of Funding: National Mango Board and Fulbright Scholars Program

(009) Shelf Life and Quality of High Tunnel and Open-field Tomatoes
Helena Pontes Chiebao*
Kansas State University, Olathe; chiebao@ksu.edu
Lani Meyer
Kansas State University, Olathe; ljm7788@ksu.edu
Cary Rivard
Kansas State University, Olathe; crivard@ksu.edu
Eleni D. Pliakoni
Kansas State University, Olathe; epliakoni@ksu.edu
The utilization of high tunnels for tomato production has rapidly expanded in the United States due various reasons including...
the expansion of organic and local markets. However, little is known about the effect of the high tunnel production system on tomato (Solanum lycopersicum) nutritional and physical quality at harvest and during storage. In particular, the effect of high tunnel production on tomato shelf life has not been reported. The aim of this work was to determine how high tunnel production affects postharvest losses, quality and shelf life of organically-grown tomatoes compared to the open-field. Tomatoes (cv. BHN 589) were grown at the Kansas State University Olathe Horticulture Research and Extension Center during summer 2013. In the high tunnel system, fabric mulch was used for weed control and drip irrigation was utilized. An equivalent open-field plot was planted at the same time using typical commercial open-field production practices including plasticulture with raised beds and drip irrigation. Tomatoes were harvested at breaker and pink maturity stages and stored at 12.5 °C for 21 days. Fruit respiration was measured every 12 hours during storage. Additionally, color (CIE L*a*b* scale) as well as incidence and severity of decay were evaluated daily. Fruit samples were evaluated at days 0, 5 and 10 for physical and nutritional quality analysis. Tomatoes grown in the high tunnel had significantly lower respiration rates compared to open field (6.75 and 7.93 mg CO2 per kg-h, respectively). Furthermore, high tunnel tomatoes showed reduced incidence and severity of postharvest disease, and the mean values of the area under the disease progress curve (AUDPC) were significantly lower (P < 0.05) for the fruit grown in the high tunnel. Fruit grown in the high tunnel fruit remained marketable (severity rating < 3) for the entire 14-day time period while fruit grown in the open-field were not marketable after 10 days in storage. The tomatoes grown in the open-field had significantly higher total antioxidant activity than tomatoes grown under high tunnel conditions throughout storage. The utilization of high tunnels for organic tomato production by local growers could lead to the reduction of food losses by extension of postharvest shelf life. However, tomatoes grown in the high tunnel had lower nutritional quality than the ones grown in the open-field. Further experiments are needed to determine if this trend is consistent across growing seasons and geographic regions.

(010) Small-scale Storage of Horticultural Crops in Bangladesh

Amrita Mukherjee*
University of California, Davis; amritajee@gmail.com

Michael S. Reid
University of California, Davis; msreid@ucdavis.edu

Ronald E. Voss
University of California, Davis; revoss@ucdavis.edu

High ambient temperatures and humidities in Bangladesh are a significant cause of postharvest losses of perishable horticultural crops. In particular, potatoes, the second most important crop in Bangladesh (after rice), are harvested in a narrow window (late February/early March) during the winter. Farmers store potatoes in their houses or in simple ambient storage structures, but storage is limited to one to two months. The rest of the potato harvest is purchased by traders and stored in large commercial cool storages for up to 10 months. We sought to demonstrate the possibility of providing low-cost but effective cool storage using the CoolBot technology. An insulated room is cooled to proper storage temperatures using a standard air conditioner and a CoolBot controller that defeats the air conditioner’s own thermostat, detects formation of frost on the evaporator, and cycles the air conditioner until the room reaches storage temperature. Working with groups of small scale farmers, we built demonstration rooms in several communities, and compared cool and ambient storage for potatoes, tomatoes, eggplant, and winter gourd. Challenges included securing a reliable electricity supply, and constructing and equipping the rooms. Nevertheless, the benefits of cool storage were readily apparent, and we are now working to develop construction and operational techniques that will make the rooms cost effective for smallholder farmers.

Specified Source(s) of Funding: USAID

(011) Commercial Scale Hydrocooling of Fresh Market Strawberry

Steven A. Sargent*
University of Florida/IFAS, Gainesville.; sasa@ufl.edu

Adrian D. Berry
University of Florida/IFAS, Gainesville.; adberry@ufl.edu

Jeffrey K. Brecht
University of Florida/IFAS, Gainesville; jkbrecht@ufl.edu

Strawberry flavor and appearance is best for fruit picked full-ripe. However, ripe strawberries soften faster and are more susceptible to bruising, decay, moisture loss, and shriveling. Therefore, commercial operations typically pick fruit 3/4-ripe, field-pack into rigid clamshell containers, place in corrugated cartons, palletize, and forced-air cool (FAC). However, achieving 7/8 cooling time for FAC can vary from 60–120 min and final pulp temperature can vary within the pallet. A 6-h delay to FAC can reduce strawberry quality after 7 d storage; such fruit are softer, lose more weight, and have lower total sugars and ascorbic acid content than fruit cooled shortly after harvest. Previous tests using immersion hydrocooling (HC) with sanitized water showed promise for strawberry shippers, in that fruit were uniformly cooled in approximately 13 min, potentially increasing throughput by 4- to 8-fold. HC strawberries in clamshells cooled at the same rate as those in bulk; after 14 d at 2 °C, quality of HC fruit was equal to or better than FAC fruit. In Spring 2014, strawberries (‘Red Merlin’, ‘Florida Strawberry Festival’, ‘Radiance’) were field-packed into 1-lb clamshells and placed in either corrugated cartons (FAC; eight clamshells/carton) or returnable plastic containers (RPC) (HC; nine clamshells/RPC). Twenty-eight RPCs (stacked two high) were sequentially immersed in a semi-commercial flume HC system installed at the cooling facility. Water (1.2 °C, 180 ppm free chlorine) was concurrently circulated (2,800 L/min) with the RPCs, achieving 7/8 cooling in approximately 15 min; RPCs were then drained (15 s), palletized (five/layer) and stored in the cold room (1.2 °C) for 15 d. Pulp temperatures were monitored in top (one probe)
Irrigation also increased the amount of superficially cracked fruit, and total fruit yield was increased by 20% (P < 0.008) and total marketable fruit was increased by 17% (P = 0.025). Weekly soil water content (SWC) throughout the season was always higher in soil covered with plastic and the standard error between plastic vs. bare ground suggested that SWC under plastic was more uniform. Soil temperatures at 0, 5, 10 and 30 cm depth were less variable under plastic. A single harvest was made on Oct. 23. Total marketable fruit was increased by 17% (P = 0.06). Trees grown under white plastic had more basal sucker production (% of trees and sucker size) at the end of the season; irrigation rate also increased sucker frequency and size. Trunk cross-sectional area was increased linearly with increasing water replacement rates. The use of an in-row durable white plastic appears to be beneficial in retaining soil moisture, reducing the need for chemical weed control, and improving pomegranate fruit yield and juice color.

(298) A Low Cost, Arduino-based System for Monitoring and Controlling Substrate Water Content

Rhuanito Soranz Ferrarezi*
University of Georgia, Athens; rhuanito@terra.com.br
Sue Dove
University of Georgia, Athens; sdove@uga.edu
Marc van Iersel
University of Georgia, Athens; mvanier@uga.edu

Soil moisture sensors can be used to schedule irrigation. Inexpensive, programmable microcontroller boards can make sensor-based irrigation available for both agricultural and domestic applications. Such irrigation control systems can be built with only basic programming and wiring knowledge. Our objectives were to use soil moisture sensors and microcontrollers to build an automated system to monitor and control substrate volumetric water content (VWC) based on real-time soil moisture measurements. We used an open source prototype board (Arduino Uno R3) combined with a stackable secure digital (SD) shield for datalogging. The stacked boards were connected to four capacitance-type soil moisture sensors (10HS, Decagon), a relay board with 8 relays, one 9VDC latching solenoid valve, and three 24VAC solenoid valves. The microcontroller program was written to power the sensors, read the raw signal from the soil moisture sensors, and convert it into VWC. The microcontroller then compared VWC to irrigation thresholds and opened and closed irrigation valves as needed. The latching valve is powered using a 9V battery, while the 24VAC valves require a separate power supply. The data were written to an SD card. To test the system, we performed a 53-d trial using four pots with Hibiscus acetosella ‘Panama Red’. The ability of the system to successfully monitor substrate VWC and controlled irrigation, requiring little maintenance. This automated irrigation controller can be used by commercial growers and homeowners, allowing irrigation-decisions to be based on plant water needs instead of visual observations or a rigid schedule. The total cost of this irrigation controller, capable of controlling four irrigation zones, is approximately $350, not including the irrigation valves.
An asterisk (*) following a name indicates the presenting author.

Specified Source(s) of Funding: Funding for this research was provided by USDA-NIFA-SCRI (award no. 2009-51181-05768) and CAPES Foundation - Ministry of Education, Brazil (BEX 2620/13-8).


Richard C. Beeson
University of Florida, Apopka; rcbesoon@ufl.edu

Dennis R. Pittenger
Cooperative Extension, Riverside, CA; dennis.pittenger@ucr.edu

Brent Mecham
Irrigation Association, Falls Church, VA; brent@irrigation.org

Roger Kjelgren*
Utah State University, Logan; rkjel@usu.edu

Water use in the urban landscape is scrutinized and prescribed by many organizations and jurisdictions that create programs, codes or standards as rules for sustainable development. Improved landscape water use efficiency is a key element in these programs and codes. Efficiency is usually assumed to consist of restricting water application rate or limiting plant palette. The new S623 standard provides a simple and science-based method to estimate the amount of water landscapes plants require to meet expectations. It can be applied both during landscape design for calculating water budgets and for landscape water management and irrigation scheduling strategies. Here we focus on the complex context for the tree component of the standard. Trees in urban landscapes are often free standing, spatially separate, or above surrounding plant material. Water use by freestanding trees and woody shrubs has been quantified for a number of species and can be reasonably predicted based on trunk dimensions or canopy footprints when normalized to reference evapotranspiration (ETo). The ratio of actual water use to ETo is defined as the plant factor (PF). Freestanding tree canopies are well-ventilated with air water deficits (humidity) typically being imposed at the individual leaf surface. High air water deficits often trigger some degree of stomatal closure that decouples transpiration from ETo and moderates rate of water use. In humid climates with small air water deficits, stomatal closure is typically less intense and prolonged, so water use rate as a fraction of ETo is greater. Consequently, the S623 standard defines PF’s separately for trees in low humidity (PF = 0.5) and high humidity (PF = 0.7) climates, with a separate category for desert plants (PF = 0.3) whose water use is even further decoupled from ETo. This PF’s result in acceptable aesthetic appearance and function when applied to irrigated landscapes. A key assumption is that complex, site-specific landscape factors — mixed species, variable plants densities, and diverse microclimates — offset each other such that water use in a given landscape zone is homeostatic and can be characterized by the PF for the most water demanding plant type within that zone. The Standard provides the first reliable, research-based set of PF’s for landscape plants that can be applied nationally.

In addition, it is simple to understand and apply, readily accommodates new plant introductions, and is scientifically and conceptually defensible. Adoption of the standard will require extensive marketing to landscape architects, professional landscape water managers and non-technical public policy-makers.

(300) Relationship Between Temporal Patterns of Soil Moisture and Microclimatic Conditions in Plasticulture Grown Poblano Pepper Under Tensiometer-scheduled Irrigation

Timothy Coolong*
University of Georgia, Tifton; tcoolong@uga.edu

Susmitha Nambuthiri
University of Kentucky, Lexington; ssnamb2@uky.edu

Managing irrigation using soil moisture sensors for automation can allow for application of water to soils, at the appropriate amounts, rates, frequency and timing to meet crop water use while avoiding drought stress and maintaining optimum yields in high value crops. Frequent monitoring of soil water status within the root zone in response to atmospheric conditions is essential to evaluate the sensitivity of any sensor based irrigation scheduling method. Eight-week old transplants of poblano pepper (Capsicum annuum) ‘Don Amelio’ were planted 9 June 2010 at the University of Kentucky Horticulture Research Farm in Lexington, KY. Transplants were set in 10-12 cm high raised beds covered with 0.025 mm-thick black plastic mulch (1.22 m wide) with a single line of drip irrigation tubing placed approximately 2.5 cm below the soil surface in the center of each bed. Automated irrigation was managed using switching tensiometers and which were placed equidistant (12-15 cm) from pepper plants and the edges of the raised beds, and at a depth of 20 cm from the upper surface of the bed. On/off set points for the five automated irrigation treatments were as follows, -30/-25, -40/-35, -50/-45, -60/-55 kPa. Irrigation treatments were implemented after plants were well established. The frequency and duration of the automated and manual irrigation events were recorded with data loggers (Hobo U9 State Data Logger). The soil was a well-drained Maury silt loam series. Soil moisture was logged at depths of 15 and 25 cm and environmental measurements of the study area were recorded at an hourly interval. Soil water potential was well correlated with environmental factors such as air temperature, relative humidity, dew point temperature, and solar radiation. Trend of soil moisture decline was in line with rise in VPD and/or ET especially during sunny and non-rainy periods of the study. Probes set at depths of 15 cm responded earlier to microclimatic conditions than probes set at 25 cm in all irrigation treatments suggesting the faster soil water depletion by evapotranspiration and timely replenishment by irrigation in this layer. The rate of change in soil water content decreased with increase in On/Off threshold soil water potentials as lower setpoints (-60/-55 kPa) hold more water and stay wetter than higher setpoint values (-60/-55 kPa) and respond quicker to VPD and/or ET variations. The study confirms the prompt response of soil moisture sensors to varying atmospheric conditions while scheduling automated irrigation.
(301) Comparing Water Use Efficiency in South Texas Furrow and Drip Irrigated Cabbage

Corina Fuentes*
Texas A&M University-Kingsville Citrus Center, Weslaco; corinaf321@gmail.com
Juan Enciso
Texas A&M AgriLife Research, Weslaco; j-enciso@tamu.edu
Luis Ribera
Texas A&M AgriLife Extension, Weslaco; lribera@tamu.edu
Juan R. Anciso
Texas A&M AgriLife Extension, Weslaco; j-anciso@tamu.edu

Vegetable production in the Lower Rio Grande Valley of South Texas is at continual risk of failure due to periodic and extreme drought conditions. Irrigation sources stem from the Rio Grande River, and when water resources are limiting growers need to change to more water conserving methods to raise horticultural crops. The purpose of this project was to evaluate drip irrigation as a water conservation strategy to conventional furrow irrigation for cabbage production. Crop water requirements were estimated using a weather station, Penman-Monteith evapotranspiration (ET) equation, and FAO crop coefficients. Plots were replicated using a completely randomized design with sub-sampling. Matrix-based soil moisture sensors were used to monitor soil water content for irrigation scheduling, and determined by replacing ET water loss within the drip irrigated plots versus irrigating to soil saturation point in furrow irrigated plots. Irrigation was applied when the soil water sensor reached a soil water level of 30 centibars for drip and 50 centibars for furrow. The furrow system was irrigated to advance water to the lower end without producing runoff by blocking the furrows. Harvested cabbage was measured for size and weight to determine marketable yield and produce quality which was determined by the characteristics of the variety. The yield and produce quality was used to determine water use efficiency for the two irrigation methods.

Specified Source(s) of Funding: USDA-NIFA HSI Award 2011-38422-30826

Monday, July 28, 2014

Fruit Breeding

(246) Verticillium Wilt Resistance Varies within Ploidy Levels in Strawberry (Fragaria Species)
Lise L. Mahoney*
University of New Hampshire, Durham; Lise.Mahoney@unh.edu
Kelly Vining
Oregon State University, Corvallis; Kelly.Vining@oregonstate.edu

Verticillium wilt is a major obstacle to U.S. strawberry production. Our current and ongoing investigations include defining new sources of resistance in cultivated and wild strawberry germplasm, and advancing genetic studies on the basis of resistance/susceptibility. We screened 26 octoploid, 1 decaploid, and 23 diploid strawberry genotypes for response to root-dip inoculation with Verticillium dahliae isolate V1. Inoculated plants were individually rated at eight weeks post-inoculation using a categorical scale: 1 = healthy; 1.5 = slightly symptomatic; 2 = moderately symptomatic; 2.5 = very symptomatic; 3 = dead. Qualitative classifications were assigned to genotypes on the basis of the following species: (in parentheses) were: 1.0-1.3 (very resistant = VR), 1.4-1.7 (moderately resistant = MR), 1.8-2.2 (intermediate = I), 2.3-2.6 (moderately susceptible = MS), and 2.7-3.0 (very susceptible = VS). Considerable variability in inoculation response existed within and between species at both the diploid and octoploid levels. VR or MR genotypes were found within each of the following species: diploids F. vesca, F. inumae, and F. nipponica; and octoploids F. chiloensis, F. virginiana, and F. × ananassa. The MS and VS genotypes were documented within F. vesca, within each octoploid species, and in a genotype of decaploid F. cascadenis. We compared our screening results to those of previous studies and constructed a pedigree of the evaluated and related octoploid cultivars for visualization. We also made resistant × susceptible crosses at both the diploid and octoploid levels as a step toward genetic analysis of wilt resistance/susceptibility and resistance gene identification in strawberry.

Specified Source(s) of Funding: RosBREED, USDA National Germplasm System (Small Fruits) award #358-2100-038-01S, Screening for Verticillium Wilt Resistance in Wild Diploid and Octoploid Strawberry Germplasm, New Hampshire-AES project #NH00433; Genomic Tools for Horticultural Crops.

(247) Characterization of Crispy Selections of the Arkansas Blackberry Breeding Program
Alejandra A. Salgado*
University of Arkansas, Fayetteville; asalgado@uark.edu
John R. Clark
University of Arkansas, Fayetteville; jrclark@uark.edu
Terrence Frett
University of Arkansas, Fayetteville; tjfrett@email.uark.edu

Flesh firmness of blackberry fruits is critical for successful postharvest handling. Therefore, this trait is a priority in the development of new cultivars in breeding programs across the U.S. and world. The University of Arkansas blackberry breeding program has released a number of cultivars with excellent postharvest quality. The program has a wide range of genotypes

An asterisk (*) following a name indicates the presenting author.
with exceptional firmness and texture. Crispy and exceptionally firm fruits have been identified. Two thornless Arkansas selections have this trait, A-2453T and A-2454T. After storage for 7-14 d, they maintain firmness, crispiness, and low color reversion (one or more drupelets turning red from black after harvest; an important problem for the blackberry fresh-market industry) beyond that of existing cultivars. This is of importance, because fresh-market potential is determined by how a genotype responds to storage and handling. The objective of this study was to characterize the fruit morphology of crispy blackberry fruits, determine the components contributing to this trait, and determine the relationship between fruit firmness and color reversion. Shiny-black fruits of 15 blackberry genotypes were harvested into 0.24 L clamshells during the 2013 season. Samples were divided in two groups. One group was evaluated for color reversion at harvest and after one week of cold storage at 5 °C utilizing a quantitative score. In the other group, firmness analysis was performed. For this, compression and penetration forces were measured on different parts of the fruit (drupelet, receptacle, and the entire fruit) at harvest utilizing a texture measurement device. For penetration and compression, 1.0 mm, and 7.2 cm cylinder probes were utilized, respectively. After one week of cold storage, the two crispy genotypes along with A-2218 showed similar levels of color reversion and were superior to other selections and cultivars. ‘Natchez’ and selection A-1960T, although having improved postharvest handling potential than many cultivars, had higher numbers of fruits having at least four drupelets with color reversion. Crispy genotypes showed the highest compression firmness values compared to non-crispy genotypes. Compression values of crispy genotypes averaged 13.0 N, almost double than ‘Ouachita’ with 7.1 N. Skin drupelet penetration force showed a similar trend as compression force. Lastly, crispy genotypes also showed a higher receptacle penetration force, reflecting enhanced firmness of the internal core of the berry. These results are promising, showing superior flesh fruit firmness, low color reversion, superior postharvest quality and shipping potential of these crispy genotypes.

(248) Validating Markers Linked to Soluble Solids Content in Octoploid Strawberry

Natalia Salinas-Aponte*
Oregon State University, Corvallis; salinasn@oregonstate.edu
James F. Hancock
Michigan State University, East Lansing; berrygenetics@hotmail.com
Kazim Gunduz
Mustafa Kemal University, 31034 Hatay; kgunduz44@gmail.com
Beatrice Denoyes
INRA, Villenave d’Ornon Cedex; denoyes@bordeaux.inra.fr
Eric van de Weg
Wageningen University and Research Center, Droevendaalsesteeg; eric.vandeweg@wur.nl
Daniel J. Sargent
Research and Innovation Centre, San Michele all’Adige, 38010 (TN); dan.sargent@fmach.it
Iraida Amaya
IFAPA-Centro de Churriana, Málaga; iraida.amaya@juntadeandalucia.es
Megan M. Mathey
Oregon State University, Corvallis; megan.mathey@oregonstate.edu
Amy F. Iezzoni
Michigan State University, East Lansing; iezzoni@msu.edu
Cameron Peace
Washington State University, Pullman; cpeace@wsu.edu
Chad E. Finn
USDA–ARS HCRL, Corvallis, OR; finnc@hort.oregonstate.edu
Nahla Bassil
USDA–ARS, NCGR, Corvallis, OR; Nahla.Bassil@ars.usda.gov

In Rosaceous crops including strawberry, the RosBREED project is focused on enabling marker-assisted breeding via identification as well as validation of markers that are associated with fruit quality traits. Around the world, strawberry is valued for its organoleptic characteristics and its nutritional content. Fruit quality traits have been prioritized in this crop. Flavor is the phenotypic result of a well synchronized combination of aroma compounds, sugars, acids and texture. The best strawberry flavor is obtained if high acids and sugars are in balance. Soluble solids content (SSC) includes mostly the concentration of sugars, followed by organic acids and soluble pectins and is positively correlated with sweetness perception and consumer likeness. The objectives of this study were: 1. to validate a previously identified QTL for SSC in 890 field-grown strawberry individuals for which SSC data were previously collected in 2011 and 2012, and 2. to identify genotypes with high SSC based on phenotypic and genotypic data. Fruit samples were collected and the resulting puree was used to measure the percent of soluble solids on a refractometer. Allele composition at the EMFv006 single sequence repeat (SSR) locus previously linked to high SSC content in the ‘Capitola’ × CF1116 strawberry population was determined after separation by capillary electrophoresis. Percent soluble solids content ranged from 3.1 to 18.7 in 2011 and between 3.7 and 16.6 in 2012 in the Oregon, and Michigan field-grown individuals evaluated. Average SSC observed in MI and OR was 11% and 8.1%, respectively. The microsatellite allele dosage and configuration establishment (MADCE) method is being used to quantitatively establish the full allelic configuration at EMFv006. We will report association of the marker alleles and haplotypes with SSC content in strawberry.

Specified Source(s) of Funding: RosBREED Project

(249) Softening Rate and Ethylene Fruit Production of Different Flesh Textures of Arkansas Peach and Nectarine Germplasm

Alejandra A. Salgado*
University of Arkansas, Fayetteville; asalgado@uark.edu
John R. Clark
University of Arkansas, Fayetteville; jrclark@uark.edu

An asterisk (*) following a name indicates the presenting author.
The peach industry requires new cultivars that meet high standards of fruit quality and postharvest potential. The fresh-market industry needs peaches firm enough to be shipped long distances without affecting flesh quality. Peach growers often harvest unripe fruits to achieve firmness at the final market, but this practice can lead to fruits with flesh disorders and poor flavor resulting in a bad eating experience. The action of different enzymes and hormones determine peach flesh texture. The enzyme endopolygalacturonase (EndoPG) is involved in the ripening and softening processes and determines if a peach will be melting (MF), non-melting (NMF), or non-softening flesh (NSF) depending on the allelic combination controlling this trait expression. Ethylene is the primary hormone involved in the ripening and softening processes of peach fruits. Currently, an endoPG DNA marker is available allowing breeders to determine on a juvenile peach tree if its flesh will be MF, NMF, or NSF facilitating marker-assisted breeding (MAB). However, there is another flesh texture present in the University of Arkansas peach breeding program that differs from these flesh types, the slow melting flesh (SMF), which is not differentiated by the endoPG marker. This texture is crispy and firm, with outstanding postharvest potential. Its melting rate is slow with the fruit maintaining firmness for a long period until completely ripe when melting occurs as in a normal MF peach. The objective of this study was to characterize the softening rate and ethylene production of different flesh textures to ultimately design a DNA test for SMF. During 2013, softening and ethylene production rates were measured daily for 6 d after harvest on fruits from a range of flesh textures. Non-softening and SMF fruits showed a slow rate of ethylene production; however, SMF individuals reached ethylene levels similar to MF during the final storage day. Flesh firmness was high for NSF and SMF individuals, but SMF fruits at the end of the period were soft and their firmness was similar to MF. Preliminary results indicate a quantitative trait loci (QTL) associated with SMF and an interaction of this QTL with the maturity date QTL, both located on linkage group 4. Currently, DNA tests are being developed and validated for both traits, and will be combined with endoPG markers to provide a single DNA test to accurately predict flesh type in peach.

(250) Incorporation of Marker–Assisted Breeding (MAB) in the University of Arkansas and Three Other RosBREED Demonstration Peach Breeding Programs

Terrence Frett*
University of Arkansas, Fayetteville; tfrett@email.uark.edu

John R. Clark
University of Arkansas, Fayetteville; jrc@uark.edu

Cameron Peace
Washington State University, Pullman; cpeace@wsu.edu

Paul Sandefur
Washington State University, Pullman; psandefur@email.wsu.edu

Ksenija Gasic
Clemson University, Clemson, SC; kgasic@clemson.edu

Nahla Bassil
USDA–ARS, NCGR, Corvallis, OR; Nahla.Bassil@ars.usda.gov

Jonathan Fresneda
University of California, Davis; jfresnedoramirez@ucdavis.edu

Alejandra A. Salgado
Virginia Tech, Blacksburg, VA; alsalgado@vt.edu

Paul Sandefur
Washington State University, Pullman; psandefur@email.wsu.edu

David H. Byrne
Texas A&M University, College Station; d-byrne@tamu.edu

Thomas Gradziel
University of California, Davis; tmgradziel@ucdavis.edu

The RosBREED project (http://www.rosbreed.org/) has successfully identified functional alleles associated with nine important peach traits: Fruit resistance to bacterial spot (Xap1 and Xap6), maturity date (G4mat), fruit type (G), blush, flesh color (Y), texture type (F-M), acidity (D), acidity and soluble solid content (G7Flav), and mealessness. Forty-eight single nucleotide polymorphism (SNP) markers significantly associated with these phenotypic traits and capable of distinguishing all functional alleles were selected and divided into two 24-SNP mini arrays. Two DNA service providers [University of Arizona Genetics Core (UA) and BioDiagnostics (BDI)] were charged with the design and testing of the mini SNP arrays. Leaf samples from 240 breeding selections or seedlings as well as control samples from the four RosBREED peach demonstration breeding programs [University of Arkansas (UofA), Clemson University, Texas A&M University and University of California, Davis] were genotyped with the arrays. Genotyping data were successfully translated into trait predictions and results were provided to each breeding program. Depending on the material genotyped, genotypic data accurately predicted phenotypic performance in 80–90% of cases across material from all breeding programs. The additional 20–10% of material required specific attention to assigning the correct haplotypes to the correct phenotypes. By associating phenotypic data with genotypic data, this molecular information was validated and for the first time put into use in the UofA breeding program. The first step to advance toward marker-assisted breeding (MAB) involves marker-assisted parent selection (MAPS), thus a MAPS breeders template was created for the 72 individuals included on the mini-SNP array v1, and the 21 cultivars and selections on the 9K Peach SNP array v1. Crosses were designed using this molecular information in February 2014 to extend and diversify the later part of the Arkansas peach season: both melting, non-melting, and non-softening flesh types, peach and nectarine, white and yellow flesh, high and low acid, high blush and resistance to bacterial fruit spot. This template will be modified as more material becomes genotyped and additional traits become
incorporated, to enhance continual future use of MAPS in the program. Additionally, primers for simple sequence repeat (SSR) markers located within the validated SNP marker haplotypes are being generated and validated for use in marker-assisted seedling selection (MASS). Overall, the collective impact of MAPS in the UofA breeding program is increased efficiency in developing superior peach cultivars that meet the needs and desires of both producers, shippers and consumers.

Specified Source(s) of Funding: RosBREED project (USDA NIFA Specialty Crops Research Initiative)

(251) Pedigree Based QTL Analysis (PBA) for Fruit Traits in the University of Arkansas Peach Breeding Program

Terrence Frett*
University of Arkansas, Fayetteville; tfrett@email.uark.edu

Alejandra A. Salgado
University of Arkansas, Fayetteville; asalgado@uark.edu

John R. Clark
University of Arkansas, Fayetteville; jrclark@uark.edu

Sujeet Verma
University of Florida, Wiamuama; sujeetgrrits@gmail.com

Paul Sandefur
Washington State University, Pullman; paul.sandefur@email.wsu.edu

Jonathan Fresno
University of California, Davis; jfresnedoramirez@ucdavis.edu

Ksenija Gasic
Clemson University, Clemson, SC; kgasic@clemson.edu

Marco Bink
Wageningen University and Research Center, Droevendaalsesteeg; marco.bink@wur.nl

Eric van de Weg
Wageningen University and Research Center, Droevendaalsesteeg; eric.vandeweg@wur.nl

Cameron Peace
Washington State University, Pullman; cpeace@wsu.edu

A genome-wide quantitative trait loci (QTL) analysis was conducted for peach ripening date and acidity using a pedigree-based analysis (PBA) approach with the University of Arkansas RosBREED peach and nectarine breeding program germplasm. A total of 1947 polymorphic single nucleotide polymorphism (SNP) markers and four years of ripening date and acidity data from six pedigree-connected F1 families were analyzed using FlexQTL™ software. Repeatable QTLs were detected at the G4mat locus on LG4 and the D locus on LG5 over four years. Approximately 60% of acidity variation was explained by genome-wide QTLs and 59% of that was solely explained by the D locus. In addition, nearly 75% of ripening date variation was explained by genome-wide QTLs, and approximately 74% was explained by the G4mat locus. No minor QTLs were detected for either trait. Haplotyping was conducted for both loci, and based on average effect the alleles were grouped into meaningful categories. Haplotypes associated with the G4mat locus were grouped into five categories [VE, E, M, L, VL], and haplotypes associated with the D locus were grouped into two categories [high and low] based on unselected material. An SSR marker, CPPCT040, was also used to screen RosBREED University of Arkansas germplasm at the D locus and alleles of this SSR marker were associated with high and low acidity. Genetic information of QTL alleles associated with ripening date and acidity will inform University of Arkansas peach and nectarine breeding program through development and implementation of DNA-based markers for genetic selection of desirable alleles and efficient development of improved cultivars.

Specified Source(s) of Funding: RosBREED - USDA NIFA Specialty Crops Research Initiative

(252) Functional Allele Validation for Bacterial Spot [Xanthomonas arboricola pv. pruni (Xap)] Fruit Resistance in Peach [Prunus persica (L.) Batsch]

Terrence Frett*
University of Arkansas, Fayetteville; tfrett@email.uark.edu

John R. Clark
University of Arkansas, Fayetteville; jrclark@uark.edu

Burton H. Bluhm
University of Arkansas, Fayetteville; bbluhm@uark.edu

Brant Smith
University of Arkansas, Fayetteville; bms010@email.uark.edu

Alejandra A. Salgado
University of Arkansas, Fayetteville; asalgado@uark.edu

Paul Sandefur
Washington State University, Pullman; paul.sandefur@email.wsu.edu

Cameron Peace
Washington State University, Pullman; cpeace@wsu.edu

Ksenija Gasic
Clemson University, Clemson, SC; kgasic@clemson.edu

Bacterial spot [Xanthomonas arboricola pv. pruni (Xap)] is a serious disease of Prunus sp. that causes premature defoliation, weak vigor of the plant, unmarketable fruit, and decline in production. Effective control methods are lacking; anti-bacterial sprays (copper-based compounds and oxytetracycline), are only partially effective in a low to medium disease pressure year and not effective at all in a high disease pressure year. Incorporating bacterial spot resistance in newly developed peach cultivars is a more promising control measure and has been a key trait of interest in peach breeding programs. Eight functional alleles, four at each QTL (Xap1 and Xap6, R1, R2, I and S respectively) associated with Xap resistance in peach fruit, have been identified in the RosBREED peach Crop Reference Set (CRS). The University of Arkansas breeding material comprises all detected Xap alleles and this program has never sprayed to control the disease in the 50-year effort. Thus selections against Xap have been possible particularly in the
warm and humid environment in Arkansas, which favors Xap infection and disease development. The goal of this study was to provide evidence of phenotypic performance for all alleles at Xap1 and Xap6 loci. Preliminary results from 2013 show that individuals homozygous for susceptible alleles (S1:S1 and S6:S6) at both loci were significantly more susceptibility to fruit Xap in comparison to homozygous resistant individuals (R1:R1 and R6:R6) \( (P < 0.0001^*, \text{Tukey HSD}) \). Significant differences were not observed when comparing individuals homozygous for intermediate alleles (I1:I1 and I6: I6) with homozygous resistant (R1:R1 and R6:R6) and homozygous susceptible individuals (S1:S1 and S6:S6). A second year of phenotypic evaluation in 2014 of the same individuals and additional 2010 seedling populations, including field and controlled inoculations, will lead to further validation of all alleles at Xap1 and Xap6 loci. Additionally the SNP haplotypes at both loci are being converted into breeder friendly DNA tests for widespread adoption of marker-assisted breeding (MAB) for bacterial fruit spot resistance.

Specified Source(s) of Funding: RosBREED–USDA NIFA Specialty Crops Research Initiative

**253) Evaluation of Peach x Almond Hybrids for Fungal Gummosis Resistance**

Daniel A. Mancero-Castillo*

University of Florida, Gainesville; dmancero@ufl.edu

Thomas Beckman

USDA–ARS, Byron, GA; tom.beckman@ars.usda.gov

J.X. Chaparro

University of Florida, Gainesville; email6@email.com

Peach trees in the Southeastern United States are damaged by fungal gummosis [incited by *Botryosphaeria dothidea* (Moug.:Fr.) Ces. & De Not.] with a fruit yield reduction up to 40% per tree in severe cases. Previous studies indicated a high level of susceptibility in commercially recommended rootstocks and cultivars. The climatic conditions in the Southeastern United States are conducive to the development of the disease and currently, there are no proven effective cultural or chemical controls for peach fungal gummosis. Our group has evaluated peach germplasm for over two decades, searching for sources of resistance to peach fungal gummosis. Preliminary research in our lab indicates that almond, a species closely related and sexually compatible with peach, may provide a new source of genes for resistance to peach fungal gummosis. Preliminary tests comparing commercial quality peach cultivars with peach x almond F1 hybrids indicated the existence of a novel source of resistance to gummosis. Parental genotypes and segregating backcross populations of peach x almond F1 hybrids, and peach x (peach x almond) progeny were evaluated for 3 consecutive years using a previously established rating system based on gummosis severity. Selected peach x almond F1 hybrids presented the lowest mean for gummosis susceptibility. Pearson chi-square analysis of the disease rating data suggested a dependent segregation of the populations for gummosis. Further analysis of the standardized residuals deviations identified differences in backcross population 8 (UFSharp x (Flordaguard x almond)). The phenotypic segregation ratio for fungal gummosis resistance is consistent with the presence of a single dominant locus. Backcross population 8 has been genotyped for SSR markers sourced from the *Prunus* reference genome map and Quantitative Trait Locus (QTL) analysis will be performed.

**254) Identifying Sand Pear Cultivar S-genotypes Using Gene Chips**

Nan Jiang

Hunan University of Technology; Central-south University of Forestry and technology, zhuzhou; changsha; 530949968@qq.com

Xiaofeng Tan*

Key Laboratory of Cultivation and Protection for Non-Wood Forest Trees, Ministry of Education, Central South University of Forestry and Technology, Hunan 410004; tanxiaofengcn@126.com

Lin Zhang

Key Laboratory of Cultivation and Protection for Non-Wood Forest Trees, Ministry of Education, Central South University of Forestry and Technology, Changsha; 398240510@qq.com

Donglin Zhang

University of Georgia, Athens; donglin@uga.edu

Hong-xu Long

Key Laboratory of Cultivation and Protection for Non-Wood Forest Trees, Ministry of Education, Central South University of Forestry and Technology, Hunan, 410004; xiaolong_001004@sina.com

Pear is a popular fruit and has been cultivated for its fruit production around the world. However, its yield depends on the combination of various cultivars because of its self-incompatibility of gametophyte controlled by a single locus and multiple S allele genes. Different S genotype varieties have to be properly mixed in cultivation for regular pollination and fertilization and successfully fruiting and breeding. Sand pear has 700 varieties and majorly cultivated in southern China for fresh fruit markets. Among them, S genotype had been completely identified for only 40 varieties and further studies on the identification of S multiple allele genes and its sequence analysis should be carried out about 85% of varieties. Conventional S genotype identification of pear varieties requires enormous investment, complicated technology, and time-consuming. Based on S multiple allele genes of pear varieties in China, by means of 3’ RACE technology, identified cDNA, and gene group sequence of 47 S genes, oligonucleotide microarray and cDNA chips for detection of S gene were established. From the pedigrees and origin of sand pear varieties and the chips, genotypes of pear varieties, especially their S genes, should be identified. Analyses on cloning, sequencing, and homology of the newly discovered unknown S genes should be further investigated. The studies should present a thorough investigation of pear S gene resources from southern China, identify S genotypes of pear varieties, and provide an important
scientific basis for the innovation and high-yield cultivation systems of sand and other pears in southern China.

Specified Source(s) of Funding: the National Natural Science Foundation of China (31272124)

(255) ‘Gem’: A New Precocious, Productive Pear Cultivar

Richard L. Bell*
USDA–ARS, Kearneysville, WV; richard.bell@ars.usda.gov

Tom van der Zweit
USDA–ARS, Agricultural Research Service, Kearneysville, WV; wizzardclip@aol.com

Steven P. Castagnoli
Oregon State University, Hood River, OR; steve.castagnoli@oregonstate.edu

Todd Einhorn
Oregon State University, Hood River; todd.einhorn@oregonstate.edu

Janet D. Turner
Oregon State University, Hood River; janet.turner@oregonstate.edu

Robert Spotts
Oregon State University, Hood River; Robert.Spotts@oregonstate.edu

Gary A. Moulton
Washington State University, Mount Vernon; gamoulton@wavecable.com

Gregory L. Reighard
Clemson University, Clemson, SC; grghrd@clemson.edu

William W. Shane
Michigan State University, Benton Harbor; shane@msu.edu

‘Gem’ is a new cultivar which combines excellent appearance, fruit quality and long storage potential with precocious and high yields. Fruit color is a light green when mature, and frequently has a red blush on the sun-exposed side. It can be eaten immediately after harvest and after storage without softening, due to a crisp, juicy texture; in this condition, the flavor will be sweet. The fruit will also soften to a melting texture if stored for two months in common air refrigeration, after which it will develop a lightly aromatic flavor. Harvest maturity begins 8 days after ‘Bartlett’, but can be harvested over a three week period without loss of storability up to five months. Trees on OHxF 97 rootstock at Hood River, Oregon have flowered and fruited as early as two years after planting, with early yield, five-year cumulative yields, and yield efficiency greater than ‘Beurré d’Anjou’. Fruit size on unthinned trees averaged 150 g, but thinning and delayed harvest increased fruit size to 259 g. At Kearneysville, WV, resistance to epiphytotic fire blight resistance was moderate, but resistance to artificial shoot infection was high. No infections occurred in trials in Michigan. ‘Gem’ was jointly released by the U. S. Department of Agriculture, Oregon State University, Michigan State University, and Clemson University.

Specified Source(s) of Funding: USDA–ARS CRIS Project 1931-21000-017-00D

(256) Marker–Assisted Seedling Selection in Sour Cherry for Fruit Color and Cherry Leaf Spot Resistance

Fransiska R.A. Basundari*
Michigan State University, East Lansing; basundar@msu.edu

Travis Stegmeir
Michigan State University, East Lansing; stegmeir@msu.edu

Audrey Sebolt
Michigan State University, East Lansing; grantzau@msu.edu

Amy F. Iezzoni
Michigan State University, East Lansing; iezzoni@msu.edu

Michigan is the leading producer of sour cherry (Prunus cerasus L.) in the United States. The goal of the sour cherry breeding program at Michigan State University is to develop new cultivars that are resistant to the major disease affecting sour cherry [cherry leaf spot (CLS), Blumeriella jaapii] and have the fruit type desired by the industry. To increase the efficiency and reduce the number of years to reach these breeding goals, new genetic tests have been developed through RosBREED (www.rosbreed.org) to implement marker-assisted seedling selection (MASS) for these two target traits. Sour cherry fruit color variations widely from dark purple skin and flesh, to orange skin with colorless flesh due to differences in anthocyanin pigmentation. The processing industry desires a sour cherry that has brilliant red flesh, as that is the market niche in the U.S. The genetic test developed for fruit color targets the anthocyanin transcription factor that controls flesh color located on linkage group 3 (LG3). Resistance to CLS is a high industry priority as more pesticides per acre are applied for this disease than any other pest of sour cherry. One major QTL controlling P. canescens-derived CLS resistance was identified on linkage group 4 (LG4). Any cherry individual must have this resistance QTL to be CLS resistant. DNA tests, using SSR primers developed to tag the desired alleles for CLS resistance and fruit color, have been developed. Seedling progeny from crosses made in 2013 are anticipated to segregate for fruit color and CLS resistance and DNA tests will be performed on these families for MASS. This MASS will be able to determine the seedlings that are predicted to be CLS resistant and have brilliant red fruit color. The implementation activities and the results of MASS for these two traits will be presented.

(257) Selection of SSR Markers for the Identification of Zygotic Seedlings in Citrus Rootstock

Emily E. Becks*
University of Florida, Gainesville; ebecks@ufl.edu

Rachel Odom
University of Florida, Gainesville; ctigress@ufl.edu

José Chaparro
University of Florida, Gainesville; jaguey58@ufl.edu

Most citrus rootstocks are clonally propagated via seed in Florida. Citrus rootstocks are typically selected to have high
levels of nucellar embryony, a type of P apomixis, to ensure that propagation is true to type. The spread of the Huang-Long-Bing disease in Florida has significantly increased the demand of citrus rootstocks for the propagation of replants to replace dying trees. Unfortunately many of the rootstock varieties are also susceptible to citrus greening and this has reduced the availability of rootstock seed. The increased demand for rootstocks has enhanced interest in using tissue culture for the clonal propagation of citrus rootstocks. The use of seed to initiate in vitro cultures of citrus rootstocks requires the fingerprinting of the resulting seedlings to ensure that the cultures are initiated from clonal ‘true to type’ seedlings of the seed parent. Microsatellite (SSR) markers are an excellent tool for the fingerprinting of citrus because the loci typically have multiple alleles, and are likely to be polymorphic in rootstock cultivars. A set of 20 SSR primers was screened on a panel of 619 citrus cultivars and selections to identify highly informative markers that were heterozygous in the rootstock cultivars being tested. A diagnostic set of five-makers that were heterozygous in each of the citrus rootstock cultivars was selected. DNA was extracted from seedlings from 14 different citrus rootstock cultivars. The SSR genotypes of the seedlings were compared with the seed parent genotype to determine if they were of zygotic or nucellar origin. The Sour Orange, US 802, US 942, and Cleopatra rootstocks had 100% nucellar progeny, all being genetically identical to the parent, and only two cultivars, Sun Chu Sha and Rough Lemon, had greater than 10% zygotic progeny. The remaining 8 cultivars had between 1% and 10% zygotic seedlings, which is a relatively low percentage. These results indicate that SSR genotyping of clones derived from embryonic tissue is very effective and efficient for the identification of zygotic progeny.

(258) Cybrids between Dancy Tangerine (Citrus reticulata Blanca) and Grapefruit (Citrus paradisi Macf.) for Improvement of Citrus Fruit Traits

Aditi D. Satpute*
University of Florida/IFAS, Lake Alfred; aditisatpute@ufl.edu

Jude W. Grosser
University of Florida/IFAS, Lake Alfred; jgrosser@ufl.edu

Qibin Yu
University of Florida/IFAS, Lake Alfred; qibin@ufl.edu

Chunxian Chen
USDA–ARS, Byron, GA; chencx2k@gmail.com

Peng Ling
University of Florida/IFAS, Lake Alfred; pling@ufl.edu

Fred G. Gmitter
University of Florida/IFAS, Lake Alfred; fgmitter@ufl.edu

Melinda Grosser
University of North Carolina Chapel Hill; mgrosser@email.unc.edu

Christine D. Chase
University of Florida, Gainesville; cdchase@ufl.edu

In cybridization, new combinations of nuclear and cytoplasmic genes result in a unique genotype that may bring cellular, physiological and biochemical changes to the plant. This has been demonstrated in cybrids generated from the fusion of citrus protoplasts in two independent experiments. The first experiment was conducted to potentially generate a seedless triploid by fusing diploid protoplasts of embryogenic ‘Dancy’ tangerine (Citrus reticulata Blanca) suspension cultured cells with haploid ‘Ruby Red’ grapefruit (Citrus paradisi Macf.) protoplasts derived from microspores. Only one triploid was recovered, but several diploid plants with typical grapefruit morphology were also regenerated. In the second experiment, protoplasts derived from embryogenic ‘Dancy’ tangerine suspension culture were fused with non-embryogenic protoplasts from ‘Duncan’ grapefruit leaves. The fruits from the resulting trees resembled grapefruit in morphology and fruit type, and maintained good fruit flavor and quality. Furthermore, fruits obtained from trees in the first experiment retained excellent quality throughout the summer, when commercial grapefruit rapidly lose quality. Fruits on these trees remain firm with exceptional sweetness and good flavor into August, with no seed germination. The regenerants obtained in the protoplast fusion experiments were confirmed as cybrids by genetic marker analysis. The nuclear genotype of the test grapefruit was determined at seven nuclear SSR marker loci, with all alleles identical to those of commercial ‘Ruby Red’ grapefruit. The mitochondrial genome in the test grapefruit trees was shown by mitochondrial intron marker analysis to have originated from the embryogenic ‘Dancy’ cultures, whereas the plastid genomes of individual trees originated from either fusion partner. Apparently in the first experiment, haploid protoplast preparations also contained diploid protoplasts, which fused with the ‘Dancy’ suspension culture protoplasts, resulting in cybrid cells following the loss of the ‘Dancy’ nucleus. Apart from the value of altered fruit quality attributes in the market, these plants provide an opportunity to understand the contributions of cytoplasmic organelle genetics to important citrus fruit breeding objectives.

Monday, July 28, 2014

Growth Chambers and Controlled Environments 1

(147) Creating Novel Basil (Ocimum basilicum) Flavors and Aromas with Light-emitting Diodes

Sofia D. Carvalho*
University of Florida, Gainesville; scarvalho@ufl.edu

Michael L. Schwieterman
University of Florida, Gainesville; schwiet@ufl.edu

Thomas A. Colquhoun
University of Florida, Gainesville; ucntcmel@ufl.edu

Kevin M. Folta
University of Florida, Gainesville; kfolta@ufl.edu

The flavors and aromas of fresh herbs are derived from a combination of genetic and environmental factors. The peculiar aromas of sweet basil are the base for its high consumer appre-
ciation as a food product. Basil aromas are built from dozens of volatile organic compounds. These molecules also possess antioxidant and antimicrobial activities. Creating tools to alter aroma-related compounds can allow creating novel basil flavors with a possible simultaneous increase in health beneficial effects. Plant growth and development, and pigments and metabolites accumulation, including aroma-related compounds, are highly influenced by environmental cues, with light being one of the most important. Use of light emitting diodes (LEDs) has shown that different portions of the spectrum affect distinct aspects of plant growth. GC-MS analyses revealed that exposing basil to selective narrow bandwidth light sources, ranging from blue to far-red wavelengths, alter aromatic qualities in leaves. Specific light qualities may be used in combination to create desired aromas. This approach has shown to be successful on adult white light-grown basil plants transferred for 5 days to LED chambers, suggesting it can be easily introduced in production chains at preharvest stages.

(148) Growth Responses of Greenhouse Tomato Seedlings to Different Spectra of Supplemental Lighting Are Season-specific in a Northern Climate

Celina Gomez*
Purdue University, West Lafayette, IN; cgomezva@purdue.edu
Cary A. Mitchell
Purdue University, West Lafayette, IN; cmitchel@purdue.edu

Arrays of red (R) and blue (B) light-emitting diodes (LEDs) were compared to a high-pressure sodium (HPS) lamp as supplemental lighting (SL) sources to propagate greenhouse-grown tomato seedlings in a temperate climate (lat. 40°N, long. 86°W). Six tomato cultivars were grown monthly throughout a year in a glass-glazed greenhouse. Five lighting treatments were evaluated: natural solar light only (control), natural + SL from a 100-W HPS lamp, or natural + SL from LEDs using either 80% R + 20% B, 95% R + 5% B, or 100% R. A variant solar daily light integral (DLI) occurred naturally for all treatments while a constant DLI of 5.1 mol·m⁻² per day was provided to all SL treatments. Supplemental lighting generally increased hypocotyl diameter, epicotyl length, shoot dry weight, leaf number, and leaf expansion relative to control across seasons, whereas hypocotyl elongation generally decreased when SL was applied. Overall, growth benefits of SL were greatest during low-ambient DLI. These results suggest that light-quality effects on tomato seedling growth from different SL treatments are season-specific and affected by ambient solar DLI. In general, a combination of R and B in SL stimulated growth and productivity for tomato seedlings during winter and summer (lowest- and highest-solar DLI, respectively), whereas fewer treatment differences were observed during milder-solar DLI spring. The addition of B light has potential to stimulate overall seedling growth compared to B-deficient SL treatments in northern climates. However, the effectiveness of growth enhancement seems to depend on the SL spectrum used.

Specified Source(s) of Funding: The research was funded in part by NIFA SCRI grant 2010-51181-21369.

(149) Evaluation of Light-emitting Diode and Metal Halide Supplemental Lighting for Greenhouse Bibb Lettuce Production in the Midwest United States

Natalie R. Bumgarner*
CropKing, Inc., Lodi, OH; nbumgarner@cropking.com
Johann Buck
Hort Americas, Euless, TX; jbuck@hortamericas.com

Controlled environment vegetable production is an expanding sector in horticulture in the US due both to consumer demand for locally produced crops as well as environmental concerns. However, many regions experience winter light levels that reduce growth rate and salable produce. Leafy crops are attractive for supplemental lighting in greenhouse operations due to lower light requirements than fruiting crops, allowing growers to enhance production with lower capital investments and operation costs. A key current grower question is the potential for light emitting diode (LED) technology to augment or replace high intensity discharge lighting (HID) in greenhouse vegetable production. This work is intended to evaluate LED and HID lighting compared with natural lighting in bibb lettuce crops in Ohio winter and spring production. All crops were produced in a double layer polyethylene greenhouse in Lodi, OH, and two runs of the experiment were carried out from January through March, 2014. Two commercial bibb lettuce (Lactuca sativa) cultivars (‘Flanida’ and ‘Teodore’) were grown using the nutrient film technique with solutions maintained at 1.8–2.0 mS·cm⁻¹ electrical conductivity (depending on ambient conditions) and 5.9 pH. Following a 96-hour germination period, seedlings were produced under lighting treatments for approximately two weeks prior to transplanting, and then harvested after an additional four weeks in the NFT channels. Three lighting treatments were compared including: 1) a naturally lighted control, 2) supplemental HID lighting (400W metal halide; PARSource, Petaluma, CA), and 3) LED lighting (Philips GreenPower deep red/blue, Eindhoven, The Netherlands). Supplemental lighting was installed to provide similar average light intensity of 100 μmol/m²/sec. Lights were operated for 16 hours per day in run one and 12 hours per day in run two to provide an additional 5.8 and 4.3 mol/m²/day, respectively, for both lighting treatments. Fresh shoot weight was measured on harvested plants along with a chlorophyll content index (CCM-200, Opti-Sciences, Hudson, NJ) and tipburn rating. Supplemental lighting showed biomass increases over controls of 193% and 104% in metal halide and 252% and 164% in LED in runs one and two, respectively. However, the potential for quality impacts, including increases in the chlorophyll content index and tipburn, were also observed in both lighting treatments. These experiments indicate opportunities for alternative lighting to impact crop yield during winter and spring greenhouse production, but illustrates that growers implementing supplemental lighting should be aware of the potential for crop quality impacts.

An asterisk (*) following a name indicates the presenting author.
High-quality bedding plant seedlings or plugs are compact, fully rooted transplants with a large stem caliper and high root dry mass. Controlling stem elongation is essential to producing a high-quality plug. End-of-day lighting (EOD) has been shown to promote or suppress stem elongation in certain plants. A high red:far-red ratio (R:FR) or blue (B) light has been used to suppress stem elongation while a low R:FR increases stem elongation in EOD treatments. Two experiments were conducted to study the effects of EOD light treatments on seedling stem elongation. Seedlings of Cosmos, Impatiens, Pelargonium, and Petunia (Expt. 1) and Capsicum, Petunia, Solanum, and Tagetes (Expt. 2) were grown at 21 °C under an 8.5-h photoperiod of ambient solar light and supplemental light from high pressure sodium lamps (HPS) that provided a PPF of 50 µmol·m⁻²·s⁻¹ at canopy level. In Expt. 1, seedlings were placed under one of five EOD light treatments that delivered 30 min of light at the end of the photoperiod from either incandescent lamps (R:FR ≈0.78), compact fluorescent lamps ([CFL] R:FR ≈8.4), or LEDs that provided a photosynthetic photon flux (PPF) of 20 µmol·m⁻²·s⁻¹ of R:FR ≈212, 4.5, or 0.9, or a no EOD control. Similarly, in Expt. 2, seedlings were placed under one of five EOD light treatments that delivered a PPF of 20 µmol·m⁻²·s⁻¹ of varying proportions (%) R:B:FR light (100:0:0, 0:100:0, 75:25:0, 25:75:0, or 50:45:5) or a no EOD control. Only Petunia was significantly affected by light treatment for both experiments. In Expt. 1, height of Petunia was greatest under LEDs providing a R:FR ≈0.9 compared to other treatments in experiments. In Expt. 2, stem elongation of Petunia was reduced by 11%, 11%, and 10% for plants grown under 100:0:0, 75:25:0 and 25:75:0 R:B:FR LEDs, respectively, compared to 50:45:5 R:B:FR LEDs. Seedling height and quality were generally unaffected by EOD treatments.

Specified Source(s) of Funding: Specialty Crop Research Initiative award no. 2010-51181-21369

(150) End-of-day Manipulation of Phytochrome and Chryptochrome Using Light-Emitting Diodes Has Limited Effect on Bedding Plant Seedling Stem Elongation

Wesley Randall*
 Purdue University, West Lafayette, IN; wrandal@purdue.edu

Robert G. Lopez
 Purdue University, West Lafayette, IN; rglopez@purdue.edu

High-quality bedding plant seedlings or plugs are compact, fully rooted transplants with a large stem caliper and high root dry mass. Controlling stem elongation is essential to producing a high-quality plug. End-of-day lighting (EOD) has been shown to promote or suppress stem elongation in certain plants. A high red:far-red ratio (R:FR) or blue (B) light has been used to suppress stem elongation while a low R:FR increases stem elongation in EOD treatments. Two experiments were conducted to study the effects of EOD light treatments on seedling stem elongation. Seedlings of Cosmos, Impatiens, Pelargonium, and Petunia (Expt. 1) and Capsicum, Petunia, Solanum, and Tagetes (Expt. 2) were grown at 21 °C under an 8.5-h photoperiod of ambient solar light and supplemental light from high pressure sodium lamps (HPS) that provided a PPF of 50 µmol·m⁻²·s⁻¹ at canopy level. In Expt. 1, seedlings were placed under one of five EOD light treatments that delivered 30 min of light at the end of the photoperiod from either incandescent lamps (R:FR ≈0.78), compact fluorescent lamps ([CFL] R:FR ≈8.4), or LEDs that provided a photosynthetic photon flux (PPF) of 20 µmol·m⁻²·s⁻¹ of R:FR ≈212, 4.5, or 0.9, or a no EOD control. Similarly, in Expt. 2, seedlings were placed under one of five EOD light treatments that delivered a PPF of 20 µmol·m⁻²·s⁻¹ of varying proportions (%) R:B:FR light (100:0:0, 0:100:0, 75:25:0, 25:75:0, or 50:45:5) or a no EOD control. Only Petunia was significantly affected by light treatment for both experiments. In Expt. 1, height of Petunia was greatest under LEDs providing a R:FR ≈0.9 compared to other treatments in experiments. In Expt. 2, stem elongation of Petunia was reduced by 11%, 11%, and 10% for plants grown under 100:0:0, 75:25:0 and 25:75:0 R:B:FR LEDs, respectively, compared to 50:45:5 R:B:FR LEDs. Seedling height and quality were generally unaffected by EOD treatments.

Specified Source(s) of Funding: Specialty Crop Research Initiative award no. 2010-51181-21369

(151) Ratio of Red to Far–Red Light-emitting Diodes Affects Growth and Cell Cycle of Lettuce Plants

Myung-jin Lee*
Chungbuk National University, Cheongju; lmj3428@chungbuk.ac.kr

Myung-Min Oh
Chungbuk National University, Cheongju; moh@chungbuk.ac.kr

As a popular artificial lighting source, light-emitting diodes (LEDs) with a short wavelength range are easily used to control light quality in plant factories. In this study, we investigated the effect of various combined ratios of red and far-red LEDs on growth and cell cycle of red leaf lettuce (Lactuca sativa L. ‘Sunmang’). Sixteen-days old lettuce seedlings were transferred into a growth chamber and cultivated under various combinations of red (R) and far-red (FR) LEDs (R/FR = 0.7, 1.2, 4.1 and 8.6, PPF 131.71 ± 7 µmol·m⁻²·s⁻¹, 12 h photoperiod) for 22 d. Red LEDs 100% (R100) and fluorescent lamps (control) were also irradiated to compare with R/FR treatments. Growth characteristics such as leaf length, leaf width, leaf area, fresh and dry weights of shoots and roots and SPAD value were measured at 11 d and 22 d of treatment. In addition, cell cycle was analysed every 2 d or 3 d until 20 d. As a result, fresh and dry weights of shoots and roots and leaf area of all R/FR treatments were higher than those of control at harvest. In particular, R/FR 1.2 showed the highest values among R/FR treatments. The number of leaves appeared to increase as R/FR increased. R/FR treatments including R100 significantly decreased specific leaf weight compared with control at 11 d of treatment but the specific leaf weight in R/FR 0.7, 1.2 and 8.6 was similar with that in control at harvest. All R/FR treatments led to longer leaf shape than control although no significant difference was observed among the treatments. In contrast, SPAD value in all R/FR treatments was lower than that in control. Cell cycle of lettuce leaves subjected to R/FR treatments appeared to increase from 4 d of treatment suggesting that R/FR LED treatments stimulate cell division of lettuce which was consistent with the growth results. In conclusion, this study suggested that R/FR 1.2 was the best ratio for lettuce growth among the treatments and R/FR should be considered when designing artificial lighting system in closed-type plant factories because it affects vegetative growth of leafy vegetables such as lettuce.

Monday, July 28, 2014: 1:00 PM

Marketing and Economics

(044) Are Consumers Willing to Pay Price Premiums for Newly Developed East Coast Broccoli Varieties?

Xiaoli Fan
Cornell University, Ithaca, NY; xf38@cornell.edu

Miguel Goméz
Cornell University, Ithaca, NY; mig7@cornell.edu

Thomas Björkman*
Cornell University Geneva, NY; tnb1@cornell.edu

Plant breeders in the “Developing an Eastern Broccoli Industry” project are developing new varieties adapted to growing conditions in the east. For economic viability, it is equally important to examine whether the new varieties are accepted by east coast consumers. In particular, east coast growers may benefit from the increased interest in locally- and regionally-produced foods in recent years. Therefore, we address the following question: Are east coast consumers willing to pay price premiums for these new varieties, which are produced...
An asterisk (*) following a name indicates the presenting author.

HortScience 49(9) Supplement—2014 ASHS Annual Conference

S275

locally/regionally? To shed light on this issue, we conducted a series of broccoli tasting experiments in Ithaca and Geneva (NY) in August, 2013. In these experiments, we manipulated broccoli attributes to assess how consumer willingness to pay is influenced by physical (e.g., crown appearance) and credence (e.g., origin) product attributes. In our experiments, over 140 subjects revealed their willingness to pay for one pound of broccoli crowns of three varieties (a west coast variety and two newly developed east coast varieties), where we manipulate information about the origin. We analyzed the experimental data using an econometric model based on random utility theory. We find that consumers are willing to pay a price premium between $0.22 and $0.30 for the local product, although the west-coast variety scores higher in appearance. Overall, the two new varieties have the potential to become a commercial success in the east coast.

(045) Does Local Label Bias Consumer Taste Bud and Choice Behavior: Evidence of a Strawberry Sensory Experiment

Chenyi He*
University of Florida, Gainesville; chenyi0617@gmail.com
Zhifeng Gao
University of Florida, Gainesville; zf ngo@ufl.edu
Charles A. Sims
University of Florida; Gainesville; csims@ufl.edu
Xin Zhao
University of Florida, Gainesville; zxin@ufl.edu

The demand for local food particularly for fresh vegetable and fruits, keeps increasing. Consumer claimed reasons of purchasing local food often include that local food are fresher, more environmental friendly and can support local community, which implies that the local information can affect consumer' perception of food quality. Previous marketing or consumer research mainly focused on the impact of local information/label on consumer preference as a credence attribute that is not observable even after purchasing the products. However, the local information of food may also influence consumer perception of the other two types of important attributes, search and credence attributes. Determining the impact of different types of attributes on consumer choice of food and the dynamics between these attributes is important for new product development and quality labeling strategies. In this study, we determined the impact of local information on consumer perception of strawberry search and experience attributes and how these three types of attributes affect consumer choice. We randomly divided 100 participants in a sensory experiment into two groups. In the first group, we didn’t tell participants that the strawberries was locally produced, and in the second group, consumers were told that the strawberries were grown on the farms within 100 miles. Participants first rated search attributes (size, color, etc.) of three boxes of strawberries in 16 oz clear plastic clamshells. Then they tasted berries and rated experience attributes (flavor and texture). Results show that providing local information significantly positively affect some of the search and experience attributes as well as their stated willingness to pay for the strawberries. In addition, consumer willingness to pay decreased after they tasted the strawberries no matter the local information was provided or not. However, when the local information was provided, the decrease in willingness to pay for some strawberries was much smaller than that without the provision of local information.

(046) Cost Estimation of Establishing a Cider Apple Orchard in Western Washington

Suzette P. Galinato
Washington State University, Pullman; sgalinato@wsu.edu
R. Karina Gallardo
Washington State University, Puyallup
Carol A. Miles*
Washington State University, Mount Vernon; milesc@wsu.edu

Cider apple production is increasing in Washington State where an estimated 204 acres were produced in 2010 and 256 acres in 2011. Common cider apple varieties grown include Kingston Black, Yarlington Mill, Brown Snout, Dabinett, Porter’s Perfection, among others. Fewer pesticide inputs are used for cider apples than for dessert apples, as minor surface blemishes are tolerated if yield and internal fruit quality are not affected. In western Washington cider apple production is not limited by environmental-induced diseases (e.g., scab) which otherwise limit apple production and yields. The objective of this study was to provide information on (1) the costs of equipment, materials, supplies, and labor required to establish and produce a cider apple orchard in western Washington; and (2) the ranges of price and yield levels at which cider apple production would be a profitable enterprise. The study outlined baseline production assumptions for a 10-acre cider apple orchard based on input from producers, including a productive orchard life of 25 years, with four years of establishment and 21 years of full production; and crop yield of 5 bins/acre, 12 bins/acre and 46 bins/acre during Years 3, 4 and thereafter, respectively. Furthermore, the baseline price received for a 900-lb bin of cider apples was $315 ($0.35 per lb). Study findings indicated that a producer will start to receive positive net returns after four years. For a fully established cider apple orchard, a producer would expect about $2,400 per acre of net returns based on a yield of 46 bins/acre at $315/bin, and the break-even return was estimated at $263/bin ($0.29 per lb). The cost of investing in the cider apple orchard was estimated to be recovered after 14 years. Changing the price level while holding all else constant, the investment cost would not be recovered within the productive life of the orchard if the price received for cider apples was $290/bin ($0.32 per lb). At higher prices of $350/bin ($0.39 per lb) and $400/bin ($0.44 per lb), the estimated payback periods were 10.06 years and 7.71 years, respectively. Given the baseline yield, price and production costs, study results show that it would be economically feasible to produce cider apples in western Washington.
Certified organic apples represented 3.4% of the total sales ($121.4 million) of all organic produce in the United States in 2011 (USDA–NASS, 2012). Washington State accounted for 84.0% of those certified organic apple sales, followed by California (10.2%), Arizona (2.0%), Michigan (1.2%) and Colorado (1.1%). The southern states tend to lag behind these states in both acres harvested and certified organic apple sales (USDA–NASS, 2012). Mon and Holland (2006) have shown that organic apples can be both profitable and sustainable in the Pacific Northwest; however, there is limited experience and published research on organic apple orchard profitability in the southern region. Surveys of southern stakeholders indicated that great opportunities exist for markets of both fresh and processed fruit, but significant challenges still exist. These challenges include a lack of information available on the economic impacts of different organic production practices and the potential returns available from organic production. In response to these challenges, the University of Arkansas has been conducting research and developing tools to help potential local and regional organic apple producers to achieve their production and economic goals. Consequently, the objective of this poster is to show the benefits of a new organic apple decision support tool by presenting examples of the different economic analysis that the tool is able to estimate. For instance, the tool can use default data, information entered by the user or a combination of both to estimate the operation’s breakeven (price and yield) points, to conduct yield and price sensitivity analyzes (answering “What If” questions related to changes in costs and returns), and 3) to provide a risk assessment of the probability of obtaining positive net present values of net returns during the entire life of the organic apple orchard. All these economic analyses allow producers to compare between different production and marketing practices and assist them to make better planning and investment decisions in Arkansas and across the southern region.
Monday, July 28, 2014

**Organic Horticulture 1**

(058) Response of Blackberry Cultivars to Fertilizer Source in an Organic Fresh Market Production System

Javier Fernandez-Salvador*
Oregon State University, Corvallis; avifernandezs80@gmail.com
Bernadine C. Strik
Oregon State University, Corvallis; strikb@hort.oregonstate.edu
David Bryla
USDA–ARS, Corvallis; david.bryla@ars.usda.gov

Blackberry (*Rubus* L. subgenus Rubus Watson) cultivars, three trailing types (‘Marion’, ‘Black Diamond’, and ‘Obsidian’) and one semi-erect type (‘Triple Crown’), were studied from 2011–2012 at a certified organic, grower site located in Jefferson, OR. Plants were fertilized with 56 kg·ha⁻¹ N each spring using three different sources: 1) a liquid fish and molasses blend (4·0·2); 2) pelleted soybean meal (8·1·2); and 3) pelleted, processed poultry litter (4·3·3). Plants were drip irrigated, and weeds were managed using a polypropylene, permeable landscape fabric. Marketable yield differed significantly between years, and total yield, berry weight, firmness, and percent soluble solids were affected significantly by year x cultivar. ‘Triple Crown’ produced the greatest yield in both years, whereas ‘Black Diamond’ and ‘Marion’ had the lowest yield in 2011 and 2012, respectively. ‘Triple Crown’ fruit had the highest percent soluble solids and were the least firm in 2011, while ‘Marion’ fruit were the least firm in 2012. The effect of fertilizer source on yield and fruit quality was relatively small and was inconsistent among cultivars and years. Soy meal produced the greatest total yield in ‘Triple Crown’ in 2011 and in ‘Obsidian’ in both years. In contrast, poultry and fish produced the greatest total yield in ‘Black Diamond’ in 2011, and fish produced the greatest yield in ‘Black Diamond’ and ‘Marion’ in 2012. Fruit weight differed more among the four cultivars, particularly when plants were fertilized with soy than with poultry or fish in 2011, but was not significantly different among the three fertilizers within each cultivar in either year. Most soil nutrient levels were within the recommended range for all fertilizer treatments, except for B, which declined to deficient levels in the second year. Fertilizer source had no effect on soil nutrient levels other than fertilization with fish increased soil K and Na. Primocane leaf tissue nutrient concentrations were above or within recommended standards for most nutrients, except for Mg, Ca, and B, which, depending on the cultivar, were below standards. Over the 2-year study, the cultivars responded similarly to the three sources of organic fertilizer. The cost per kg N, however, varied from $18.00 for the liquid fish and molasses blend, $11.80 for the soybean meal, and $5.60 for the poultry litter. Supplemental fertilization with B, Mg, and Ca would be required with each fertilizer studied to maintain recommended soil fertility levels.

---

The vast majority of the strawberries grown in Arkansas are sold in local markets. The rapid in the number of Farmers’ Markets in Arkansas and the region combined with increasing demand by consumers for local produce has created lucrative opportunities for strawberry growers. Local strawberry growers are able to provide fresh and flavorful berries without spoilage and quality problems encountered when berries are shipped long distances. With new advances in plastic mulch and protected culture technologies, Arkansas growers have more opportunities to extend the strawberry season to meet the year-round demand. For the past three years, the University of Arkansas has evaluated extended season strawberry production using high tunnels. Our recent studies at the University of Arkansas, Fayetteville have yielded up to 2.25 lb/plant (compared to 1.0–1.5 lb/plant field production) and provided harvest from late fall through winter and into spring using a high tunnel plastic culture production system. This technology is adaptable throughout the South Central and Southeast United States. In this poster, we are presenting a decision support tool that allows strawberry growers evaluating the economic sustainability of two production systems (e.g., high tunnel and field production systems) by estimating and comparing the expected risk-return tradeoff of each system. The economic sustainability of each system will be evaluated by creating interactive strawberry budgets which allow three different economic analyses: 1) break-even analysis 2) sensitivity analysis and 3) risk analysis. These analyses will help to highlight any economic tradeoffs (for example between fruit quality and price received) that may exist when choosing between different off-season production systems. The interactive organic strawberry budget will be created using visual basic for applications (VBA-code) including numeric and graphical representations. This interactive tool will allow the user to select interest rate, planting density, high tunnel dimensions, expected yield, expected market prices, marketing venue (i.e., fresh market or processed market) and production practices; a detailed budget will be then calculated automatically. After creating the budget, the user can estimate break even, sensitivity and risk analyses. These analyses would provide the producer with much needed economic metrics by displaying the eventual real effects of alternative conditions and courses of action by highlighting risk-return tradeoffs that may exist between expected fruit quality and expected market prices. Comparisons among total costs, gross revenues and net returns will assist organic strawberry producers to make better planning, marketing and financial decisions.

Specified Source(s) of Funding: This project is funded by a grant from the Walmart Foundation and administered by the University of Arkansas System Division of Agriculture Center for Agricultural and Rural Sustainability.

An asterisk (*) following a name indicates the presenting author.
(059) Performance of Eight Strawberry Cultivars in Organically Managed High Tunnels for Fall and Spring Production in North Carolina

Sanjun Gu*
North Carolina A&T State University, Greensboro; sgu@ncat.edu

John Beck
North Carolina A&T State University, Greensboro; jebeck@ncat.edu

Aaron Moore
North Carolina A&T State University, Greensboro; jamoore2@ag.ncat.edu

Der Xiong
North Carolina A&T State University, Greensboro; dxiong@ncat.edu

In 2012, strawberry production in North Carolina ranked 4th in the United States. While most production continues to take place in open fields with conventional practices, strawberry production in high tunnels has been on the rise due to its potential high economic returns. Very little research has been conducted on cultivar evaluation and plant management techniques for organic strawberry production in high tunnels. Growers have found that many well performing field cultivars, for example ‘Chandler’, are ideal for high tunnels. The objective of this study was to investigate cultivars and plant management strategies that would lead to fall and the following spring production in organically managed high tunnels. Strawberry plugs of eight cultivars were planted in high tunnels at Greensboro and Lincolnton, North Carolina, in late August 2013. Cultivartypes included conditioned June-bearing, short-day, ever-bearing and day-neutral. Out of the eight cultivars, ‘Albion’ was first to bloom and produce fruit. ‘Camarosa’ and ‘Camino Real’ had significantly higher number of runners, while ‘Radiance’ (a short day cultivar) had the lowest. Cultivars performed differently at the two locations in terms of yield and pest incidence. At the Greensboro site, only four cultivars had produced marketable fruit and six had bloomed by the end of October. The total yield by December 31, 2013 ranged from 149.3 gram/replication for ‘Camarosa’ to 1009.7 for ‘San Andreas’, although no statistical difference existed. The low yield might be caused by severe two-spotted spider mites infestations. At the Lincolnton site, cultivars Benicia, Festival, Sweet Charlie, and Radiance had significant higher marketable yield and total yield than other cultivars. The Spider mites problem was less severe than the Greensboro site. Economical analysis indicates that the yield from both sites were too low to compensate for the cost of materials and labor for fall production. However, an earlier planting date at the end of July may speed up plant growth to allow for earlier harvest in the fall.

(060) Yield of Organically Grown Mango As Affected by Soil Applications of a Biostimulant Alga Extract

J. Pablo Morales-Payan*
University of Puerto Rico, Mayaguez; Morales.payan@upr.edu

Research was conducted in Lajas, Puerto Rico, to determine the effects of an extract of the marine alga Ascophyllum nodosum on the fruit yield of organically-grown ‘Curva’ mango. The orchard was managed following U.S. organic production regulations. The commercially-available alga extract formulation was labeled as having active ingredients equivalent to 0.01% kinetin. The alga extract was drench-applied in aqueous solution at the rates of 0 (control), 10, 20, 40, and 60 ml of extract per tree, starting at flowering and applying the same rates three more times at 14-day intervals. Fruit retention was determined every two weeks after the first extract application, while fruit number and size were determined at harvest. Alga extract rates did not significantly affect fruit retention and marketable fruit number. The alga extract rates of 40 and 60 ml per tree per application did not significantly affect fruit size. However, on average marketable fruits from plants treated with the rate of 20 ml of extract per tree per application were 13% larger than fruits from control trees.

(061) The Production of Organic Vegetables in the Southeastern United States in Reference to Sod-based Rotation and Strip versus Conventional Tillage

Peter C. Andersen*
University of Florida NFREC-Quincy; pcanld@ufl.edu

Chris Bliss
University of Florida NFREC-Quincy; cbliiss@ufl.edu

Brent V. Brodbeck
University of Florida NFREC-Quincy; bvb@ufl.edu

Cheryl L. Mackowiak
University of Florida NFREC-Quincy; echo13@ufl.edu

Stephen M. Olson
University of Florida NFREC-Quincy; smolson@ufl.edu

David L. Wright
University of Florida NFREC-Quincy; wright@ufl.edu

James J. Marois
University of Florida NFREC-Quincy; jmarois@ufl.edu

The Southeastern United States provides much of the nation’s spring, fall and winter vegetables, although it only represents only 0.3 % of the US organic production due to poor soils, high temperature/humidity/rainfall and high pest pressures. We have previously shown that two or more years of bahiagrass and strip tillage increase organic matter and reduce fertilizer and water inputs. The purpose of this study is to transition to organic vegetable production by: 1) variable years in bahiagrass pretreatment, and; 2) strip-till versus conventional tillage. We utilized yearly crop rotation of oats/ryegrass (winter cover), green beans (spring cash crop), soybeans (summer cover) and broccoli (fall cash crop). We quantified the increase in soil quality and chemistry with consecutive years in bahiagrass and the depletion of soil quality indices with the vegetable crop rotations. Available soil N and P decreased with increased years in bahiagrass, especially in Year 3. Potential carbon mineralization was not affected by treatments, possibly due to vegetation inputs from cover crops and weed biomass. Yields of green beans
and broccoli in our organic production system were usually comparable to that published for conventional production. In the initial year of the study, yields were consistently higher in conventional compared to the strip tillage treatments. However, in subsequent years, tillage effects were less apparent and yields were well correlated with years in bahiagrass pretreatment. In a companion study, plots that had initially been in bahiagrass for over twenty years maintained high yields in vegetables until the third year of continued vegetable production suggesting that benefits in soil quality from bahiagrass may begin to diminish in the third year of vegetable production. Increasing years in bahiagrass often reduced populations of Meloidgyne root-knot and Rotylenchus reniform nematodes. Weed communities were altered by bahiagrass pretreatment; rapid growth of grass and sedge species was more problematic in strip-till plots. Soil nutrient cycling enzymes and the soil microbial community were also studied.

Specified Source(s) of Funding: USDA NIFA ORG

(062) Tomato Yield, Plant and Soil Nitrogen as Affected by High Tunnel and Field Production Systems Under Conventional or Organic Fertility Treatments
May Elfar Altamimi*
Kansas State University, Manhattan; mtamimi@ksu.edu
Rhonda Janke
Kansas State University, Manhattan; rrjanke@ksu.edu

A multi-disciplinary experiment was initiated in 2008 to study crop yield, soil and plant nitrogen (N) when using organic versus conventional fertility amendments. Tomatoes (Solanum lycopersicum L. ‘Bush Celebrity’) were used to examine the effect of fertility rate (control, low, and high) and source [conventional (Conv) and organic (Org)] in two different production systems [high tunnel (HT) and field (F)]. The experiment was conducted in the summer of 2008–2010 at the KSU Research Center in Olathe in replicated HT and F plots with a consistent management since 2002. The experimental design was a split plot where control plots received no supplemental fertilizer, low plots received a 97 kg·ha⁻¹ of N of pre-plant fertilizer (Conv) or mixed source compost (Org), and high plots received the same pre-plant amendments plus 6.72 kg·ha⁻¹ of N per week of soluble fertilizers during the growing season (Conv) or fish hydrolyzate (Org). All plots had cover crops of rye (Secale cereale L.) during the winter. Soil NO₃-N and NH₄-N were measured, as well as NO₃-N in leaf petiole sap. Soil NH₄⁺-N and NO₃⁻-N levels were affected by production system, and fertility source and rate, but statistical significance varied by crop and stage. Petiole sap NO₃⁻-N reflected treatment regimes but not necessarily soil N status at each plant stage. Yield of tomato was significantly higher in HT than F. There were no significant differences in tomato yield between Org and Conv in either production system. Tomato yield differences were significant for fertility rate.

Specified Source(s) of Funding: SARE

(063) Organic Heirloom Tomato Response to Surface-applied High Poultry Compost Level
Lurline E. Marsh*
University of Maryland Eastern Shore, Princess Anne; lemarsh@umes.edu
Fawzy Hashem
University of Maryland Eastern Shore, Princess Anne; fmhashem@umes.edu
Corrie P. Cotton
University of Maryland Eastern Shore, Princess Anne; cpcotton@umes.edu
Brett D. Smith
University of Maryland Eastern Shore, Princess Anne; bdsmith@umes.edu

Poultry compost application to cropland is known as an inexpensive way to provide nutrients such as nitrogen to plants. However, environmental factors such as rainfalls may decrease the availability of nutrients to crops while increasing their runoff to water bodies. A field study was conducted in 2014 to evaluate the response of two organic heirloom tomato cultivars, Debarao Plum and Brandywine Red on soils that were surface amended with the following four treatments of high compost levels and vesicular arbuscular mycorrhiza (VAM); control, VAM at 5 g/m², compost at 3.375 tons /acre and VAM plus compost. Plants from the poultry compost treatment generally had highest leaf chlorophyll content, shoot height, and number of branches in the vegetative and reproductive phases. During the first seven weeks after transplanting, plants experienced excessive rainfall of 19.4 cm; thereafter, all plants exhibited purple leaf coloration and leaf chlorosis. Although tests of soils and leaves showed no phosphorus deficiency, nitrogen deficiency was reported. The harvested tomatoes and the plant biomass from high compost treatments were significantly higher in yield and biomass than those from the treatments without compost. These results imply that a more efficient method of application than surface application should be investigated to optimize the usage of poultry compost fertilizer in order to decrease its wastages or runoff under excessive rainfalls conditions. The purple leaf disorder raises the alert for investigating this situation in future studies and finding ways to assess and address it.

Specified Source(s) of Funding: Evans Allen

(064) Yield of Tomato Cultivars Grown in the Organic Management in the U.S. Virgin Islands
Dilip Nandwani*
University of the Virgin Islands, Kingshill; dilipnandwani@yahoo.com

Shamali Dennery
University of the Virgin Islands, Kingshill; 900072062@myuvi.net

Vanessa Forbes
University of the Virgin Islands, Kingshill; VForbes@live.uvi.edu

Thomas Geiger
University of the Virgin Islands, Kingshill; thomas.geiger@uvi.edu

An asterisk (*) following a name indicates the presenting author.
Increasing food prices, food safety concern and environmental impact resulted more and more consumers seeking alternatives to conventional system of food production. Organic farming offers a welcome alternative as to bring benefits to make a positive impact on the environment, health, and future yields. Tomato (Solanum esculentum L.) is a highly valued vegetable and grown for fresh market in the United States Virgin Islands. Four cultivars ca. ‘Mountain fresh’, ‘Red Defender’, ‘Security 28’ and ‘Defiant’ were grown under organic management system at the Sejah farm, Kingshill. The experimental design was a randomized complete block and three replications for each cultivar grown in the field. Two trials were conducted in fall 2012 and 2013. Seeds were procured from Harris Seeds Co., NY, and planted in seedling trays containing organic compost. Crop was grown under organic management practices approved National Organic Program (NOP) and products listed by Organic Materials Review Institute (OMRI). Transplants were raised in the greenhouse and transplanted in the field 3 weeks after germination. Field was disk harrowed and roto-tilled. Plots were consisted of three rows spaced 4’ apart, with 12 plants per row spaced and 2’ between the plants within a row. Plants were tied and supported with T-posts (6’). The experimental design was a randomized complete block, with 3 replications. Plants were drip irrigated 2–3 times in a week as necessary. Data collected from plants #2-11 from center row on maturity, plant height, fruits weight, marketable fruits (US#1), and yield. Fields were scouted and monitored for insect pests and diseases by staff and Extension entomologists periodically. Weeds were controlled manually or mechanically. N, P, and K fertilizers obtained from Planet Natural Inc., Bozeman, MT and applied weekly basis. N, P, and K fertilizers obtained from Planet Natural Inc., Bozeman, MT and applied weekly basis.

Specified Source(s) of Funding: NIFA (Hatch)

An asterisk (*) following a name indicates the presenting author.

Juan Socorro Martínez-Pérez
Universidad de Colima, Tecomán, Colima; jsmartinezperez@hotmail.com

John E. Foster
University of Nebraska Lincoln; jfoster@unl.edu

Use of inorganic or chemical fertilizers and organic amendments are required in the agricultural systems for increasing the crop yields. The abuse in the use of chemical fertilizers has caused an increase in the soil and water contamination; however, the application of organic amendments improves the soil characteristics causing increase in plant growth and yield. Our aim was to evaluate the effect of sole organic amendments and combined with inorganic fertilizers on the agronomic traits and yield of corn. The experiment was conducted in field conditions under pressurized irrigation in Tecomán, Colima, México. Six treatments were evaluated, sole organic amendments were: bovine manure, sugarcane molasses, and vermicompost, and the combined treatments included the formula 150–50–00 Kg of Nitrogen, Phosphorus, and Potassium, respectively. Organic amendments were applied in a dose of 8 ton/ha. The treatments were distributed in a randomized complete-block design with four replications. Our results showed highly significant differences in combined treatments, single effects, and their interactions in plant height, ear equatorial diameter, ear length, ear grain yield, and grain yield/ha. The application of vermicompost combined with inorganic fertilizers showed the most significant results in all the agronomic traits and grain yield evaluated, producing 0.218 Kg, and 13.8 ton/ha in ear grain yield, and yield/ha, respectively. Our results sustain the integration of inorganic and organic fertilization to improve corn yields.

Monday, July 28, 2014

Propagation 1

(159) Pretreatment Effects on Seed Germination: An Interspecific Comparison of Two Nyssa Species
Frank D. Balestri*
Iowa State University, Ames; balestri@iastate.edu

William R. Graves
Iowa State University, Ames; graves@iastate.edu

The genus Nyssa gronov. ex L. includes several woody species with traits valued by horticulturists, but only Nyssa sylvatica Marsh. (black gum) is prevalent in the nursery trade. Although we hypothesize that a closely related species, Nyssa biflora Walt. (swamp tupelo), can be a useful tree for managed landscapes, little is known about propagating it from seeds. Embryos of Nyssa display moderate dormancies that may be overcome with cold, moist stratification. Fruits of Nyssa biflora were collected in 2013 from indigenous trees at two sites in Virginia and one site in North Carolina; fruits of Nyssa sylvatica were collected from trees at the Minnesota Landscape Arboretum. We compared germination of seeds (depulped drupes) of Nyssa
biflora and Nyssa sylvatica, and whole fruits (intact drupes) of Nyssa biflora after stratification at 5 °C for up to 112 days. Germination value of Nyssa biflora was as high as 0.60 for seeds stratified for six weeks, compared to non-stratified seeds that showed a germination value of 0.25. Germination percentage of Nyssa biflora was not affected by duration of stratification. Germination percentage of non-stratified seeds of Nyssa sylvatica was 1%, and germination increased only slightly after 14 days of stratification, increased more after 28 days, and was as high as 85% after 42 days of stratification. We conclude that seeds of Nyssa biflora are less resistant to germination than are seeds of Nyssa sylvatica. Mean germination percentage of Nyssa biflora over 0, 14, 28, and 42 days of stratification was 9.6% with pulp intact and 77.6% with pulp removed. We postulate that the pulp may contain germination inhibitors and recommend that propagators remove pulp before sowing seeds of Nyssa biflora.

Specified Source(s) of Funding: J. Frank Schmidt & Son Co.

Wholesale Tree Growers

(160) Micropropagation of a Selected Clone of Amelanchier alnifolia

Areej Ahmed Alosaimi*
University of Idaho, Moscow; are_ej_ahmed@hotmail.com

Robert R. Tripepi
University of Idaho, Moscow; btripepi@uidaho.edu

Shoots of serviceberry (Amelanchier alnifolia) propagated in tissue culture often fail to form roots readily. In vitro cultured shoots from a selected dwarf plant were examined for their ability to form roots when the basal salt concentration was adjusted or different plant growth regulators were used in the medium. Different concentrations of Murashige and Skoog (MS) salts were used (full, 1/2, 1/4, and 1/8 strength). In addition, the plant growth regulators indole-3-butyric acid (IBA) or naphthaleneacetic acid (NAA) at concentrations of 0, 0.5, 1, 5, or 10 µM were tested for their ability to induce root formation. The effects of 2 µM benzyladenine (BA) on root formation were tested by combining BA with five NAA concentrations. The 1/8 strength MS treatment induced 38% of the shoots to form roots, whereas roots failed to form on shoots grown on full strength MS medium. The mean number of roots per responding shoots was 1.6. Indole-3-butyric acid and NAA concentrations induced root formation on full strength MS medium. The best rooting was achieved with 10 µM IBA or 10 µM NAA, and the percentage of shoots forming roots was 33% for IBA treated and 67% for NAA treated shoots. The mean number of roots per responding shoot were 6.1 and 2.5 for 10 µM IBA and 10 µM NAA treated shoots, respectively. Shoots treated with BA combined with NAA formed callus at their bases but failed to form roots. This study demonstrated that 1/8 basal salt or 10 µM IBA or NAA were effective for inducing root formation on serviceberry shoots produced in vitro.

Specified Source(s) of Funding: Hatch funds Idaho agriculture experiment

(161) Rooting of Adult Stem Cuttings of Cupressus sempervirens L. ‘Stricta’

Yujuie Yang*
Central South University of Forestry and Technology, Changsha, Hunan; yangyujie910@gmail.com

Donglin Zhang
University of Georgia, Athens; donglin@uga.edu

Jinying Dong
University of Georgia, Athens; jdong@uga.edu

Xiaoling Jin
Central South University of Forestry and Technology, Changsha; jxl0716@hotmail.com

Zhuhui Li
Central South University of Forestry and Technology, Changsha, Hunan; lzh1957@126.com

Cupressus sempervirens L. ‘Stricta’ (Italian cypress), native to the eastern Mediterranean region, is widely cultivated as an ornamental tree all over the world because of its evergreen, drought, heat, and salt tolerance, wide pH adaptability, and narrow-upright habit. To meet the increasing market demand, we carried out the rooting experiment of adult stem cuttings in January 2013 and treated them with K-IBA at 1000, 3000, 8000 mg/L and talc Hormodin #1, #2, #3. Rooting hormone had significant effects on rooting of Italian cypress and all treated cuttings had greater rooting percentages and longer total root length than that of the control after six months. The highest rooting percentage, 56.3%, was obtained under the treatment of K-IBA at 3000 mg/L and both higher and lower concentrations reduced the rooting percentage and rooting quality. Cuttings treated with powdery hormone had rooting percentages from 37.5%, 25.0%, and 53.1% for Hormodin #1, #2, #3, respectively. Hormodin #3 treatment also produced the highest number of roots (24) per cutting and K-IBA at 3000 mg/L had the longest total length of roots (96.8cm). Growers should apply 8000 mg/L IBA-talc or 3000 mg/L K-IBA to root adult stem cuttings of Cupressus sempervirens ‘Stricta’. It is possible to had higher rooting percentage with juvenile stem cuttings and post-chilling period for adult stem cuttings.

(162) Hormones Improved Rooting of Zelkova serrata Softwood Stem Cuttings

Jinying Dong
University of Georgia, Athens; jdong@uga.edu

Yujuie Yang
Central South University of Forestry and Technology, Changsha, Hunan; yangyujie910@gmail.com

He Li
Central South University of Forestry and Technology, Changsha, Hunan; yangyujie910@gmail.com

Xiaoling Jin
Central South University of Forestry and Technology, Changsha; jxl0716@hotmail.com

Donglin Zhang*
University of Georgia, Athens; donglin@uga.edu

An asterisk (*) following a name indicates the presenting author.
Zelkova serrata is a deciduous tree in Ulmaceae introduced from East Asia and has been widely used for bonsai, shade tree or park landscape because of its attractive habit, foliage colors, and drought tolerance. Its disease/pest resistant features placed it as a great substitute of American elm. To better regenerate Zelkova serrata for market demand, softwood stem cuttings treated with rooting hormones at various concentrations were investigated in 2013. Terminal cuttings from one year-old seedling plants were dipped into K-IBA, K-NAA at 1000, 3000, 8000 mg·L⁻¹ and dusted with powdery Hormodin #1, #2, #3. Rooting hormones should be applied for rooting of Zelkova serrata cuttings and no root was found under the control. The highest rooting percentage of 40.6% was under the treatment of Hormodin #2, which also yielded the highest root length of 9.0cm. Liquid K-IBA was significantly more effective on rooting than that of K-NAA. Under 1000 mg·L⁻¹ hormone concentration depended on the application methods. The concentration of 1000 mg·L⁻¹ should be recommended for liquid hormones and 3000 mg·L⁻¹ for powdery hormones. Although rooting hormones induced the rooting of softwood cuttings of Zelkova serrata, further studies should focus on semi-hardwood and hardwood cuttings and improve Zelkova rooting percentage and quality.

(163) Cutting Type and Hormone Affect Vegetative Propagation of Phlox pulchra

Jeremiah J. DeVore*
Auburn University, Auburn, AL; jjd0016@tigermail.auburn.edu
Amy N. Wright
Auburn University, Auburn, AL; awright@auburn.edu
Raymond Kessler
Auburn University, Auburn, AL; kessljr@auburn.edu
Donald J. Eakes
Auburn University, Auburn, AL; eakesdj@auburn.edu

Phlox pulchra Wherry is an herbaceous perennial endemic to Alabama that only occurs naturally in five counties: Autaga, Bibb, Butler, Shelby, and Tuscaloosa. To bring P. pulchra into production, this study examined stem cutting type and rooting hormones to determine if vegetative propagation is feasible for expansion of stock material. In September 2013, terminal or medial cutting sections were treated with a 1000 ppm IBA (indole-3-butyric acid) and 500ppm NAA (1-naphthaleneacetic acid) solution, 1000ppm IBA/talc, or untreated (control). Cuttings were stuck in 1206 cell packs filled with 1:1 peat/perlite substrate and placed in a shaded greenhouse under intermittent mist. The experiment was a completely randomized design with 6-packs as experimental units and individual cells as subsamples. After 6 weeks, number of roots greater than or equal to 5 mm, length of the three longest roots, and subjective root ratings (0–6) were recorded. Overall, 77% of terminal cuttings rooted, while only 11% of medial cuttings rooted. Terminal cuttings had higher number of roots, length of three longest roots, and root rating. For terminal cuttings, untreated cuttings and those treated with IBA/NAA solution had higher values for root number, length of second and third longest roots, and root rating. Rooted cuttings were transplanted to trade gallons after measurements were taken and overwintered in a shade structure. Plants received daily irrigation and were protected when nighttime temperatures fell below 40 F. All but one cutting survived overwintering. With no difference between the control and IBA/NAA solution treatments, poorer performance of the IBA talc treatment, and no difference in overwintering survival, these results suggest application of the hormones tested is unnecessary to propagate terminal stem cuttings of P. pulchra taken in September.

(164) Plant Regeneration through Protocorm-like Bodies Induced from Leaf and Petiole Explants of Pinellia ternata, an Important Medicinal Plant

Shufang Fan
Jingchu University of Technology, Jingmen; fsf03@163.com
Xuemin Wang
Jingchu University of Technology, Jingmen; wxm641213@tom.com
Dawei Jian
Jingmen Forestry Bureau, Jingmen; jd0577@126.com
Jianjun Chen*
University of Florida,IFAS, Mid-Florida Research and Education Center;member of ASHS, Apopka, FL; jjchen@ufl.edu

Pinellia ternata (Thunb.) Breit. is an important herb of traditional Chinese medicine, and Jing Pinellia, a landrace of south central Hubei Province, China, is particularly popular due to its renowned high-quality tubers. Pinellin acid from the tuber has been identified to be an effective oral adjuvant for nasal influenza vaccine. Current production of pinellia relies mainly on the tuber, which significantly limits its production. The objective of this study was to establish protocols for efficient regeneration of plantlets as liners for commercial production. Leaf and petiole explants were cultured on Murashige and Skoog (MS) basal medium supplemented with 2.22, 4.44, and 8.88 µM 6-benzyladenine (BA) and 0.54, 1.07, and 2.69 µM α-naphthaleneacetic acid (NAA) in a factorial design. Protocorm-like bodies directly appeared from leaf explants 30 days after inoculation. Petiole explants first produced calluses and then protocorm-like bodies 40 days from the initial culture. MS medium with 2.22 µM BA and 1.07 µM NAA resulted in 100% of leaf and petiole explants producing protocorm-like bodies, up to 11 and 8.59 per explant, respectively. The mean diameters of the protocorm-like bodies derived from leaf and petiole explants were 0.27 and 0.2 cm, respectively. All protocorm-like bodies produced adventitious shoots and roots with shoot height ranging from 1.79 to 2.79 cm and root length of 1.77 to 2.39 cm. The regenerated plantlets were morphologically stable and grew vigorously in cell plug trays filled with a soilless substrate in a shaded greenhouse. The liners were healthy and readily available for commercial production.

An asterisk (*) following a name indicates the presenting author.
(165) Seed Provenance and Substrate as Significant Factors on *Picea abies* (L.) Karst. Production

Laura M.R. Rinaldi*
IVALSA CNR, Sesto Fiorentino; l.rinaldi@ivalsa.cnr.it

Annarita Leva
IVALSA CNR, Sesto Fiorentino; a.leva@ivalsa.cnr.it

Luigi Paolo D’Acquii
ISE CNR, Sesto Fiorentino; dacqui@ise.cnr.it

*Picea abies* (L.) Karst. is commonly cultivated in Italy for sale as Christmas trees. Experiments were carried out to investigate the emergence and growth of three seed provenances of *Picea* to different levels of organic material. Mature seeds were collected from forests enrolled in the “Libro Nazionale Boschi da Seme” (L.N.B.S.). Three certified seed provenances ‘Gran Bosco di Salbertrand’, ‘Pezzel e Fochino’, and ‘Val di Fiemme’ were studied. The collected seeds were subjected to chilling treatment (4 °C for 21 days), then were sown on benches in greenhouse. Two levels of organic material (manure) were used to achieve a total organic C content of 6.26% for substrate 1 and 9.82% for substrate 2. After 12 weeks, the seedlings were transferred in pots and placed in a shaded (50% light reduction) outdoors for one year. The seedling growth performance was significantly influenced by provenances and substrates (*P < 0.05*). The interactions between substrate and provenance were evident 15 days after sowing. ‘Val di Fiemme’ showed a better growth performance than the other ones, 91% and 47% of seedling emergence for substrate 1 and substrate 2, respectively. ‘Pezzel e Fochino’ displayed the worst performance, 25% and 20% on the respective substrates. Furthermore, seedling growth was favored by a lower organic material in medium (substrate 1). In fact, the stem height of seedlings ranged from 2.4 to 4.2 cm on substrate 1, and from 2.1 to 3.2 cm on substrate 2. ‘Val di Fiemme’ seedlings showed the highest stem height 3.7 and 3.2 cm for substrate 1 and substrate 2, respectively, and this provenance appeared to be more resistant to pathogens. ‘Pezzel e Fochino’ seedlings exhibited the lowest growth on both substrates while ‘Gran Bosco di Salbertrand’ showed a growth of 4.3 cm and 2.6 cm on substrate 1 and 2, respectively. Among provenances, seedlings grown in pots exhibited differences in early growth, fresh and dry weights. ‘Gran Bosco di Salbertrand’ and ‘Pezzel e Fochino’ seedlings reached stem heights of 14.7 and 13.8 cm, respectively, whereas, ‘Val di Fiemme’ attained a height of only 10 cm. However, the biomass values were similar in spite of the linear growth differences. The results demonstrated that both provenance and level of organic C in the substrate are significant factors for a large-scale production of *Picea* as Christmas trees.

(070) Increasing IPM Awareness through Customized Educational Workshops

Tamla Blunt*
Colorado State University, Fort Collins; tamla.blunt@colostate.edu

Carol O’Meara
Colorado State University Extension, Boulder County, Longmont; comeara@bouldercounty.org

Mary Small
Colorado State University Extension, Jefferson County, Golden, CO; msmall@co.jefferson.co.us

Jean D. Reeder
Colorado State University, Fort Collins; jjbreeder@comcast.net

During the past several years, our team has presented educational workshops and trainings. These educational workshops emphasizing Integrated Pest Management (IPM) practices are excellent outreach tools for Extension Educators. However, these workshops need to be customized to the specific audience to which they are presented. Some information can remain consistent such as chronic disease and insect problems. Some components need to be updated based on the location of the workshop including: soil types, plant varieties, moisture availability and weather conditions. We show how one model can be customized to suit three different audiences: market growers, Master Gardeners, and community garden leaders.

(071) A Comparison of the Effectiveness of Eight Types of Learning Activities When Teaching “Organic Farming Systems” to Horticulture and Non-horticulture Majors

Rhonda R. Janke*
Kansas State University, Manhattan; rrjanke@ksu.edu

May Elfar Altamimi
Kansas State University, Manhattan; matamimi@ksu.edu

Carolyn D. Tanner
Kansas State University, Manhattan; cdtanner@ksu.edu

The Organic Farming Systems class has been offered at Kansas State University since 2006 and class size has grown from eight students to 22 in 2012, with half of those coming from other departments than horticulture. A variety of teaching methods have been used in the class, with a strong emphasis on assigned readings, lectures/discussion, and homework assignments. These have been supplemented with occasional field trips to farms and guest speakers. In 2012, in addition to these five methods, we expanded the breadth of teaching methods to include three additional activities; student farm hands-on field work, research projects in the greenhouse, and art/self-expression. To assess the effectiveness of these eight teaching methods, an in-class survey was administered the last week of class. Students were asked to rate each activity on a 1 to 5 scale for whether the activity
helped them to learn more about agriculture, helped them learn specifically about organic agriculture, and whether the activity was enjoyable. There were at least two activities in each teaching method category, and the eight categories were compared in addition to activities within a category. For the question, “did this activity help you learn about organic farming systems?” the students rated guest speakers, field trips, and homework assignments (filling out organic certification application forms) the highest, with all scoring 4 or higher on a 5 points scale. The reading assignments, working at the student farm, and in-class discussion all scored between 3.7 and 3.8. The greenhouse research project and art/self-expression activities ranked 3.5 and 2.5 respectively. When asked if these activities were enjoyable, field trips ranked the highest (4.6), followed by working at the student farm and guest speakers (3.9). Reading assignments were ranked as least enjoyable (2.8). The art/self-expression assignments received mixed ratings, with some students giving it the highest score possible and others the lowest (overall rating of 3.4). Within a teaching method category activities received similar rankings with the exception of the greenhouse experiment. Students enjoyed designing and conducting the experiment but not writing up the final report; all three activities were rated highly for learning value. Horticulture students ranked guest speakers and farm tours higher for learning value than non-horticulture students. This was initially a surprising result, but having previous knowledge of the topic apparently added to the value of the experience for the horticulture students.

(072) How To: Best Methods to Present Research Information to a Public Audience

Rosa Kim Bevington*
University of Arizona Cooperative Extension, Yuma; rosa@cals.arizona.edu

Kurt D. Nolte
University of Arizona, Yuma; knolte@ag.arizona.edu

Channah M. Rock
University of Arizona, Maricopa; channah@ag.arizona.edu

Robert Wilson
University of Arizona Cooperative Extension, Yuma; Rcw@email.arizona.edu

Most researchers and students will publish the results of their research in journal publications, books or at a professional conference. However, the most effective way to deliver content and research impacts to the general public can greatly depend on the audience who is being targeted. Extending our research impacts regarding the safe production and handling of fresh produce, our target audience has always been the grower, field worker and consumer. In today’s technology driven world, we determined that, it’s most effective to spread the impacts of our research and grower recommendations through short, modular training videos and social media. Currently, 2,326,347,842 people use Facebook, Twitter, Pinterest, and YouTube combined. From within that group, 32.3% of those people use Facebook, 43% utilize Twitter, 3% use Pinterest, and 21.7% make use of YouTube. Within this social media platform, people typically share among a variety of topics including opinion, humor, stories, and current events, each containing subgroups of wide arrays of personal interests. However, our previous work suggested, that social media provided a niche in areas covering fresh produce safety outreach and specifically lacked a collection of bilingual training videos whose focus was on the safe production of specialty crops. As a result, social media has allowed us to provide our original video content, to a public seeking clear and concise information. We typically upload our edited video materials onto YouTube and then subsequently share them on Facebook, Twitter, and Pinterest. Since 2012, 28.3% of our social network “likes” us on Facebook, 53.6% “follow” us on Twitter, 14.6% “follow” us on Pinterest and 3.5% “subscribe” to us on YouTube. The data suggests that specific material like our Fresh Produce Safety content, is accessed by the general public differently from how the world views social media. As people typically use social media to connect with friends and relatives and for entertainment purposes, other people use social media as a way to educate themselves and to learn about a specific subject. We find that using multiple social platforms has enabled us to have an audience base that has an alternative structure than that of a general populace. Moreover, we continue to work toward ways to exploit the social media alignments to best meet the needs of our grower clientele base. We believe that one of the many effective ways to do that in a high speed world, is through videos and social media.

Specified Source(s) of Funding: Improving the Safety and PostHarvest Quality of Field Grown Organic Leafy Greens: Assessment of Good Production Practices Along the Farm to Fork Continuum Grant

(073) Adapting Extension Agritourism Training for Undergraduate Education

Michelle L. Infante-Casella*
Rutgers Cooperative Extension, Clayton, NJ; minfante@aesop.rutgers.edu

Brian Schilling
Rutgers NJAES, New Brunswick, NJ; schilling@aesop.rutgers.edu

William Bamka
Rutgers NJAES, Westampton, NJ; bamka@aesop.rutgers.edu

Stephen J. Komar
Rutgers NJAES, Newton, NJ; skomar@AESOP.Rutgers.edu

Jack Rabin
Rutgers NJAES, New Brunswick, NJ; rabin@njaes.rutgers.edu

William Hlubik
Rutgers Cooperative Extension of Middlesex, North Brunswick, NJ; hlubik@aesop.rutgers.edu

Cooperative Extension educators at Land Grant Universities have taught non-traditional students within the agricultural community and general populous for over 100 years. Much of the information presented in the field is also valuable to undergraduate students within the confines of traditional uni-
University classrooms. Many traditional students seek practical and applied research based agricultural information. In 2012, the Rutgers New Jersey Agricultural Experiment Station, Cooperative Extension Agritourism Working Group presented comprehensive agritourism workshops throughout New Jersey to educate extension clientele on a number of topics. Topics presented included risk management, safety and marketing. The working group began preparation to teach a similar class to undergraduates in a traditional classroom setting at Rutgers School of Environmental and Biological Sciences. At Rutgers NJAES, extension faculty hold graduate degrees and achieve tenure like their fellow teaching and research faculty at the university. The undergraduate class (11:015:315 Direct Farm Marketing and Agritourism), was developed as an agricultural marketing class. The class was offered during the fall, 2013 semester and was designed to prepare students to manage agritourism or direct marketing operations. Key topics covered in the course included: agritourism expansion and evolution in the United States; resource assessment, agritourism feasibility plans; marketing; enterprise budgeting and basic financial analysis; hospitality/customer service; safety/risk management and liability; and regulatory and policy issues. The course was deemed a required undergraduate course for students in the agriculture major. The semester long, three-credit course was presented in the classroom by four agricultural agents and an extension specialist using a team-teaching approach. The course included tours of two highly successful commercial farms with agritourism marketing, organized by the local County Agricultural Agent proximate to campus. Student interaction and discussion with the farm operators was a key lesson component, providing hands on learning. Students found on-farm experiences to be a valuable learning tool. Exposing students to farm operations is one method extension can use to facilitate hands-on learning. In lieu of a final exam, students were assigned a semester long project to develop a comprehensive plan for a hypothetical agritourism farm from a farm scenario assigned to them during the first lecture. Responses collected from student surveys at the end of the semester were overwhelmingly positive. Some students responded, “this was the most valuable and extensive class they have had during their coursework.”

(075) Establishing a New Graduate Program in a Multidisciplinary Campus

Eleni D. Pliakoni
Kansas State University, Olathe; epliakoni@ksu.edu
Candice Shoemaker
Kansas State University, Manhattan; cshoemak@ksu.edu
Rhonda R. Janke*
Kansas State University, Manhattan; rrjanke@ksu.edu
Cary Rivard
Kansas State University, Olathe; crivard@ksu.edu

The Department of Horticulture, Forestry and Recreation Resources of Kansas State University (K-State) launched a new horticulture MS specialization called Urban Food Systems (UFS) in 2011. This program has an interdisciplinary training focus with emphasis on the impact of urban food systems on the economic and community development of urban and peri-urban areas. The specialization requires seven credits of required course work, a food production practicum, experiencing the grant process from preparation through the final report, and attendance at bi-weekly UFS cohort meetings in addition to meeting the requirements of the MS program. Graduates of the program are well prepared to work as director/program managers in not-for-profit organizations, city governments, and extension programs in urban districts, facilitating community gardens, urban farming, farmers’ markets, and farm-to-school programs. Recently Kansas State University opened a new campus in Olathe, KS, which is in the Kansas City metropolitan area. One of the primary goals of the new campus is to bring together faculty from different disciplines and industry related to food systems and address the needs of the rapidly changing world regarding food safety and security. The UFS specialization was the first graduate program offered through the K-State Olathe campus. This paper will present an overview of the program focusing on the model of collaboration between the two campuses. Also, we are going to address the opportunities and the challenges of locating a traditional graduate program with tenure-track faculty on a campus that has expectations to serve the local residents and the greater Kansas City animal and food industries, help attract new business to the local county, provide training to the local workforce, and develop new technologies in collaboration with public and private companies.

(074) Using Innovative Technologies to Create A Custom Learning Environment

Tim Rhodus*
The Ohio State University, Columbus; rhodus.1@osu.edu

Utilizing IT, “Innovative Technology” to create interactive course notes, multimedia student portfolios and full screen presentations, while also being Mac, PC, iOS and Android friendly seems like a huge requirement and a lot to learn. Traditionally, that would be true but teachers and students can utilize Evernote (on the web, on a laptop or on a mobile device) to manage all of those requirements and do so without requiring a tech support professional or a large financial investment. In addition, combining AirPlay (desktop streaming from an iPad) with AirServer (software on a computer that connects to the class projector), this environment becomes incredibly collaborative and exciting to utilize. The goal of this poster is to visually demonstrate the integration of innovative technology in two Ohio State Horticulture courses, “Creating a Virtual Perspective” and “Managing a Virtual Portfolio.” Students in both classes utilize iPads provided by the instructor and Evernote to work on assignments which combine text, photos, screen captures, audio and video files to produce online digital portfolios, web sites or online presentations. In addition to Evernote, the instructor and students utilize various IOS apps to create and edit audio and video content, upload to online storage sites and present their projects during class. This poster is visually enhanced with a video tour at: http://youtu.be/XuyT6KTeCyAo and made interactive using Layar.
(367) The DSS GeScoN for Managing Irrigation and N Fertilization in Vegetable Crops: Application in Processing Tomato Crop in Southern Italy

Antonio Elia  
University of Foggia, Foggia 71100; antonio.elia@unifg.it

Giulia Conversa*  
University of Foggia, Foggia; giulia.conversa@unifg.it

The work illustrates the theoretical basis, the methodological approach and the structure of a new decision support system program (GesCoN) designed for the management of N fertigation in vegetable crops. The methodological approach is based on daily water and N balance, considering the water lost by evapotranspiration and the N uptake by the crop as output and irrigation, net rainfall, N fertilization, N mineralization from soil organic matter as main inputs. The software calculates on a daily basis the availability of water and N into the root zone, and assesses when to start a fertigation event and the amount of irrigation water and N fertiliser that has to be applied in order to fulfill the water and N-crop requirements. The models used by GesCoN for the prediction of plant growth, including root apparatus geometry and its interaction with wet soil zones, N uptake as well as the approaches used for predicting N mineralization and the dynamics of N and water into the soil are also described. Water balance is done by estimating ET0 through Penman-Montheit or a calibrated Hargreaves model. ETc can be estimated by using the single or dual Kc approach. The flow-chart of the program and the basic information for its functioning are described. The application of the DSS in a processing tomato crop including its parametrization in a Southern Italy environment, are also reported.

(368) Eggplant (Solanum melongena L.) Plant Growth and Fruit Yield as Affected by Drip Irrigation Rate

Juan Carlos Diaz-Perez*  
University of Georgia, Tifton.; jcdiaz@uga.edu

Touria E. Eaton  
University of Massachusetts, Amherst; eaton@unext.umass.edu

The objective was to assess the effects of irrigation rate on plant growth and fruit yield in eggplant. The study was conducted in Tifton, GA. Eggplant (‘Santana’) plants were grown on raised beds (1.8 m centers) covered with white plastic film mulch. There was a single drip tape along the center of the bed. The design was a randomized complete block with five treatments and four replications. Treatments consistent of irrigation rates based on crop evapotranspiration (33%, 67%, 100%, 133%, and 167% ETo). Plant growth, chlorophyll index (SPAD) and volumetric soil water content (SWC) were monitored over the season. As expected, SWC increased with increasing irrigation rates. Chlorophyll index decreased with irrigation rate, possibly as a result of a dilution effect on leaf N. Additionally, increased irrigation rates possibly resulted in increased nitrate leaching. Stem diameter, leaf dry weight and vegetative top dry weight increased with increasing irrigation rate. Fruit number and fruit yields (marketable and total) were lowest at 33% ETc and there were little yield differences among irrigation rates higher than 33% ETc. Results suggest that eggplant may tolerate mild water stress, since plants irrigated at 67% ETc produced fruit yields similar to those of plants irrigated at 100% ETc or higher rates. Thus, there is potential to reduce irrigation rates without negatively impacting fruit yields.

(369) Evaluation of Selected Black Seeded Bean (Phaseolus vulgaris L.) for Flavonol and Triterpens Content in Nuevo León, México

Eleazar Reyes-Barraza*  
Centro de Biotecnologia-FEMSA, Tecnologico de Monterrey, Monterrey; elreyes@itesm.mx

Rigoberto Rosales-Serna  
INIFAP, Durango, Dgo.; rigoberto_serna@yahoo.com

Janet A. Gutiérrez-Uribe  
Centro de Biotecnologia-FEMSA, Tecnologico de Monterrey, Monterrey; jagu@itesm.mx

Sergio Serna-Saldivar  
Centro de Biotecnologia-FEMSA, Tecnologico de Monterrey, Monterrey; sserna@itesm.mx

Delia Serna-Guerrero  
Centro de Biotecnologia-FEMSA, Tecnologico de Monterrey, Monterrey; delia.sergro@gmail.com

Black Seeded bean (Phaseolus vulgaris L.) possesses different functional and nutraceutical compounds that might contribute to prevent and reduce degenerative diseases when included within daily basic diet within Mexican population. This legume has been studied extensively for its nutraceutical properties recently in ITESM(Tecnológico de Monterrey). Bioactive compounds from...
the flavonols and triterpenes groups were measured in selected black seeded varieties at Hualahuises, N.L., in different growing seasons. Previous studies compared within commercial cultivars and local black seeded cultivars for the content of kaempferol, myricetin 3-O-glucoside, quercetin 4-O-galactoside and several soyasaponins (Af, V, rag, bg), indicated significant differences among phenolic and saponins compounds within commercial varieties as well as individual selected plants (P < 0.01). An average value of 139 µg·g⁻¹ was observed for soyasaponing Af with values from 115 to 186 µg·g⁻¹. Myricetin 3-O-glucoside was found at concentrations above 52 µg·g⁻¹ and quercetin 4-O-galactoside was observed at the highest value for the cultivars evaluated 211 µg·g⁻¹. Four different lines with high amount of these bioactive compounds were identified when compared to the original population planted at Nuevo León (PFNNNL). High seed yield under irrigation in spring and summer allowed identify the potential to use this legume as a source for industrial bioactive compounds. Further studies indicated the potential for identifying new individuals for high content of flavonols and saponins from local planted black seeded cultivars. However, soil and climate conditions might affect the level of bioactive substances associated to this cultivars. New bean varieties and germplasm screening might be studied for the content of bioactive compounds as a mean to contribute to reducing degenerative diseases in México. The authors would like to thank the financial support from Catedra Nutrigenomica-Fundacion FEMSA.

Specified Source(s) of Funding: Centro de Biotecnología-FEMSA

(370) On-farm Evaluation of Fresh Market Tomato Cultivars for Summer Field Production

James W. Shrefler*
Oklahoma State University, Durant; jim.shrefler@okstate.edu
Lynn P. Brandenberger
Oklahoma State University, Stillwater; lynn.brandenberger@okstate.edu
Brian A. Kahn
Oklahoma State University, Stillwater; brian.kahn@okstate.edu
Danielle R. Williams
Oklahoma State University, Stillwater; Danielle.R.Williams@okstate.edu

High summer temperatures pose a significant challenge to field-grown tomato production in Oklahoma. In recent years many growers experienced substantial crop losses due to low levels of fruit set in spring planted crops. With the objective of identifying cultivars that can be recommended for summer field production in Oklahoma, trials were initiated in 2012 through cooperation with commercial producers to evaluate tomato cultivars for fruit productivity. Cultivars were selected for use in the trials based on advertised high temperature fruit set capabilities. Trial sites were selected to represent current commercial production locations and systems. All tomato transplants were grown in Oklahoma State University research greenhouses and distributed to cooperators. Tomatoes were transplanted into fields using plastic mulch with drip irrigation at all locations except for one site in 2013—in which case organic mulch was used. All trials used 3 replications. The 2012 cultivars were Bella Rosa, Biltmore, Florida 91, Red Bounty, Red Defender, Red Deuce, Redline, Rocky Top, Solar Fire, Tasti-Lee, Tribeca, andtribute. Based on 2012 results and grower preferences, the 2013 cultivars were Bella Rosa, BHN-964, Charger, Florida 91, Rocky Top, Solar Fire, Sunkeeper, Tasti-Lee, Top Gun, Tribeca, Tribute, and Volante. A reduced cultivar number was used at one location in 2013 that included Bella Rosa, Solar Fire, Sunkeeper, Tasti-Lee and Volante, plus BHN-1064, which was not used in the other trials. Several cultivars were among the top performers in both years. Solar Fire was among the top three cultivars at one location in 2012 and three locations in 2013 and was among the better performers at other locations. Bella Rosa and Tribeca were each among the top five cultivars at one location in 2012 and three locations in 2013. Tribute was also among the top five cultivars in both trials in 2012 and at two locations in 2013. Trials will be established again in 2014 to further ascertain the productivity of fresh market tomatoes under Oklahoma field conditions. At the website http://www.hortla.okstate.edu/research-and-outreach/research/vegetable-trial-reports trial details can be viewed.

Specified Source(s) of Funding: Oklahoma Department of Agriculture, Food and Forestry

(371) Grafted Vegetable Transplants for Earliness and Productivity during Northern Field Seasons

Meriam Karlsson*
University of Alaska Fairbanks, Fairbanks, AK; mgkarlsson@alaska.edu

Grafting vegetable seedlings for field production is expected to decrease days to crop maturity while increasing yields, improving ability to withstand unfavorable climatic conditions, and enhancing resistance to soil-borne diseases and nematodes. Although studies are under way evaluating grafting in various North American regions, assessments of suitable rootstocks, cultivars, and crop benefits for using grafted vegetables are limited in high latitude areas. Grafting may be a technique to increase earliness and yields of fruited vegetables in regions of short growing seasons and cold soils. A field test was initiated in the interior of Alaska to evaluate grafted tomatoes for productivity and rate of development. The selected tomato cultivar for the study was ‘Beaverlodge Slicer’ because of its adaptation to produce mature tomatoes in the time frame of high latitude field seasons. The selected rootstocks were ‘Maxifort’, ‘DRO138TX’ and ‘SuperNatural®’. The ‘Maxifort’ rootstock has been used extensively for year-round greenhouse produced tomatoes. ‘DRO138TX’ is considered less vigorous than ‘Maxifort’ and may be better suited to shorter production cycles in unheated greenhouses or high tunnels. ‘SuperNatural®’ is a recently developed rootstock and recommended for certified organic growers. The scions and the rootstocks were seeded in a greenhouse and the seedlings were grafted three weeks later. As control treatments, non- and self-grafted transplants

An asterisk (*) following a name indicates the presenting author.
were included. Four weeks after grafting, the plants were field planted during the first week of June, in 60 cm wide raised beds covered with black polyethylene plastic. Harvest started on 31 July and continued until 30 Aug. Preliminary results suggest limited advantages of grafting tomatoes on rootstocks for earliness and productivity. The highest yields were recorded for intact and self-grafted ‘Beaverlodge Slicer’ at 2.2 ± 0.15 kg per plant. There were no differences in productivity or earliness among plants grafted on the three rootstocks. The average yield per plant for tomatoes grafted on the selected rootstocks was 1.6 ± 0.13 kg. Although these results did not show significant yield improvements, additional studies are necessary to include additional cultivars, crop management procedures, field locations and seasonal conditions to fully evaluate grafting for field production of tomatoes at high latitudes.

(372) Bioclimatic Modeling of Crisphead Lettuce Phenology As a Tool for Planning Seeding and Harvest
Gaetan Bourgeois*
Agriculture Agri-Food Canada, Saint-Jean-sur-Richelieu, QC; gaetan.bourgeois@agr.gc.ca
Sylvie Jenni
Agriculture Agri-Food Canada, Saint-Jean-sur-Richelieu, QC; sylvie.jenni@agr.gc.ca
Danielle Choquette
Agriculture Agri-Food Canada, Saint-Jean-sur-Richelieu, QC; danielle.choquette@agr.gc.ca

In order to provide a constant supply of crisphead lettuce for the fresh market during the growing season, growers should plan their seeding over several weeks and have to manage their field activities under high climate variability. A bioclimatic model that predicts crop phenological stages in response to temperature and photoperiod would be a useful tool for planning prior to the beginning of the growing season and for monitoring crop development in real time during the growing season. From several experiments in the field, in growth chambers, and in greenhouses, rates of crisphead lettuce seedling emergence, leaf appearance, and head development were established in response to temperature and photoperiod for cultivars ‘Ithaca’ and ‘Estival’. All rates of development have a nonlinear response to temperature. In general, the lower threshold, optimum, and upper threshold temperatures are around 0 °C, 28 °C, and 35 °C, respectively, depending on the phenological phase of crisphead lettuce. Short photoperiods slightly reduce the rates of post-emergence phenological phases. These different responses were incorporated into a bioclimatic model that predicts, from sowing to harvest maturity, phenological stages expressed in terms of the modified BBCH scale (Biologische Bundesanstalt, Bundessortenamt und CHemische Industrie) based on weather data measured in the field. For several years and seeding dates per year, the phenological model of crisphead lettuce has generated excellent predictions of different phenological stages observed from sowing to harvest maturity. This tool can be used for helping producers of crisphead lettuce to better manage the impacts of climate variability throughout the whole growing season and to better plan the marketing and distribution of their harvested crops.

(373) Grafting with Hybrid Rootstocks to Increase Tomato Productivity in the Great Plains
Lani Meyer*
Kansas State University, Olathe; ljm7788@ksu.edu
Ravin Poudel
Kansas State University, Manhattan; rp3448@ksu.edu
Helena Pontes Chiebao
Kansas State University, Olathe; chiebao@ksu.edu
Ari Jumpponen
Kansas State University, Manhattan; ari@ksu.edu
Karren A. Garrett
Kansas State University, Manhattan; kgarrett@ksu.edu
Jason J. Griffin
Kansas State University, Haysville; jgriffin@ksu.edu
Eleni D. Pliakoni
Kansas State University, Olathe; epliakoni@ksu.edu
Megan Kennelly
Kansas State University, Manhattan; kennelly@ksu.edu
Cary Rivard
Kansas State University, Olathe; crivard@ksu.edu

Grafting tomatoes is gaining interest among growers throughout the U.S. for several reasons including organic disease management and increased crop productivity. Growing space constraints for urban and high tunnel growers limit crop rotation as well as expansion of production area. Grafting with vigorous rootstocks provides the potential for higher yields without additional growing space. Our main objective is to identify tomato rootstocks that improve productivity and decrease losses from disease for high tunnel and open-field growers in the Great Plains region. Trials using a replicated randomized complete block design were implemented at seven sites throughout Kansas: four on-farm sites and three KSU research stations. Four sites under high tunnel cultivation used the tomato variety ‘BHN 589’ as the scion. Of the three open-field sites, one used ‘BHN 589’ as the scion and the other two used the heirloom variety ‘Cherokee Purple.’ Across the sites, we assessed seven different hybrid rootstocks: ‘Maxifort,’ ‘Multifort,’ ‘Trooper Lite,’ ‘DRO 131,’ ‘Arnold,’ ‘RST 04-106,’ and ‘RT 1028.’ All sites used typical farm management practices and yield data was collected during weekly harvests. Fruit was graded based on marketability and then counted and weighed. At two high tunnel sites, fruit collected during peak harvest were analyzed for acidity, soluble solids, and nutritional quality. At one high tunnel trial, ‘BHN 589’ produced 74%, 70%, 64%, and 52% higher marketable yield when grafted to ‘Maxifort,’ ‘Multifort,’ DRO 131, ‘Arnold,’ RST 04-106, and ‘RT 1028.’ All sites used typical farm management practices and yield data was collected during weekly harvests. Fruit was graded based on marketability and then counted and weighed. At two high tunnel sites, fruit collected during peak harvest were analyzed for acidity, soluble solids, and nutritional quality. At one high tunnel trial, ‘BHN 589’ produced 74%, 70%, 64%, and 52% higher marketable yield when grafted to ‘Maxifort,’ ‘Multifort,’ DRO 131, and ‘Arnold,’ respectively, compared to the nongrafted ‘BHN 589’ (P < 0.05). ‘Maxifort’ grafted with ‘BHN 589’ also significantly increased marketable fruit yield by 42% in the open-field compared to the nongrafts (P < 0.05)

An asterisk (*) following a name indicates the presenting author.
when verticillium wilt was evident. ‘Cherokee Purple’ grafted to ‘DRO 131’ increased marketable yields by 62% compared to nongrafts at one site. At the other ‘Cherokee Purple’ trial, which had low to moderate levels of root-knot nematode pressure, the rootstock ‘Trooper Lite’ increased marketable yields by 56% compared to nongrafts ($P < 0.05$) and RKN ratings were not significantly different. Rootstocks RT-1028 and RST-04-106 did not increase yields when grafted with ‘BHN 589’ or ‘Cherokee Purple’ tomato scions in both high tunnel and open-field production across several locations indicating the importance of rootstock selection when little disease pressure is evident from soil pathogens. Our results suggest that tomato growers in the Great Plains should be strategic when selecting rootstocks in order to increase crop productivity.

Specified Source(s) of Funding: CERES; NCR-SARE

Monday, July 28, 2014

Undergraduate Student Poster Competition (Session 1)

(134) Influence of Seaweed Extract and Vesicular–Arbuscular Mycorrhizae on Growth and Development of Bell Pepper

Cadien K. Beckford*
University of Maryland Eastern Shore, Princess Anne; cbeckford@umes.edu

Corrie P. Cotton
University of Maryland Eastern Shore, Princess Anne; cp cotton@umes.edu

Fawzy M. Hashem
University of Maryland Eastern Shore, Princess Anne; fmhashem@umes.edu

Liquid extracts of marine brown algae are marketed for use in agriculture and horticulture. Seaweed extracts are marine plants rich in vitamins and minerals that are known to improve root development, plant growth, and increase nutrient uptake. Vesicular–Arbuscular Mycorrhizae (VAM) is also known to increase nutrients uptake and aid in water absorption. The main objective of this study was to examine the effect of application of seaweed extract and VAM on the growth and development of bell peppers. The study was conducted in a greenhouse at the University of Maryland Eastern Shore (UMES) Agricultural Experiment Station for 80 days in a complete randomized design with four treatments (Control, Seaweed, VAM, and Seaweed plus VAM) with four replications each. Treatments were applied twice; during sowing of the seeds and again at transplanting. Liquid seaweed was applied both foliarily and at the base of each plant every two weeks at the rate of 150 ml per plant. Nitrogen fertilizer (250 ppm) was added once at 500 ml per pot throughout the study. Fruit number, fruit weight, plant height, root length, and root shoot dry weight were determined. There was no significant difference between the treatment for fruit weight and root length; however, there were significant differences in shoot height and root and shoot dry weights in the seaweed treatment. Significant differences were also found in the height, root dry weight and shoot dry weight. Further studies will be conducted to evaluate the effects of seaweed and VAM on bell peppers growth and development.

Specified Source(s) of Funding: CERES; NCR-SARE

(135) Growth and Morphology of Greenhouse Bell Pepper Transplants Grown Under Supplemental LEDs and HPS Lighting

Ricardo Hernández
University of Arizona, Tucson; ricahdez@email.arizona.edu

Chieri Kubota
University of Arizona, Tucson; ckubota@ag.arizona.edu

Jose P. Santana*
University of Arizona, Tucson; josepablo10@email.arizona.edu

High pressure sodium lamps (HPS) have been the standard supplemental lighting technology used by nursery greenhouses to improved transplant growth and quality. Growers have observed that bell pepper transplants develop undesirable leaf curling if supplemented with HPS. Light emitting diodes (LEDs) are a promising supplemental lighting technology since they are reported to have higher electrical efficiency and the spectrum can be customized for specific plant applications. At the University of Arizona, an experiment was conducted to evaluate pepper morphological and growth rate responses when grown under LEDs and HPS supplemental lighting side-by-side. Four greenhouse bell pepper (Capsicum annuum) cultivars (Orangela, Viper, Fascinato, and PP0710) were grown in a greenhouse under low daily solar-light integral of 5.2 ± 0.8 mol·m$^{-2}$·d$^{-1}$ for 56 days. The supplemental lighting treatments provided 55 µmol·m$^{-2}$·s$^{-1}$ PPF for 18 hours (2 AM–8 PM) for an additional 3.5 mol·m$^{-2}$·d$^{-1}$ over the plant canopy surface. The treatment consisted of a red-LED (peak wavelength 633 nm, full width at half maximum (FWHM): 16 nm), a blue-LED (peak wavelength 443 nm, FWHM: 19 nm), and a 600W HPS. The growth of pepper transplants was variety dependent, ‘Orangela’ and ‘Viper’ did not show any statistical significant differences in shoot dry mass between the three treatments; the shoot dry mass of ‘Fascinato’ was 19% greater in the HPS treatment compared to the LED treatments; and the shoot dry mass of ‘PP0710’ in the HPS treatment was 17% and 30% greater than the red and blue LED treatments, respectively. There was no significant difference in leaf net photosynthetic rate (PN) between treatments or varieties. In order to evaluate leaf morphology (curling) under the different treatments, the midrib vein was cut from a mature leaf to compare the extent of leaf curling geometrically, using the ratio of sagitta (height of the arc from the midpoint) and the half-chord-length (the length between the two end points of the arc). Results showed that the HPS and red-LED treatments had 57% greater sagitta:half-chord-length ratio (leaf curling index) than the blue-LED treatment, regardless of cultivar. From these preliminary results it is evident that bell pepper plant responses to supplemental light quality are
cultivar specific, and that blue-LED supplemental lighting can be an alternative to conventional HPS supplemental lighting to prevent leaf curling on pepper transplants.

(136) Effect of Cultivar on Growth and Strobile Production in Hops (Humulus lupulus) in Central Florida

Brian J. Pearson
University of Florida, Mid-Florida Research and Education Center, Apopka; bpearson@ufl.edu

Richard M. Smith*
University of Florida, Mid-Florida Research and Education Center, Apopka; richsmth01@ufl.edu

Hops (Humulus lupulus) is a perennial, herbaceous agricultural crop cultivated for its strobiles which contain a resinous compound used for flavoring and aroma in food, tea, and beer. The United States is the second largest global producer of hops with greater than 30,000 acres in production (Davis and King, 2012). Increased demand for hop products has recently resulted in production of hops in non-traditional areas. Successful hop cultivation outside traditional areas of the Pacific Northwest has been reported in North Carolina and New Mexico (Davis and King, 2012; Lombard, 2013). Preliminary investigations conducted in Central Florida at the Mid-Florida Research and Education Center support viability of hop production in climate zones previously considered too mild. Sixty hop rhizomes consisting of four varieties (Chinook, Columbus, Amallia, and Neo1) were transplanted into native deep sand soil (Tavares-Millhopper soil series) within a polyethylene covered, open-sided greenhouse. Plant bine length and quantity of strobiles produced were collected weekly. Differences among cultivars for both bine length and strobile production will be discussed. Results from this work will assist in selection of hop cultivar for production in Zone 9 climates.

(137) Nutritional Quality Parameters in Kale Cultivars Are Higher Under Narrow-band LED Light than Under Fluorescent/Incandescent Light

Heather D. Lowery*
University of Tennessee, Knoxville; thelowerys77@gmail.com

Dean A. Kopsell
University of Tennessee, Knoxville; dkopsell@utk.edu

Carl E. Sams
University of Tennessee, Knoxville; carlsams@utk.edu

Previous research in our group has shown that narrow-band wavelengths of light from light-emitting diodes (LEDs) can improve the nutritional quality of brassica specialty crops. The objective of this study was to measure the impact of different light treatments on the concentrations of nutritionally quality parameters among several kale (Brassica oleracea L. var. acephala D.C.) cultivars, and to compare incandescent/fluorescent light with LEDs. ‘Tuscano’, ‘Red Russian’, ‘Green Lance’, and ‘Redbor F1’ were grown in controlled environment chambers to the 30-day old stage (baby greens). Plants were cultured in hydroponic solutions under two fertility levels and four light treatments. Light treatments consisted of: 1) 250 μmol·m⁻²·s⁻¹ of fluorescent/incandescent light; 2) 100 μmol·m⁻²·s⁻¹ of blue (455-470 nm) / 150 μmol·m⁻²·s⁻¹ red (627-630 nm) LED light; 3) 100 μmol·m⁻²·s⁻¹ of blue / 150 μmol·m⁻²·s⁻¹ red for 22 days, followed by a 10-day exposure of 100 μmol·m⁻²·s⁻¹ of blue only; and 4) 100 μmol·m⁻²·s⁻¹ of blue / 150 μmol·m⁻²·s⁻¹ red for 22 days, followed by a 10-day exposure of 100 μmol·m⁻²·s⁻¹ of red only. Light treatments were set to a 16-h photoperiod with an air temperature of 24 °C. Thirty days after seeding, plants were harvested, freeze dried, and measured for nutritionally important metabolites. Kale leaf tissue biomass among cultivars was higher under the high fertility level; however, biomass did not differ among light treatments. Leaf tissue chlorophyll, lutein, beta-carotene, B, P, S, K, Ca, Cu, Mn, Fe, Zn, and Mo were higher under the high fertility treatment. Moreover, these same metabolites were significantly higher under the LED light treatments as compared to the fluorescent/incandescent light treatment. Results demonstrate the ability to increase the nutritional values of 30-day old kale using narrow-band LED light.

(138) Viability and Colonization of Vesicular Arbuscular Mycorrhiza on Tomato and Cowpea Roots

Chelsea Y. Grainger*
University of Maryland Eastern Shore, Princess Anne; cygrainger@umes.edu

Fawzy M. Hashem
University of Maryland Eastern Shore, Princess Anne; fmhashem@umes.edu

Lurline E. Marsh
University of Maryland Eastern Shore, Princess Anne; lemarsh@umes.edu

Luke O. Lee
University of Maryland Eastern Shore, Princess Anne; lolee@umes.edu

Brett D. Smith
University of Maryland Eastern Shore, Princess Anne; bdsmith@umes.edu

Symbiotic relationship between vesicular arbuscular mycorrhiza (VAM) and plant roots is beneficial to plant growth due to increased nutrient uptake, protection of host roots from pathogens, and increased tolerance to drought. This study was conducted to evaluate the viability and efficacy of the VAM inoculum used in plant-microbe interaction studies at the University of Maryland Eastern Shore Agricultural Experiment Station. The viability of the VAM was determined via culturing. VAM were grown on potato dextrose agar at 26 °C and examined after three days. Fungal colonies of different sizes and colors were produced indicating the viability of VAM. VAM was then evaluated on organic tomato roots that were grown in a certified organic research field with three
Environmental Stress Physiology

(190) Electrical Potentials in ‘W. Murcott’ Tangor Trees in Response to Salinity Stress

Jaecy Alexandra Koryzma-Zepp
Universidad Viña del Mar, Viña del Mar; jaecy86@gmail.com

Pilar M. Gil
Pontificia Universidad Católica de Chile, Santiago; pgil@uc.cl

Bruce Schaffer*
University of Florida, Homestead; bas56@ufl.edu

In response to abiotic stress, plants have been shown to generate electrical signals which may serve as rapid communication pathways between roots and shoots. The objectives of this study were to test the effects of salinity stress on electrical potentials (EP) in tangor citrus trees and to determine if EP responses to salinity are related to physiological variables such as stem water potential (SWP) or stomatal conductance (gs). Two experiments were conducted with 2-year-old ‘W. Murcott’ tangor trees growing hydroponically in dilute Hoagland solution in a greenhouse. In the first experiment, trees were subjected for 9 days to either no NaCl (T0) or 50 mM of NaCl (T1) added to the nutrient solution. In a second experiment, trees were subjected for 7 days to either no NaCl (T0) or 62.5 mM of NaCl (T1) added to the nutrient solution. In each experiment, EP was continuously monitored with electrodes placed at 3 different locations along the stem of each tree: EP1) base of the trunk, EP2) middle of the trunk, and EP3) within the canopy. Electrical potential differences (ΔEP) between each pair of electrodes [base of the trunk and center of the trunk (Δ1), ~ center of the trunk and within the canopy (Δ2), and base of the trunk and within the canopy (Δ3)] were also determined. Additional variables measured were: vapor pressure deficit in the greenhouse, electrical conductivity of the nutrient solution (EC), SWP, and gs. In experiment 1, the initial EC of the nutrition solution was 1.3 and 8.3 mmhos/cm for T0 and T1, respectively and 1.1 and 10.6 mmhos/cm for T0 and T1, respectively in experiment 2. In both experiments, VPD influenced EP regardless of electrode location. However, VPD had less of an influence on EP in trees subjected to salinity stress (T1) than in the control (T0) trees. Trees grown in nutrient solution with higher salinity (T1) had significantly lower SWP after 3 days than trees in the control (T0) treatment. Also, EP was positively correlated with SWP in both experiments. The electrical response variable most highly correlated with SWP was EP3 (R² = 0.76) in experiment 1 and Δ1 (R² = 0.95) in experiment 2. No differences in gs were observed between treatments in either experiment. This study showed that there are detectable EP changes in response to salinity stress that are correlated with SWP in tangor citrus trees.

Specified Source(s) of Funding: Fondecyt-Conicyt, Chile
(191) Comparative Responses of *Glaucium* Species to Salinity Stress
Ahmed O.M. Getlawi*
Colorado State University, Fort Collins; ahmadomer1976@yahoo.com
Mohamed Shahba
Colorado State University, Fort Collins; shahbam@lamar.colostate.edu
Harrison Hughes
Colorado State University, Fort Collins; Harrison.Hughes@colostate.edu

Salinity is considered a major factor that reduces plant growth in arid and semiarid regions where soil salinity is naturally high and precipitation is insufficient to achieve proper leaching. Horned Poppies (*Glaucium* sp.) are members of the Poppy family, Papaveraceae and are native to the Mediterranean and Middle East where they are considered to be somewhat salt tolerant. The objectives of this study were to: 1) evaluate the comparative salinity tolerance of Horned Poppy species 2) examine the effects of salinity on plant characteristic associated with aesthetics of the species; and 3) determine tolerance mechanisms associated with superior salinity tolerance among species. With increased salinity levels from the control (tap water) to EC levels of 5, 15, and 25 dS m⁻¹, leaf color declined over time to unacceptable ratings (below 6). In *G.flavum*, leaf color was least affected while all other species declined to unacceptable ratings of 5.3 (*G. acutidentatum*), 4 (*G. grandiflorum*), and 3.2 (*G. corniculatum*) at the salinity level of 25 dS m⁻¹. Leaf area decreased linearly in all species with increasing salinity. *G.flavum* maintained the greatest leaf area at all salinity levels. In *G. flavum*, as salinity levels increased from control to 5, 15 and 25 dS m⁻¹, average total nonstructural carbohydrate content (TNC) decreased by 15.7, 28.6 and 43.6% while the average TNC decrease in *G. acutidentatum* shoots was 17.6%, 36.8 and 48%. The decrease in *G. grandiflorum* was 20, 40, and 48.6% while the decrease in *G. corniculatum* was 28.9, 49, and 53, respectively. As salinity levels increased from control to 5, 15, and 25 dS m⁻¹, average proline content in shoots increased by 218, 367, and 537% in *G. flavum*, 64.5, 296 and 510% in *G. acutidentatum*, 156, 273 and 428% in *G. grandiflorum*, and 79, 188, and 337% in *G. corniculatum*. Results indicated that K⁺/Na⁺ ratio was ≥ 1 at all salinity levels in *G. flavum*, as compared to *G. acutidentatum*, *G. grandiflorum*, and *G. corniculatum*. In conclusion, as salinity increased, *Glaucium* sp. exhibited a reduction in leaf characteristics, plant height, flowering characteristics, overall plant quality, TNC, and K⁺/Na⁺ ratio, and increased shoot total reducing sugars and proline content. *G. flavum* showed higher salinity tolerance at all salinity levels as compared to the other species. Proline accumulation likely added to the salinity tolerance through osmoregulation or by acting as a carbon and nitrogen sink for stress recovery.

(192) Screening *Glaucium* Species for Drought Resistance with Emphasis on the Contributing Physiological Characters and Overall Performance
Ahmed O.M. Getlawi*
Colorado State University, Fort Collins; ahmadomer1976@yahoo.com
Mohamed Shahba
Colorado State University, Fort Collins; shahbam@lamar.colostate.edu
Harrison Hughes
Colorado State University, Fort Collins; Harrison.Hughes@colostate.edu

With increasing population demands on the world’s water supply, there is a greater need for water conservation, especially in arid and semiarid regions. Horned Poppies (*Glaucium* sp.) are members of the Poppy family, Papaveraceae, and are native to the Mediterranean and Middle East regions where they are considered somewhat drought tolerant. The objectives of this study were to 1) screen for drought tolerance of the common Horned Poppy species; 2) examine the effects of drought on plant characteristics as related to their aesthetics as well as the mechanisms associated with drought tolerance. Lysimeter columns were used in this study which was replicated twice. All columns were placed in the Colorado State University Plant Science Greenhouse in Fort Collins, CO. Fifty seedlings, at the 3 leaf stage, of each species were transplanted, 1 each per PVS tubes (15 cm diameter and 50 cm long) containing commercial potting mix. The potting mix was mixed with sand 2:1 to increase pore space. Water regimes applied included control [100% of the total ET, (evapotranspiration)], as well as 75%, 50% and 25% of the total ET. With lower water regimes, leaf color declined over time to unacceptable ratings (below 6) in both *G. grandiflorum* and *G. corniculatum*. In *G. flavum* and *G. acutidentatum*, leaf color was not adversely affected under all water regimes. Leaf area decreased linearly in all species with increasing drought. *G.flavum* maintained the greatest leaf area at all water regimes followed by *G. acutidentatum*, *G. grandiflorum*, and *G. corniculatum*. Increased water stress resulted in fewer flower buds, reduced flower number, and smaller flowers in all species. Also, increasing drought decreased the attractiveness of all *Glaucium* sp. although at different degrees. *G.flavum* showed greater transpiration efficiency (TE) since it was able to maintain its ET at lower rates while maintaining higher attractiveness when compared with *G. acutidentatum*, *G. grandiflorum*, and *G. corniculatum*, respectively. In summary, as drought increased, *Glaucium* sp. exhibited reduction in leaf characteristics, plant height, flowering characteristics, overall plant quality, TNC, and K⁺/Na⁺ ratio, and increased shoot total reducing sugars and proline content. *G. flavum* showed higher drought tolerance at all water regimes when compared to the other tested species. Since proline accumulation increased with drought stress it is likely that it aided drought tolerance through osmoregulation or by acting as a carbon and nitrogen sink for stress recovery.

An asterisk (*) following a name indicates the presenting author.
(193) The Effect of Flooding Duration and Portion of the Roots Submerged on the Physiology, Growth, and Survival of Papaya (Carica papaya L.)

Gustavo Rodríguez
Central University of Venezuela, Maracay; gusrodriguez@gmail.com

Bruce Schaffer*
University of Florida, Homestead; bas56@ufl.edu

Ana I. Vargas
University of Florida, Homestead; avargas22@ufl.edu

Carmen Basso
Central University of Venezuela, Maracay; cabassofiguera@gmail.com

Flooding for as little as 1 day has been shown to cause a dramatic decline in leaf gas exchange of potted papaya (Carica papaya L.) plants. However, the ability of papaya to recover from different durations of short-term flooding has not been reported. Therefore, a study was conducted to determine the effects of flooding duration on physiology, survival and recovery of 10-month-old ‘Red Lady’ papaya plants. During a 7-day period, plants in 11.3-L containers in Pro-Mix® potting medium were subjected to one of 6 different flooding durations: 0, 1, 2, 3, 4, or 5 days of root submersion in a completely randomized design with 6 single-plant replications per treatment. The study was conducted in a greenhouse where the mean air temperature was 26.1 °C (range 19.4 to 33.4 °C). Plants were unflooded immediately after treatment. Soil redox potential in flooded pots was measured daily; these measurements indicated that the soil became anaerobic after 24 hours of flooding. Leaf gas exchange [net CO₂ assimilation (A), transpiration (E), and stomatal conductance (gs)], the ratio of variable to maximum chlorophyll fluorescence (Fv/Fm), and leaf chlorophyll index (determined with a SPAD meter) were determined daily for 10 days for all plants. These measurements began 1 day before plants were flooded, continued until 1 day after plants in the 5-day flooding treatment were unflooded, and concluded 4 days later. At the end of the study period, plant survival was recorded. All plants flooded for 0 or 1 day survived. After 1 day of flooding, A, E, gs, Fv/Fm, and leaf chlorophyll index of flooded plants began to decline compared to the non-flooded controls, but values for these variables recovered to those of the non-flooded controls 9 days after unflooding. For plants flooded for 2 or more days, A, E, gs, Fv/Fm and leaf chlorophyll index continued to decline during flooding. Nearly all plants flooded for 2 or more days permanently wilted by day 11. In a subsequent experiment where plants were flooded by inundating 100%, 75%, 50%, or 0% (control) of the root system for 3 days, only plants with the root system totally submerged did not recover after unflooding. The data indicate that, under the conditions of this study, papaya plants are very intolerant of total root submersion, but can tolerate up to 75% of the root system continuously submerged for at least 3 days.

(194) Enhancing Drought Tolerance in Common Bean, the Most Widely Consumed Legume

Jesse Traub*
Michigan State University, East Lansing; traubjes@msu.edu

James D. Kelly
Michigan State University, East Lansing; kellyj@msu.edu

Wayne H. Loescher
Michigan State University, East Lansing; loescher@msu.edu

Among the legumes, common beans, Phaseolus vulgaris, are grown in the greatest quantity for direct human consumption. Beans provide to the human diet an inexpensive source of quality protein, and also essential micronutrients like iron and zinc. Common beans and related species are thus particularly important to the nutritional and economic livelihood of smallholder farmers, especially those in East Africa and South America. Nearly 60% of the production of common beans occurs in regions susceptible to intermittent and terminal droughts, and because beans are often grown without irrigation, crop yield is reduced by periods of drought. To improve food security of these farmers, plant breeders need to develop new bean varieties with traits that stabilize yield under drought stress. Consequently, we investigated the physiological mechanisms of drought tolerance within P. vulgaris and characterized how drought response varies between tolerant and susceptible varieties. We also compared the response of the closely related, drought tolerant tepary bean, Phaseolus acutifolius. Leaf photosynthesis and conductance decreased earlier in response to drought stress in more drought tolerant varieties, but drought susceptible varieties maintained higher gas exchange rates under well watered conditions. When exposed to exogenously applied abscisic acid (ABA), a hormone involved in abiotic stress signaling, drought tolerant varieties more severely decreased conductance at lower ABA concentrations. Drought tolerant varieties also accumulated more organic acids and soluble sugars when exposed to drought stress; leaf samples contained three to seven-fold more malic acid, inositol, fructose, and glucose than well watered controls. To more closely separate root and shoot influences on drought tolerances, reciprocal interspecific grafts were made between a drought susceptible P. vulgaris variety and drought tolerant P. acutifolius. As grafted plants were exposed to increasing drought, scion identity played a greater role in early and moderate drought tolerance while root identity had a greater impact on severe drought tolerance and recovery. Overall, drought tolerant Phaseolus varieties and species take a more conservative approach to growth; their photosynthetic and conductance rates are lower under ideal conditions, and they respond more quickly to drought stress.

Specified Source(s) of Funding: USDA–NIFA

(195) Auxin and Indol Acetic Acid Oxidase Activity during Sweetpotato Storage Root Initiation

Xiang Wang
Mississippi State University, Pontotoc; xw119@msstate.edu

Initiation of sweetpotato storage root formation is a complex biological event that involves the formation of a storage root meristem and the initiation of storage root-related transcription factors and regulatory mechanisms. Among these factors, auxin and indol acetic acid (IAA) are of particular interest because of their role in root development. Auxin and IAA are synthesized and transported in the shoot and root systems and are important for the development of the storage root meristem. In this study, we investigated the activity of auxin and IAA oxidase during sweetpotato storage root initiation. Our findings suggest that the activity of auxin and IAA oxidase is essential for the development of the storage root meristem and for the initiation of storage root-related transcription factors and regulatory mechanisms. Further research is necessary to understand the regulatory mechanisms involved in storage root initiation.
The use of biofuel has become one of the solutions to face increased oil costs, increased world population growth, and environmental pollution. Switchgrass is a major biofuel grass in North America. To determine the feasibility of growing switchgrass on saline soil and irrigated with saline water, we have completed two greenhouse pot experiments to test two upland switchgrass varieties (Trailblazer and Blackwell) for their germination and growth as affected by irrigation with different saline waters. The first experiment was conducted in 2011–12 and the second experiment was conducted from March to September, 2013. For each cultivar, seventy seeds were planted in forty 2-gallon pots containing sand mixed with 20% organic matter. The five salinity levels of irrigation water were 0.1 (control), 4, 8, 12, and 14 dS·m⁻¹. Germination rate decreased with increased salinity level of irrigation water. Germination rate decreased from 100% to 60% as soil salinity increased to 16 dS·m⁻¹ in the first experiment, but in the second experiment germination rate decreased from 100% to 50% as salinity level reached 9.5 dS·m⁻¹. The first harvest of aboveground biomass started to decrease after salinity level reached 7.7 dS·m⁻¹. The final harvest of aboveground biomass was reduced by 33-40% as soil salinity increased to 7-9 dS·m⁻¹. Root biomass decreased as salinity level reached 9.5 and 7 dS·m⁻¹ in the first and the second experiment. Our results suggest switchgrass has a moderate level of salinity tolerance.

(197) Temperature Effect on Seed Germination in Spinach (Spinacia oleracea L.)

Jessica Chitwood*
University of Arkansas, Fayetteville; jchitwo@email.uark.edu

Michael R. Evans
University of Arkansas, Fayetteville; mrevans@uark.edu

Curt R. Rom
University of Arkansas, Fayetteville; crom@uark.edu

Beiquan Mou
USDA–ARS, Salinas, CA; beiquan.mou@ars.usda.gov

Dennis Motes
University of Arkansas, Fayetteville; dmotes@uark.edu

Jianbing Ma
University of Arkansas, Fayetteville; jxm044@uark.edu

Haizheng Xiong
University of Arkansas, Fayetteville; heixiazi2006@sina.com

Aiinong Shi
University of Arkansas, Fayetteville; ashi@uark.edu

The economic value of spinach (Spinacia oleracea L.) continues to increase both in the United States and globally. In order to meet increasing demand, spinach production must be improved so that spinach may be grown in alternate seasons and locations, or in greenhouse and high tunnel as a year-round vegetable. Breeding spinach for heat tolerance is necessary for the improvement of spinach production, and seed germination is the first stage to test and to screen in order to develop heat-tolerant spinach lines. The objective of this research was to determine temperature effect on the seed germination rate, and to select heat tolerant spinach lines. A total of 41 spinach lines were studied. The germination experiment 1 was conducted using five controlled treatment temperatures: 20 °C, 24 °C, 28
developing commercial cultivars that are specifically adapted
screening of spinach germplasm is a significant step toward
toleration traits. Through a combination of greenhouse and
water-stress conditions to identify spinach exhibiting drought-
ated in fields in the Salinas Valley under carefully controlled
identified through initial greenhouse trials, were further evalu-
stored at high temperatures in experiment
1 were tested again under four temperature treatments; 20 °C,
32 °C, 36 °C, and 40 °C. Germinated seeds were counted on a
72-hour interval. It is expected that several lines will be iden-
identified for heat tolerant germination and these will be directly
used in spinach production or will serve heat-tolerant parents in
spinach heat-tolerant breeding and selection.

(198) Initial Evaluation of Spinach Collections
for Drought Tolerance
Caleb Knepper
USDA–ARS, Salinas, CA; Caleb.Knepper@ARS.USDA.GOV

Spinach (Spinacia oleracea) production in California represents
73% of all production in the United States covering more than
28,000 acres with a value over $150 million in 2012. California
has abundant fertile farmland along with a climate favorable
to leafy vegetable production, but a combination of factors are
building to threaten the future viability of spinach production
in the state. Irrigation water supplies are being increasingly
constrained due to reduced precipitation along with regulatory
changes reducing water allotments for growers. California is
currently in a historic drought with Governor Brown declaring
an official drought emergency in 2014. Furthermore, climate
change is estimated to increase these types of extreme weather
events further reducing water availability. Leafy vegetables, such
as spinach, have high water content, which makes these crops
particularly vulnerable to water stress. Reducing the irrigation
water required for a spinach crop can represent not only a sub-
stantial cost savings to the grower, but can also help growers to
meet tightening water quality regulations. To identify spinach
cultivars adapted to drought-stress conditions, more than 400
spinach varieties and germplasm were initially screened for
drought-tolerance traits in greenhouse trials by evaluating leaf
relative water content, wilt-resistance, and shoot fresh weights
in response to limited water availability. Candidate varieties
identified through initial greenhouse trials, were further evalu-
ated in fields in the Salinas Valley under carefully controlled
water-stress conditions to identify spinach exhibiting drought-
tolerance traits. Through a combination of greenhouse and
field trials, differences were observed in the ability of spinach
genotypes to adapt to limited-water environments. This initial
screening of spinach germplasm is a significant step toward
developing commercial cultivars that are specifically adapted
to production in regions that are facing tightening freshwater
supplies and will serve as a tool for breeders to utilize in the
ongoing development of abiotic-stress tolerant spinach.

Specified Source(s) of Funding: CDFA

(199) Abscisic Acid Impacts Tomato Fruit
Quality by Increasing Carotenoids and Soluble
Sugars and Decreasing Organic Acids

T. Casey Barickman*
University of Tennessee, Knoxville; tbarickm@utk.edu

Dean A. Kopsell
University of Tennessee, Knoxville; dkopsell@utk.edu

Carl E. Sams
University of Tennessee, Knoxville; carlsams@utk.edu

Plant growth regulators (PGRs) are chemicals used on a wide
range of horticultural crops. Similar to endogenous plant hor-
mones, these exogenous chemicals regulate plant development
and stimulate growth. Research in recent years has focused on
using PGRs to improve fruit quality parameters such as soluble
sugars, fruit color, and phytonutrients. One such PGR is abscisic
acid (ABA), which has been used effectively to improve fruit
quality, specifically sugars and phytonutrients. The purpose of
this study was to examine the effects of exogenous applications
of ABA on tomato (Solanum lycopersicum) fruit carotenoids,
soluble sugars and organic acids. ABA treatments were applied
foliarly or through the irrigation to the roots. This study also
compared how ABA and calcium (Ca) treatments together affect
fruit quality and whether there are added benefits to treating
plants with both simultaneously. Seeds of ‘Mt. Fresh Plus’ tomato
were grown in the greenhouse at 25 °C/20 °C (day/night) under
a 16 h photoperiod. Plants were treated with ABA applications
weekly. Ca treatments were applied at three different treatment
levels of 60, 90, and 180 mg·L⁻¹. Ca treatments were applied
to the plants via the irrigation lines. ABA treatments were ap-
plicated as a combination of foliar sprays and root applications.
For foliar ABA applications treatments consisted of a DI water
control (0.0 mg·L⁻¹ of ABA) or 50 mg·L⁻¹ of ABA. For ABA
root applications, treatments consisted of a DI water control (0.0
mg·L⁻¹ of ABA) or 50 mg·L⁻¹ of ABA applied via the irrigation
lines. The ABA spray treatments were applied once weekly till
dripping from the foliage, while root applications were applied
four times per day with the irrigation cycle. Fruit tissue was
harvested at red ripe maturity and evaluated for carotenoids,
soluble sugars and organic acids. The application of ABA had
a significant impact on tomato fruit lutein, β-carotene, and
lycopene. Glucose and fructose concentrations increased with
ABA applications in the fruit tissue. Furthermore, ABA applica-
tions increased malic and citric acids concentrations. Therefore,
ABA treatments did prove effective in increasing tomato fruit
carotenoids, soluble sugars and organic acid concentrations. This
study demonstrated that ABA is a viable PGR to significantly
improve tomato fruit quality.

Specified Source(s) of Funding: The University of Tennessee,
Institute of Agriculture

An asterisk (*) following a name indicates the presenting author.
There are various environmental stress factors that can potentially impact plant performance and quality parameters. Adequate levels of calcium (Ca) in tomato (Solanum lycopersicum) fruit have positive impacts on fruit quality, specifically firmness. One of the results of insufficient Ca uptake and movement in tomato is the physiological disorder blossom-end rot (BER), which is associated with a Ca deficiency in the distal fruit tissue. Previous research has demonstrated that foliar abscisic acid (ABA) applications decreased the incidence of BER and increased the uptake of Ca into fruit tissue. This study examined how foliar spray and root ABA applications, individually and in combination, affected the partitioning of Ca between the leaves and fruit of tomato plants, especially in the distal tissue, and how ABA affects the incidence of BER in the distal tissue of tomato fruit. Seeds of ‘Mt. Fresh Plus’ tomato were grown in the greenhouse at 25 °C/20 °C (day/night) under a 16-h photoperiod. Plants were treated with different Ca concentrations applied via the irrigation lines at 60, 90, or 180 mg·L⁻¹ of Ca. ABA treatments were applied as a combination of foliar sprays and root applications. Foliar ABA applications consisted of DI water control (0.0 mg·L⁻¹ of ABA) or 500 mg·L⁻¹ of ABA. For ABA root applications, treatments consisted of a DI water control (0.0 mg·L⁻¹ of ABA) or 50 mg·L⁻¹ of ABA applied via the irrigation lines. ABA spray treatments were applied once weekly till dripping from the foliage (tops of pots were covered to prevent spray drip into the media), while root applications were applied four times per day through the irrigation system. Fruit tissues were harvested 84–90 d after seeding. Fruit tissue was harvested at red ripe maturity and evaluated for yield, BER and Ca concentrations. Leaves were harvested at time of fruit harvest and were analyzed for Ca concentrations. The results indicate that a combination of the spray and root-applied ABA resulted in the greatest decrease in BER. The foil spray application of ABA combined with the Ca treatment of 180 mg·L⁻¹ decreased the incidence of BER even under stress conditions. Results also demonstrate that ABA treatments are very effective in increasing fruit Ca and preventing BER in the early stages of plant development, but are less effective in preventing Ca deficiency in the later stages of plant growth.

**Specified Source(s) of Funding:** The University of Tennessee, Institute of Agriculture
available for L. macranthoides, which will permit isolation and characterization of genes related to flower development and CGA biosynthesis in L. macranthoides, an important traditional Chinese medicinal plant.

(209) Developing Molecular Marker Resources for Pecan
Charles Rohla
The Samuel Roberts Noble Foundation, Ardmore, OK; ctrohla@noble.org
Will Chaney*
The Samuel Roberts Noble Foundation, Ardmore, OK; jwchaney@noble.org

Pecan [Carya illinoinensis (Wangenh.) K. Koch] is a long-lived diploid (2n = 2x = 32) tree species native to the Mississippi River Valley. Pecan has a complex inheritance pattern and high levels of heterozygosity. Thus, efforts aimed at characterizing the available germplasm resources to understand the existing genetic variation and opportunities for trait improvement in pecan could be accelerated with the availability of genomic tools. Although genomic resources in pecan lag behind other major species, progress is being made. We report here the results of initial collaborative efforts to develop molecular marker resources for pecan. The pecan cultivars evaluated in this study differ in nut characteristics, disease resistance and maturity. DNA from the cultivars Mahan, Wichita, Kanza, and Pawnee (the most widely planted pecan cultivar) was extracted using a modified CTAB method. PCR was used to amplify genomic regions targeting EST sequences, conserved gene sequences in multiple plant species and simple sequence repeats. Our initial results demonstrate the feasibility of developing genomic resources for Carya sp. and provide the foundation for their utilization in germplasm characterization and identification of molecular markers linked to traits with practical value. Ultimately, the genomic resources generated could facilitate selection and implementation of molecular breeding approaches in pecan improvement programs.

(210) Determining the Genotypes for and Genetic Distances between Two Loci Controlling Caladium Leaf Spotting and Main Vein Colors
Zhe Cao*
University of Florida, Wimauma; cjun01@ufl.edu
Zhanna Deng
University of Florida, Wimauma; zdeng@ufl.edu

Caladiums are grown in the containers and landscapes for their long-lasting, colorful leaves. Leaf traits are very important for caladium cultivars’ ornamental value. Information about caladiums’ genotypes for leaf traits and the genetic distances between the loci controlling leaf traits can help plant breeders to design appropriate hybridization schemes and estimate breeding population sizes needed to achieve specific breeding objectives. In this study, 45 crosses were made among 13 caladium cultivars and 16 breeding lines, and their progeny were phenotyped for leaf spotting and main vein color, two important leaf traits in caladium. Phenotyping results showed that eight red-veined caladium cultivars (Carolyn Whorton, Florida Fantasy, Florida Red Ruffles, Florida Sweetheart Freida Hemple, Red Flash, Tapestry, and White Queen) are heterozygous at the main vein color locus (V), with the genotype VrVg. Among the 14 caladium breeding lines that exhibit red main veins, two genotypes were observed: 11 breeding lines have the VrVg genotype and three breeding lines possess the VrVw genotype. Four caladium cultivars (Aaron, Florida Moonlight, Gingerland, and Miss Muffet) and two breeding lines that have white main veins have the VwVg genotype, as expected. The green veined ‘Florida Elise’ and three breeding lines are homozygous and carry the VgVg genotype. Three spotted cultivars (Gingerland, Miss Muffet, and Red Flash) and four spotted breeding lines are heterozygous at the leaf spotting locus (S), with the genotype Ss. ‘Gingerland’ and ‘Miss Muffet’ were crossed with ‘Candidum’, a non-spotted cultivar to determine the genetic distance between the S and V loci, which were found to be linked in a previous study. Nearly 6000 progenies were obtained and phenotyped, and segregation data indicated a tight linkage between the two loci.

(211) Possible Ancestor of Japanese Persimmon (D. kaki Thunb.) Existing in Yunnan Province and Northern Vietnam
Keizo Yo nemori*
Kyoto University, Kyoto; keizo@kais.kyoto-u.ac.jp
Shinya Kanzaki
Kinki Univ; Nara 631-8505; skanz@nara.kindai.ac.jp
Akihiko Sato
National Institute of Fruit Tree Science, Hiroshima 729-2494; satoaki@affrc.go.jp
Hoa Tran
Vietnam Academy of Agricultural Sciences, Hanoi; tranthihoa@agi.vaas.vn
Yong Yang
Northwest Sci-Tech University of Agriculture and Forestry, Shaanxi; yang_yong@nwsuaf.edu.cn
Renzi Wang
Northwest Sci-Tech University of Agriculture and Forestry, Shaanxi; wrenzi@163.com
Zhengrong Luo
Huazhong Agricultural University, Hubei; luozhr@mail.hzau.edu.cn

Japanese persimmon or simply persimmon (Diospyros kaki Thunb.) is cultivated for a long time in China, Korea and Japan, and is a quite important fruit crop in East Asia. However, the ancestor of persimmon is not clarified until now. There is only one report in 1978 for speculating an ancestor of persimmon by Ng (Malaysian Forester 41:43-50), in which he proposed D. roxburghii (syn. D. glandulosa) as a possible ancestor. Persimmon is hexaploid with a few exceptions of nonaploid cultivars and distributes in temperate zone, while wild relatives of the same genus are mainly diploid and distribute in tropical and subtropical regions. This proposed species, D. glandulosa, distributes in tropical to subtropical regions in Indochina and...
demonstrated to be diploid. As the first stage, we organized several survey trips in Thailand between 1992 and 2001 for collecting some Diospyros species including D. glandulosa, and elucidated phylogenetic relationships among these collected wild species to D. kaki. As the results, the relationships of these species are not close enough to D. kaki and we felt that we should collect wild relatives in subtropical and temperate regions in East Asia to obtain closer species to D. kaki. So, as the second stage, we started the survey trips in southern China since 2008 and collected an interesting individual until now. This individual is found in Xishuangbanna of Yunnan Province, China, and called “ye-mao-shi” in Chinese. The morphology of fruit in this individual is just like D. kaki, except that the fruit skin is pubescent in contrast with glabrous skin for D. kaki. Currently, we are looking for the species related to “ye-mao-shi” in northern Vietnam and look to collect several individuals in northern Vietnam. In this presentation, we will discuss the relationships of these individuals collected in southern China and northern Vietnam to D. kaki, especially using the sequence analysis of matK gene of the chloroplast DNA.

Specified Source(s) of Funding: Grant-in-Aid for Scientific Research (B) (24405024)

(212) Toward Understanding Genotype x Environment Interactions in Black Raspberry (Rubus occidentalis L.)

Jill M. Bushakra*
USDA–ARS, NCCR, Corvallis, OR; jill.bushakra@ars.usda.gov

Christine M. Bradish
North Carolina State University, Raleigh; cmbradis@ncsu.edu

Courtney A. Weber
Cornell University, Geneva, NY; caw34@cornell.edu

Joseph C. Scheerens
The Ohio State University-ORADC, Wooster; scheerens.1@osu.edu

Michael Dossett
B.C. Blueberry Council (in partnership with Agriculture and Agri-Food Canada), Pacific Agri-Food Research Centre, Agassiz, BC; Michael.Dossett@agr.gc.ca

Mary Peterson
USDA–ARS, HCRU, Corvallis, OR; mary.peterson@ars.usda.gov

Gina Fernandez
North Carolina State University, Raleigh, NC; gina Fernandez@ncsu.edu

Jungmin Lee
USDA–ARS, HCRU, Corvallis, OR; Jungmin.Lee@ars.usda.gov

Nahla Bassil
USDA–ARS, NCCR, Corvallis, OR; Nahla.Bassil@ars.usda.gov

Chad E. Finn
USDA–ARS, HCRU, Corvallis, OR; chad.finn@ars.usda.gov

Over the last 75 years, the black raspberry industry in the United States has undergone a steady contraction because of a lack of adapted, disease resistant cultivars. Recent research supporting the health benefits of a diet rich in polyphenolics, and black raspberries in particular, has led to a resurgence of interest in this fruit and a renewal of breeding efforts. This study seeks to advance and streamline identification of traits of interest to growers and consumers in black raspberry germplasm through the development of genomic tools, phenotyping, and socioeconmic analyses. Two related full-sib populations, designated ORUS 4304 (192 progeny) and ORUS 4305 (115 progeny), were planted across North American production regions. Primocane (non-fruiting canes) vigor was rated from 1 (dead) to 9 (very vigorous) at each site. Initial analysis of genotype by environment influences on primocane vigor indicated that individual genotypes showed significant variation depending on site conditions. Vigor data will be compared with the genetic linkage map to determine which genomic regions contribute to the control of this complex trait. The information will be integrated into breeding programs with the goal of developing disease resistant cultivars that satisfy the demands of the marketplace, adding to the sustainability and profitability of the industry. The genomic tools we are developing will be applied to the identification of quantitative trait loci and alleles important for breeding objectives regionally and nationally.

(213) Genetic Study of Serpentine Leafminer Resistance in Valmaine Romaine Lettuce

Ramkrishna Kandel*
University of Florida, Belle Glade; rkkandel@ufl.edu

Huangjun Lu
University of Florida, Belle Glade; hjlu@ufl.edu

Gregg Nuessly
University of Florida, Belle Glade; gnuessly@ufl.edu

Heather McAuslane
University of Florida, Gainesville; hjmca@ufl.edu

Serpentine leafminer (Liriomyza trifolii) is an economically important pest of lettuce in the United States. Control of the insect historically relies on use of pesticides but this increases crop production costs and causes environmental concerns. The insect has also developed resistance to many pesticides, rendering chemicals useless in protection of the lettuce crop. Host plant resistance is an environmentally friendly method that can be readily integrated into IPM to control the insect. The edible romaine lettuce cultivar Valmaine is known to be resistant to serpentine leafminer and three other insect species. In this study, a population consisting of 126 F2 families derived from a cross of Valmaine and Okeechobee was developed for genetic study of the serpentine leafminer resistance. Plants of each family and the parents are being screened for response to stippling by the serpentine leafminer using a clip cage method. A damage score, based on the amount of stippling, is being measured on each plant on a scale of 0–4. The data will be subjected to statistical analysis to determine inheritance of the resistance in Valmaine. A preliminary result from 20 families suggests that the resistance to serpentine leafminer may be controlled by the same gene Bcb1 for resistance to banded cucumber beetle. Genotyping the F2 individual to identify closely linked molecular markers is underway.
(214) Resistance to *Phytophthora rubi* in Wild North American Red Raspberry Germplasm

Michael Dossett*  
B.C. Blueberry Council (in partnership with Agriculture and Agri-Food Canada), Pacific Agri-Food Research Centre, Agassiz, BC; Michael.Dossett@agr.gc.ca

Tom Forge  
Agriculture and Agri-Food Canada, Summerland, BC; tom.forge@agr.gc.ca

Carol Koch  
Agriculture and Agri-Food Canada, Agassiz, BC; Carol.Koch@agr.gc.ca

Chaim Kempler  
Agriculture and Agri-Food Canada (retired), Agassiz, BC; kemplerc@yahoo.com

Phytophthora root rot is a serious problem in red raspberry production around the world and improving resistance is a major objective in many raspberry breeding programs. The native North American red raspberry, *Rubus idaeus* strigosus, has been identified as a source of resistance, but is only represented by a few founding clones in modern breeding lines. Little information exists regarding the frequency or distribution of root rot resistance among wild populations. We screened seedlings from 64 wild red raspberry populations collected from across North America for reaction to *P. rubi* using a semi-hydroponic system in the greenhouse. Root and shoot symptoms were rated on a 1–8 and 1–3 scale, respectively and compared to named varieties known to be resistant and susceptible. Resistance to *P. rubi* was widespread but varied geographically. Populations collected from eastern North America generally showed few symptoms and had high proportions of resistant plants, while those from western North America were more variable with some showing excellent resistance, some showing apparent segregation for resistance, and others appearing uniformly very susceptible. While further sampling would help to fill in gaps across the distribution of this species, this work indicates that resistance to Phytophthora root rot in wild red raspberry is widespread but variable across North America. These sources of root rot resistance may be valuable in broadening the genetic base of this trait in breeding programs.

(215) Evaluation of Red Cabbage Genotypes for Anthocyanin Content and Quality

Alexandra Amanda Bennett*  
Cornell University NYSAES, Geneva, NY; Alexandra.A.Bennett@gmail.com

David Christopher Manns  
Cornell University NYSAES, Geneva, NY; dcm38@cornell.edu

Anna Katharine Mansfield  
Cornell University NYSAES, Geneva, NY; akm87@cornell.edu

Phillip Griffiths  
Cornell University NYSAES, Geneva, NY; pdg8@cornell.edu

Red cabbage (*Brassica oleracea* var. capitata) epidermal tissues are a known source of cyanadin-based anthocyanins, which provide a wide range of health benefits including neurological, anti-inflammatory and analgesic effects. Red cabbage genotypes were identified to evaluate for total anthocyanin content and levels of specific anthocyanins using HPLC and spectrophotometric analysis. Pre-screening identified 11 red cabbage hybrid cultivars, 2 green cabbage control cultivars, 24 accessions from HRI Wellesbourne, UK, and 48 heading genotypes from USDA NE-9 identified from initial seedling screening of the crucifer collection for color, followed by field screening. Genotypes were grown to maturity in Freeville, NY, and harvested in October 2012. Sections of the harvested cabbage heads were lyophilized and blended into powder samples. These were concentrated via acidified methanol extraction and acidified water reconstitution for assaying. Significant variation was identified for anthocyanin content among the genotypes ranging from 0 mg·g⁻¹ in green control cultivars to 10.50 mg·g⁻¹ (dry weight, Cyanidin 3,5-di-glucoside equivalent). Three genotypes were identified with a concentration of anthocyanins in excess of 9 mg·g⁻¹ that represent concentrations significantly higher than those identified in any of the hybrid cultivars. Acylated anthocyanins accounted for over 75% of those identified, representing types that are more stable than non-acylated under variable pH, temperature and light conditions. These genotypes represent sources that can be utilized to introgress into new red cabbage cultivars containing higher levels of anthocyanins to promote nutritional, health, and aesthetic traits.

Specified Source(s) of Funding: USDA CGC Screening, Goichman Endowment

(216) Exploring Diversity in *Brassica* Crops for Glucosinolates and Cancer Chemopreventive Bioactivity

Talon M. Becker*  
University of Illinois at Urbana-Champaign; tbecker2@illinois.edu

John A. Juvik  
University of Illinois at Urbana-Champaign; juvik@illinois.edu

In the 21st century, cancer is expected to surpass heart disease as the number one cause of death in the United States. With the current cancer treatment methods only showing limited efficacy in decreasing cancer-related deaths, some believe that in the short term the prevention of carcinogenesis may be the more prudent objective. Several dietary factors have been shown to increase one’s risk of developing cancer, including saturated and trans-fats, but other compounds have been shown to be associated with a decreased cancer risk. Among these compounds are the glucosinolates (GSs), which are found in many common crops from the *Brassica* genus including broccoli, cauliflower, cabbage, and kale. Even though there is evidence that glucosinolates, and more specifically their bioactive hydrolysis products, have a negative effect on carcinogenesis, there is still much to learn about these compounds. Many genes involved in GS and hydrolysis product formation have been identified, but little is known about the underlying genetic factors leading to variability in these compounds,

An asterisk (*) following a name indicates the presenting author.
An asterisk (*) following a name indicates the presenting author.

**Tuesday, July 29, 2014**

**Ornamentals/Landscape and Turf 1**

**(118) Ornamental Annuals and Perennials Differ as Insect Attractors**

**Bethany Harris**
University of Georgia, Griffin; bah5191@uga.edu

**Kris Braman**
University of Georgia, Griffin; kbraman@uga.edu

**Svoboda V. Pennisi**
University of Georgia, Griffin; bpennisi@uga.edu

Plant and floral resources can be used to attract beneficial and pollinating insects, which can reduce pesticide inputs. The use of ornamental landscapes can offer additional ecosystem benefits such as weed suppression and conservation of biodiversity. A total of 65 plant types were evaluated in the Conservation Garden on University of Georgia Griffin Campus. Plants were chosen based on factors including high production of pollen and nectar, attractiveness to beneficial and pollinating insects, flowering phenology, and availability of floral resources. Plants located throughout the garden were monitored biweekly for one hour and visual observations consisted of family and order of beneficial and pollinating insects observed, plant or location insects visited, and ecological classification of the insects. Each insect order had fifteen top plant resources that functioned as arthropod “attractors”. Insect orders observed throughout the garden consisted of Lepidoptera (butterflies and moths), Diptera (flies), Hymenoptera (bees, wasps, and ants), Coleoptera (beetles), Araneae (spiders), and Hemiptera (true bugs, planthoppers, assassin bugs, stink bugs and others). All orders contain predatory, parasitoid, and foraging species that provide arthropod-mediated ecosystem services such as pollination and pest control. Differences between ornamentals were found with regard to types of insects attracted to a particular plant species. Top Lepidoptera attractors were: Agastache ‘Black Adder’, Lantana ‘Miss Huff’, Lantana ‘Mozzle’, *Verbena bonariensis*, and Buddleja. Top Araneae attractors were: Rudbeckia ‘Goldsturm’, *Amsomia hubrichtii*, Bellamcanda, Gaura ‘Passionate Blush’, Nepeta ‘Walker’s Low’, and Chrysanthemum ‘Cambodian Queen’. Top Diptera attractors were: Foeniculum vulgare, Coreopsis ‘Red Shift’, Bellamcanda, Aster ‘Wood’s Pink’, and Gaura ‘Passionate Blush’. Top Hymenoptera attractors were Agastache ‘Acapulco’, and ‘Black Adder’, Nepeta ‘Walker’s Low’, Salvia ‘Hot Lips’ and ‘Mystic Spires’, and Gaura ‘Passionate Blush’. Top Coleoptera attractors were: Achillea ‘Coronation Gold’ and ‘Seduction Yellow’, Coreopsis ‘Red Shift’, Gaura ‘Passionate Blush’, and *Rudbeckia triloba*. Top Hemiptera attractors were Buddleja, Achillea ‘Coronation Gold’, Curcuma ‘White Emperor’, *Rudbeckia triloba*, Coreopsis ‘Red Shift’, and *Cassia hebecarpa*.

**Tuesday, July 29, 2014**

**(119) Initial Landscape Evaluation of Daylily Cultivars for Rust Resistance**

**Eugene K. Blythe**
Mississippi State University, Poplarville; blythe@pss.msstate.edu

**Cecil Pounders**
USDA–ARS, Poplarville, MS; cecil.pounders@ars.usda.gov

**Michael Anderson**
Mississippi State University, Poplarville; jma4@msstate.edu

Daylilies (*Hemerocallis* sp.) are popular perennials in the Southern U.S. because they thrive in full sun, heat, humidity, and periods of dry weather. Daylilies are generally considered to be pest-free. However, a rust disease (*Puccinia hemerocallis*), which was introduced into the U.S. on imported plants in 2000, has become a prevalent problem on daylilies in the lower South. Through the cooperation of a daylily grower in south Mississippi, we evaluated a large landscape collection of 575 newer cultivars which had not been sprayed with fungicides to prevent infection by daylily rust during the summer of 2013. The warm, damp summer of 2013 was ideal for spread of daylily rust. Plants were rated at the end of the summer on a 1 to 3 scale with 1 showing very little or no disease, 2 showing moderate infection (approximately 33% infected leaves), and 3 showing severe infection. A total of 119 clones received a median rating of 1 or 1.5 and are thus worthy of further evaluation for resistance to daylily rust. Some of these clones may be more susceptible to the disease than a single rating might reveal. Planting rust-resistant daylily clones would eliminate the time and expense of spraying plants to prevent daylily rust.
(120) River Birch (Betula nigra) Growth and Root Extension from Three Production Systems during Landscape Establishment

Catherine Neal*
University of New Hampshire, Durham; cathy.neal@unh.edu

Amy Papineau
University of New Hampshire, Boscawen; amy.papineau@unh.edu

Daniel Lass
University of Massachusetts, Amherst; dan.lass@resecon.umass.edu

Twelve harvested river birch from each of three production systems [field, below-ground fabric container (FC) and pot-inpot (PiP)] were set in above ground rows heeled in with wood chips for two months, then transplanted in June 2012. Half of the trees from each treatment were root pruned to remove any visible defects and 2” thick root mats were removed from PiP trees. In November 2013, trees were air-spaded to expose roots in a 3’ wide x 1’ deep trench the length of the tree row. We counted the number of roots at 3”, 5”, and 7” transects and measured the extension of the longest roots in each direction. All trees were able to establish new roots, with a mean north-south spread of 11.7” for PiP, 12.1” for FC and 13.3” for field-grown trees, which corresponded with total stem caliper increases of 2.0, 2.7 and 3.7” respectively. These differences were correlated with initial tree size (field-grown trees were largest and PiP smallest at transplanting). The strong radial distribution of structural roots observed in field-grown trees is purported to be the best structure for long term tree health. Circling roots in unpruned PiP rootballs were still prominent and enlarged, which would potentially restrict growth in future years; however, they did not prevent successful extension of new roots into the surrounding soil during landscape establishment. Root pruning to remove defects in PiP trees at transplanting was successful and no additional defects were observed at the termination of this experiment. The FC trees generally had good root structure but some new roots grew inward or tangentially to the original rootball.

Specified Source(s) of Funding: USDA-NIFA and NH Ag. Expt. Station provided funding for this project

(121) Soil Water Content Affects Decomposition of Plantable Biocontainers for Landscape Use

Svoboda V. Pennisi*
University of Georgia, Griffin; bpennisi@uga.edu

Mussie Habteselassie
University of Georgia, Griffin; mussieh@uga.edu

Bethany Harris
University of Georgia, Griffin; bah5191@uga.edu

With increasing environmental awareness, the market is moving toward sustainable landscape practices, such as biodegradable containers. The rate and amount of biodegradation of these containers, however, has been reported as incomplete at the end of the growing season, which, depending on the geographic region, may be 3–5 months in the case of color rotations. When the next crop rotation is planted, container remnants have been reported to impede rototilling, slowing down planting and dulling blades. This is an impediment to the wider adoption of plantable containers, even though they can increase labor efficiency. Biodegradation largely depends on soil microbial activities, which in turn is impacted by soil type, available nitrogen, moisture, and temperature, among others. This study investigated the decomposition of paper sleeve plantable container (Ellepot®) in sandy clay soil with two moisture contents. The experiment was conducted under laboratory conditions, using glass containers holding soil with added shredded fabric, which were placed in an incubation chamber and held under constant 26 °C. Carbon dioxide traps (1N NaOH) were replaced daily and cumulative amount of carbon dioxide released was assessed using standard titration protocols for measuring soil respiration. Microbial activity and degradation of the fabric was assessed by the amount of soil respiration that is carbon dioxide released. After 6 days, moisture content affected soil respiration; under 60% Water Holding Capacity (WHC), the soil with paper fabric had the highest respiration measured in mg of CO2 released. Under 40%WHC, soil respiration was lower compared to soil with the same moisture content but without fabric.

(122) Establishment of Roses in High Soil Moisture Conditions

Pamela Collins*
Mississippi State University; pcollins@pss.msstate.edu

Geoff Denny
Mississippi State University; gcd42@msstate.edu

A section of new research plots within the Veterans Memorial Rose Garden (VMRG) at Mississippi State University suffer from high soil compaction and poor drainage issues similar to conditions often found on urban development sites. Such soils are expensive, difficult or even impossible to completely remediate. Several attempts to drain, rip and amend the soil on the VMRG site have failed to solve the problem. Trials of garden plants are now in process at this site to test their ability to survive or thrive in highly disturbed, degraded and wet soils. The first trial in this series tested the establishment of seven rose cultivars in soil moisture levels ranging from well-drained to continuously wet. Cultivars included ‘Knockout’ and ‘Pink Double Knockout’ as large shrub roses, ‘Red Drift’ and ‘Peach Drift’ as groundcover shrub roses, ‘Sunshine Daydream’ as a floribunda, ‘Francis Meilland’ as a hybrid tea, and ‘Look-a-Likes Phloxy Baby’ as a polyantha. A no-spray, low maintenance protocol was followed for management of the roses. The experimental design was a randomized complete-block design with 2 replications per cultivar per block with 4 blocks. The roses were planted 6 feet apart. The control block is on the highest ground with well-drained soil. The remaining blocks vary in soil wetness by their elevation within the field. Soil moisture, growth data, SPAD readings, and ratings of quality and disease were collected monthly May through October, 2013. Cultivars reported to impede rototilling, slowing down planting and dulling blades. This is an impediment to the wider adoption of plantable containers, even though they can increase labor efficiency. Biodegradation largely depends on soil microbial activities, which in turn is impacted by soil type, available nitrogen, moisture, and temperature, among others. This study investigated the decomposition of paper sleeve plantable container (Ellepot®) in sandy clay soil with two moisture contents. The experiment was conducted under laboratory conditions, using glass containers holding soil with added shredded fabric, which were placed in an incubation chamber and held under constant 26 °C. Carbon dioxide traps (1N NaOH) were replaced daily and cumulative amount of carbon dioxide released was assessed using standard titration protocols for measuring soil respiration. Microbial activity and degradation of the fabric was assessed by the amount of soil respiration that is carbon dioxide released. After 6 days, moisture content affected soil respiration; under 60% Water Holding Capacity (WHC), the soil with paper fabric had the highest respiration measured in mg of CO2 released. Under 40%WHC, soil respiration was lower compared to soil with the same moisture content but without fabric.
varied significantly in all of the parameters measured according to soil moisture with the exception of SPAD. A second year of data will be collected if a viable number of roses leaf out this spring after a full year of growing in wet soils.

(123) Comparisons of Species Diversity of Intensive Green Roofs between Honolulu, Hawaii, and Guangzhou, China

Wei Liu
Zhongkai University of Agriculture and Engineering, Guangzhou; victorialw@163.com

Nian Liu
Zhongkai University of Agriculture and Engineering, Guangzhou; liunian678@163.com

Chunhua Guo
Zhongkai University of Agriculture and Engineering, Guangzhou; gchgarden@163.com

Hye-Ji Kim*
University of Hawaii at Manoa, Honolulu; hkim2@hawaii.edu

The environment on a green roof is considerably different from the terrestrial environment in terms of soil construction, temperature, atmosphere, wind and solar irradiation. Plants on green roofs are purposefully selected for better adaptation to severe ecological and environmental conditions. Guangzhou, China, and Honolulu, HI, are two cities with a similar climate and geography. We randomly selected eight intensive green roofs in each city to compare the species diversity of plant communities present on these green roofs, as measured by Abundance, Jaccard’s index, Shannon-Wiener Index, and Evenness. According to our data, Abundance, Shannon-Wiener Index, and Evenness were interdependent to some degree, and higher Abundance and Shannon-Wiener index were associated with higher Evenness. Species diversity was higher in Guangzhou compared to Honolulu. The Jaccard’s index demonstrated that more than 30 plant species were present on green roofs in both cities. A reference list of more than 200 plant species used in green roofs was compiled from both cities for the entire study area. The total number of plant species was 24.8% greater in Guangzhou than in Honolulu. This reference list will be valuable for those creating green roofs in cities with tropical and subtropical climates.

(124) What Does the Consumer Say? South Florida Survey on Ornamental Grasses

Nancy Calderone-Ripak*
University of Florida, FLREC, Davie; nunziata2@aol.com

Kimberly K. Moore
University of Florida, Fort Lauderdale; klock@ufl.edu

Sandra B. Wilson
Indian River Research and Education Center, Fort Pierce, FL; sbwilson@ufl.edu

Gary W. Knox
North Florida Research & Education Center, Quincy; gwknox@ufl.edu

Zhanao Deng
University of Florida, Wimauma; zdeng@ufl.edu

Ornamental grasses are becoming more popular in many areas of the United States due to their ability to survive low-input landscaping conditions. As part of the National Ornamental Grass Trials initiated in 2012, Panicum virgatum and Schizachyrium scoparium cultivars were evaluated at the University of Florida, Florida Research and Education Center. In June’ 2013, an on-site survey was conducted to gain insight on consumer opinion about the use of ornamental grasses as landscape plants. Thirty-four people were surveyed and asked to rate the appearance of ten selected grasses on a scale of 1 to 5 (1 = poor, 5 = excellent). The grasses were identified by number only and included a variety of heights, textures and form. Respondents ranked Panicum virgatum ‘Shenandoah’ as their top preference based on appearance. Overall, respondents who were born in the US preferred the use of grasses as landscape plants more than respondents who were foreign-born. Eight out of ten grasses were ranked higher by US born respondents than foreign-born survey participants. Of the people surveyed 65% had not used ornamental grasses in landscape but 86% responded that they would use ornamental grasses in the future knowing that grasses help conserve water.

(125) National Ornamental Grass Trials 2014

Jane Rozum*
Colorado State University, Fort Collins; jane.rozum@colostate.edu

Mary Hockenberry Meyer
University of Minnesota, Chaska; meyer023@umn.edu

James E. Klett
Colorado State University, Fort Collins; jim.klett@colostate.edu

Many ornamental grasses require low water and fertilizer inputs and minimal maintenance, making them complementary plants in landscape settings. The National Ornamental Grass Trial, coordinated through the University of Minnesota, began in 2012. Collaborators are conducting trials on cultivars of ornamental grasses evaluating landscape characteristics and sustainability features in varied growing conditions throughout the United States. Seventeen regional sites in 11 states including: Vermont, North Carolina, Florida (4 sites), Minnesota, Pennsylvania, Ohio, Nebraska, Texas (5 sites), Colorado and Oregon are evaluating 22 cultivars of Panicum amarum, Panicum virgatum, and Schizachyrium scoparium. Four plants of each cultivar were established in summer of 2012 at collaborator sites. Data were collected in 2013 for plant size, overall growth habit rating, floral impact, foliage color, fall color, self-seeding, winter survivability and pest problems. Reports from collaborators indicate that variations in survival existed across sites and hardiness zones. Cultivar quality and performance including which plants were top performers also differed between trial sites. The trial collaborators will continue to post information and data on a national website (www.grasstrials.com) for the next two years (2014 and 2015). This pertinent and timely information will enable growers, retailers and consumers to make more informed decisions when choosing grasses for sustainable landscape settings.
(290) Struvite as a P Fertilizer Source for Irrigated Vegetables on Calcareous Soils

Charles A. Sanchez*
University of Arizona, Yuma; sanchez@ag.arizona.edu

Dan Froelich
Ostara, Vancouver, BC; dfroehlich@ostara.com

Trudy Naugler Klassen
Ostara Nutrient Recovery Technologies, Vancouver, BC; tnaugler@ostara.com

Struvite derived from a proprietary fluidized bed reactor system that recovers ammonia and phosphate from nutrient rich fluids, including waste streams, is a pearl or granule based P fertilizer and marketed by Ostara as “Crystal Green (CG)”. However, little is known on the efficacy of this product as a P fertilizer source on calcareous soils in the southwestern United States. Field studies were conducted from 2010 through 2014 comparing this struvite P fertilizer source (CG) against, and in combination with, commonly used commercial P fertilizers (triple superphosphate (TSP) and mono-ammonium phosphate (MAP)). Studies were conducted with lettuce (Lactuca sativa), watermelons (Citrullus lanatus), carrot (Daucus carota), potato (Solanum tuberosum), celery (Apium graveolens), and onions (Allium cepa). For lettuce, CG produced higher yields than TSP in one experiment but lower yields than MAP in two experiments. CG generally produced higher potato yields than MAP. For most cropping systems, CG produced yields comparable to the conventional P sources. Selected blends of CG and MAP show promise, especially for the longer season crops and crops grown into the warm season such as carrot and potato. 

(291) Low-molecular-weight Organic Acids As a Phosphorus Fertilizer Alternative for Vegetable Production in Calcareous Soil Regions

Dagoberto Osorio*
Texas State University, San Marcos; dag12683@gmail.com

Ken Mix
Texas State University, San Marcos; km77@txstate.edu

The purpose of this study was to investigate low-molecular-weight organic acids and their ability to solubilize native phosphate (P) from calcareous soil regions as a possible alternative for commercial P fertilizer. As a highly dependent P-nutrient crop, Solanum melongena (eggplant) was employed in a pot study and field grown using two distinct soil types native to the Central Texas region. S. melongena was grown in two distinct soil orders: Using mullisols and vertisols, each soil pot was treated with two molar concentrations for each acid using oxalic (0.1 mM, 100 mM) or citric acid (0.1 mM, 100 mM). The control received the recommended triple superphosphate [Ca(H2PO4)2] for eggplant production. Equal parts of urea [CO(NH2)2] fertilizer was applied to all pots. After crop maturity, fruit was harvested in weekly intervals for five weeks and measured to determine quantity and quality, based on weight and USDA standards. P solubilization from each pot was measured using a spectrophotometer (mg/L). A factorial MANOVA further determined statistical significance between organic acid application, P solubility and fruit biomass production, P > 0.05.

Specified Source(s) of Funding: Texas State University

(292) Influence of Leaching Fractions of Fertigation on Soil Chemical Properties and Plant Growth during Hot Pepper Plug Seedling Production

Jong Myung Choi
Chungnam National University, Daejeon; choi1324@cnu.ac.kr

Chiwon W. Lee*
North Dakota State University, Fargo; chiwon.lee@ndsu.edu

Growers generally use root media with high electrical conductivity (EC) for growing hot pepper plugs in Korea which often results in the suppression of early seedling growth. This study investigated the influence of varied leaching fractions during fertigation on changes in root substrate EC and seedling growth. Four different growing media formulations were used: peatmoss (PM)+pelite (PL) (7:3, v/v), PM+vermiculite (VM) (5:5), coir dust (CD)+PL (7:3), and CD+VM (5:5). Equal amounts of macronutrients (760 N, 265 P2O5, 596 K2O, 480 CaO, 97.2 MgO and 78 S, in mg·L⁻¹) were incorporated into all root media as pre-plant fertilizers. Seeds were germinated in 50-cell (volume 33 cc) plastic trays and seedlings were fertilized once a week with 100 mg·L⁻¹ N at stage 2 and with 200 mg·L⁻¹ N using 20-10-20 or 14-0-14 fertilizers at stages 3 and 4. Leaching fraction (LF) (leachate volume/volume applied x 100) were controlled to 0, 50, 100, 150, or 200%. When LF were 0 and 0.5, seedlings 31 days after sowing grew well in PM+PL. But seedlings grew better in PM+VM or CD+VM than in PM+PL or CD+PL as LF were 1.0 or greater. After 31 days, PM+VM and CD+VM had a higher EC than PM+PL and CD+PL at the same LF. In all growing media, soil solution EC was reduced as LF was elevated. For best seedling growth, optimum LF ranges were 0.5 to 1.0 for PM+PL and CD+PL and 1.5 to 2.0 for both PM+VM and CD+VM.

Specified Source(s) of Funding: Technology Development Program for Agriculture and Forestry, Ministry for Food, Agriculture, Forestry and Fisheries, South Korea (Project No. 312034-04).

(293) The Effects of a Soar Peach Micronutrient and Biostimulant Program on Peach Yield in South Georgia

Eric Waldo*
Chemical Dynamics, Inc., Plant City, FL; erichortpro@yahoo.com

The Effects of a Soar® Peach and Soar® Bloom Foliar Applied Program on the Yield and Fruit Size of Peaches (cv. ‘Carored’) in Central Georgia David Moore, SE Ag Research Services; Aaron Wise, SE Ag Research Services; Eric Waldo, Chemical Dynamics, Inc. In most years, peach growers in Georgia and Florida receive higher prices for their fruit early in the season,
but yields are often limited by early season fruit not reaching a marketable size. Consequently, growers are searching for methods to increase marketable yield and fruit size when growing early maturing varieties. The application of Soar® micronutrients and biostimulants (Chemical Dynamics, Inc., Plant City, FL) to vegetable and fruit crops has been shown in previous studies to increase earliness, fruit set, and fruit size. This study was conducted to evaluate the yield response of peach (cv. ‘Carored’) to foliar-applied ‘SOAR Bloom Spray’ and ‘SOAR Peach’ programs. Soar®Peach and Soar® Bloom are micronutrient packages provided on a biostimulant platform engineered from seaweed extracts, humic acids, and fulvic acids. In the first year of this trial, 2013, the application of ‘SOAR Bloom Spray’ and ‘SOAR Peach’ based programs had a positive impact on peach yield. Yields were generally 40% greater in treated plots compared to untreated plots. The increase in yield was due to more marketable fruits being harvested. Soar® products also hastened maturity considerably. Only 11% of the total yield in untreated plots was collected on the first two harvest dates, while 26-44% of total yield in treated plots was collected on the first two harvest dates. (Soar® is a registered trademark of Chemical Dynamics, Inc., Plant City, FL)

(294) Effects of Fertilizer Rate and Media Formulation on Vertical Growth and Basal Shoot Production of Transplanted Tissue-cultured Plugs of Dracaena ʻRuth Luka’

John L. Griffis*
Florida Gulf Coast University, Ft. Myers; jgriffis@fgcu.edu

Malcolm M. Manners
Florida Southern College, Lakeland; mmanners@flsouthern.edu

Adam D. Caple
Florida Southern College, Lakeland; acaple@mocs.flsouthern.edu

Kheng T. Cheah
University of Hawaii at Manoa, Honolulu; kheng@hawaii.edu

Andrew F. Kawabata
University of Hawaii at Manoa, Honolulu; kawabataa@hawaii.edu

Dracaena ʻRuth Luka’ is a new introduction by the Hawai‘i Export Nursery Association. It was discovered in Mauritius in 2004, as an unnamed, cultivated plant. DNA analysis has confirmed that it is a Dracaena but is a different species from other Dracaena selections and varieties currently in the trade. No recommendations on appropriate potting media or fertilizer programs for this plant have been published. In this experiment, 2-month-old single-stemmed tissue-cultured plugs were transplanted into 15.2 cm standard pots filled with one of three potting media: volcanic cinders and coco-chips (2:1, v:v), coco-peat and parboiled rice hulls (2:1, v:v), or sphagnum peat and perlite (1:1, v:v). All media were supplemented with micronutrients and either lime or gypsum as appropriate. Additionally, these media were supplemented with either of two rates of a slow-release (5-6 month) 15-6-12 fertilizer formulation, for a total of six treatments. Plants were grown in a shaded greenhouse and irrigated automatically. After six months, plants grown in peat-perlite media supplemented with the lower of the two fertilizer rates (7.6 g/pot) had taller central stems than plants grown in any other fertilizer/medium combinations. Plants grown at the lower fertilizer rate were more likely to grow upright, whereas plants grown at the higher rate (17.3 g/pot) often leaned or fell over. Plants grown in all of the media and fertilizer combinations were inclined to produce from one to six basal shoots after the original transplant stem length exceeded 20cm in height. All of the tested media/fertilizer combinations could produce a marketable plant of ‘Ruth Luka.’ It appears that the lower fertilizer rate is adequate for production of this cultivated variety, regardless of potting medium.

(295) Using Heat Unit Models to Predict N Release from Controlled Release Fertilizers for Vegetable Production

Eric Ellison
Agrium Advanced Technologies, Loveland, CO; eellison@agrimumat.com

Charles A. Sanchez*
University of Arizona, Yuma; sanchez@ag.arizona.edu

Terry Tindall
JR Simplot, Boise, ID; Terry.Tindall@simplot.com

Controlled release N fertilizers (CRN) perform poorly when N release rates are mismatched with crop demand. Studies were conducted to develop a method to predict N release rates from CRN products and develop a tool to recommend specific products for specific crop planting and harvest windows. Initial studies involved weighing CRN products into nylon mesh bags and burying the bags 7 to 8 cm into the soil within vegetable production fields. Soil temperature measuring data loggers were installed in each site and the mesh bags were excavated approximately every 7 to 14 days after burial. Replica samples pulled at each recovery date were digested, and total N was determined in the laboratory. Studies also involved correlating measured field release rates to laboratory release tests using alternative temperature summation models. These data were used to match up predicted release rates with soil temperature summations for alternative crop planting and harvest windows based on long term data bases of weather and crop growing period. We have compiled a list of recommended CRN products for various vegetable crops and planting dates in the arid southwestern United States.

(296) Controlled Release Fertilizers Affect Croton Production

Sueyde Oliveira*
University of São Paulo, Piracicaba; sueydefo@yahoo.com.br

Simone Mello
University of São Paulo, Piracicaba; scmello@usp.br

Keigo Minami
University of São Paulo, Piracicaba; kminami@usp.br

Paul R. Fisher
University of Florida, Gainesville; pfisher@ufl.edu

An asterisk (*) following a name indicates the presenting author.
The fertilizer management is an essential step in the production process, because allows the use as much of plant productive capacity. Thus, maximum improvement of nutrients by plants and lower losses are topics of studies aiming to increase productivity by reducing environmental impacts. Therefore, this study aimed to evaluate different sources and doses of controlled release commercial fertilizer (CRF) on growth of croton. The experiment was conducted in a greenhouse during the period of August, 2013 and January, 2014. The experimental design was in block randomized and treatments two sources of CRF (Osmocote and Basacote) with four doses (1.5, 3.0, 4.5 and 6.0 g L⁻¹ of substrate) of it one, water soluble fertilizer and no fertilizer, entering 10 treatments. The cultivation carried out in plastic pots 4L, containing substrate prepared with pine bark and doses of fertilizer previously added to the substrate at planting. Each block included two replicate (or container) of each treatment for all variable measured for each sample data. Over the course of 5 months data were collected for all measurement variables from destructively sampled containers, every 30 days. The evaluated characteristics were number of leaves, number of nodes, leaf area, height of stem and dry mass of leaves, branches and roots. Plants grown in less doses of CRF were similar to treatment with fertilizer, entering 10 treatments. The results showed that FLC can improve effectiveness of crop production compared to the conventional system and showed particular promise in the production of ornamental plants in containers.

Specified Source(s) of Funding: Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq)
A chilling-sensitive peach (*Prunus persica* cv. ‘Mibaeukdo’) was pre-treated with 30% CO$_2$, stored at 7 °C for 4 weeks, and followed by 3 days of subsequent ripening at room temperature. Significant reductions in both chilling injuries and softening were observed during the cold storage and also the subsequent ripening period. The high CO$_2$ pre-treatment inhibited the decreases of antioxidant activity and the total phenolics. The beneficial effects of high CO$_2$ were clearly apparent after 3 days at room temperature after cold storage, and the CO$_2$ treatment had a strong effect on the high phytochemical content in peaches. Our results indicated that high levels of antioxidant activity, total phenolics, and ascorbic acid in the CO$_2$ treated peach might be directly responsible for reducing chilling injury in peaches under high CO$_2$, which efficiently protects cells from free radicals induced by chilling stress.

Specified Source(s) of Funding: This work was carried out with the support of the Cooperative Research Program for Agricultural Science & Technology Development (Project No. PJ009765), Rural Development Administration, Republic Korea.

**Specified Source(s) of Funding:** This work was carried out with the support of the Cooperative Research Program for Agricultural Science & Technology Development (Project No. PJ009765), Rural Development Administration, Republic Korea.

### (014) Proteases Associated with Programmed Cell Death and Watersoaking in Ethylene-treated Immature Cucumber Fruit

**Jin Su Lee**
University of Florida, Gainesville; jslee.horti@gmail.com

**Donald J. Huber* **
University of Florida, Gainesville; djhuber@ufl.edu

**Eduardo C. Vallejos**
Horticultural Sciences Department, IFAS, University of Florida, Gainesville; vallejos@ufl.edu

**Brandon M. Hur**
Syngenta, Jealott’s Hill Intl. Research Centre, Bracknell; brandon.hurr@gmail.com

Continuous ethylene exposure induces acute tissue watersoaking of immature, commercial-harvest maturity beit-alpha cucumber fruit (*Cucumis sativus* L., cv. Manar). Ethylene-induced watersoaking is preceded by hallmark features of programmed cell death (PCD) including loss of cell viability, increased nuclease activity, and DNA laddering. Our previous studies demonstrated that enhanced reactive oxygen species (ROS)-generating capacity and increases in specific and bifunctional nucleases represent early events in ethylene-induced PCD in cucumber fruit. The present study examined the participation of proteases in ethylene-induced PCD. Immature cucumber fruit (avg. length 12.7 cm, avg. mass 69.4 g) were treated continuously with air or 10 µL·L$^{-1}$ ethylene for up to 6 d at 15 °C. Ethylene-treated fruit showed incipient watersoaking in hypodermal tissue at 4 d that intensified and progressed into mesocarp and endocarp at 6 d. Protease activity and total protein content in air-stored fruit remained unchanged through 6 d. In ethylene-treated fruit, significant protein degradation was observed at 2 d, with total protein levels declining about 60% through 6 d. The decline in total protein in response to ethylene was accompanied by significant increases in protease activity. Increased activity was noted after 2 d, reaching levels 9.3-fold higher than initial values after 6 d. Total protease activity was highest at pH 5 and declined sharply through pH 8. Acidic pH preference suggests vacuolar localization, or activation in the cytoplasm under acidic conditions upon tonoplast rupture. In-gel assays revealed three ethylene-responsive proteases with apparent molecular weights of 56, 106, and 180 kDa. The 106 and 180 kDa proteins increased after 2 d of ethylene exposure, reaching maxima at 4 to 5 d coincident with symptoms of watersoaking. The 56 kDa protease was observed only in ethylene-treated fruit and was first detected after 4 d of ethylene exposure. Together with up-regulated nuclease activities and ROS-generating capacity, the early appearance of proteases in response to ethylene provides additional evidence that watersoaking in immature cucumber fruit reflects the execution phase of a PCD pathway.

**Specified Source(s) of Funding:** USDA NIFA Award (SCRI) #2009-51181-05783 Federal formula funds NE1036

### (015) Sample Handling Affects Accuracy of HS-SPME GC for the Study of Volatile Aroma Compounds in Apple Tissue

**Guadalupe Isela Olivas**
Centro de Investigacion en Alimentacion y Desarrollo, Chihuahua; golivas@ciad.mx

**Javier Molina-Corral* **
Centro de Investigación en Alimentación y Desarrollo, Cuauhtémoc; javiermolina@ciad.mx

**Miguel Espino-Díaz**
Centro de Investigación en Alimentación y Desarrollo, Cuauhtémoc; aster3000@hotmail.com

**David Sepulveda**
Centro de Investigación en Alimentación y Desarrollo, Cuauhtémoc; dsepulveda@ciad.mx

**Carla Gutiérrez**
Centro de Investigación en Alimentación y Desarrollo, Cuauhtémoc; carlacge_24@hotmail.com

HS-SPME coupled to GC has been widely used for analysis of volatile aroma compounds (VACs) in apple tissue. Several factors influence the accuracy of these methodologies such as SPME conditions, GC conditions, sample preparation and sample handling. In the present work, the effect of sample handling was evaluated. Storage time, storage temperature, vial material, and addition of sodium chloride prior or after sample storage were assessed to optimize the conditions for a reproducible and accurate HS-SPME analysis of VACs in apple tissue. Freshly made apple juice was placed in plastic or glass vials (20 mL juice in 20 mL plastic vials –conical cap-, or 2 mL juice in 4 mL glass vials –SPME vials-), stored for 10 or 30 days at three different temperatures: 0, –20, or –70 °C. Sodium chloride was added (36% w/v) prior or posterior to storage. For VACs analysis, tissue was thawed and those samples stored in 20 mL plastic vials were pipetted into 4 mL glass vials (2 mL of juice into SPME vials). For those samples stored without sodium chloride, this was added prior analysis. VACs were analyzed by HS-SPME.
(65 μm PDMS/DVB fiber; 45 min fiber exposure time) with a GC-MS instrument. Storage time of 30 days was the factor with the greatest effect on the VACs content in apple tissue, independently of temperature or vial. Concentration of 2-hexenal, 1-butanol, and 2-methyl propyl acetate, considerably increased after 30 days of storage; while concentration of hexanol, butyl acetate, 2-methyl butyl acetate highly decreased after 30 days of storage. At 10 days of storage, there was an effect on VACs concentration due to the type of vial: plastic vials increased values of hexanal, hexanol, 2-methyl-1-butanol, and decreased values of hexyl acetate, butyl acetate, 2-methyl butyl acetate; whereas glass vials didn’t affect VACs, at any temperature (0, –20 or –70 °C). On glass vials, addition of salt prior to storage, helped to maintain VACs concentration. From this study we recommend to store samples for no more than 10 days, using glass vials (SMPE vials), and adding sodium chloride prior to storage, at temperatures below –20 °C. The optimal storage conditions for the reproducible and accurate analysis of headspace apple juice VACs requires further studies to elucidate the complex interactions between the many participating factors.

**V016** Volatiles Production from Isoleucine in Fresh-cut Apple, Using Alginate Coatings As the Holding Matrix

Guadalupe Isela Olivas  
Centro de Investigacion en Alimentacion y Desarrollo, Chihuahua; golivas@ciad.mx

Miguel Espino-Díaz*  
Centro de Investigacion en Alimentacion y Desarrollo, Cuauhtémoc; aster3000@hotmail.com

Gloria Velasco  
Centro de Investigacion en Alimentacion y Desarrollo, Cuauhtémoc; galejandra_velasco@hotmail.com

Javier Molina-Corral  
Centro de Investigacion en Alimentacion y Desarrollo, Cuauhtémoc; javiermolina@ciad.mx

David Sepulveda  
Centro de Investigacion en Alimentacion y Desarrollo, Cuauhtémoc; dsepulveda@ciad.mx

Gustavo A. González-Aguilar  
Centro de Investigacion en Alimentacion y Desarrollo, Hermosillo; gustavo@ciad.mx

Edible coatings (EC) have been successfully used for the preservation of fresh-cut apples, since EC create semipermeable barriers to gases and water vapor. EC are also potential carriers of additives that can help to preserve apple quality. Aroma is one of the main quality parameters in apples; naturally occurring fatty acids and amino acids are the main aroma precursors in this fruit. EC could be used as carriers of amino acids, to enhance the aroma of fresh-cut apple, where the fruit, through the amino acid pathway, could metabolize the amino acid contained in the EC to produce volatile aroma compounds (VACs). The objective of this work was to study fresh-cut apple wedges covered with alginate coatings formulated with isoleucine as a precursor for VACs. Fresh-cut apple wedges were first immersed in a CaCl2 solution followed by one of these EC: coating of pure alginate (ALG), alginate coating containing 10 mM isoleucine, or alginate coating containing 50 mM isoleucine, (LAA and HAA, respectively). Apple wedges were stored for 12 days at 4 °C and 85% relative humidity. The development of VACs during storage was measured chromatographically utilizing HS-SPME by GC-MS. The presence of isoleucine caused an increase in the concentration of 2-methyl butanol, 2-methylbutyl acetate, butyl 2-methyl butanoate, and hexyl 2-methyl butanoate, which are branched VACs derived from the isoleucine metabolism. This increase was proportional to the amino acid content, showing higher values in HAA apples than in LAA ones. The concentration of branched VACs increased during storage for HAA and LAA apples getting the highest values at day 9 of storage, while control and ALG apples did not show any changes throughout the storage period. At day 9, 2-methyl butanol showed a concentration seven fold higher in HAA apples when compared to control ones. The esters 2-methylbutyl acetate, butyl 2-methyl butanoate, and hexyl 2-methyl butanoate showed values 8-, 4- and 1.6-fold higher, respectively, in HAA apples when compared to control wedges, at day 9. EC did not influence the production of straight chain volatiles since those VACs are synthesized by the fatty acid metabolic pathway. On the other hand, the content of the aldehydes hexanal and trans-2-hexenal resulted higher in control wedges, when compared to coated apples. EC containing isoleucine enhanced the production of the VACs derived from the isoleucine metabolic pathway. EC formulated with isoleucine have a great potential in the fresh-cut apple industry.

**V017** Effect of Alginate Edible Coatings Formulated with Linoleic Acid on the Aroma and Quality of Fresh-cut Golden Delicious Apple Wedges

Guadalupe Isela Olivas  
Centro de Investigacion en Alimentacion y Desarrollo, Chihuahua; golivas@ciad.mx

Gloria Velasco  
Centro de Investigacion en Alimentacion y Desarrollo, Cuauhtémoc; galejandra_velasco@hotmail.com

Javier Molina-Corral  
Centro de Investigacion en Alimentacion y Desarrollo, Cuauhtémoc; javiermolina@ciad.mx

Miguel Espino-Díaz*  
Centro de Investigacion en Alimentacion y Desarrollo, Cuauhtémoc; aster3000@hotmail.com

David Sepulveda  
Centro de Investigacion en Alimentacion y Desarrollo, Cuauhtémoc; dsepulveda@ciad.mx

Gustavo A. González-Aguilar  
Centro de Investigacion en Alimentacion y Desarrollo, Hermosillo; gustavo@ciad.mx

Edible coatings (EC) preserve the quality of fresh-cut apple by creating semipermeable barriers to gases, avoiding quality loss. The EC also serve as carriers of active ingredients. In this

*An asterisk (*) following a name indicates the presenting author.*
study alginate coatings were used as carriers of linoleic acid, for fresh-cut apple. The aim of this study was to evaluate the ability of Golden Delicious fresh-cut apple to metabolize linoleic acid to enhance the biosynthesis of volatile aroma compounds (VACs). Fresh-cut apple wedges were immersed in a CaCl₂ solution followed by a coating of alginate (ALG), or alginate containing linoleic acid (ALG-FA) and stored at 4 °C and 85% RH. VACs were analyzed by two means: a) in apple macerated tissue, periodically during 12 days; b) in the headspace of apple wedges kept in 0.5-L sealed containers, periodically during 7 days. In both experiments VACs content was determined by HS-SPME and GC-MS. Browning and tissue softening was delayed and texture was improved significantly by both ALG and ALG-FA coatings, when compared to uncoated wedges (CTRL). ALG-FA treatment significantly reduced weight loss in fresh-cut apples. The presence of linoleic acid caused an increase in the concentration of butyl acetate on apple tissue, been 4, 6, and 12 fold higher when compared to control apples at days 3, 6 and 9 of storage, respectively. Butyl acetate is one of the main VACs in apples, which is derived from linoleic acid metabolism through β-oxidation pathway. No effect of linoleic acid was observed in apple tissue on VOCs derived from linoleic acid through the lipoxygenase pathway such as hexyl acetate, hexanol and hexanal. Furthermore, higher concentration of hexanal (as well as 3-hexenal) was observed in control wedges. The concentration of aldehydes and alcohols was greater in apple tissue than in the headspace of apple wedges; while, esters showed a higher concentration in the headspace. 2-methylbutyl acetate and butyl 2-methylbutanoate content in the tissue was higher for the coated treatments, while content of hexyl butanoate and hexyl hexanoate was higher in CTRL wedges. ALG-FA coatings preserved the quality, induced the biosynthesis of butyl acetate. ALG coatings offered improved barrier properties to VACs in fresh-cut ‘Golden Delicious’ apple wedges. However, further studies are necessary to better understand the alginate EC properties as substrates carriers for the biosynthesis of VACs, and the activation of enzymes related to apple metabolism.

(018) Biochemical and Molecular Processes during Ripening and Over-ripening of Banana (Musa AAA Cavendish Subgroup) Fruit Exhibit Characteristics of Programmed Cell Death

Maricruz Ramírez-Sánchez*
Horticultural Sciences Department, IFAS, University of Florida, Gainesville; mramirez16@ufl.edu

Donald J. Huber
Horticultural Sciences Department, IFAS, University of Florida, Gainesville; djhuber@ufl.edu

Eduardo C. Vallejos
Horticultural Sciences Department, IFAS, University of Florida, Gainesville; vallejos@ufl.edu

Karen Kelley
Electron Microscopy and Bio-imaging Core, ICBR, University of Florida, Gainesville; vau@ufl.edu

Programmed cell death (PCD) has been well characterized in floral and vegetative tissues but little has been reported on fleshy fruits. The purpose of this study was to determine if ripening and over-ripening of fleshy fruit are accompanied by classic symptoms of PCD. Bananas were ethylene-treated at green stage and shipped overnight to the UF. Upon arrival they were stored at 20 °C and evaluated for biochemical and molecular changes. Fresh peel tissue was collected and stored in 4% parafomaldehyde in phosphate buffered saline (pH7.0) for microscopy and in situ cell death detection (Terminal deoxynucleotidyl transferase dUTP nick end labeling, TUNEL). Fruit arrived at color stage 2, after 4 d they had reached color stage 4 and on day 8 fruit were at stage 7 with presence of senescence-related spots (SRS). Ethylene production increased within 24 h of storage and reached climacteric peak after day 2 (0.55 ± 0.01 mg·kg⁻¹·s⁻¹). The CO₂ production sharply increased on day 2, reaching a maximum on day 4 (31.4 ± 1.0 mg·kg⁻¹·s⁻¹). Both Chroma and a* reached highest values at day 6, 48.14 ± 0.27 and 48.11 ± 0.26, respectively. Pulp °Brix increased until day 6 when it reached a plateau while peel °Brix increased throughout the evaluation period. Total electrolyte leakage of peel tissue increased from 10% at day 0 to 30% at day 6. Among the nutrients evaluated for leakage, calcium leakage reached 65% by day 6. Colorimetric analysis of nuclease activity of peel tissue showed an increase from 108 ± 7.1 units kg FW per second on day 0, reaching a maximum at day 4 of 359.4 ± 15.8 units kg FW per second. SDS-PAGE analysis for nuclease followed by staining detected three nucleases with apparent molecular mass of 22.5, 27 and 29 kDa and showed intensification by day 4. Total protease activity was 66.3 ± 1.94 units kg FW per second at day 0 and reached a maximum of 88.04 ± 1.94 units kg FW per second at day 6. Among the nutrients evaluated for leakage, calcium leakage reached 65% by day 6. Light microscopy revealed morphological changes during ripening of the banana peel, particularly epidermal and subepidermal cells. Images of SRS on stage 7 peel revealed shrinkage of the surface layers, visually suggesting cell death. TUNEL-positive nuclei on the SRS confirmed DNA fragmentation. Ripening and over-ripening of banana peel do share biochemical and molecular processes previously described for programmed cell death in other plant systems.

Specified Source(s) of Funding: Acknowledgments Supported by USDA NIFA Award (SCRI) #2009-51181-05783, and by Federal formula funds NE1036.

(019) Acute Suppression of Ripening and Negation of a Respiratory Climacteric In Midsclimacteric Tomato Following Short-Term Application of 1-Mcp Under Hypobaric Hypoxia

Xiaoqing Dong
University of Florida, Gainesville; xiaoqingdong09@163.com

Donald J. Huber*
University of Florida, Gainesville; djhuber@ufl.edu

Jing-Ping Rao
College of Horticulture, Northwest A&F University, Yangling; dqr0723@163.com

An asterisk (*) following a name indicates the presenting author.
James H. Lee
University of Florida, Gainesville; jhlee@ufl.edu

Our previous studies have shown that midclimacteric tomato exposed to hypobaric hypoxia for 6 h show increased sensitivity to subsequent treatment with 1-methylecyclopentene (1-MCP), exhibiting an additional 2- to 3-d delay in the progression of ripening compared with fruit treated with 1-MCP without prior exposure to hypobaric hypoxia. In the present study, midclimacteric tomato were subjected to brief (1 h) combinatorial treatment with 1-MCP (500 nL·L⁻¹, 20.8 µmol·m⁻³) under hypobaric hypoxia (10 kPa, 2.1 kPa O₂) or normal atmospheric conditions. Treatment with 1-MCP for 1 h under atmospheric conditions had negligible effects on softening and timing and magnitude of peak ethylene production, and moderate effects on respiration and lycopene and PG accumulation compared with fruit treated under hypobaric hypoxia or atmospheric conditions without 1-MCP. By sharp contrast, fruit exposed to 1-MCP under hypobaric hypoxia for 1 h showed acute, long-term disturbance of ripening. Mid-climacteric trajectories for hue angle and firmness declines were arrested for 10 days and peak ethylene production delayed for 12 d compared with those for all other treatments. Fruit treated with 1-MCP/hypobaric hypoxia required nearly 10 to 12 d before lycopene, PG levels and hue angle reached mid-climacteric tomato to brief treatment with 1-MCP under hypobaric hypoxia or atmospheric conditions. After 1-h exposure, internal 1-MCP averaged 10.8 ± 2.2 µL·L⁻¹ under hypobaric hypoxia compared with 5.3 ± 1.4 µL·L⁻¹ under atmospheric conditions. The hyper-response of mid-climacteric tomato to brief treatment with 1-MCP under hypobaric hypoxia is reminiscent of that of mature-green fruit treated with supraoptimal levels of 1-MCP under atmospheric conditions. The results indicate that tomato fruit at advanced ripening stage remain strongly ethylene responsive and also suggest that an ethylene-associated respiratory climacteric is not an obligatory requirement for completion of ripening.

Specified Source(s) of Funding: USDA NIFA Award (SCRI) #2009-51181-05783 and Federal formula funds NE1336

(020) Preliminary Physicochemical Characterization of Genomically Diverse Georgia Grown Bananas during Postharvest Ripening

Floyd M. Woods
Auburn University, Auburn, AL; woodsfm@acesag.auburn.edu

Gabriela Hernandez*
Auburn University, Auburn, AL; gzh0011@auburn.edu

There is limited information concerning sensitivity of genomic hybrids of Musa sp. adaptable to southeastern United States to ethylene treatment during postharvest ripening and storage. The objective of this study was to compare the physicochemical properties and ripening behavior of three banana cultivars differing in genotype following application of Ethephon. ‘Ele Ele’ (Musa AAB Group), ‘Kandarian’ (Musa ABB Group) and Brazilian (Musa ABB Group) were grown at the University of Georgia Bamboo Farms and Coastal Gardens in Savannah, Georgia (latitude 32.133’S, 81.2’W, elevation 14 meters). Mature green bananas at the full three quarter stage were separated and either treated with aqueous solution of Ethephon (500 ppm immersion for 5 minutes) or controls (water immersion for 5 minutes) and stored for 9 days at 20°C and 95% RH. Fruit quality was characterized by measuring peel color, dry matter, soluble solids, pH and titratable acidity. Results from this study indicate that perceived sensitivity to Ethephon (500 ppm immersion for 5 minutes) treatment and modification in ripening behavior was variable when comparing genotype and measured fruit quality parameters during 9 days of storage. ‘Kandarian’ fruit were more sensitive to postharvest Ethephon treatment when compared to ‘Brazilian’ and ‘Ele Ele’ respectively. There were significant interactions observed for Ethephon treated ‘Kandarian’ fruit and days in storage in external peel color (L, a, and ho values) and corresponding changes in internal fruit quality (dry matter, soluble solids, pH and titratable acidity). Variable postharvest ripening behavior and sensitivity to Ethephon treatment was observed for ‘Brazilian’ and ‘Ele Ele’ respectively. Preliminary findings from this study indicate that sensitivity or responsiveness to postharvest ethylene treatment and hence degreening process of banana to obtain optimal consumer eating quality is highly dependent on selected cultivars. Detailed postharvest studies are ongoing to determine optimal concentration of Ethephon and desired changes in consumer flavor and nutritional quality that reflect changing consumer demographics.

(021) Glucosinolates Are Enhanced by Controlled Application of Abiotic Stresses in Broccoli (Brassica oleracea var. Italica) during Postharvest Storage

Elina D. Coneva
Auburn University, Auburn, AL; edc0001@auburn.edu

Joseph M. Kemble
Auburn University, Auburn, AL; kembljm@auburn.edu

Kalidas Shetty
North Dakota State University, Fargo; Kalidas.Shetty@ndsu.edu

D. Camille Crosby
Auburn University, Auburn, AL; dcc0011@auburn.edu

Michael Barnhill
Auburn University, Auburn, AL; mzb0013@auburn.edu

An asterisk (*) following a name indicates the presenting author.
Glucosinolates are amino acid-derived health-promoting phytochemicals related to plant defense in *Brassica* including broccoli. The major glucosinolates in broccoli are aliphatic glucoraphanin and indole-type glucobrassicins. It is highly perishable and the glucosinolate content decreases during storage along with quality. Given that plants produce secondary metabolites as weapons to combat stresses, it is conceivable that the plant responses can well be tuned to achieve an enhancement of phytochemicals that offer plant protection and/or health benefits and acceptability of the produce by exposing them to controlled doses of stressors. The objective of this work was to enhance the levels of glucosinolates in broccoli florets by low doses of abiotic stresses without compromising the quality during the postharvest storage. Five abiotic stresses were applied to broccoli florets and stored at 4 °C for over 21 days. Gene expression and glucosinolate content were monitored during the storage period. The applied stresses were UV-B at 1.5 and 7.2 kJ·m⁻²; UV-C at 1.2 and 3.0 kJ.m⁻²; ozone (O₃) at 5ppm for 60 and 720 min; hydrogen peroxide (H₂O₂) 1.25 and 5mM for 180 min and heat at 41 °C/180 min and 47 °C/12 min. Following the treatment, the overexpression of tryptophan N-hydroxylase (CYP79A2) was observed in broccoli florets exposed to UV-B, O₃ and hydrogen peroxide; while high doses of UV-B and O₃ had a strong influence on the overexpression of phenylalanine N-hydroxylase (CYP79A2). Overexpression of these genes was in concordance with the enhancement of total glucosinolates titer in florets in response to both the doses of hydrogen peroxide and the higher dose of UV-B. The most effective stress to induce glucosinolates in broccoli was hydrogen peroxide, where glucoraphanin, glucobrassicin and its metabolites were all enhanced. Low doses of UV-B, UV-C and heat enhanced titers of neoglucobrassicin. Ozone on the other hand, enhanced titers of 4-methoxyglucobrassicin and 4-hydroxyglucobrassicin. Further, the indole pathway is favorably affected by the oxidative stresses compared with the aliphatic glucosinolate pathway. Results of this investigation suggest that abiotic stresses may enhance the content of glucosinolates in broccoli florets during the postharvest storage.

Specified Source(s) of Funding: MAPAQ and NSERC

---

**Viticulture and Small Fruits 1**

**327** Improved Productivity of Chambourcin Grape Grafted to Seven Rootstocks

Arturo Duarte Sierra*  
Université Laval, Quebec, QC; arturo.duarte-sierra.1@ulaval.ca

Paul Angers  
Université Laval, Quebec, QC; Paul.Angers@fsaa.ulaval.ca

Dominique Michaud  
Université Laval, Quebec, QC; dominique.michaud@fsaa.ulaval.ca

Charles F. Forney  
Agriculture & Agri-Food Canada, Kentville, NS; charles.forney@agr.gc.ca

Joseph Arul  
Université Laval, Quebec, QC; Joseph.Arul@fsaa.ulaval.ca

Glucosinolates are amino acid-derived health-promoting phytochemicals related to plant defense in *Brassica* including broccoli. The most effective stress to induce glucosinolates in broccoli florets during the postharvest storage. Five abiotic stresses were applied to broccoli florets and stored at 4 °C for over 21 days. Gene expression and glucosinolate content were monitored during the storage period. The applied stresses were UV-B at 1.5 and 7.2 kJ·m⁻²; UV-C at 1.2 and 3.0 kJ.m⁻²; ozone (O₃) at 5ppm for 60 and 720 min; hydrogen peroxide (H₂O₂) 1.25 and 5mM for 180 min and heat at 41 °C/180 min and 47 °C/12 min. Following the treatment, the overexpression of tryptophan N-hydroxylase (CYP79B3) was observed in broccoli florets exposed to UV-B, O₃ and hydrogen peroxide; while high doses of UV-B and O₃ had a strong influence on the overexpression of phenylalanine N-hydroxylase (CYP79A2). Overexpression of these genes was in concordance with the enhancement of total glucosinolates titer in florets in response to both the doses of hydrogen peroxide and the higher dose of UV-B. The most effective stress to induce glucosinolates in broccoli was hydrogen peroxide, where glucoraphanin, glucobrassicin and its metabolites were all enhanced. Low doses of UV-B, UV-C and heat enhanced titers of neoglucobrassicin. Ozone on the other hand, enhanced titers of 4-methoxyglucobrassicin and 4-hydroxyglucobrassicin. Further, the indole pathway is favorably affected by the oxidative stresses compared with the aliphatic glucosinolate pathway. Results of this investigation suggest that abiotic stresses may enhance the content of glucosinolates in broccoli florets during the postharvest storage.

Specified Source(s) of Funding: MAPAQ and NSERC

---

**328** Deficit Irrigation Strategies and Wine Grape Cold Hardiness

Krista C. Shellie*  
USDA–ARS, HCRL, Parma, ID; Krista.Shellie@ars.usda.gov

An increase in frequency of extreme and variable weather events, predicted by climate change models, poses a threat to wine grape production at northern latitudes where winter survival depends upon the ability of ecodormant tissue to withstand low temperature exposure and dynamically acclimate to winter temperature fluctuations. Deficit irrigation is used extensively in arid wine grape production regions to manage growth for improved grape quality, yet the influence of deficit irrigation strategies, such as sustained or regulated deficit irrigation, on the resilience of grape tissue to winter injury has received little research attention. The cold hardiness of field-grown vines of the cultivar Merlot was evaluated after a minimum of six sequential growing seasons where the severity of water stress is reduced by deficit irrigation and its potential for yield and quality benefits and acceptability of the produce by exposing them to controlled doses of stressors. The objective of this work was to enhance the levels of glucosinolates in broccoli florets by low doses of abiotic stresses without compromising the quality during the postharvest storage. Five abiotic stresses were applied to broccoli florets and stored at 4 °C for over 21 days. Gene expression and glucosinolate content were monitored during the storage period. The applied stresses were UV-B at 1.5 and 7.2 kJ·m⁻²; UV-C at 1.2 and 3.0 kJ.m⁻²; ozone (O₃) at 5ppm for 60 and 720 min; hydrogen peroxide (H₂O₂) 1.25 and 5mM for 180 min and heat at 41 °C/180 min and 47 °C/12 min. Following the treatment, the overexpression of tryptophan N-hydroxylase (CYP79B3) was observed in broccoli florets exposed to UV-B, O₃ and hydrogen peroxide; while high doses of UV-B and O₃ had a strong influence on the overexpression of phenylalanine N-hydroxylase (CYP79A2). Overexpression of these genes was in concordance with the enhancement of total glucosinolates titer in florets in response to both the doses of hydrogen peroxide and the higher dose of UV-B. The most effective stress to induce glucosinolates in broccoli was hydrogen peroxide, where glucoraphanin, glucobrassicin and its metabolites were all enhanced. Low doses of UV-B, UV-C and heat enhanced titers of neoglucobrassicin. Ozone on the other hand, enhanced titers of 4-methoxyglucobrassicin and 4-hydroxyglucobrassicin. Further, the indole pathway is favorably affected by the oxidative stresses compared with the aliphatic glucosinolate pathway. Results of this investigation suggest that abiotic stresses may enhance the content of glucosinolates in broccoli florets during the postharvest storage.

Specified Source(s) of Funding: MAPAQ and NSERC

---

An asterisk (*) following a name indicates the presenting author.
deficit was either sustained (SDI) or varied (RDI) during berry development. Replicated trial plots were deficit irrigated from fruit set to harvest at fractional amounts of their estimated crop evapotranspiration (ETc). Plots under SDI were irrigated at 90%, 70%, or 35% ETc and plots under RDI were irrigated at 35% ETc pre-veraison and 70% ETc from veraison to harvest. Cold hardiness was evaluated by ratings of visible injury in the spring, bud-forcing bioassays with single node cane sections and Differential Thermal Analysis. Spring injury was significantly greater in vines under SDI at 35% ETc than under RDI or SDI at 70% or 90% ETc. The low temperature exotherm of xylem tissue in 1-year-old canes occurred at a warmer temperature in vines under SDI at 35% ETc than vines under RDI or SDI at 90% ETc. Single node, dormant cane sections de-acclimated under bud-forcing conditions significantly faster in vines under SDI at 35% ETc than vines under RDI or SDI at 90% ETc. The total fresh and dry weight of clusters that emerged from single node cane sections was lowest in vines under SDI at 35% ETc and RDI and highest under SDI at 90% ETc. Results from this research show that irrigation practices during the growing season, particularly vine water deficit severity and phenological timing of deficit severity, influence subsequent cold hardiness of vine tissue. The alleviation of water deficit severity between veraison and harvest appeared to beneficially influence cold hardiness. Development of irrigation strategies to enhance grapevine cold hardiness requires an understanding of the underlying mechanisms by which vine water status influences subsequent cold hardiness in grapevine. Results from this research demonstrate that this topic warrants further investigation.

Specified Source(s) of Funding: USDA–ARS project no. 5358-21000-034-00D

(329) Frontenac Response to Training System and Leaf Removal Treatments

Brittany Korynta Olson*
North Dakota State University, Fargo; brittany.J.Korynta@my.ndsu.edu

Harlene Hatterman-Valenti
North Dakota State University, Fargo; h.hatterman.valenti@ndsu.edu

Collin P. Auwarter
North Dakota State University, Fargo; collin.auwarter@ndsu.edu

Experiments were conducted at the North Dakota State University research vineyard near Absaraka, North Dakota, in 2013 and will be repeated in 2014 to evaluate the effects of leaf removal and training systems on yield and quality of the wine grape, Frontenac. The applications of four leaf removal treatments exposed ripening grape clusters to various degrees of sunlight. The four training system treatments manipulated vine growth habit, fruit bearing zones, and sunlight interception. Variables include pruning weight, length of time to bud burst, bloom, and veraison, yield, number of grape clusters, average berry weight, pH, soluble solid concentration, and titratable acidity. Data were analyzed as a RCBD with a split plot arrangement.

Analysis of variance indicated that only the training system had significant effects on pH and soluble solids. Training system had no significant effects on pruning weight, length of time to bud burst, bloom, and veraison, yield, number of grape clusters, average berry weight, and titratable acidity. Leaf removal and its interaction with training systems were nonsignificant for all components. Soluble solid concentrations were only significantly different among Vertical Shoot Positioning (VSP) and Geneva Double Curtain (GDC) training systems. The pH from the VSP training system was significantly higher than all other training systems. Four Arm Kniffin pH values were lower than those of VSP. The pH values from High Wire and GDC training systems differed from each other and VSP, but were similar to the Four Arm Kniffin. This research supports the use of training system to influence fruit ripening.

(330) Delay of Bud Break on ‘Edelweiss’ Grapevines with Multiple Applications of Amigo Oil and NAA

Benjamin A. Loseke
University of Nebraska, Lincoln; bloseke2@unl.edu

Paul E. Read*
University of Nebraska, Lincoln; pread@unl.edu

‘Edelweiss’ is an important grape cultivar grown in the Midwestern part of the United States. It is one of the earliest cultivars in the vineyard to break bud, making it very susceptible to late spring freezes. ‘Edelweiss’ primary buds produce a significant amount of fruit, while unlike many other hybrids, the secondary and tertiary buds will have little to no yields, thus making it important to protect the primary buds from a late freeze. The objective of this research was to determine if multiple applications of Amigo Oil or naphthaleneacetic acid (NAA) achieve a greater bud delay when compared to single applications. ‘Edelweiss’ vines were treated in January, February or March. Amigo Oil was applied at 10% (v/v) and NAA at 1000 mg/L with a custom built all-terrain vehicle (atv) sprayer. All treatments of oil led to a significant bud break delay ranging from 3 to 11 days as compared to the control. Buds treated with NAA showed no significant delays when compared to the oil or control treatments. None of the treatments resulted in negative effects on harvest parameters such as yield or fruit characteristics. A controlled laboratory experiment was also conducted, where single bud cuttings were forced in 200 mg/L 8-hydroxyquinoline citrate and 2% sucrose at 25 °C under 12-h days. Treatments of one, two, and three applications of Amigo Oil and 1000 mg/L NAA were applied to single buds at weekly intervals. Julian days until bud break were recorded and treatment-related bud break-delays were observed. Two and three applications of oil significantly delayed bud break from 14 to 24 days. All NAA treatments led to significant bud delay ranging from 6 to 9 days. Grape growers in climates with the potential of late spring freezes may consider the use of Amigo Oil as a potential means to protect their vines from frost injury.
(331) The Use of Different Plant Growth Regulators in ‘Scarlet Royal’ Table Grape Production to Determine Postharvest Quality

Victoria Towers*
California State University, Fresno; victoriatowers@mail.fresnostate.edu
Sonet Van Zyl
California State University, Fresno; svanzyl@csufresno.edu

Scarlet Royal is a new red seedless table grape variety developed by USDA–ARS, which ripens mid to late August. As a late season variety grown in the San Joaquin Valley, Scarlet Royal is subject to early rain events which increases its susceptibility to Botrytis bunch rot and other diseases during the harvest period. In addition, this variety lacks a thick epicuticular wax on the skin and seems to be prone to berry crack when the clusters set too tight which can favor fungal infections. This problem is sustained through postharvest storage where the grapes become unsuitable for shipping, marketing and consuming. The aim of this project is to evaluate disease incidence and berry quality parameters on Scarlet Royal after postharvest storage using different combinations of plant growth regulators (PGR) during the growing season. The experimental layout consisted of three treatments arranged as a complete randomized design with six replicates and three vines per replicate. The treatments included a Control (no PGR applied), 5 ppm Gibberelic Acid (GA) and a combination of 5 ppm GA + 6 ppm Forchlorfenuron (CPPU). Bunch thinning and removal of bunch shoulders were performed for all treatments. After commercial cold storage was completed, berries were evaluated for Botrytis bunch rot, berry crack, berry shatter, other diseases and other damage. Normal quality parameters were also evaluated including pH, TA, °Brix, berry firmness, berry diameter, berry length and skin color. Results showed no significant differences for Botrytis bunch rot incidence, berry crack, other damage or other disease. Berry shatter showed significant differences, the 5 ppm GA treatment presented the highest percentage of loose berries while the 5 ppm GA + 6 ppm CPPU treatment had the lowest percentage. Berry length was significantly larger for the 5 ppm GA + 6 ppm CPPU treatment with a mean length of 28.34 mm while the control treatment had the smallest berries with a mean length of 26.93 mm. Berry firmness and berry diameter were statistically equal for all treatments. No significant differences were obtained for the juice parameters pH, TA and °Brix. Berry color presented no differences in lightness, chroma or hue. The results of this study are dependent on rain events during the harvest period in the San Joaquin Valley. During the past two seasons, the absence of rain may serve as an explanation for the lack of significant differences between treatments.

Specified Source(s) of Funding: California Table Grape Commission

An asterisk (*) following a name indicates the presenting author.

Specified Source(s) of Funding: California Table Grape Commission

(332) Early Primocane Yield Data of Advanced Thorny and Thornless Primocane-fruited Blackberry Selections at Kentucky State University

Kirk William Pomper*
Kentucky State University, Frankfort, KY; kirk.pomper@kysu.edu
Jeremiah Lowe
Kentucky State University, Frankfort, KY; jeremy.lowe@kysu.edu
Sheri B. Crabtree
Kentucky State University, Frankfort, KY; sheri.crabtree@kysu.edu
John G. Strang
University of Kentucky, Lexington, KY; jstrang@uky.edu
John R. Clark
University of Arkansas, Fayetteville; jrc Clark@uark.edu

Primocane fruited blackberries are an attractive niche-crop for Kentucky growers because they have an extended harvest period and can be grown organically. Primocane fruited blackberry selections usually produce fruit from July until October in Kentucky, providing fruit for sale at farmers’ markets, community supported agriculture, and organic markets. In June 2011, a blackberry variety trial was established at Kentucky State University (KSU). Plants of the commercially available primocane-fruited cultivar ‘Prime-Ark 45®’ (thorny erect, primocane-fruited) and the Arkansas Primocane-fruited (APF) selections of thorny or thornless (T) advanced selections (APF-153T, APF-156T, APF-158, APF-172T, APF-185T, APF-190T, and APF-205 T) from the UARK blackberry breeding program, were planted at the KSU Research and Demonstration Farm, in Frankfort, KY. Plants were arranged in a randomized complete block design, with 4 blocks, including 5 plants of each cultivar per block (total of 20 plants of each cultivar) in a 10 foot plot. Spacing was 2 feet between each plant, and 5 feet between groups of 5 plants. Rows were spaced 14 feet apart. This trial was established on certified organic land and managed following National Organic Program standards. In 2012, primocane fruit production began in late July or early August for most selections. APF-158 had the highest yield at 2559 lbs/acre. Other selections ranged from 62–575 lbs/acre. In 2013, there was both floricane fruit production, starting in late-June, and primocane fruit production, which ended in mid-October. The two highest yielding selections were APF-158 and APF-190 T with yields of 7147 and 5636 lbs/acre, respectively; all other advanced selections had lower yields. Both of these selections had higher yields than Prime-Ark 45® (control) at 3795 lbs/acre. Fruit weight was similar for APF-158 (5.2 g) and Prime Ark 45 (4.9 g), and lower for APF-190 T (4.4 g). Year to year yield and fruit quality characteristics will continue to be evaluated.

Specified Source(s) of Funding: NIFA USDA 1890s Evans Allen Funding
Tools for Extension Impact Reporting

Jared Hoyle*
Kansas State University, Manhattan; jahoyle@ksu.edu

James McCurdy
Mississippi State University; jamesmccurdy@gmail.com

Cheryl R. Boyer
Kansas State University, Manhattan; crboyer@ksu.edu

With technological developments in mobile technology, Extension personnel are able to record, store, and analyze data more efficiently. New non-traditional tools are able to collect information, such as Extension contacts and field data, while conducting normal Extension operations. Among these tools is an automated form application called doForms™. doForms™ is a free application that allows users to build customized electronic forms. The objective of this study was to survey the data management tool, doForms™, for efficiency, effectiveness, and application to Extension in turfgrass science. doForms™ was downloaded, installed and forms were created for use during 2013. For duration of the survey period, Extension personnel testing doForms™ spent approximately 70% of Extension related activities conducting on site visits with turfgrass managers. From conception to deployment of doForms™ approximately 3 hours was required. Information that was able to be collected in the initial form included date and time of contact between Extension personnel and turfgrass manager, category of turfgrass manager, nature of contact, nature of response, subject matter, specific weed species, and location. Information obtained from initial testing included time allocated to data acquisition, effort to extract data, and practicality. Extension personnel discovered that minimal effort was required to operate doForms™. After the conclusion of an Extension site visit or contact, data could be recorded in less than one minute. Ability to extract data from a computer interface required negligible effort. Extension personnel also noted that the ability for the user to record data on mobile devices that were already in their possession increased practicality. Although, doForms™ greatly increased Extension personnel efficiency and effectiveness of data collection, initial disadvantages were also observed. Initially, Extension personnel were not able to alter forms previously created and were required to create new forms to implement desired changes. After updated versions of doForms™ were released Extension personnel were able to alter individual forms through the web interface. Ultimately, use of applications such as doForms™ can allow Extension personnel to obtain information efficiently and effectively. Due to the minimal time required to record Extension contact data with applications such as doForms™, Extension personnel are able to devote time to other activities, ultimately increasing efficiency. Most importantly, this allows Extension personnel to record information about common out-reach practices to ultimately help determine individual impact on industry stakeholders. This information is applicable to any Extension faculty or staff searching for an easier way to record and report Extension contacts.

Using Online Learning Modules as a Tool for Delivering Complex Information to SCRI Stakeholders

Matt Chappell
University of Georgia, Athens.; Hortprod@uga.edu

Paul Thomas*
The University of Georgia, Athens.; Pathomas@uga.edu

John D. Lea-Cox
University of Maryland, College Park; jlc@umd.edu

Marc van Iersel
University of Georgia, Athens; mvianer@uga.edu

Lauren Crawford
Decagon Devices, Inc., Pullman, WA; lauren@decagon.com

Bruk Belayneh
University of Maryland, College Park; belayneh@umd.edu

John Majsztzik
University of Maryland, College Park; jcmajsz@umd.edu

William Bauerle
Colorado State University, Fort Collins; bill.bauerle@colostate.edu

Taryn Bauerle
Cornell University, Ithaca, NY; Bauerle@cornell.edu

Dennis King
University of Maryland, Solomons; dking@umces.edu

David Kohanbash
Carnegie Mellon University, Pittsburgh, PA; dkohanba@cmu.edu

Erik Lichtenberg
University of Maryland, College Park; elichten@umd.edu

Andrew Ristvey
University of Maryland, Queen Anne; aristvey@umd.edu

As a Coordinated Agricultural Specialty Crops Research Initiative (SCRI) project, the Managing Irrigation and Nutrition via Distributed Sensing (MINDS) team has focused for four-plus years on delivering a commercial wireless sensor network capable of supporting the intensive production system requirements for field nurseries, container nurseries, greenhouse operations and green roof systems. The goals of this project are (1) to provide a more integrative and mechanistic understanding of plant water requirements, spanning from micro-scale (e.g. plant level) to the macro-scale (e.g. whole production site) for irrigation and nutrient management and (2) to quantify private and public economic benefits of this technology. The project is integrated across various scales of production including small and large nursery, greenhouse, and green roof systems/operations. The complexity of stakeholders can cause outreach efforts to become disjointed and it is critical to our, or any successful SCRI project, to have the ability to deliver information obtained from a large complex grant to a diverse set of stakeholders, while minimizing redun-
Reach, engagement, and maximizing impact. It is also important to provide information that can be either long-lasting or easily updated with current information. The approach taken by the MINDS team has been to create a single online, self-guided “Knowledge Center” website (http://smart-farms.org/) that provides specific information using a number of discrete learning modules to our target audiences. These audiences include: (1) Owners (or decision-makers), who want to find out exactly what benefits a sensor network might provide, and some examples of return on investment with these systems. (2) Irrigation Managers (or practitioners), who want to find out what it takes to install and maintain sensor networks. (3) Consultants and students, who want to learn how to use the software tools that are available, and interpret the data for devising new irrigation monitoring and control strategies. Concepts presented in learning modules are presented in a manner that facilitates self-guided learning opportunities, starting with basic concepts and progressing to very complex topics. Also included are a series of case studies that document project-related work that has been done at grower-cooperators. This poster will reflect our efforts to date in planning, constructing and launching online learning modules related to the MINDS project to serve as an example of a successful SCRI stakeholder engagement device.

Specified Source(s) of Funding: USDA NIFA SCRI Funded Project

(067) Reach, Engagement, and Impact of eViticulture and the eXtension Grape Community of Practice

Eric Stafne*
Mississippi State University, Poplarville; estafne@ext.msstate.edu
Rhoda L. Burrows
South Dakota State University, Rapid City; rhoda.burrows@sdsstate.edu
Matthew W. Fidelibus
Kearney Agricultural Research and Extension Center, Parlier CA; MWFidelibus@uancr.edu
Lane Greer
Oklahoma State University, Stillwater; lane.greer@okstate.edu
Paul Jenkins
Michigan State University, East Lansing; jenki132@msu.edu
Kevin Ker
Brock University, St. Catharines, ON; kker@brocku.ca
Michelle Moyer
Washington State University, Prosser; michelle.moyer@wsu.edu
Patricia A. Skinkis
Oregon State University, Corvallis; skinkisp@hort.oregonstate.edu
Hans Walter-Peterson
Cornell University, Penn Yan, NY; hcw5@cornell.edu

Reach, engagement, and impacts are important metrics in Extension reporting. Social media is a growing method to inform interested parties. Facebook and Twitter are the most used platforms by eViticulture, having over 500 likes and followers, respectively. Two out of three tweets are retweeted, thus expanding our reach and engagement. The Grape Community of Practice (GCoP) eXtension and eViticulture websites have garnered over 686,000 pageviews since Dec. 27, 2010. This accounts for nearly 4% of all visitors to eXtension.org. Readers average 2 minutes and 12 seconds on the GCoP eXtension pages and 2 minutes on the eViticulture pages. Determining value to the reader is difficult; however, if we extrapolate from reported income levels we can estimate the value (Stafne and Fidelibus, in press). In 2013 the average U.S. household net adjusted disposable income was $38,001. At 686,000 pageviews and 2 minutes per page, one could estimate the value at $411,600 for the general public. If the income is targeted to vineyard managers, then that income rises to $87,683 for the United States (based on CA). The value would then jump to $960,400 from December 27, 2010 to February 20, 2014. Some state Extension programs also inherently value their publications (for a paper copy) which are similar to those on eViticulture. For example, Alabama Cooperative Extension Service and Oregon State University Extension Service value similar Extension publications at $1 to $2 each. One could take the estimated value to the public ($411,600) plus the value of traditional Extension publication charges ($1) x page views on eViticulture ($686,000) for a total value to clientele of $1,097,600 from 2010 to early 2014. This is one way to calculate the value of GCoP content and quantify our accomplishments. While it provides an estimate of worth based on how individuals value their time, it does not include the additional “value” of savings or income generated as a result of knowledge gained. Obtaining quantifiable data regarding impact through online surveys have been tried, but response was low. A better method may be collecting anecdotal comments from users via email, social media, and face-to-face feedback as evidence of impact.

(068) Infographics: Revealing Complex Data Quickly and Clearly

Wendy V. Hamilton*
New Mexico State University, Las Cruces; whamilto@nmsu.edu

We live in a society where information overload is changing how we accept text and interact with data. Our information preferences are becoming more selective and succinct. This behavior change has created challenges for extension horticulture educators, especially in educating young clientele. With data visualization or information graphics, typically dry text or lessons can be presented succinctly and interactively, in a variety of short, sharp, digestible formats.

(069) Exploring Opportunities for International Engagement in Horticulture

Mary E. Henry*
University of Florida, IFAS, Bartow, FL; mbhenry@ufl.edu

The International Consultants Working Group has been a longstanding part of the American Society for Horticultural Science (ASHS). Although organized workshops are consistently well attended, with many available working groups related to international topics few members attend the planning session.
for the group. Topics related to opportunities for international service are among the most popular sessions. The objective of this poster is to present opportunities for international service and engagement to the wider ASHS membership, offering a starting point for future activities and partnerships.

Tuesday, July 29, 2014

Floriculture 1

(094) Color Expression, Pigment Composition, and Related Gene Transcription in Double Coloring Petals of Cut Roses
Wan Soon Kim*
The University of Seoul, Seoul; wskim2@uos.ac.kr
Seul Ki Lee
The University of Seoul, Seoul; soony1117@naver.com

This study was conducted to investigate the bicolor expression in petals of double coloring cut roses due to temperature stress. Plant materials were grown in controlled growth cabinets at 25/18 °C AT and 65% RH in the lighting condition of 800 μmol·m⁻²·s⁻¹ PAR of 16hr photoperiod. The treatments of high temperature stress (39/18 °C, HTS) and low temperature stress (25/6 °C, LTS) were applied during 3 days just before petal coloring as the most susceptible development stage to air temperature. HTS had directly affected the petal growth as well as color expression, while LTS hadn’t significantly induced the change in petal development or coloring. Both color expression and anthocyanin content in petals had been seriously diminished by HTS, 24.7% and 64.6%, respectively. Two anthocyanidins detected by HPLC had changed in the ratio according to temperature stress. To know the mechanism for decolorization in double coloring cut roses, the pigmentation-related gene expression was detected by qRT-PCR.

(095) Optimum Substrate Moisture Content Improves Quality of Impatiens and Coleus
Xinxin Li
University of Hawaii at Manoa, Honolulu; lixinxin0476@163.com
Hye-Ji Kim*
University of Hawaii at Manoa, Honolulu; hkim2@hawaii.edu

Maintaining proper moisture content is essential to the success of a variety of crops because it affects the amount of water and fertilizer application, disease incidence, plant growth and production cost, and ultimately determines farm income. The purpose of this study was to determine the optimum moisture content to enhance productivity and quality of impatiens (Impatiens sdenii) and coleus (Solenostemon scutellarioides). Plants were potted into 15-cm pots containing Sunshine #1 medium mixed with fully expanded Soil Moist (SM) hydrophilic polymers at different mixing ratio, 0% (100:0, v:v) as control, 20% (80:20 v:v), 40% (60:40 v:v), 60% (40:60, v:v), or 80% (20:80, v:v). Volumetric water content (VWC) was monitored by using a soil moisture detector (SPTDR100, USA) and maintained by fertigating plants when the VWC was below threshold. In impatiens, plant height and the number of branches and leaves were significantly higher at 20% mixing ratio during the 6 weeks of growing period. In coleus, lower mixing ratio significantly enhanced plant growth, but there was no big difference among 0%, 20%, and 40%. However, leaf surface area was significantly increased at 20% in both plant species, resulting in a higher shoot dry weight. In addition, plants grown at 20% had greater root dry weight, and a higher root-to-shoot ratio regardless of plant species. Mixing ratio over 60%, however, negatively affected plant growth. Measurements of VWC showed that mixing ratio of 20% maintained higher VWC compared to that of control, resulting in less water consumption during the entire production period in both plant species. Our results confirm that proper substrate moisture contents can help enhance plant productivity and quality. Taken together, maintaining an optimum water content will help reduce water input and produce better quality crops.

(096) Growth and Development of Canna Lily ‘Ermine’ Liners Treated with Flurprimidol or Paclobutrazol
Michael Maurer*
Stephen F. Austin State University, Nacogdoches, TX; maurerma@sfasu.edu
Adam Summerville
Stephen F. Austin State University, Nacogdoches, TX; summerviar@titan.sfasu.edu

An experiment was designed to evaluate flurprimidol and paclobutrazol on the growth and development of canna lily liners. Canna lily (Canna X generalis) ‘Ermine’ liners were transplanted into 11.4-L containers and treatments applied March 1, 2012 when plants averaged 29 cm in height (3 to 4 well developed leaves). The 16 treatments were an untreated control, floral sprays of flurprimidol and paclobutrazol at rates of 25, 50 and 100 μg·g⁻¹, soil drenches of flurprimidol and paclobutrazol at rates of 1, 2 and 4 μg·g⁻¹ and granular flurprimidol at rates of 1, 2 and 4 μg·g⁻¹. Foliar sprays were applied with a spray bottle at a volume of 3.8 L per 18.6 m² (spray-to-drip) and soil drenches at 740 mL per container. Each treatment consisted of 8 replicates. Initial results from this study indicate that flurprimidol treatments applied as a soil drench and granular at the 2 and 4 μg·g⁻¹ rates significantly reduced plant height > 50% from the control. Soil drenches of paclobutrazol and foliar sprays of flurprimidol reduced plant height 19% and 17%, respectively. The foliar sprays of paclobutrazol did not significantly reduce plant height 3.5%. Scape length was significantly reduced for the soil drench and granular flurprimidol treatments at the 4μg·g⁻¹ rate. Days to flowering was not significantly different with flowering occurring between 42 to 47 days for all treatments.

(097) Co-effectiveness of Supplemental Lighting and Irrigation in Conjunction with Compensation for Midday Depression of Photosynthesis of Cut Roses
Wan Soon Kim*
The University of Seoul, Seoul; wskim2@uos.ac.kr

An asterisk (*) following a name indicates the presenting author.
Plants grow better in circadian conditions that correspond to natural environments. However, to increase cut rose productivity, supplemental lighting was applied during night period, which might reset the circadian rhythms of the rose crops. Also, previous study indicated that drought stress occurred in none-irrigation regime under nocturnal supplemental lighting. To investigate the effect of supplemental lighting and irrigation during night on diurnal photosynthetic rate, cut rose ‘Charming Black’ was subjected to three treatment: TControl (without supplemental lighting), TSLNI (PAR 90 without irrigation during night) and TSL (PAR 90 with irrigation once per hour). Diurnal photosynthetic rate showed an increasing tendency from 9:00 am and the highest value occurred from 11:00 h to 14:00 h. Then photosynthetic rate decreased from 15:00 h and then remained steady in three treatment conditions. Compared with TControl, TSLNI demonstrated higher photosynthetic rate during night due to supplemental lighting. Nonetheless, from 9:00 to 15:00, photosynthetic rate was lower than TControl. Under irrigation condition TSL, photosynthetic rate increased by 4.96 µmolm-²·s-¹ compared with TControl at 13:00 h. Under TSLNI, photosynthetic rate peak appeared earlier (at about 11:00 h) than TSL condition (13:00 h). The Co-effectS-I indicated that irrigation and supplemental lighting compensate for each other to promote the photosynthesis.

**Response of Chrysanthemums to Various Day–Night Air Temperature Differences/Drops and Root Zone Temperatures at the Same Daily Integrated Temperature**

Xiuming Hao
Agriculture and Agri-Food Canada, Harrow, ON; xiuming.hao@agr.gc.ca

JingMing Zheng
Agriculture and Agri-Food Canada, Harrow, ON; jingming.zheng@agr.gc.ca

Celeste Little
Agriculture and Agri-Food Canada, Harrow, ON; celeste.little@agr.gc.ca

Temperature is one of the most important climate factors in greenhouse ornamental cultivation since it not only affects plant growth rates, quality and time of production cycle but also heating costs. It has been known that proper root zone heating could reduce energy consumption without compromising plant growth & quality. However, there has been little research on the interaction between root zone heating and air temperature management in ornamental crop production. Since the highest heating energy use usually occurs during the pre-morning or early morning periods, temperature regimes with temperature drop during pre-morning and/or early morning periods could reduce energy use. In this study, two growth chamber trials were conducted to investigate the response of Chrysanthemums to various temperature regimes with temperature drops at the same daily integrated temperature and their interactions with root zone heating for conserving energy while ensuring crop quality. Four air temperature regimes with different day-night temperature differences (DIFs, +6 °C, +3 °C, 0 °C, and -3 °C) were applied in 4 large growth chambers (one for each chamber). The different DIFs were achieved mostly by lowering the pre-morning or early morning temperature down to 13 °C. The air temperatures in other periods during a 24-h period were also adjusted to maintain the same 24-h average temperature (19 °C) or daily integrated temperature for all 4 temperature regimes. Four root zone temperatures (20 °C, 23.3 °C, 26.7 °C, and 30 °C, set-points) were applied inside each of the air temperature regimes (chambers) with 4 electrical root heating mats. The air temperature regime with +3 °C DIF at 24 °C root zone temperature (actual bottom media temperature measured with needle thermocouple, 26.7 °C set-point) had the highest biomass, leaf area and flower number as well as good flower size, and slightly taller plants. Therefore, this combination of air temperature regime and root zone temperature has achieved better plant growth and quality except for slightly taller plants. The air temperature regime has good energy saving potentials because of its low temperature during pre-morning (13 °C) and early morning period (15 °C).

**(098) Nutrient Status of Cosmos (Cosmos bipinnatus) in Response to Mycorrhizal Treatment**

Marietta Loehrlein*
Western Illinois University, Macomb, IL; mm-loehrlein@wiu.edu

Mycorrhizae are beneficial root-associated fungi that occur in the environment. They improve water and nutrient uptake for their host plant. Commercial mycorrhizae products are available as inoculants, and may be added to growing media at the time of planting. Soiless media products are also available with pre-added mycorrhizae for use in bedding plant production. The addition of mycorrhizae to soiless media creates a higher cost for inputs of bedding plant production. However, the benefits of mycorrhizae inoculation may be cost-effective, due to the ability of the beneficial fungi to improve nutrient and water uptake by plant roots. Growers may be able to reduce fertilizer inputs while maintaining optimal plant growth. They may realize further benefits of reducing fertilizer run-off in irrigation water effluent, especially two nutrients of major environmental concern, phosphorus and nitrogen. Increased phosphorus uptake could improve floral development, an important aspect of bedding plant production. Two mycorrhizae products, Mighty Myco and Mycormax, were applied according to label directions at the time of planting Cosmos bipinnatus seeds. Plants were evaluated for time to germination, time to first visible flower, time to first open flower, shoot and root fresh and dry weight, and for whole-plant fertility at 63 DAP.

Specified Source(s) of Funding: Midwest Ornamentals
(100) Petunia Mutagenesis and Identification of a Self-fertilizing Mutant for Tilling

Peng Jiang*
University of Georgia, Athens; pjiang@uga.edu
Yihua Chen
University of Georgia, Athens; yhchen@uga.edu
James Gegogine
University of Georgia, Athens; gegogine@uga.edu
Dayton Wilde
University of Georgia, Athens; dwilde@uga.edu

The development of a chemically-mutagenized population of Petunia ×hybrida could enable the identification of novel alleles for crop improvement. Conditions were determined for mutagenizing petunia with ethyl methanesulfonate (EMS), while minimizing deleterious effects on viability and fertility. A mutagenized population of the doubled haploid P. hybrida line ‘Mitchell Diploid’ was developed as a resource for TILLING. A dominant mutant was identified in the M1 population that could self-pollinate, possibly due to changes in floral morphology. Other morphological changes were observed in the self-pollinating (SP) mutant, including alterations of leaves, fruit, and seeds. Nearly 100% of the M2 and M3 generation plants resulting from SP mutant self-pollination retained the SP phenotype. Backcrossing the SP mutant with wild-type plants, either as the maternal or paternal parent, produced progeny with the phenotype of the maternal parent. The SP mutant has characteristics that could potentially facilitate the TILLING of petunia.

(101) Productivity of Direct-seeded versus Transplanted and Season-long versus Successional Plantings of Zinnia Cut Flower Field Crops

Yu Gu*
North Carolina State University, Raleigh; ygu2@ncsu.edu
Julia Kornegay
North Carolina State University, Raleigh; julia_kornegay@ncsu.edu
John M. Dole
North Carolina State University, Raleigh; john_dole@ncsu.edu

North Carolina is the second largest producer of specialty cut flowers on the East Coast of the United States. A recent survey of the North Carolina cut flower industry found that most production occurs in open ground as field crops and that the majority of growers use organic practices. Zinnia is the most commonly grown annual cut flower crop. To increase yield and flower quality, and to control diseases, growers use a variety of production practices. Unfortunately, there is very limited research comparing annual cut flower production practices in terms of their effect on flower quality and yield. Two studies were conducted on zinnia cut flower production at the North Carolina State University Horticultural Field Lab in Raleigh, NC. Study one evaluated the productivity of two planting methods (direct seeded vs. transplanted) and two planting densities on zinnia ‘Benary Giant Scarlet’. Study two focused on the effects of season long vs. successional planting times on the productivity of zinnias ‘Benary Giant Scarlet’ and ‘Zowie Yellow Flame’. Data were collected three times a week after flowering during the 2013 growing season. Flower quality was measured by stem length and flower diameter. Yield was measured by number of stems harvested. Preliminary data analysis showed that there was a tendency of longer/larger stem-length and flower diameter in lower planting densities, but not by planting methods, while higher yields were obtained at higher planting densities. In terms of planting time, the third planting had longer/larger stem-length and flower diameter in most cases. Further analysis of these results will be presented.

Specified Source(s) of Funding: Association of Specialty Cut Flower Growers

Tuesday, July 29, 2014

Local Food Systems

(031) Survival Analysis and Detection of Human Pathogens for Organic Strawberry Production in Tennessee

Himabindu Gazula*
Tennessee State University, Nashville; bindu.gazula@gmail.com
Yibing Yan
Tennessee State University, Nashville; yyan@Tnstate.edu
Sarabjit Bhatti
Tennessee State University, Nashville; sbhatti@tnstate.edu
Fur-Chi Chen
Tennessee State University, Nashville; fchen1@Tnstate.edu
Suping Zhou
Tennessee State University, Nashville; zsупing@tnstate.edu

The consumption of strawberry (Fragaria xananassa) in the United States has grown favorably in the recent years. This consumption of strawberries has brought a rapid increase in food-borne illnesses too. According to food borne and illness outbreak database, strawberries are the second main produce in the United States that are associated with the outbreak of many pathogenic diseases. These outbreaks indicate that strawberries are suitable substrates for foodborne pathogens to survive and their consumption may cause infection. Little information is known about the behavior of these human pathogens in the strawberry. So, the main objective of this research is to develop a strategic plan to study the survival analysis and detection of these human pathogens on fresh strawberries. For this study, fully mature fresh strawberries were collected from U-pick farms and spot inoculated with bacterial species including Escherichia coli 0157:H7, Salmonella typhimurium and Listeria monocytogenes. Isolated colonies of bacteria were transferred into tryptic soy broth and incubated overnight at 35 °C. After harvesting and suspending cells in butterfield buffer, fresh strawberries were spot inoculated with these pathogenic bacteria and stored at 4 °C and 25 °C. Ten microliters of inoculum were used to inoculate strawberry surface. After drying for 30 minutes, strawberries
were transferred to blender bags and filled with 50 mL of butterfield buffer and homogenized in a stomacher. Appropriate serial dilutions were made in butterfield buffer and spread plated on selective media (E. coli O157:H7; Sorbitol MacConkey agar, Salmonella; XLT- 4 agar supplemented with Tergitol, Listeria; Selective Agar supplemented with SR0140) and incubated at 35°C for 48 hours. Enumeration studies were done until third and fifth day of inoculation and two experiments were conducted with triplicate samples. At 4°C E. coli O157:H7, Salmonella and Listeria populations declined by 0.32-0.71 log CFU/berry and 0.56-0.97 log CFU/berry over a period of 48hrs and 96hrs respectively. At 25°C these bacterial populations declined by 0.9-1.91 log CFU/berry over a period of 48 hours. A significant decline in pathogen population was found in strawberries at each time point. Strawberry surface didn’t support the growth of these bacteria.

Specified Source(s) of Funding: Walmart Foundation Strawberry Initiative Grant and USDA

(032) New Market Opportunities for Dry Beans (Phaseolus vulgaris): Are Northwest Washington State Heirloom Varieties More Productive?

Kelly A. Atterberry
Washington State University, Mount Vernon.; kelly.atterberry@wsu.edu

Carol A. Miles*
Washington State University, Mount Vernon.; milesc@wsu.edu

Brook Brouwer
Washington State University, Mount Vernon; brook.brouwer@wsu.edu

Dry bean (Phaseolus vulgaris) is a pulse crop that is relatively easy to grow throughout Washington and benefits vegetable crop rotation by breaking disease cycles and providing nitrogen for the following crop. Consumer demand for regionally produced staple crops has opened a market opportunity for dry bean production and niche market varieties (colored, patterned beans) are sold at local farmer’s markets for $6 to $14 per pound. Small-scale growers have been successfully growing dry beans in Northwest (NW) Washington for over 100 years, however it is not clear if these varieties are suitable for production on a larger scale. The objective for this study was to compare heirloom dry bean varieties that have been grown in NW Washington for 20–130 years with standard varieties (seed grown outside the region) to determine which are more productive in the region. This study was initiated in 2013 and will be repeated in 2014. In May, 14 NW heirloom dry bean varieties and 11 standard varieties were seeded in a replicated field trial at WSU Mount Vernon NWREC. Plots were 10 ft long, 4 rows wide with 4 replications in a randomized complete block design. Plots were hand harvested 1 Sept. through 1 Oct. In 2013, yield and days to maturity differed significantly among varieties (P < 0.001 and P = 0.003, respectively). Average yield for NW heirloom varieties was 2330 lb/acre and average days to maturity was 109 days after seeding; in comparison, average yield for standard varieties was 2298 lb/acre and average days to maturity was 114 days. Highest yielding varieties were Eclipse (standard black; 3094 lbs/acre), Lariat (standard pinto; 3008 lbs/acre), and Ireland Creek Annie (standard yellow; 2747 lbs/acre). NW heirloom varieties that were next highest yielding were Youngquist (brown; 2612 lbs/acre), Bale (cranberry; 2617 lbs/acre), and Ireland Creek Annie (yellow; 2595 lbs/acre). Varieties with the shortest days to maturity included five NW heirloom varieties: Black Coco (101 days), Decker (101 days), Ireland Creek Annie (101 days), Francis Kring cranberry (104 days), and Rockwell (107 days). One standard variety, Ireland Creek Annie, also matured early (104 days), while all other entries matured from 101–124 days of seeding. Growers in NW Washington would benefit most from dry bean varieties that are early to mature as the onset of rains by late Sept. makes harvest difficult.

Specified Source(s) of Funding: Northwest Agricultural Research Foundation (NARF)

(033) What’s Hop’pening in Northwest New Mexico? Hops (Humulus lupulus) Trials Summary 2009 to 2014

Kevin Lombard*
New Mexico State University Agricultural Science Center at Farmington; klombard@nmsu.edu

Katie McCarver
New Mexico State University, Las Cruces; mccarver@nmsu.edu

Franklin Jason Thomas
New Mexico State University Agricultural Science Center at Farmington; fjt@nmsu.edu

Ram Acharya
New Mexico State University, Las Cruces; acharyar@nmsu.edu

Todd Bates
Independent Consultant, Embudo, NM; nnnpr68@yahoo.com

U.S. hop (Humulus lupulus) production and processing is centralized in the Pacific Northwest (e.g. Yakima Valley, Washington State). There is, however, evidence that New Mexico craft brewers would be interested in purchasing their hops from a local grower. Cursory research indicates that some standard hop cultivars grow well in Northern New Mexico, even possessing certain terroir characteristics. For instance, in Farmington, NM, Cascade attained 9.8% alpha acids and 6.1% beta-acids, higher than literature values reported for the same cultivar when grown in the Pacific Northwest. Additionally, hybrids bred from Hu- mulus lupulus var. neomexicana, indigenous to the mountains of northern New Mexico, could potentially allow small-scale farmers in New Mexico to approach growing hops as a small-scale, specialty crop that craft brewers can use to produce unique New Mexico branded beer styles which in turn would help boost local economies and add another angle to the “locally grown” trend presently experienced across the U.S. While New Mexico might play a role in the hops market, the production/processing/market model will look much different than the Pacific Northwest and will be small-scale in nature. Communications with a
small number of local hops growers, brewers, and researchers identified the following barriers to small-scale commercial hops production in New Mexico: 1) lack of knowledge on cultivar adaptability across growing conditions; 2) limited understanding of the target market, New Mexico breweries, and how the needs of this market could be met by New Mexico growers; 3) limited direct marketing schemes for locally produced hops in the state; 4) limited educational opportunities for New Mexico producers to gain more knowledge on the crop; and 5) limited small-scale mechanization of key labor intensive processes such as picking and pelletizing. This research aims to evaluate the prospects for small-scale hops production in New Mexico and to assess New Mexico craft brewer’s perceptions about utilizing locally produced hops.

(034) Hoophouses for Health: Building the Good Food Infrastructure
Laura Haselhuhn
Michigan State University, East Lansing; haselhu2@msu.edu
Dru Montri
Michigan Farmers Market Association, East Lansing, MI; dru@mifma.org
Adam Montri
Michigan State University, East Lansing; admontri@msu.edu
Gillian Cobb
Michigan Farmers Market Association, East Lansing, MI; gillian@mifma.org
Bridget Behe*
Michigan State University, East Lansing; behe@anr.msu.edu

An increasing trend among farmers in northern climates is the use of unheated greenhouses, commonly referred to as hoophouses or high tunnels. These hoophouses enable farmers to extend the growing season and provide locally grown, fresh produce for 10–12 months of the year. While hoophouses are relatively low cost plastic covered structures, for a new or beginning farmer, access to capital to purchase and build these structures is a common obstacle. On the consumer side, there is increased interest in supplying fresh, healthy, fair, and affordable produce to vulnerable youth and families. One means of addressing this has been the increased acceptance of food assistance benefits at farmers markets throughout the country. Up to this point programs have addressed either the farmer side or the consumer side, however, Hoophouses for Health addresses both sides of these issues. Hoophouses for Health is a unique program that provides farmers with access to capital, at 0% interest for five years, to build hoophouses and provides ongoing technical assistance (TA) to increase production and business success. This TA includes construction assistance, crop selection, spacing and fertility recommendations, projected target yields, and crop enterprise budgeting assistance. Simultaneously the program works with community partners to introduce vulnerable youth and their families to Michigan farmers markets by providing monetary incentives in the form of vouchers that encourage these consumers to become loyal, repeat customers. As the vouchers are redeemed by participating farmers, an amount equal to the vouchers is deducted from the amount borrowed by farmers. At the close of 2013, there were 24 farms with 28 hoophouses funded by the program and 13 farmers markets from across the state of Michigan participating in the program. The program has partnered with local Head Start agencies and community organizations to facilitate distributing vouchers to families. Evaluations of the program have concluded that at least 2,740 individuals representing 752 families were served during the 2013 market season (Lelle, 2014).

Specified Source(s) of Funding: Support is provided by the W.K. Kellogg Foundation

(035) Resources Required By Different Types of Food Hubs
Kevin Duerfeldt*
Iowa State University, Ames; kduerf@iastate.edu
Cynthia Haynes
Iowa State University, Ames; chaynes@iastate.edu
Jennifer Bousselet
Colorado State University, Fort Collins; jmbouss@iastate.edu

Aggregation and access to supply chains have been identified as a limiting factor to increasing scale and availability of local foods; food hubs have been identified as one solution. The objectives of this study were to 1) review the types of local food aggregation entities found regionally and nationally and 2) document financial, tangible, human, and information resources needed to operate at different scales and structures. To complete these objectives we developed a 52-question survey divided into questions about financial, physical, human, and information resources needed to operate a food hub and general questions about operating practices. We compiled a list of 97 food hubs in the 12 state area North Central SARE region. Businesses on this list meet the USDA working definition of food hub, “a centrally located facility with a business management structure facilitating the aggregation, storage, processing, distribution, and/or marketing of locally/regionally produced food products.” Of these food hubs, 79 were surveyed online using Survey Monkey, 12 were surveyed through mail, and six were not surveyed due to insufficient contact information, or scopes of business outside the goals of this study. Of the 79 food hubs contacted through Survey Monkey 32 responded for a 41% response rate. Two produce auctions responded to mailed surveys for a response rate of 16%. The combined response rate for all collectors was 37%. In general results of the survey exemplify the diversity of food hubs, customers, and business organization types including consumer or producer cooperatives, non-profit community organizations, for-profit businesses, retail stores, and consignment auctions. Due to the wide range size and scope, amounts of financial, physical, human, and information resources needed to operate also varied considerably. For example, refrigerated storage space ranged from 0 to 15,000 square feet and full time yearround employees ranged from 1 to 500. More similarities can be found in questions pertaining to ideals, goals, and operating procedures. Sixty-four percent of food hubs indicated that they
facilitate communication between growers, 73% between growers and customers, and 41% between growers and government or nongovernment organizations. Nearly all food hubs surveyed take physical possession and ownership of the produce, 86% and 73% respectively. Notable exceptions would be consignment produce auctions and brokers. These differences are a result of niches each business is trying to fill and characteristics of their community. Further analysis may lead to replicable conditions and practices that will help grow local foods industries.

(036) Local Fertility: Municipal and Industrial Waste as a Source of Organic Matter and Nitrogen, and Its Effect on Vegetable Yields

Rebecca J. Long*
University of Rhode Island, Kingston; rlong86@hotmail.com
Edwin M. Fava
University of Rhode Island, Kingston; edwin.fava@yahoo.com
Angela R. Possinger
Cornell University, Ithaca, NY; arp264@cornell.edu
José A. Amador
University of Rhode Island, Kingston; jamador@uri.edu
Rebecca N. Brown
University of Rhode Island, Kingston; brownreb@uri.edu

Locally available industrial and municipal residual wastes are a potential source of organic matter (OM) and nitrogen for peri-urban farmers. Land application would not only divert residuals from landfills or incineration but could also improve soil fertility and quality, thereby increasing yields. Factors which may limit the suitability of residuals for agricultural use include heavy metal and salt content, as well as carbon to nitrogen ratio. We evaluated (1) paper fiber sludge/chicken manure, (2) biosolids/yard waste co-compost, (3) multi-source compost, (4) leaf compost, (5) dehydrated food waste and (6) gelatin waste against a mineral fertilizer control for their effects on soil inorganic N levels and yield of sweet corn (Zea mays cv. Applause), butternut squash (Cucurbita moschata cv. JWS 6823 PMR (F1)), and potatoes (Solanum tuberosum cv. Eva). The experiment was conducted in 2013 on a silt loam in southern Rhode Island, with crops and amendments arranged in a randomized block design (n = 4). Residual amendments were spring applied at a rate of 10,200 kg OM/ha. Soil samples were collected periodically from May to October and analyzed for ammonium and nitrate. Total weight of crop yield from the center of each plot was recorded. Soil ammonium and nitrate levels were generally significantly higher in plots amended with gelatin waste. Levels of potentially mineralizable N (PMN) were significantly higher in gelatin waste amended plots later in the season, indicating its potential as a slow-release source of N. Negative PMN values for some amendments indicated net immobilization of inorganic N. Yields varied by crop, with high yields (by weight) observed in plots amended with biosolids co-compost and gelatin waste. The high levels of inorganic soil N in plots amended with gelatin waste (up to 1.268 µg N/g dry soil in August) were not reflected in proportionately higher yields, indicating N supply may have surpassed the point at which any additional benefit was obtained and that application rates could be reduced without reducing yields. Only yard waste compost consistently gave poorer yields across all three crops when compared to the control, although corn yields were not significantly different from the control. All residual amendments evaluated appear to have some potential to act as a substitute for mineral fertilizer. This, when considered alongside their potential to improve soil quality through the addition of OM, may make them a viable local source of soil fertility.

Specified Source(s) of Funding: Rhode Island Agricultural Experiment Station

(037) Evaluating Baby-leaf Salad Greens for Spring and Fall Production in Northwest Washington

Charlene Margaret Grahn*
Washington State University, Mount Vernon; charlene.grahn@wsu.edu
Carol A. Miles
Washington State University, Mount Vernon; milesc@wsu.edu
Chris Benedict
Washington State University Whatcom County Extension, Bellingham; chrisbenedict@wsu.edu
Tom Thornton
Cloud Mountain Farm Center, Everson, WA; cloudmountain@telebyte.com

Leafy greens crops such as lettuce (Lactuca sativa), kale (Brassica oleracea), arugula (Eruca sativa), and mustard greens (Brassica juncea) thrive in the cool, humid climate of the maritime Pacific Northwest, particularly in the spring and fall seasons when farmers in the region experience decreased income relative to the main summer growing season. Thus, baby-leaf salad greens are a popular direct-market crop for producers in Northwest Washington. To identify varieties best suited for shoulder-season production, 10 leafy green varieties were grown in replicated trials in a randomized complete block split-plot design with three replications at two locations in the fall and spring for two years in Northwest Washington. Varieties were evaluated for marketable yield, leaf length, days to harvest, and associated weed pressure. Results from fall 2012, spring 2013, and fall 2013 reveal that Brassica crops have a higher yield:days-to-maturity ratio than lettuce, spinach, or beet crops (P = 0.0234), suggesting that leafy green Brassica crops are better suited for baby-leaf salad green cultivation in Northwest Washington than lettuce, beet, and spinach. Weed pressure was significantly higher in spring than in fall (P < 0.0001). The ratio of grams marketable yield per grams weeds harvested differed by variety in the spring (P < 0.0001), with ‘Komatsuna’ and ‘Bekana’ mustard greens, ‘Joi Choi’ pac choi, ‘El Real’ spinach, and ‘Winter Red’ kale having the lowest weed weight per gram of marketable yield. The ratio of grams marketable yield per grams weeds harvested did not differ between varieties in the fall. These results suggest that weed management and variety selection for weed competi-
tiveness is more important for spring production of baby-leaf salad greens in Northwest Washington than for fall production. In an adjacent study, bed flaming was assessed as an organic weed management option for baby-leaf salad greens production. Beds of arugula were planted and assigned randomly to one of three treatments: 1) pre-seeding flaming, 2) post-seeding flaming, and 3) control (no flaming). Stand counts and weed density were recorded for each plot at two, four, and six weeks after planting. Flaming was found to significantly decrease the number of weeds in the beds of arugula ($P < 0.0001$), and the timing of bed flaming (before seeding and after seeding) did not significantly affect arugula stand counts ($P = 0.9956$), indicating that exposure to a flaming treatment did not affect the crop’s germination rate.

Specified Source(s) of Funding: WSDA Specialty Crop Block Grant Program

(038) Growing Growers in the Kansas City Metropolitan Area

Molly Fusselman*
Kansas State University, Olathe; mfusselman@ksu.edu
Candice Shoemaker
Kansas State University, Manhattan; cshoemak@ksu.edu
Marlin Bates
Kansas State University Research and Extension, Lawrence; batesm@ksu.edu
Alicia Ellingsworth
Cultivate Kansas City, Kansas City, KS; alicia@cultivatekc.org
Lala Kumar
University of Missouri Extension, Blue Springs; kumarl@missouri.edu
Katie Nixon
Lincoln University Cooperative Extension, Kansas City, MO; NixonK@lincolnu.edu
Laura Christensen
Kansas State University, Olathe; growers@ksu.edu
Cary Rivard
Kansas State University, Olathe; crivard@ksu.edu

Like many urban areas across the United States, Kansas City has a growing demand for local fruits and vegetables. The Growing Growers program was developed to train new and existing specialty crop growers on effective growing practices in Missouri and Kansas with a particular focus on organic production. The Growing Growers program is a collaborative effort between Kansas University State Research and Extension, University of Missouri Extension, Lincoln University Cooperative Extension, Cultivate Kansas City, Kansas City Food Circle, and the Kansas Rural Center. The program provides various workshops that cover many of the skills to run a successful farm, as well as an apprenticeship program that locates interested farmers-in-training to work on a host farm. Host farms are fruit and vegetable growers in the surrounding Kansas City and Lawrence areas with a focus on sustainability. A few host farms also raise livestock and make specialty products. In addition to the first-hand, practical experience apprentices get while working on a farm; they receive one-on-one mentorship with the host farmer on topics such as business management, soil management and production planning. Apprentices attend at least six of the Growing Growers workshops and farm tours, receive course materials and textbooks, meet new and experienced growers, and build relationships with other growers. The Growing Growers program also hosts the [growerskc] listserv, which is comprised of over 500 growers, buyers, restaurateurs, farmers market managers, Extension professionals, and consumers interested in the local food system. The Growing Growers program started in 2004 and over 80 apprentices have completed the apprenticeship certification program since its inception. Current research includes a comprehensive evaluation of the Growing Growers program using surveys models and focus groups to analyze the economic and social impact of the program on the local food system. Survey participants will include apprentices, host farms, and workshop participants. We hope to determine if the Growing Growers program is effective at preparing beginner farmers to start a farm business and how the program has expanded the local food system in the Kansas City metro area.

Specified Source(s) of Funding: Kansas State University

Tuesday, July 29, 2014

Propagation 2

(166) Development of a Pre-screening Method for Storage of Grafted Cucurbitaceae Seedlings

Karla Patricia Garcia*
University of Arizona, Tucson; pakarla11@email.arizona.edu
Chieri Kubota
University of Arizona, Tucson; ckubota@ag.arizona.edu

Grafting is a unique horticultural technology that enhances plant growth and development, and facilitates sustainable crop production practices by reducing rates and overall use of soil fumigants as an alternative to manage soil borne diseases. However, vegetable grafting demands an intensive propagation process. Short-term storage of grafted seedlings up to several weeks was successfully demonstrated as a possible solution to limited production capacity in United States relative to potentially large demand (e.g., Justus and Kubota, 2010). However, optimum storage temperature is specific for each species and cultivar and a standardized temperature pre-screening method using scion and rootstock genotypes can be helpful to develop an efficient short-term storage technique for grafted seedlings. In this study, we examined seedling radicle elongation rates at different temperatures for evaluating genotype-specific chilling sensitivity. Seeds of ‘Tetsukabuto’ squash rootstock (*Cucurbita maxima* × *Cucurbita moschata*), ‘Olympic Gold’ muskmelon scion (*Cucumis melo*) and ‘Sweet Harmony’ watermelon scion (*Citrullus lanatus*) were germinated at 25 °C under darkness inside a pair of vertically oriented Plexiglas sheets holding seeds against moist paper towel. After the radicle reached 5–10 mm long, the seedlings were subjected to one of three differ-
ent temperatures (5 °C, 12 °C, or 25 °C) in darkness. After 72 hours, all seedlings were transferred to a recovery treatment at 25°C until their roots reached 100 mm long. Root growth of ‘Tetsukabuto’, ‘Olympic Gold’ and ‘Sweet Harmony’ seedlings were significantly lower at 5 °C and 12 °C than that at 25 °C. ‘Tetsukabuto’ seedlings had 2.47 times higher rate of radicle growth than ‘Olympic gold’ at 5 °C, and 6.10 and 6.17 times higher rate of growth than ‘Sweet harmony’ at 5 °C and 12 °C, respectively. At 12 °C, no significant difference were found between ‘Testukabuto’ and ‘Olympic gold’ showing ‘Sweet harmony’ as the most chilling sensitive. Under the recovery following the chilling treatment, there was no significant difference between the genotypes; however, ‘Tetsukabuto’ seedlings radicle length reached 100 mm faster than the others. The results obtained in this experiment demonstrated that ‘Testukabuto’ was highly tolerant and ‘Sweet harmony’ was most sensitive to low temperatures, which is in general agreement with the results of our previous research comparing the storability of the same three genotypes at low temperatures (Spalholz, 2013). In conclusion, root growth rate of young seedlings can be used as a temperature pre-screening method for testing storability of cucurbitaceae genotypes used for scion and rootstock.

Specified Source(s) of Funding: University of Arizona

(167) Effects of Grafting Methods and Re-rooting on the Growth Characteristics of Grafted Muskmelon Plants

Wenjing Guan*
University of Florida, Gainesville; wguan@ufl.edu

Xin Zhao
University of Florida, Gainesville; xzin@ufl.edu

Grafting has been used as an effective approach to controlling soil-borne diseases and overcoming abiotic stresses in production of solanaceous and cucurbitaceous vegetables. With respect to melon grafting, grafting methods vary considerably among geographic regions and nurseries, while the practice of rootstock re-rooting during graft healing process has been used by some propagators. In this study, three grafting methods including hole-insertion (HI), one-cotyledon (OC), and non-cotyledon (NC) methods were examined for their influences on the seedling growth and root characteristics of muskmelon ‘Athena’ (Cucumis melo) grafted onto hybrid squash rootstock ‘Strong Tosa’ (Cucurbita maxima □Cucurbita moschata). Non-grafted rootstock and scion plants were included as controls. Both grafted and non-grafted plants were examined with or without re-rooting. Root measurements were conducted every four days after grafting (DAG). At 16 DAG, root length and surface area and average root diameter were similar between re-rooted plants and plants without re-rooting (with original roots). NC method resulted in a decrease in root length and surface area as well as shoot fresh and dry weights compared with HI and OC methods and non-grafted controls. Due to the reduced transplant quality, NC method was excluded from the following experiment. In the second part of the experiment, plants were transplanted into 3.8 L pots and grown in a greenhouse until anthesis of melon female flowers, and belowground and aboveground growth characteristics were then evaluated. Flowering time did not differ between HI- and OC-grafted plants and non-grafted scion controls. Shoot fresh and dry weights, leaf area, chlorophyll content, and stomatal conductance were also similar between these treatments. Re-rooting did not impact aboveground growth characteristics. Interestingly, the re-rooted rootstock controls generated longer roots compared with those without re-rooting; however, this was not observed on grafted plants and non-grafted scion controls. The experiment demonstrated that NC method suppressed root development and reduced transplant quality. HI and OC methods did not show any significant effects on aboveground and belowground growth characteristics compared with non-grafted scion and rootstock controls, respectively. Further studies are warranted to evaluate the field performance of re-rooted grafted melon plants.

Specified Source(s) of Funding: Southern SARE

(168) Shoot Forcing and Rooting of Stem Cuttings of Morus (Mulberry) Species

Kyle Roberson
USDA–ARS, Davis, CA; kjroberson@ucdavis.edu

John E. Preece*
USDA–ARS, Davis, CA; John.Preece@ars.usda.gov

Jenny Smith
USDA–ARS, Davis, CA; jenny.smith@ars.usda.gov

Woody stem segments were forced to produce softwood shoots for propagation from 6 fruited mulberry cultivars in the USDA–ARS collection at the National Clonal Germplasm Repository, Davis, CA, including ‘Beautiful Day’, ‘Hunza White Seedless’, ‘Illinois Everbearing’, ‘Pakistan’, ‘Saharanpur Local’, and ‘Shangri-La’. Stem segments 40 ± 2 cm long and 2.5–9.5 cm caliper were harvested mid-September (run 1) and mid-October, 2013 and placed horizontally into flats of vermiculite in a greenhouse under drip irrigation in a randomized complete-block design, blocking on stem diameter and gradients in the greenhouse. The number of 1 cm long buds and ≥3 cm long shoots were recorded on a weekly basis. When shoots ≥3 cm long, they were identified they were removed from the stem segments their bases were treated with 1000 ppm IBA in talc before planting in a 50/50 perlite-vermiculite mix and placed under intermittent mist. The cuttings were examined weekly to check for roots at least 1 cm long for data collection. ‘Shangri-La’ produced the most leafy softwood shoots (5.3/stem segment), which rooted at 82% within 4 weeks. Other cultivars produced few shoots and 50% to 100% rooting success was achieved for all other cultivars, except cuttings of ‘Saharanpur Local’ that did not root.

(169) Clonal Propagation of Guayule through Cuttings

Adam Spanier
University of Arizona, Tucson; AdamSpanier@email.arizona.edu

Joy Hought
University of Arizona, Tucson; hought@email.arizona.edu

An asterisk (*) following a name indicates the presenting author.
Shoot and root growth of asparagus and overall propagation as a high multiplication rate compared to solid culture. Thus, Asparagus officinalis L. is a dioecious plant that has been successfully micropropagated in vitro on solid medium, but woody tissues of guayule plants. Clonal propagation can be successfully used to propagate Parthenium argentatum Gray) is woody perennial, native to the Chihuahuan Desert of central Mexico and southwestern Texas. Other relatives in the genus are used in landscaping, but guayule shows promise as a rubber/latex producing crop and potential bioenergy crop. Guayule has a complex breeding system (facultative apomixis) often making it difficult to produce predictable progeny. In order to advance uniform lines vegetative propagation techniques were explored. A preliminary study was made to identify variables that needed further investigation in order to optimize cutting production. Parent material consisted of approximately one-year-old field grown plants, originally from transplants produced from seed. Terminal cuttings of varying lengths were made during cooler and more humid times of day with pruning shears. Between one and six cuttings were made from around 300 plants, totally approximately 3,000 cuttings. Cuttings were transferred from the field, on ice or in moist plastic bags, to a propagation house with mist benches and bottom heat. Upon arrival they were either recut or not, and dipped into liquid Hormex (0.013% IBA and 0.24% NAA), powdered Rootone (0.2% NAA with thiram), or liquid naphthalene acetamide for 60 or 90 seconds, then placed into prepared trays of either a pre-wetted mixture of sand and Sunshine 1 mix or only sand. After three weeks, approximately 70 percent of cuttings had rooted. Cuttings that survived with callus, but no roots, were either recut and re-dipped, or just re-dipped, and placed back into trays. The cuttings were reevaluated at four weeks. Variables identified for further study were: (1) length of cuttings; (2) concentration of hormones; (3) time in hormone dip; (4) propagation media; and (5) environmental conditions. Our preliminary results show that clonal propagation can be successfully used to propagate woody tissues of guayule plants.

Specified Source(s) of Funding: Undergraduate Biology Research Program, University of Arizona

(170) Development of a Liquid Micropropagation System for Asparagus officinalis L.

Xinyu Chen*
University of Guelph, Guelph, ON; xchen04@uoguelph.ca

David Wolyn
University of Guelph, Guelph, ON; dwolyn@uoguelph.ca

Asparagus (Asparagus officinalis L.) is a dioecious plant that has been successfully micropropagated in vitro on solid medium, but efficiency is not optimum, especially for recalcitrant genotypes. Liquid culture has been used for propagation in other plant species and showed improvement of explant morphology as well as a high multiplication rate compared to solid culture. Thus, shoot and root growth of asparagus and overall propagation efficiency could be improved by the development of a liquid culture system. The objectives of this research were to test the effects of basal medium (DKW, MS), NAA and kinetin concentrations (0, 0.125, 0.25, 0.5 µM), and types and concentrations of carbohydrates (sucrose, glucose, fructose, maltose; 0%, 3%, 6%) and growth retardants (ancymidol, paclobutrazol; 0, 0.25, 0.5, 1 µM) on shoot growth in a liquid culture system. Nodal segments on DKW medium with 0.5 µM kinetin and 0.125 µM NAA, three percent glucose and 1 µM ancymidol produced the best results: a high percentage of nodal segments that initiated at least one shoot, and long, thick shoots with a large number of nodes. The effects of culture parameters on rooting are currently under analysis and plantlets will ultimately be tested for survivability in soil.

(171) Growth of Christ Thorn (Euphorbia milli var. Splendens) Slips in Different Substrates

Jaime Molina-Ochoa*
Universidad de Colima, Coordinación General de Investigación Científica, Tecomán, Colima; jmolina18@hotmail.com

Oscar Rebolledo-Domínguez
Universidad de Colima, Tecomán, Colima; oscarrd@ucol.mx

Abel González-Torres
Universidad de Colima, Tecomán, Colima; agonzalezt@ucol.mx

John E. Foster
University of Nebraska Lincoln; jfoster@unl.edu

Arnoldo Michel-Rosales
Universidad de Colima, Tecomán, Colima; amichel_20@hotmail.com

Francisco Radillo-Juárez
Universidad de Colima, Tecomán, Colima; radillo55@hotmail.com

Our hypothesis was that the combinations of organic and inorganic substrates improve the growth of Christ thorn slips grown under greenhouse conditions. The aim of this research was to determine the combinations of organic and inorganic substrates to improve the grow slips of Christ thorn (Euphorbia milli var. Splendens). Combinations of organic and inorganic substrates were mixed to prepare 10 treatments. Vermicompost, compost, uncured rum, pumice stone, coconut fiber powder, sawdust, and a check (sand). About 410 g of the combinations were deposited in 1-kg plastic containers. The vegetative material used were slips of Christ thorn collected from nurseries in Colima, México. The basal part of the Christ thorn slips were impregnated with a rooting solution of Enraizador Plus™, and then the slips were planted in plastic containers with 4 inches of diameter containing each of the combinations of substrates. The combinations were distributed in a Complete randomized design with ten treatments and four replications, each replication had three containers. The variables evaluated were: fresh and dry weights of the plants. They were recorded and the data were processed for ANOVA and the means were separated by Tukey test (P ≤ 0.05). The hypothesis was supported with our results. The combination of uncured rum 30%, coconut fiber powder 40%, and sand 30% produced the highest fresh, and dry weights (34.5, and 4.5 g, respectively).
respectively); meantime, the combinations of uncrured rum 30%, pumic stone 40%, and sand 30% produced the highest dry weights (4.6 g). Lower, but not statistically different values were also obtained with the combination of vermicompost 30%, coconut fiber powder 40%, and sand of river 30% in fresh and dry weights (27.2, and 2.6 g, respectively).

(172) Yield Performance and Bean Quality Traits of Cacao Propagated by Somatic Embryogenesis and Grafting

Ricardo Goenaga*
USDA–ARS, Mayaguez, PR; ricardo.goenaga@ars.usda.gov

Mark Guiltinan
The Pennsylvania State University, University Park; mjg9@psu.edu

Siela Maximova
The Pennsylvania State University, University Park; snm104@psu.edu

Ed Seguine
Seguine Cacao Cocoa & Chocolate Advisors, Hanover, PA; ed@seguinecacao.com

Twelve cacao (Theobroma cacao) clones propagated by grafting and rooted cuttings of somatic embryo-derived plants were grown on an Ultisol soil at Corozal, Puerto Rico and evaluated for six years under intensive management. Year, variety, the year x variety and propagation treatment x variety interactions showed significant effects for dry bean yield, number of pods produced, pod index, plant height and stem diameter. Propagation treatments had a significant effect on dry bean yield and pod index but not on number of pods produced. Average yield across varieties for both propagation treatments was 2,087.9 kg·ha⁻¹ per year of dry beans. There was a highly significant variety effect. ‘UF-668’ was the top yielder averaging 2,536.7 kg·ha⁻¹ per year of dry beans; however, this yield was not significantly different than the average yield of varieties TARS-30, TARS-1, TARS-13, TARS-14 and TARS-2 which averaged 2,427.0 kg·ha⁻¹ per year. Except for ‘UF-668’, the TARS varieties were released in 2009 as high-yielding selections. Propagation treatments had a significant effect on dry bean yield. Dry bean yield of varieties propagated by grafting was 7% higher (2,166.7 kg·ha⁻¹ per year) than those propagated by somatic embryogenesis (2,009.2 kg·ha⁻¹ per year). This yield difference could not be attributed to grafted plants being more vigorous nor by differences in root architecture. The lowest pod index value in both propagation treatments was obtained for ‘UF-668’ however, pod index for this variety did not differ significantly from values for ‘TARS-2’ and ‘TARS-23’ in grafted plants and from ‘TARS-2’, ‘TARS-23’, and ‘TARS-1’ in plant propagated by somatic embryogenesis. With few exceptions, flavor characteristics were not significantly affected by propagation treatments. Although there were significant differences between plant propagation treatments for some of the variables measured in this study, these were not of a magnitude that would preclude the use of somatic embryogenesis as a viable and reliable propagation system for cacao.

(173) Propagation and Growth Parameters of Preselected Pomegranate (Punica granatum) Cuttings from the USDA–ARS National Clonal Germplasm Repository

John M. Chater*
University of California, Riverside; john.chater@email.ucr.edu

Donald J. Merhaut
University of California, Riverside; donald.merhaut@ucr.edu

John E. Preece
USDA–ARS, Davis, CA; John.Preece@ars.usda.gov

The following pomegranate (Punica granatum) accessions from the USDA–ARS National Clonal Germplasm Repository, Davis, CA were accessed for propagation success and early plant growth: ‘Ki Zakuro,’ ‘Phoenicia,’ ‘Nochi Shibori,’ ‘Golden Globe,’ ‘Green Globe,’ ‘Loffani,’ ‘Wonderful,’ ‘Eversweet,’ ‘Haku Botan,’ ‘Parfianka,’ ‘Desertnyi,’ and ‘Ambrosia.’ Stem cuttings were harvested from basal suckers, cut to a length of 10.5 ± 1.0 cm long, and treated with 3 g·L⁻¹ of indolebutyric acid and planted in 1 Sunshine potting mix : 1 perlite in 2.5 cm x 2.5 cm potting containers, separated by block in plastic flats irrigated with DI water. A randomized complete-block design was used with 8 blocks and 4 pseudoreplicates per block, totaling 32 trees for each accession. ‘Green Globe’ was found to root the poorest compared to the other cultivars, with ‘Ambrosia’ having the second poorest success rate. All other accessions had rooting success rates above 80%. ‘Parfianka’ had greater branching than ‘Eversweet,’ ‘Nochi Shibori,’ ‘Haku Botan,’ ‘Desertnyi,’ ‘Loffani,’ ‘Ki Zakuro,’ and ‘Golden Globe.’ Apical shoot length was also different between two groups, with ‘Golden Globe,’ ‘Phoenicia,’ and ‘Wonderful’ with greater apical shoot growth and ‘Ki Zakuro,’ and ‘Haku Botan’ growing slower. ‘Golden Globe’ and ‘Phoenicia’ were taller than ‘Eversweet’ and ‘Haku Botan.’ Leaf chlorophyll was measured with a SPAD-502 chlorophyll meter, and ‘Haku Botan’ and ‘Loffani’ had greener leaves than ‘Eversweet,’ ‘Ambrosia’ and ‘Desertnyi.’ The results of this study indicate that pomegranate cultivars vary significantly in a range of pomegranate propagation parameters and that not all pomegranate cultivars are readily propagated by vegetative cuttings treated with exogenous rooting hormone.

(174) In Vitro Culture of Immature Peach Embryos

Filipe Bittencourt Machado Souza*
Clemson University, Clemson, SC; fbritten@clemson.edu

Rafael Pio
Universidade Federal de Lavras, Lavras/MG; rafaelpio@hotmail.com

Gregory L. Reighard
Clemson University, Clemson, SC; grghrd@clemson.edu

Edvan Alves Chagas
Embrapa, Boa Vista/RR; echagas@pa.cnpa.br

Moacir Pasqual
Universidade Federal de Lavras, Lavras/MG; mmpasqual@ufla.br

An asterisk (*) following a name indicates the presenting author.
Embryo culture of peach and nectarine in an improvement program for development of early maturation cultivars is an indispensable process. This study aimed to evaluate the effect of BAP and GA3 on the in vitro immature embryo development of peach and nectarine. Seeds from mature peach and nectarine fruits, obtained by natural crossing of ‘Aurora 1’, ‘Tropical’, ‘Rubrosoñ’ and ‘Centenária’ cultivars, were removed and treated for five minutes in ethanol (70%), followed by sodium hypochlorite (20%) for 20 minutes and then washed 3 times with distilled and autoclaved water. The ovules were inoculated in 250 mL bottles, containing 50 mL of Wood Plant Medium culture medium, with 150% of the original concentration, modified at the GA3 (0; 0.1; and 1 mg·L\(^{-1}\)) and BAP (0; 0.2; 0.4; and 0.8 mg·L\(^{-1}\)) concentrations in all possible combinations. The experiment was a completely randomized block design in a 4 x 3 x 4 factorial, with four replications, each consisting of 4 seeds in a test tube. The data were subject to ANOVA and qualitative data means were compared with Tukey’s test at \(P = 0.05\) of probability. The quantitative data were compared using polynomial regression. After 60 and 90 days, the plantlets were harvested and the average length of the aerial part (CPA), number of leaves (NF), average length of the root system (CSR) and average weight of the total fresh mass (PMFT) were recorded. The best in vitro development of the plantlets of peach and nectarine was obtained with the use of 1 mg·L\(^{-1}\) of GA3 combined with 0.5 to 0.8 mg·L\(^{-1}\) of BAP.

(175) Effects of Indole-3-butyric Acid, Silver Nitrate, and Management on the Rooting and Stimulation of Active Growth of Hybrid Hazelnuts (Corylus americana x C. avellana) Stem Cuttings

Ronald Scott Revord*

University of Illinois at Urbana-Champaign; revord1@illinois.edu

Available breeding and genomic techniques, and further expansion of an eastern and midwestern U.S. hazelnut industry, have been restricted by challenges preventing the creation of asexual propagation protocol. Several studies of propagation by rooting of stem cuttings show some promise for research and mid-commercial scale genotype replication of the hazelnut (Corylus sp.); however, these results vary in their consistency within and across the hazelnut species. Recently, the successful rooting of European hazelnut (C. avellana) stem cuttings through the application of low levels of indole-3-butyric acid (IBA) and the ethylene inhibitors silver nitrate (AgNO\(_3\)) and 1-Methylcyclopropene (1-MCP) was reported. This study expands upon these findings to determine their effectiveness to induce rooting and allow for subsequent vegetative growth of hybrid hazelnuts (Corylus americana x C. avellana); Low concentrations of IBA were assessed independently and in combination with AgNO\(_3\) to decipher if ethylene blockage treatments influence rooting, bud abscission, and/or bud break in cuttings of hybrid hazelnut stem tissue. Our results demonstrate high levels of hybrid hazelnut propagation are possible with low IBA concentration and that AgNO\(_3\) helps to improve propagation through a high degree of bud break. However, AgNO\(_3\) application did not significantly affect the number of successfully rooted cuttings or the reduction of bud abscission in the plant material studied, as was reported in previous work. Additionally, AgNO\(_3\) application did not result in continued vegetative growth in all cases, whereas management practices, such as transplanting time, appear to be more effective in encouraging continuous growth.

Specified Source(s) of Funding: Agroecology and Sustainable Agriculture Program

Tuesday, July 29, 2014

Teaching Methods 2

(077) Smart Devices and Apps Help Support Research, Extension, and Teaching

Kent D. Kobayashi*

University of Hawai\'i at Manoa, Honolulu; kentko@hawaii.edu

Teresita D. Amore

University of Hawai\'i at Manoa, Honolulu; amore@hawaii.edu

With advances in communications technology, smart devices have become essential tools for day-to-day activities in research, extension, and teaching. The objective is to describe the ways tablets, smartphones, and apps support our work related activities. Searching by keywords or journals, the Read by QxMD app automatically finds the latest scientific research articles. Cloud storage apps (Dropbox, Box, and Google Drive) allow file storage and file synchronization among mobile devices, computers, and mobile device applications. RSS news reader and news aggregator apps (Feedly, Pulse, and Zite) locate articles, websites, and videos about the latest news and technological developments in horticulture which are disseminated to extension personnel and stakeholders. Weebly, an iOS app website builder, was used to create mobile websites such as “Micro-hydroponics” about non-circulating hydroponic vegetable systems. Keynote is an iPhone/iPad/iPod touch app used to create and deliver oral presentations. The latest version of Keynote enables an iPhone or iPod touch to be used as a remote control to run a keynote presentation on an iPad.

Mind mapping apps (SimpleMind+, Total Recall, and instaGrok) create mind maps of the topics that are covered in a presentation or classroom lesson. Students use mobile devices with QR code reader apps (i-nigma) to scan QR codes to get relevant information to supplement class discussions. The Video Tube app finds and views YouTube videos for flipped classroom discussions. Notability and Evernote are useful for taking notes by typing or writing with a stylus while simultaneously recording audio, or taking photographs to incorporate into the note. Notability also annotates PDFs, and has the capability to back up notes to cloud storage sites such as Dropbox, Google Drive, or Box. Social networking sites such as Line allow researchers to set up groups, share photos, voice, or video call using Wi-Fi connections. Facebook hosts plant groups where hobbyists and scientists can exchange information. Camera apps can range from the simple Camera app to more sophisticated apps like ProCam and KitCamera. AppsGoneFree explores at no cost apps with
An asterisk (*) following a name indicates the presenting author.

Specified Source(s) of Funding: CTAHR Research/Extension Supplemental Funds. Smith-Lever Funds.

(078) Promoting Horticulture in the United States—A National Study and Action Plan
Marnie Conley
Longwood Gardens, Inc., Kennett Square, PA; mconley@longwoodgardens.org

John M. Dole
North Carolina State University, Raleigh; john_dole@ncsu.edu

Mary Hockenberry Meyer
University of Minnesota, Chaska; meyer023@umn.edu

Douglas C. Needham
Longwood Gardens, Inc., Kennett Square, PA; dneedham@longwoodgardens.org

Michael Neff
ASHS, Alexandria, VA; mwneff@ashs.org

Brian Trader*
Longwood Gardens, Inc., Kennett Square, PA; btrader@longwoodgardens.org

Our world is highly dependent on horticultural expertise to provide the technology and people necessary to meet the rapidly increasing global demand for fruits, vegetables, nuts, herbs and ornamentals in the face of the changing global environment and limited natural and financial resources. Additionally, horticulture plays a critical role in promoting positive mental well-being on a large scale from public botanic gardens, parks, and sports fields, to small scale individual home gardens. There is a concern, for those aware of horticulture, the perception is increasingly negative, while much of the public, especially today’s youth, appear to have little or no awareness of the importance and value of horticulture. Interesting, challenging, and impactful careers are available in horticulture at all levels, and there is an increasing need for well-trained and educated students. A National Initiative has begun to promote horticulture in the United States and increase public awareness of the positive attributes of this industry. To date, over 150 gardens, schools, colleges, universities, associations, government agencies, commodity groups and horticultural industries have shown support for this National Initiative. Six endorsing partners for the National Initiative include Longwood Gardens, American Society for Horticultural Science, National Junior Horticultural Association, American Horticultural Society, American Public Gardens Association and AmericanHort. The National Initiative will include a national study, education plan, and marketing and advocacy campaigns. Through a request-for-proposals a firm has been identified to lead a national study and assist our industry in improving public perceptions of horticulture, integrating horticulture into national educational curriculum, increasing youth participation in institutions like 4-H and FFA, increasing enrollment in horticulture and plant sciences in high schools, colleges and universities, and ultimately increasing well-trained horticulture professionals and public awareness of horticulture.

(079) Assessing Student Learning from an Experiential Hydroponics Production Module in a Greenhouse Management Course
Joshua K. Craver*
Kansas State University, Manhattan; joshuakcraver@gmail.com

Kimberly A. Williams
Kansas State University, Manhattan; kwilliam@ksu.edu

Student learning from a 6-week, hands-on hydroponics crop production module in the course HORT 570 Greenhouse Operations Management at Kansas State University was assessed during Fall 2013. The module design followed Kolb’s Experiential Learning Circle, with teams of students responsible for production of lettuce or basil and chives crops in either a nutrient film technique (NFT) or in-pot recirculating culture system. Objectives were to discern if this class experience would 1) improve student understanding of not only hydroponic systems, but also general crop nutrient management principles; and 2) improve higher-order learning skills (HOL) of applying, analyzing, and evaluating information. Students were given responsibility for all management decisions for implementing both organic and inorganic nutrient management programs during Monday through Friday for 6 weeks. Student learning was evaluated by administering the same survey, which included questions to evaluate student perception, lower-order learning (LOL), and HOL, at four separate times during the semester: 1) prior to mentioning plant nutrition or hydroponics; 2) after plant nutrition lectures but before the hydroponics module; 3) immediately upon completion of the hydroponics module; and 4) at the end of the semester. An increase in student confidence related to managing hydroponics production and nutrient management was perceived upon completion of the module. The greatest increase in LOL occurred after the material was presented during the course lectures, with a slight increase also occurring upon completion of the hydroponics module. In contrast, HOL did not significantly increase after the lecture material was presented, but significantly increased upon completion of the hydroponics module. This evidence suggests that experiential learning improves student understanding and fosters HOL. Though designed experiential learning activities are expensive and time-consuming to implement, these results show that experience-based modules can be used to build student confidence regarding complex crop management scenarios and promote an increase in their HOL.

Specified Source(s) of Funding: KSU College of Agriculture Innovations in Teaching, Learning and Assessment

(080) A Pilot Study of College Students’ Experiences with an Educational Game to Learn Difficult Plant Science Concepts
Kathryn S. Orvis*
Purdue University, West Lafayette, IN; orvis@purdue.edu
College students are typically challenged when learning science content in introductory courses. Particularly, students majoring in agriculture and natural resources related sciences need to master difficult plant science concepts such as photosynthesis and respiration. At the same time, students benefit from learning abstract concepts using educational games because they are more engaged in learning and had greater retention when computer games are used compared to conventional classroom instruction. The purpose of this pilot test was to describe college students’ experiences of playing an early prototype of an educational game focused on learning about the concepts of photosynthesis and respiration. When developing educational games it is important to conduct early field-tests of the prototype to get feedback from students. Results from this study guided the instructional design team to more accurately target educational outcomes with relevant game features. Early feedback is critical in educational game development, and this pilot provides important information moving forward with continued development of the project.

(081) A Proactive Model for Recruiting Students into Agriculture Disciplines

Caula A. Beyl*
University of Tennessee, Knoxville; cbeyl@utk.edu

Anna F. Adams
University of Tennessee, Knoxville; afilipek@utk.edu

Recruitment of students into any field of agriculture is sometimes hampered by traditional perceptions of agriculture as being a study of “cows, sows, and plows”. Contrary to this misperception, modern agriculture encompasses discipline specializations that appeal to almost every student. Dispelling this myth of agriculture and replacing that image with the dynamic and cutting edge reality is the first challenge that we face in recruiting students. A second challenge that exists is the decline in the numbers of high school graduates entering college as evidenced by static and even declining higher education enrollments occurring in the last couple of years. We have developed a cadre of effective strategies for recruitment of high quality students that have enabled us to sustain an enrollment growth of 50% since 2007. These include peer reviewed print material, aggressive use of social media, hiring of a student communications assistant, targeting primary influencers, generous scholarship support, broad communication about job opportunities, and Ag Ambassador peer-led tours ending with personal contact with professors in each discipline area. Today’s students are driven by a desire to “make a difference” and impact the world around them in a positive manner. Agriculture and all of its subdisciplines offer an excellent opportunity to satisfy those needs.

Tuesday, July 29, 2014

Tropical Horticultural Crops

(315) Genetic Diversity of Papaya Ring Spot Virus in Puerto Rico

Dimuth Siritunga*
University of Puerto Rico Mayaguez; dimuths@hotmail.com

Cristina Zambrana
University of Puerto Rico Mayaguez; crisitna.Zambrana@upr.edu

Rocio Marquez
University of Puerto Rico Mayaguez; Rocio.Marque@upr.edu

Lorraine De Jesus Kim
University of Puerto Rico Mayaguez; Lorraine.DeJesus@upr.edu

David Jenkins
USDA-Tropical Agricultural Research Station, Mayaguez, PR; david.jenkins@ars.usda.gov

The Food and Agriculture Organization estimates that 20-40% of crop yield is lost due to pests and diseases. Viruses are agents that cause diseases which contribute greatly to the global yield loss. Because of this, food production is negatively affected, especially in the tropics. *Carica papaya*, commonly known as papaya, paw paw, or lechosa, is an economically and culturally important crop in Puerto Rico. Its fruits are a source of vitamins, antioxidants and papain, an enzyme used as a meat tenderizer and other industrial uses. Despite its economic value, papaya production is being affected by the Papaya Ring Spot Virus (PRSV). Belonging to the Potyviridae family, PRSV is found in tropical and subtropical regions. Its host range consists of members of the Caricaceae, Cucurbitaceae (cucurbits) and Asteraceae families. The virus has a 10kb positive single stranded RNA genome and is transmitted by aphids in a non-persistent manner. It has two biotypes, PRSV-W, which affects cucurbits but not papaya, and PRSV-P that affects both plants. When a plant is infected with the virus it can develop symptoms like leaf distortion, chlorotic mottling, shoestrings and blisters, deformed papaya fruits with ring spots, among others. If the plant is infected at early stages of its life it will not produce fruits, thus contributing to production losses. Coat protein gene sequence of PRSV from papaya and cucurbits are being analyzed to determine the variability of the viral population between biotypes in Puerto Rico. In addition, a phylogenetic analysis of PRSV isolates from around the world will indicate the relationship between the strains from the island and other countries based on sequence similarity.

(316) Assessing Avocado for Laurel Wilt Resistance, Fruit Quality, and Horticultural Traits for Production in East Central Florida

Cristina Pisani*
University of Florida, Fort Pierce, FL; cpisani@ufl.edu

An asterisk (*) following a name indicates the presenting author.
than 5% open flowers on each cluster. Peak bloom ranged from open flowers on 4 March 2013. By 26 April 2013, there were less presence of clusters and flowers per shoot with an estimation until the occurrence of fruit set. Flowers were assessed on the Evaluation of bloom was conducted on a two-week interval disease resistance is being collected over the next three years. Data on tree growth, fruit quality (fruit weight, seed weight, size and diameter, oil content, number of fruits per tree, fruit dry weight, fruit and pulp firmness, and peel color), and number of fruits per tree, oil content, number of fruits per tree, fruit dry weight, fruit and pulp firmness, and peel color), and disease resistance is being collected over the next three years. Evaluation of bloom was conducted on a two-week interval until the occurrence of fruit set. Flowers were assessed on the presence of clusters and flowers per shoot with an estimation of open flowers at each evaluation. On trees that flowered, they occurred on almost every shoot apex with an average of 42% open flowers on 4 March 2013. By 26 April 2013, there were less than 5% open flowers on each cluster. Peak bloom ranged from 14 March to 26 April 2013. Edible and non-edible portions of the fruit were evaluated according to presence/absence of common disorders such as flesh bruising and other body rots. Other less common disorders such as vascular leaching, stones in the flesh, flesh adhesion to the seed, and uneven ripening were also noted. Fruit weight was highly variable, ranging between 96.8 and 686.6 g. Lightest and heaviest seed weight ratios were 5.9 and 5.5 g. Range of flesh weight ratios were 2.7 to 10.2 g. An informal taste panel was conducted with 10 judges on seven selections using a store-bought Hass as the standard. One of the selections that panelists “liked moderately” and “liked very much” was rated as having a creamy and smooth texture with a nutty flavor. This selection is promising as it has a seed to flesh weight ratio of 8.1 g and the skin turns dark during ripening helping mask minor imperfections. This extensive set of phenotypic data will be used to identify DNA markers associated with important traits.

**Development and Biochemistry of Timbiriche (Bromelia hemisphaerica Lam.) Fruits**

Genetic diversity of tropical fruits from the American Continent is under-exploited as the harvested fruits from these species are only used locally and barely commercialized in larger markets, both nationwide and worldwide. Bromeliaceae is a botanical family that includes several little known species with potential for ornamental use and/or fruit production purposes. Timbiriche (Bromelia hemisphaerica Lam.) is a little known species that exhibits traits that make it potentially valuable for intensive cultivation: 1) its dense populations and leaf orientation may reduce hydric erosion in soils with sharp slope and, 2) due to its low water demand, it may be cultivated in rainfed agricultural systems. The objective of this study was to determine the development of fruits and some biochemical characteristics of timbiriche to advance in the understanding required for the cultivation of this tropical species. The study was conducted in five natural populations in Tepujpico, México (18°53′59" N, 100°08′00" W, 1330 meters above sea level). Fruit development from blooming was studied, including fruit diameter, volume, firmness, color, total dissolved solids (°Brix), titratable acidity (citric acid), juice pH, respiration and ethylene production, and weight loss during postharvest. Results indicate that the development of the fruit takes 28 weeks from blooming and fits a simple sigmoidal curve. As fruit developed, there was an increase in total dissolved solids and a decrease in titratable acidity. Fruit firmness and juice pH remained constant. Carbon dioxide and ethylene production varied according the provenance of fruits, although tended to decrease. Fruits lost 30 to 50% of their weight during a 30-day postharvest period.

**Banana Fruit Production in More Temperate Climates: Making a Case for Banana Fruit Production in Coastal Alabama**

One of the selections that panelists “liked moderately” and “liked very much” was rated as having a creamy and smooth texture with a nutty flavor. This selection is promising as it has a seed to flesh weight ratio of 8.1 g and the skin turns dark during ripening helping mask minor imperfections. This extensive set of phenotypic data will be used to identify DNA markers associated with important traits.
Penelope Perkins-Veazie
North Carolina State University, Plants for Human Health Institute, Kannapolis; penelope_perkins@ncsu.edu

Greg E. Fonsah
University of Georgia, Tifton; gregfonsah@gmail.com

Jeff L. Sibley
Auburn University, Auburn University, AL; sibleje@auburn.edu

Fruit and vegetable crop diversity is being encouraged in farm operations as a means to increase economic sustainability while a growing body of evidence suggests that increased consumption of fruits and vegetables reduces the risk of diet-related chronic diseases. At the confluence of these two issues rests opportunities for niche market crops such as banana fruit. The United States is the world’s largest consumer of bananas, which have traditionally been a product of the tropics. More recently, banana cultivars have been developed that are cold-tolerant and short-cycled and can be cultivated in the U.S. subtropics. Other countries in the subtropics such as Australia and South Africa have successful banana production operations. The purpose of this project is to determine best suited cultivars for production in coastal Alabama and compare phenological parameter data to data in the literature from studies conducted in other subtropical regions. Thirteen banana cultivars were planted in Fairhope, AL, on June 5, 2013. Bananas were blocked by type and planted using a single-plant, completely randomized design. Phenological parameters measured included leaf emergence rate (LER), leaf area, leaf area index (LAI), plant height, pseudostem circumference, total leaf number, number and type of sucker produced. Preliminary results are encouraging. Cardinal temperatures for banana production fall in the range of 14 °C to 31 °C with optimal range of 22 °C to 31 °C. In coastal Alabama mean temperatures are within the acceptable range for most of the year. During the winter mean temperature range was tolerable for banana pseudostems at 0 °C to 14 °C. Leaf emergence rates ranged from 5.0 – 8.0 leaves month-1 from July through September and were similar to banana plants produced in other subtropical regions. According to the literature, leaf area index (LAI) of ‘Grand Nain’ and ‘Dwarf Cavendish’ banana cultivars ranged from 1.94 – 2.03 and 2.37 – 2.65, respectively, at harvest in the subtropics. Five months after planting, LAI of ‘Grand Nain’ and ‘Dwarf Cavendish’ grown in Fairhope was 1.0 and 1.31, respectively. At the same point of maturity, ‘Grand Nain’ and ‘Dwarf Cavendish’ reached pseudostem circumferences that were 51% and 56%, respectively, of their counterparts at harvest grown in other subtropical regions. This data suggests that vegetative growth of bananas produced in coastal Alabama is commensurate with growth of bananas produced in other subtropical regions and supports the potential of banana fruit production.

(320) Lessons Learned in Conservation Tillage Vegetable Systems in the Sub-tropics and Tropics

Danielle D. Treadwell
University of Florida, Gainesville; ddtreadw@ufl.edu

Stuart Weiss*
University of the Virgin Islands, St. Croix, Kingshill; sweiss@live.uvi.edu

Elide Valencia
University of Puerto Rico, Mayaguez; elide.valencia@upr.edu

Kenneth Beamer
University of the Virgin Islands, St. Croix, Kingshill; kenneth.beamer@uvi.edu

Tropical smallholder farmers operating under low-external-input (LEI) conditions rely upon non-intensive on-farm or locally available inputs for agricultural production; however, conventional resources are limited in the tropics and there is sparse data regarding the sustainability of tropical LEI agroecological systems. The primary objective of these studies is to develop tropical cover crop technologies for use as surface mulch in minimum-till vegetable systems to provide alternative weed management strategies and ensure competitive vegetable yields. Cover crop cultural practices including species selection, seeding date and termination strategies, and the manner in which they influence weed diversity and density as well as vegetable crop yield and quality are the primary issues to define. Vegetable system research conducted in three subtropical/tropical locations (Florida, Puerto Rico, and the U.S. Virgin Islands) has resulted in several key lessons concerning LEI systems. Successful systems are associated with: 1) cover crop species selection that do not exhibit post-termination regrowth traits; 2) significant cover crop surface mulch that is retained throughout the vegetable crop season; and 3) a reduction in weed establishment leading to reduced weeding frequency. Limitations to the system include a limited number of cover crop species that respond to roller-crimper termination and the overall additional management effort required relative to traditional vegetable systems.

Specified Source(s) of Funding: SR-SARE

(321) The Guam Plant Extinction Prevention (GPEP) Program for Saving Rare Plants in Guam

James McConnell*
University of Guam, Mangilao; mcconnel@uguam.uog.edu

The US Forest Service supported the planning development of the Guam Plant Extinction Prevention (GPEP) program with two grants awarded in 2011 and 2013. This Program is being developed jointly with the Guam Department of Agriculture Forestry & Soil Resources Division and the University of Guam with collaboration of the Hawaii Department of Land & Natural Resources and Hawaii Plant Extinction Prevention program. The main objective of the program is to protect and restore rare plants in Guam’s natural forests. The Guam Rare Plant Restoration Group (GRPR), the advisory body of the program was formed to support the program. The members consist of botanists, environmentalists and conservationists from the private sector, US and local agencies, and military bases. A poster and a brochure on GPEP were created for public education and outreach program to support Guam’s forest biodiversity protection. The program
An asterisk (*) following a name indicates the presenting author.

Specified Source(s) of Funding: USDA, Forest Service

(393) Propagation of the Fruit Crop Artocarpus altilis by Root Cuttings of Various Lengths and Diameters

J. Pablo Morales-Payan*
University of Puerto Rico-Mayaguez Campus; morales.payan@upr.edu

Artocarpus altilis is a tropical fruit crop of increasing importance in Puerto Rico. The plant is commonly propagated by root cuttings, but little research has been conducted in the island to determine the influence of root cutting length and diameter for A. altilis transplant production. Experiments were conducted in Mayaguez, Puerto Rico, to evaluate various lengths (10, 15, 20, 25, 30, and 40 cm) and diameters (1.25, 2.50, 3.75, and 5.00 cm) of root cuttings from two selections from Puerto Rico (PR 1 and PR 2) on sprouting and growth for transplant production in the nursery. Roots were separated from the mother trees, cut to the desired length and separated by diameter. The resulting root cuttings were placed horizontally in plastic containers filled with a sphagnum-based growing medium and irrigated daily. Sprouting, shoot height, and leaf number were determined every two weeks for 6 months. There were no significant differences in the results between A. altilis selections. Root cuttings 1.25 cm in diameter and 10 or 15 cm in length generated very few plants that did not survive in the nursery long enough to produce transplants. Root cuttings 40 cm-long tended to sprout faster but produced several shoots that competed among themselves slowing their vertical growth. Root cuttings 2.5 to 5 cm in diameter and 15 to 20 cm in length tended to sprout fast and to have greater shoot length and leaf number, with the highest rate of success in producing transplants for orchards.

Specified Source(s) of Funding: The project was supported by the Small Business Innovation Research program of the U.S. Department of Agriculture, grant number 2012-33610-19526.

(375) Compost for High Tunnel Tomato Production

Kate Marshall
University of Maine, Orono; Kathleen_Marshall@umit.maine.edu

Susan Erich
University of Maine, Orono; erich@maine.edu

Mark Hutton*
University of Maine, Monmouth; mark.hutton@maine.edu

Mark Hutchinson
University of Maine, Waldoboro; mhutch@maine.edu

Ellen Mallory
University of Maine, Orono; ellen.mallory@maine.edu

High tunnel use for tomato cultivation is on the rise in the northeastern United States. Use of high tunnels both extends the growing season and increases yield. Compost is frequently used in high tunnel tomato production to supply nutrients and improve soil quality. While various studies have looked at the use of compost in field soils, fewer studies have assessed the

Tuesday, July 29, 2014

Vegetable Crops Management 2

(374) Nutritionally Important Pigments in Baby Chinese Kale Are Higher Under Narrow Band LED Light than Under Fluorescent/Incandescent Lighting in Controlled Environments

Dean A. Kopsell*
University of Tennessee, Knoxville; dkopsell@utk.edu

Carl E. Sams
University of Tennessee, Knoxville; carlsams@utk.edu

Robert C. Morrow
ORBITEC, Madison, WI; morrowr@orbitec.com

Narrow-band wavelengths of light from light-emitting diodes (LED) can improve nutritional quality parameters in specialty vegetable crops. Work by our group has demonstrated the ability to increase brassica microgreen shoot tissue pigments using short and long-term exposure to LED light with higher percentages of blue wavelengths. The objectives of this study were to measure the impacts of: 1) different percentages of blue LED light; and 2) different levels of nutrient fertility on the concentrations of nutritionally important pigment in Chinese kale (Brassica oleracea var. alboglabra L.) grown to the 30-d baby greens stage. A comparison of kale pigment responses between incandescent/fluorescent light and LED light was also conducted. ‘Green Lance’ Chinese kale was grown hydroponically in controlled environments under the light treatments of: 1) fluorescent/incandescent light; 2) 10% blue/90% red; 3) 20% blue/80% red; and 4) 40% blue/60% red wavelengths from LEDs. The growing air temperature was set at 22 °C with a 16-h photoperiod using a light intensity of 250 µmol·m-2·s-1 for all light treatments. Plants within light treatments were cultured in either a ½ strength or a ¼ strength Hoagland’s #2 nutrient solution. Three complete experimental runs were conducted. All plants were harvested 30 d after seeding and analyzed for nutritionally important shoot pigments. Kale under the fluorescent/incandescent light treatment had significantly higher shoot fresh and dry mass compared to plants under all other LED light treatments. Shoot tissue violaxanthin, neoxanthin, antheraxanthin, lutein, beta-carotene, chlorophyll a, and chlorophyll b concentrations were significantly lower under the fluorescent/incandescent light treatment. Higher fertility levels resulted in higher shoot tissue concentrations for most of these same pigments. Results from the current study support previous data showing stimulation of nutritionally important shoot tissue pigment concentrations following exposure to higher percentages of blue light wavelengths from LEDs.

Specified Source(s) of Funding: The project was supported by the Small Business Innovation Research program of the U.S. Department of Agriculture, grant number 2012-33610-19526.
effectiveness of compost in high tunnels, where both temperature and soil moisture may be relatively high. In this experiment, four finished composts from commercial producers in Maine were analyzed for nutrient content, pH, conductivity, lignin, and soluble C. A randomized complete block design with four replications was used to compare the four compost treatments with an unamended control and a control receiving inorganic nutrient in a field study. Composts were all added at the rate of 270 lb. of total N per acre, while inorganic fertilizer was added at the rate of 100 lb. of N per acre. Tomatoes were grown in these treatments in cemented tunnels at the Maine Agricultural and Forest Experiment Station in Monmouth, ME during the summer of 2013. Soil nitrate (NO$_3^-$), ammonium (NH$_4^+$), and moisture were measured throughout the growing season, along with total marketable tomato yield and tomato N uptake at the end of the season. Composts had significantly different properties. Compost treatments affected early season soil NO$_3^-$ and NH$_4^+$, and total marketable yield. Composts with high levels of inorganic N produced higher total marketable yields.

**Specified Source(s) of Funding:** Maine Agriculture Center

**(376) Effect of Compost Application Rates on High Tunnel Tomato Yield**

Mark Hutton*
University of Maine, Monmouth; mark.hutton@maine.edu

Mark Hutchinson
University of Maine, Waldoboro; mhutch@maine.edu

David Handley
University of Maine, Monmouth; david.handley@maine.edu

Compost application has become a cornerstone of soil health and soil improvement practices on many farms in the Northeast, particularly in high tunnels. However, the lack of researched-based information on compost application rates has led to excessive applications of compost and resultant accumulations of phosphorus and salts in the soil. High compost rates have broad ranging effects on soil health and quality and may have significant impact on irrigation needs. For example, insufficient irrigation may lead to salt accumulation in the root zone of compost-amended soils. The objectives of this experiment were: 1) to investigate possible interactions between irrigation frequency and compost application rates; 2) develop baseline data for recommendations regarding compost application within high tunnels. The study employed two irrigation treatments: one designed to mimic “typical” grower practices (2–3 irrigation events per week lasting between 1 and 2 hours), and a second treatment to provide the equivalent of 1 acre inch of water to the crop split into 2 irrigation events per day. Five compost application rates: control (0 compost + N-P-K), 10, 20, 55, and 90 yd$^3$/acre were randomly assigned within each irrigation main plot. ‘Big Beef’ tomato seedlings were transplanted at 15” spacing. The plants were trellised and pruned to a single stem. Yield (number and weight of fruit graded as first, second and cull) was measured from the center four plants of each plot. At the end of the growing season, stem fresh and dry weights were recorded for each plant. No differences fruit yield were detected between irrigation treatments. Possibly due to the frequent high rainfall events which occurred through the summer. Fruit number was significantly lower in the 10 yd$^3$/acre compost treatment compared to the 20, 50 and control treatments. No significant differences were seen among the 20, 50, 90 yd$^3$ or control treatments. However, fruit number and weight were lower in the 90 yd$^3$ treatment compared to the 20 or 50 yd$^3$ treatments, suggesting an over-application of compost. These data indicate that compost application rates greater than 20 yd$^3$/acre have no additional beneficial effect on yield. This experiment will be repeated during the 2014 growing season.

**Specified Source(s) of Funding:** USDA

**(377) Antioxidant Content of Pepper Grown in Recycled Waste**

George Antonious*
Kentucky State University, Frankfort; george.antonious@kysu.edu

Peppers, a significant component of the human diet in many regions of the world, provide vitamins A (β-carotene) and C, and are also a source of many other antioxidants such as capsaicin, dihydrocapsaicin, and phenols. Enhancing the concentration of antioxidants in plants grown in soil amended with recycled waste has not been completely investigated. Changes in pepper antioxidant content in relation to soil amendments and fruit development were investigated. The main objectives of this investigation were to: i) quantify concentrations of capsaicin, dihydrocapsaicin, β-carotene, ascorbic acid, phenols, and soluble sugars in the fruits of *Capsicum annuum* L. (cv. Xcatic) grown under four soil management practices: yard water (YW), sewage sludge (SS), chicken manure (CM), and no-much (NM) bare soil and ii) monitor antioxidant concentrations in fruits of plants grown under these practices and during fruit ripening from green into red mature fruits. Total marketable pepper yield was increased by 34% and 15% in SS and CM treatments, respectively, compared to NM bare soil; whereas, the number of culls (fruits that fail to meet the requirements of foregoing grades) was lower in YW compared to SS and CM treatments. Regardless of fruit color, pepper fruits from YW amended soil contained the greatest concentrations of capsaicin and dihydrocapsaicin. When different colored pepper fruits (green, yellow, orange, and red) were analyzed, orange and red contained the greatest β-carotene and sugar contents; whereas, green fruits contained the greatest concentrations of total phenols and ascorbic acid.

**Specified Source(s) of Funding:** USDA

**(378) Biostimulants Effects on Bell Pepper (*Capsicum annuum*) Plant Growth, Fruit Yield, and Incidence of Fruit Disorders**

Juan Carlos Diaz-Perez*
University of Georgia, Tifton; jcdiaz@uga.edu

Jesus Bautista
University of Georgia, Tifton; jesusb@uga.edu

An asterisk (*) following a name indicates the presenting author.
In this study, we examined the possible use of fatty alcohol as a technique applied for cucurbit rootstocks. It is found that fatty alcohol has been demonstrated as part of a grafting technique applied for cucurbit rootstocks. Axillary shoots (suckers) can be problematic because of the distance between the graft union and the soil line, potential grow-out of suckers from contacting the soil. For tomato, while grafting above the graft union has to be high to prevent the vulnerable scion from succumbing to stress during harvest time (spring) or during crop establishment (fall). Crop biostimulants have been shown to increase crop yield and quality under adverse environmental conditions. The objectives were to determine the effects of plant biostimulants on plant growth, and fruit yield and incidence of physiological disorders of bell pepper grown in spring and fall seasons. Study carried out at the University of Georgia, Tifton Campus, in the spring and fall of 2013. Experimental design was a randomized complete block with five treatments (biostimulants) and four replications. Biostimulants were abscisic acid (1000 ppm ABA); MaxCel (6-benzyladenine; 1 mL/L); Screen Duo (aluminum silicate; 15 g/L); seaweed (brown alga, Ascophyllum nodosum (Phaeophycaceae)) extract (5 g/L), and untreated control (UTC). Cultivars were Wild Cat (spring) and Islas Morada (fall). Fruit graded according to USDA standards and weighed to determine yields. Number of fruit with blossom-end rot (BER) and sunscald were recorded. In the spring, southern blight (caused by Sclerotium rolfsii) severely affected bell pepper crop causing high plant mortality. In the spring, plant stem diameter was lowest in ABA treatment; marketable yield was highest in ABA and lowest in UTC and seaweed treatments. Yield differences were attributed to differences in fruit number. In the fall, stem diameter was greatest in seaweed and aluminum silicate treatments, while marketable yield was not affected by biostimulant treatments. Individual fruit weight and incidences of blossom-end rot and sunscald were unaffected by biostimulants in both spring and fall seasons. Effect of biostimulants on plant growth and fruit marketable yield was inconsistent and depended on the season.

(379) Sucker Control of Tomato Seedlings by Fatty Alcohol Application

Tomomi Eguchi*
University of Arizona, Tucson; gogotomoppe@gmail.com

Chieri Kubota
University of Arizona, Tucson; akubota@ag.arizona.edu

Vegetable Grafting offers an alternative technology to fumigants to manage soil-borne diseases under open-field conditions. Given that grafted seedlings are transplanted by machines, the position of the graft union has to be high to prevent the vulnerable scion from contacting the soil. For tomato, while grafting above the rootstock cotyledons could be a solution to assure adequate distance between grafted union and soil line, potential grow-out of rootstock axillary shoots (suckers) can be problematic because of high labor cost to manually prune suckers. Fatty alcohol has been used to control sucker growth after decapitation in tobacco production and recently demonstrated as part of a grafting technique applied for cucurbit rootstocks. It is found that fatty alcohol kills only rapidly-dividing meristematic tissue in tobacco. In this study, we examined the possible use of fatty alcohol for sucker control of tomato seedlings (Solanum lycopersicum cv. ‘Roma VF’). We applied various concentrations (0%, 5%, 7.5%, 10%, 12.5%, 15%, 20%, or 30%) of commercially available fatty alcohol to the axillary meristematic region of three true-leaf stage tomato seedlings grown inside a greenhouse. Suckers were forced to develop by pinching the seedlings. We evaluated incidence of visible axillary bud/sucker development and degree of damage on seedlings on days 1, 7, 14, and 21 after pinching. Sucker incidence decreased with increasing concentration of fatty alcohol. The sucker incidence also increased over time except for at 0%. After 14 days of pinching, application of fatty alcohol at 15% or higher concentration significantly suppressed the percent sucker incidence below 10%. Twenty-one days after pinching, the sucker incidence was further increased in all concentrations, and the sucker incidence exceeded 10% except at the highest concentration of 30%. Damage on seedlings was mainly observed for cotyledons. The percentage of damage increased with increasing concentration of fatty alcohol, resulting in more than 10% damage at 12.5% or higher concentrations. Under a stereomicroscope, we observed that axillary meristems contacted by fatty alcohol turned brown and withered. This study showed that fatty alcohol effectively killed axillary meristems of tomato and might be a useful chemical tool to control sucker growth from tomato rootstocks. Further studies are currently underway to evaluate the influence of fatty alcohol application on grafting success as well as recurring rootstock adventitious shoot growth.

(380) An Investigation of Weed Suppression Using Various Pre-emergent Herbicide Treatments on a Direct-seeded, Field Grown Leaf Lettuce ‘Green Salad Bowl’ Crop

Kathryn Fontenot*
LSU AgCenter, Baton Rouge, LA; kkfontenot@agcenter.lsu.edu
Ron E. Strahan
LSU AgCenter, Baton Rouge, LA; rstrahan@agcenter.lsu.edu
Charles E. Johnson
LSU AgCenter, Baton Rouge, LA; cjohnson@agcenter.lsu.edu
J. Beasley
LSU AgCenter, Baton Rouge, LA; JBeasley@agcenter.lsu.edu

Commercial lettuce producers struggle with weed control in direct-seeded fields. Pre-emergent herbicides with the ability to control weeds without injuring the crop would be beneficial to producers. In this study, ‘Green Salad Bowl’ leaf lettuce was seeded into plots arranged in a randomized complete block with 4 replications three days prior to pre-emergent herbicide application. Precision single row push seeders were used to direct seed the crop. Plot size was 4 rows totaling 16 ft. x 20 ft. The 2 center rows were used to collect data. Eight treatments were evaluated for their potential weed control without suppression of lettuce growth. Treatments included: Pronamide at 1 lb/A and 2 lb/A rates. Pronamide is currently labelled for use in leaf lettuce production. Non-labeled herbicides were also evaluated, including Imazapic at 2oz/A, 4oz/A and 6oz/A rates and Imazethapyr at 6 fluid oz/A rate. An untreated weed-free control was included. The 2 center rows were used to collect data. Eight treatments were evaluated for their potential weed control without suppression of lettuce growth. Treatments included: Pronamide at 1 lb/A and 2 lb/A rates. Pronamide is currently labelled for use in leaf lettuce production. Non-labeled herbicides were also evaluated, including Imazapic at 2oz/A, 4oz/A and 6oz/A rates and Imazethapyr at 6 fluid oz/A rate. An untreated weed-free control was included. The 2 center rows were used to collect data. Eight treatments were evaluated for their potential weed control without suppression of lettuce growth. Treatments included: Pronamide at 1 lb/A and 2 lb/A rates. Pronamide is currently labelled for use in leaf lettuce production. Non-labeled herbicides were also evaluated, including Imazapic at 2oz/A, 4oz/A and 6oz/A rates and Imazethapyr at 6 fluid oz/A rate. An untreated weed-free control was included.

An asterisk (*) following a name indicates the presenting author.
check was maintained by weekly cultivation and an untreated check receiving no cultivation served as a control treatment. Herbicides were sprayed at the listed rates with a CO2 backpack sprayer delivering 15 GPA. Throughout the 78d study, lettuce germination rates and heights were recorded. Final lettuce fresh and dry weight was collected and statistically analyzed. Data were subjected to analysis of variance (P = 0.05) and means were separated using Fisher’s LSD. Plots treated with Pronamide at the 1 lb/A rate and 2 lb/A rate and the untreated weed-free check produced significantly more fresh and dry tissue weight than all other treatments. Although lettuce germinated and grew in the Imazapic and Imazethapyr treated plots, growth was severely stunted. Preliminary results suggest that Imazapic and Imazethapyr not be considered for pre-emergent weed control in direct seeded leaf lettuce as weed control was sufficient but lettuce growth was severely stunted. Additional research in a second season is warranted.

Tuesday, July 29, 2014

Undergraduate Student Poster Competition 2

(140) The Effects of Control Release Fertilizer Packets on Nutrient Leaching
Angie Fleurissaint*
Agroecology Program, Department of Earth and Environment, Florid International University, Miami, FL; afleu005@fiu.edu

Stewart Reed
USDA–ARS, Subtropical Horticulture Research Station, Miami, FL; stewart.reed@ars.usda.gov

Krish Jayachandran
Agroecology Program, Department of Earth and Environment, Florid International University, Miami, FL; jayachan@fiu.edu

Nutri-Pak is a slow release fertilizer in a micro-pore polyethylene packet where moisture enters the packet through micro-pores located on both sides of the packet. The pressure caused by heat and vapor, releases the dissolved fertilizer through the same micro-pores and into the soil gradually providing nutrients to plants for a year. The principle objective of this study is to compare the nutrients levels in leachate samples of Nutri-Pak to a control release fertilizer and a conventional granular product. The fertilizers used for this experiment includes Nutri-Pak (12-4-12), Harrell’s (controlled release 12-4-12), and Atlantic (8-4-12). Atlantic fertilizer was used as the control in this experiment. These fertilizers were applied to Chinese Fan (Livistona chinensis) and Queen (Syagrus romanzoffiana) palms based on each manufacturer’s recommendation. In order to measure the impact of fertilizer type on nutrient loss, leachate samples were collected after each scheduled irrigation. The mean values for N, P, and K leached from Nutri-Pak or Harrell’s were divided by control values for comparison. From pots containing Chinese Fans, Harrell’s lost 1.85 N, 2.59 P, and 1.88 K times that of the control. Nutri-Pak lost 0.08 N, 0.67 P, and 0.07 K times that of the control values. From Queen Palms, Harrell’s lost 2.52, 2.76, and 1.99 times the N, P, and K, respectively. Nutri-Pak lost 0.06, 0.35, and 0.12 times the N, P, and K, respectively. Subsequent leachate collections after 60 days indicated similar trends, however Nutri-Pak’s leaching potentials of N, P, and K were reduced. The ICP analysis showed least amount of Ca2+, Cu2+, Fe2+, Mg2+, Mn2+ and Zn2+ from Nutri-Pak compared to Harrell and conventional fertilizers. Experiment is in progress further evaluating these fertilizer types for recommendations. Specified Source(s) of Funding: USDA-NIFA- Multicultural Scholars Program 2011-38413-30118

(141) Teaching Elementary Age Students about Sustainable Food Production through a Successful Local School–University Student Club Partnership
Deanna Bayo*
University of Florida, Gainesville; dbayo@ufl.edu

Sam Hart
University of Florida, Gainesville; samehart@ufl.edu

Brandi Sadler
University of Florida, Gainesville; bsadler@ufl.edu

Xin Zhao
University of Florida, Gainesville; zxin@ufl.edu

Public understanding of sustainable food production is poor, and many people are unaware of where their food comes from and the multifaceted nature of the horticulture industry. Research suggests that specific horticultural/agricultural programs in primary schools carried out in partnerships with universities lead to increased understanding of food production and ultimately increased student enrollment in university horticultural science courses. As an outreach program of the Organic and Sustainable Agriculture Club at the University of Florida, we developed a combination of lesson plans and workshops for second grade students that focused on sustainable crop production systems with a hands-on component. These second graders were given the opportunity to identify seeds and vegetables, transplant seedlings, observe composting techniques, and learn about nutritive values of fruit and vegetables. Worksheets were also provided to students to gauge knowledge gained during the course of the lessons. Observations suggest that students gained significant knowledge of sustainable food production systems due to the diverse exercises designed for the lessons. Students were able to successfully define sustainability, identify the basic needs of a plant, and provide examples of ways in which horticultural systems can be more sustainable, when previously unable to do so before the lessons. These second grade students expressed great enthusiasm toward gardening, and several students began composting and gardening projects at home. This local school–university student club partnership turned out to be a success in increasing awareness of sustainable food systems and fostering an interest in horticultural production among elementary students. The elementary school teachers expressed strong interest in strengthening this unique partnership in the future. This outreach program also helped recruit members to
the Organic and Sustainable Agriculture Club and engage the club members in pursuing more opportunities for community educational projects. We are continuing this program, with a propagation workshop and a tour of a local sustainable farm planned. This program will serve as a template for our club to continue their outreach efforts in horticultural sustainability to elementary school children.

(142) Iowa State University Heritage Tree Program: Preserving the Genetic Heritage of Iowa State’s Award-winning Campus
Jonathan D. Mahoney*
Iowa State University, Ames; jmahoney@iastate.edu
Frank D. Balestri
Iowa State University, Ames; balestri@iastate.edu

Iowa State University’s campus landscape has attracted students, faculty, alumni, and visitors, since the university was founded in 1858. The 490-acre central campus features historical trees that either predate the institution or were planted as the campus was established. Many historical specimens of trees are approaching the end of their life spans or have developed structural faults that represent safety hazards. The objective of this project, supported by the Bob and Eileen Martin Heritage Tree Fund, is to preserve the genetic heritage of the campus landscape by: 1) identifying historical tree specimens, 2) collecting seeds or other plant parts that can be used to propagate, and 3) establishing progeny on campus and distributing excess young trees to alumni and supporters of Iowa State. Specimens of interest include northern catalpa (Catalpa speciosa), swamp white oak (Quercus bicolor), black maple (Acer nigrum), ginkgo (Ginkgo biloba), katsuratree (Cercidiphyllum japonicum), eastern redbud (Cercis canadensis), and sycamore (Platanus occidentalis). We have collected seeds and have determined how they must be treated to induce germination. Seeds of a notable specimen of northern catalpa that had grown near Pearson Hall for nearly 100 years before its removal were germinated in early 2013. Progeny of the historic catalpa were planted on campus in late 2013, and about 170 additional seedlings were sold to alumni and supporters in cooperation with the Iowa State University Alumni Association. A similar effort with a different species is supported by the Bob and Eileen Martin Heritage Tree Fund, and is to preserve the genetic heritage of the campus landscape by: 1) identifying historical tree specimens, 2) collecting seeds or other plant parts that can be used to propagate, and 3) establishing progeny on campus and distributing excess young trees to alumni and supporters of Iowa State. Specimens of interest include northern catalpa (Catalpa speciosa), swamp white oak (Quercus bicolor), black maple (Acer nigrum), ginkgo (Ginkgo biloba), katsuratree (Cercidiphyllum japonicum), eastern redbud (Cercis canadensis), and sycamore (Platanus occidentalis). We have collected seeds and have determined how they must be treated to induce germination. Seeds of a notable specimen of northern catalpa that had grown near Pearson Hall for nearly 100 years before its removal were germinated in early 2013. Progeny of the historic catalpa were planted on campus in late 2013, and about 170 additional seedlings were sold to alumni and supporters in cooperation with the Iowa State University Alumni Association. A similar effort with a different species is anticipated in 2014 and annually thereafter.

Specified Source(s) of Funding: URECA Grant

(144) Interaction of e-Brassinolide and Unicanzole on the Salt Stress in Two Cultivars of Sweetpotato
Devi Prasad V. Potluri*
Chicago State University, Chicago, IL; vpotluri@csu.edu
Ashvi Patel
Chicago State University, Chicago, IL; apatel26@csu.edu

Brassinosteroids are growth regulators that enhance plant growth and development. While natural brassinosteroids are not yet reported from many plants including sweetpotatoes, external application of brassinosteroids is shown to alleviate abiotic stress in plants. Unicanzole [UCZ], a fungicide, blocks the synthesis of naturally occurring brassinosteroid biosynthesis. The present work has been carried out to confirm the effects of external supply of brassinosteroids on alleviating the salt stress in sweetpotato and to examine if unicanzole reverses

Song Cui
Middle Tennessee State University, Murfreesboro, TN; song.chui@mtsu.edu

Synsepalum dulcificum (Miracle Berry), is an evergreen tropical shrub, native to the West Africa region, and is known for its taste modifying properties. The berry contains a homodimeric glycoprotein called miraculin that binds to the taste receptors and converts sour stimuli to sweetness. Little research has been conducted on the production requirements of this plant due to its current lack of popularity as a horticultural crop. In our earlier research, germination percentage, rate, and uniformity in response to scarification and seed coat removal were evaluated. Seedlings resulting from that project produced anywhere from 1 to 4 shoots branching out from the seed. Shoot number data was collected from all 127 seedlings at 75, 82, and 110 days post-emergence. Removing seed coats prior to germination resulted in a significantly higher rate of seedlings with multiple shoots (37.4%) compared to seedlings germinated from intact seeds (8.7%) and seeds scarified with sulfuric acid (2.6%). Seedlings with varying numbers of shoots were selected and transplanted into various media ratio mixtures to evaluate the effects of different media on plant growth. The first ratio was a 2:1 ratio of sphagnum peat moss and perlite. The second ratio was 1:1 ratio of perlite and sphagnum peat moss. The third ratio was a 1:1 ratio of sphagnum peat moss and ground pine bark. The fourth was a 1:1 ratio of perlite and ground pine bark. All treatments were provided a standard fertilizer regime. The Virginia Tech Pour-thru method was used every two weeks to assess nutrient uptake and media pH changes. Relative growth rates were calculated every 4 weeks. The health and productivity was assessed using a Li-Cor portable CO₂ and water vapor infrared gas analyzer. This equipment measures ET and plant net photosynthesis. Plants grown in the different media treatments differed significantly in growth. These results provide growers with practical information regarding propagation and growth of this potential crop.

Specified Source(s) of Funding: Bob and Eileen Martin Heritage Tree Fund

(143) Evaluation of (Synsepalum dulcificum) Growth and Productivity in Response to Media Formulation
Carly M. Schall*
Middle Tennessee State University, Murfreesboro, TN; cms6t@mtmail.mtsu.edu
Nathan C. Phillips
Middle Tennessee State University, Murfreesboro, TN; nate.phillips@mtsu.edu

An asterisk (*) following a name indicates the presenting author.
these effects. Two cultivars of sweetpotato [Ipomoea batatas L.] Salybоро and Commensal were used and the experiments. Experiments were carried under in vitro conditions using nodal cultures. We confirm our previous studies that e-Brassinolide has a positive effect on reducing the salt stress effects. UCZ inhibited the root growth, leaf chlorophyll and shoot height and reversed some of the positive effects of e-Brassinolide. These results will be discussed in relation to possible use of brassinosteroids as growth regulators for sweetpotato.

(145) Effects of Nutrient Salt Formulations and 6-Benzylaminopurine on Micropropagation of ‘Blue Moon’ Wisteria

Nathan Jahnke*
North Dakota State University, Fargo; nathan.j.jahnke@my.ndsu.edu
Todd P. West
North Dakota State University, Fargo; todd.p.west@ndsu.edu

Wisteria frutescens var. macrostachya ‘Blue Moon’, a Kentucky Wisteria, is a flowering vine native to the United States. W. frutescens var. macrostachya is probably the hardiest of the wisteria and ‘Blue Moon’ is one of the two hardiest cultivars in Zone 4 to 8(9). ‘Blue Moon’ is great addition to a landscape as a fast growing vine, which has long purple racemes during the spring. Although it is hardy, ‘Blue Moon’ does not have the profuse blooming that many species of wisteria have. Also, wisteria grows very quickly making sometime invasive and looking unkept. When grown from seed it might not bloom for 10 years, making breeding a challenging, long-term commitment. Because of its hardness it is of interest to improve this species in terms of flowering and dwarfing or slowing growth. Currently there is no published micropropagation protocol for Wisteria. The objective of this study was to establish a micropropagation protocol for ‘Blue Moon.’ A 4 x 5 factorial of four nutrient salt formulations (MS, WPM, DKW, and LP) and six concentrations of 6-benzylaminopurine (BA) (0, 2, 4, 8, 16 µM) were used to determine shoot growth and shoot proliferation of viable microshoots. Bud explants were 5mm in length and initiated into cultures on the various factorial media plus 30g/l sucrose and 7g/l agar at a pH of 5.8. Explants were incubated approximately 30 cm beneath cool white fluorescent lamps that provide a photon flux of approximately 30 mmol·m⁻²·s⁻¹ for a 16-h photoperiod at 25 ± 3 °C. Nodal explants were transferred every 6 weeks for a total culture period of 12 weeks. At each transfer date, data was taken on shoot number and propagation related to the precocity in mangaba. The mangaba tree (Hancornia speciosa Gomes-Apocinaceae) is a Brazilian native fruit tree of major social and economic relevance to the country’s northeastern coastline. The fruits are rich in vitamin C and have characteristic flavor greatly appreciated. Normally the time for the first fructification is five years. The specific genotype (CP2) of the Germplasm Bank of Embrapa Coastal Tablelands showed characteristics of precocity, with fruiting at 14 months. The objective of this study was to evaluate the genetic diversity among 18 genotypes of all ‘CP’ access, using ISSR for molecular identification of a marker associated with the precocity in mangaba. The use of eight ISSR primers resulted in 89% of polymorphism. We could not identify a specific marker, however, the CP2 presented 100% divergent from the other genotypes. The identification of genotypes with characteristics of interest and genetically divergent may contribute to strategies of conservation this germplasm and will contribute to development of breeding programs and commercial exploitation.

Wednesday, July 30, 2014

Genetics and Germplasm 3

(217) Breeding for Improved Germination Under Water Stress in the Russian Dandelion

Katrina Hodgson-Kratky*
University of Guelph, Guelph, ON; katrina@uoguelph.ca
David Wolyn
University of Guelph, Guelph, ON; dwolyn@uoguelph.ca

The Russian dandelion (Taraxacum kok-saghyz Rodin) is a promising candidate for introducing natural rubber production into North America; however, the plant must be domesticated before it can be cultivated. Germination in Southwestern Ontario is only 10% to 30% due to a lack of adaptation for establishment on bare soil where water stress can occur. Phenotypic and half-sib family selection were compared for improving germination under low water potential, where seeds were incubated in a polyethylene glycol solution. After one cycle of half-sib or phenotypic recurrent selection, percent germination increased 128.5% and 2.8%, and time to 10% germination decreased 14.3% and 18.3%, respectively. Thus, recurrent selection has potential to improve germination under water stress in the Russian dandelion, and half-sib family selection provided better overall gain compared to phenotypic selection. Additional breeding cycles and assessment of germination under field conditions will be critical for

An asterisk (*) following a name indicates the presenting author.
developing a method to improve this crop.

(218) QTL Analysis for the Identification of Loci Controlling Antioxidant Capacity in *Brassica oleracea* L. var. *italica*

Alicia M. Gardner*
University of Illinois at Urbana-Champaign; agardmr2@illinois.edu

Kang Mo Ku
University of Illinois at Urbana-Champaign; ku8@illinois.edu

Gad G. Yousef
North Carolina State University, Kannapolis; ggyousef@ncsu.edu

Allan F. Brown
North Carolina State University, Kannapolis; afbrown2@ncsu.edu

John A. Juvik
University of Illinois at Urbana-Champaign; juvik@illinois.edu

This research has identified regions of genetic control over the antioxidant capacity of broccoli (*Brassica oleracea* L. var. *italica*). 92 F2:3 families from the mapping population BNC x VI1158 (Brown et al., 2007), grown in 2009 and 2010 in Salisbury, NC, were assayed for 2,2’-azino-bis(3-ethylbenzothiazoline-6-sulphonic acid) (ABTS) radical scavenging capacity and 2-Diphenyl-1-picrylhydrazyl (DPPH) radical scavenging capacity according the protocol described by Ku et al. (2010). Briefly, 75 mg of freeze-dried tissue was extracted with 1.5 mL of ddH2O for 24 hrs at room temperature. 10 µL of extract was added to 190 µL of ABTS or DPPH solution and incubated at room temperature for six minutes or thirty minutes, respectively. The radical-species extinction was measured spectrophotometrically against a Trolox standard curve. All tests were performed in triplicate. Multiple-QTL-mapping (MQM) analysis of the data for each year individually and the average of the two years was conducted in the software package MapQTL 5 using a step size of 0.5 cM. The LOD-score significance threshold was set at the 95% genome-wide confidence level, determined by permutation testing (1000 iterations), and a 1-LOD drop-off interval was used to determine QTL position. The linkage map used in this analysis was developed by Brown et al. (2014) using a 60K Illumina (single-nucleotide polymorphism) SNP array of *Brassica napus*, and was anchored to the genomic sequence of the rapid cycling *Brassica oleracea* T01000. It is a dense link-}

(219) Collard Landraces are Novel Sources of Glucoraphanin and other Aliphatic Glucosinolates

Zachary Stansell*
USDA–ARS, Charleston; zachary.stansell@ars.usda.gov

Mark W. Farnham
USDA–ARS, Charleston, SC; mark.farnham@ars.usda.gov

Wendy Cory
College of Charleston, Charleston, SC; coryw@cofc.edu

Glucosinolates form an important class of metabolites in *Brassicas* whose cognate isothiocyanates may provide chemoprotective effects in humans. Although certain *B. oleracea* crops have well documented glucosinolate profiles, collard (*Brassica oleracea* L. subsp. *oleracea* convar. *acephala* var. *viridis* L.) remains relatively unexplored. Recently, 86 neglected collard landraces were collected from the coastal plain region of the southeastern United States from seed savers and small farmers. In the last few decades, the diversity of cultivated collards has likely been diminished due to the wide scale adoption of a few commercial F1 hybrid cultivars. The objectives of this study were to: [a] compare glucosinolate profiles within collard cultivars against the of recently conserved collard landraces; [b] identify any accessions with a particularly distinct or abundant glucosinolate profile (i.e. elevated glucoraphanin); and [c] determine the potential of *Brassica oleracea* L. *viridis* as a target for chemoprotective based plant breeding. During the winter of 2010–11, 86 collard landraces and also four common commercial cultivars were evaluated in the field and harvested leaves assayed for glucosinolates. In a subsequent study, 19 selected landraces plus the cultivars were included in a repeat trial in the fall and winter 2012/2013. Average glucoraphanin content of leaves in the commercial cultivars in both environments was never found above a threshold of 1.83 µmol·g⁻¹ dry leaf-tissue weight and usually was undetectable. Among the collard landraces, 18 accessions contained detectable levels of glucoraphanin and three were found to repeatedly contain glucoraphanin in excess of 11 µmol·g⁻¹ DW under both growth environments. These landraces are rich sources of important glucosinolates, previously thought to be unique to broccoli.

(220) Integrating Genetics and Weed Management

Sarah E. Levy*
University of New Hampshire, Durham; sxz23@wildcat.unh.edu

Thomas M. Davis
University of New Hampshire, Durham; tom.davis@unh.edu

Weeds are a major problem on organic farms, where ecological weed management without the use of synthetic chemicals is challenging and strategically different from traditional farming practices. Impacts of invasive species and weeds are also expected to rise in response to climate change. In an effort to develop more efficient weed management strategies, we must gain a better understanding of the current biodiversity of these weed species. Ten of the most problematic weed species in...
Northern New England (NNE) were selected for genetic analysis based on a survey of organic farms in NNE. Genetically, little is understood about the weeds that inhabit NNE, their patterns of evolutionary change, or their responses to environmental selection pressures. Developing strategies to both predict and reduce the impact of invasive weeds will help farmers save money and resources in weed management. The objectives of this research are to: 1) Genetically characterize problematic weed species of interest in NNE; and 2) Assess the biodiversity among and within weed species at multiple sites in NNE. Genome size is being determined using flow cytometry procedures to calculate the C value(s) of each species. Genetic variation within each species is being measured using high-throughput genotyping. Collaborative efforts with the University of Maine and University of Vermont will also use these genetic results to correlate genetic biodiversity with seed bank and climate data analysis. Results from this research will help move the field of ecological weed management forward by gaining a better understanding of the genetic structure and potential for evolutionary success of current weed populations in NNE.

Specified Source(s) of Funding: Funding for this work is provided by the New Hampshire Agricultural Experiment Station as part of the Northern New England Collaborative Research Funding Program.

**Cryopreservation Protocols Using Aluminium Plates, V Cryo-plate and D Cryo-plate Method**

Takao Niino*
Gene Research Center, Univ. of Tsukuba, Tsukuba; niino.takao.fp@u.tsukuba.ac.jp

Wunna U
Gene Research Center, Univ. of Tsukuba, Tsukuba; yarwunnathwin@gmail.com

Kazu U Watanabe
Gene Research Center, Univ. of Tsukuba, Tsukuba; nabechan@gene.tsukuba.ac.jp

Tariq Rafique
National Institute of Agrobiological Sciences (NIAS), Tsukuba; tariqrafiq@affrc.go.jp

Shin-ichi Yamamoto
National Institute of Agrobiological Sciences (NIAS), Tsukuba; shiyam@affrc.go.jp

Kuniaki Fukui
National Institute of Agrobiological Sciences (NIAS), Tsukuba; fukuik@affrc.go.jp

Carlos R. Castillo-Martinez
National Genetic Resources Center, National Forestry, Crops and Livestock Research Institute, Tepatitlan de Morelos; castillo.carlos@inifap.gob.mx

Esmeralda J. Cruz Gutierrez
National Genetic Resources Center, National Forestry, Crops and Livestock Research Institute, Tepatitlan de Morelos; cruz.esmeralda@inifap.gob.mx

Miriam Valle-Arizaga
National Genetic Resources Center, National Forestry, Crops and Livestock Research Institute, Tepatitlan de Morelos; valle.miriam@inifap.gob.mx

Toshikazu Matsumoto
Faculty of Life and Environmental Science, Shimane Univ., Matsue; tmatsumoto@life.shimane-u.ac.jp

Cryopreservation protocols using aluminium plates were successfully developed by our team. The size of an aluminum cryo-plate used is 7 mm × 37 mm × 0.5 mm with 10 to 16 wells fitting in 2 ml cryotube. The cryo-plates were custom-made by Taiyo Nippon Sanso Corp. Tokyo, Japan. The cryopreservation protocols developed using this cryo-plate are V cryo-plate method based on PVS2 dehydration of explants on the plates, and D cryo-plate method based on air dehydration. These procedures include the following steps: preparation of material to be cryopreserved, preconditioning, excision, preculture, mounting the shoot tips on cryo-plate, osmoprotection, dehydration, storage and regeneration. Both methods are efficient, ensure rapid cooling and warming rates, and reduce damage to explants before cryopreservation by attached shoot tips on cryo-plate. Also, they were developed with the aim of limiting the problems linked to operator skills and simplifying the procedure. The V cryo-plate method have been adapted to several plants, such as mint, dalmatian chrysanthemum, carnation, mulberry, mat rush and potato with high regrowth rates after cryopreservation. The D cryo-plate method have been adapted mat rush and mulberry. Both are a very practical cryopreservation methods now, appearing to be promising for the cryopreservation of other plants with a slight modification of the procedure. The V cryo-plate method and D cryo-plate method are complementary to each other. Cryopreservation using cryo-plate will facilitate large scale cryostorage of plant genetic resources with uniform and healthy materials. This research was partially supported by JST/JICA, SATREPS.

Specified Source(s) of Funding: JST/JICA, SATREPS

(222) Cryopreservation of Blueberry Dormant Shoot Tips Using V Cryo-plate Method

Toshikazu Matsumoto*
Shimane University, Matsue; tmatsumoto@life.shimane-u.ac.jp

Shin-ichi Yamamoto
National Institute of Agrobiological Sciences, Tsukuba; shiyam@affrc.go.jp

Kuniaki Fukui
National Institute of Agrobiological Sciences, Tsukuba; fukuik@affrc.go.jp

Takao Niino
University of Tsukuba, Tsukuba; niino.takao.fp@u.tsukuba.ac.jp

Cryopreservation of dormant buds of blueberry (Vaccinium virgatum) at –196 °C using V cryo-plate method was investigated. Blueberry was mainly used as the experimental material. Dormant twigs of blueberry were collected from Shimane University orchard in winter and stored at 2 °C. After the surface sterilization,
shoot tips about 1 mm size were dissected from the dormant buds and precultured overnight at 25 °C on solidified 1/4 MS medium containing 0.3 M sucrose. Precultured shoot tips were embedded in calcium alginate gel on aluminium cryo-plates. Osmoprotection treatment for the shoot tips was performed by immersing the cryo-plates for 30 min at 25 °C in a LS solution (2 M glycerol plus 0.6 M sucrose in 1/2 MS). Then the shoot tips on aluminium cryo-plates were treated with PVS2 solution for different duration 25 °C, cooling was performed by placing the cryo-plates in uncapped cryotubes, which were immersed in liquid nitrogen. For rewarming, cryo-plates were immersed in 1/2 MS with 1.0 M sucrose for 20 min at room temperature. The highest survival (84%) after cryopreservation was obtained in shoot tips dehydrated for 30 min by PVS2. The V cryo-plate procedure was applied to 10 additional cultivars of blueberry. The V cryo-plate procedure may facilitate cryostorage of blueberry germplasm.

Specified Source(s) of Funding: Ministry of Agriculture, Forestry, and Fisheries of Japan (Genomics-based Technology for Agricultural Improvement, CRS-1001)

(223) Effect of Time in Cryoprotectant Solution and Dehydration in Shoot Apex Regeneration of Genipap for Cryopreservation

Ana S. Ledo
EMBRAPA, ARACAJU; ana.ledo@embrapa.br
Francielen Paola Sá
EMBRAPA, ARACAJU; francielenpaola@yahoo.com.br
Ana Veruska Cruz Silva
EMBRAPA, ARACAJU; ana.veruska@embrapa.br
Marina F. Vitória*
EMBRAPA, Aracaju; marina_fv@hotmail.com
Josué Francisco Silva Junior
EMBRAPA, ARACAJU; josue.francisco@embrapa.br
Fernanda Vidigal Duarte Souza
EMBRAPA, Cruz das Almas; fernanda.souza@embrapa.br

Genipa americana L. is native and cultivated throughout the Neotropics, from Mexico to Patagonia and is a source of products widely used by humans, such as in ornamentals, food, medicine, and a popular herbal medicine. The conservation of genetic resources of this species has great relevance to breeding programs and maintenance of genetic diversity. Thus, this study aimed to evaluate different times of immersion in cryoprotectant solution and time of dehydration in a laminar flow in the regeneration of shoot tips of G. americana for the purpose of long-term conservation. Were used apexes encapsulated in alginate, they were immersed for 24 and 48 hours in 0.5 M sucrose and dehydrated for 0; 2 and 4 hours in a laminar flow then were inoculated on regeneration medium MS supplemented with 30 g/L sucrose, and 1 mg/L BAP, gelled with 4.5 g/L Phytagel®. After 30 days of culture were assessed the percentage of regeneration, number of shoots issued, the length of the largest shoot and number of leaves / shoot apex of genipap. The immersion in cryoprotectant solution of 0.5 M sucrose and dehydration in a laminar flow does not modify the viability of encapsulated shoot tips of genipap. Immersion for 24 hours in cryoprotectant solution of 0.5 M sucrose and dehydration for 2 hours in a laminar flow has potential for use in future studies of cryopreservation by encapsulation–dehydration of genipap.

(224) Effect of Different Procedures and Time Storage on the Contamination of Zygotic Embryos for the Purpose of Exchange of Coconut Germplasm

Ana S. Ledo
EMBRAPA, ARACAJU; ana.ledo@embrapa.br
Caroline A. Machado
EMBRAPA, ARACAJU; caroline_machado866@hotmail.com
Francielen Paola Sá
EMBRAPA, ARACAJU; francielenpaola@yahoo.com.br
Semiramis R.R. Ramos
EMBRAPA, ARACAJU; semiramis.ramos@embrapa.br
Ana Veruska Cruz Silva
EMBRAPA, ARACAJU; ana.veruska@embrapa.br
Marina F. Vitória*
EMBRAPA, Aracaju; marina_fv@hotmail.com

Southeast Asia is the main reference point as the center of origin and diversity of Coconut palm (Cocos nucifera L.), and its cultivation has spread to Latin America, Caribbean and Tropical Africa. Currently, coconut palm is grown in over 200 countries. The conservation and management of coconut genetic resources include target collection, maintenance of field collections, characterization and identification, information management and effective and safe exchange germplasm. The aim of this study was to evaluate the effect of different procedures for packaging and storage time on the contamination of coconut zygotic embryos. The following treatments were applied to Cameroon Red Dwarf (CRD), Malayan Yellow Dwarf (MYD) and Malayan Red Dwarf (MRD) accessions; T1- endosperm disc storage at 10 ± 2 °C for 5 days; T2- endosperm disc storage at 10 ± 2 °C for 8 days; T3- disc storage 10 ± 2 °C 1 for 12days (before de embryo excision and inoculation in the Y3 culture medium); T4- individual zygotic embryo inoculated in the Y3 culture medium and storage in the Eppendorf 5 mL and after 2 days transferred to Y3 cultured medium; T5- five zygotic embryos inoculated in Y3 culture medium in the Petri dish and after 2 days transferred to Y3 culture medium. There wasn’t a significant effect of accessions (and treatments in the fungal contamination at 30 days after inoculation; however for the bacterial contamination was significant differences between accessions and treatments. The MDR accession showed higher bacterial contamination (27%) compared with CRD (11%) and MYD (5%) accessions. The zygotic embryos submitted to T4 presented less bacterial contamination (3.33%) compared with the others.

Specified Source(s) of Funding: EMBRAPA, COGENT/Bioversity, FAPITEC

An asterisk (*) following a name indicates the presenting author.
(225) Mid-term In Vitro Preservation in Minimum Growth Condition of Wild Chayote (Sechium compositum Donn.Sm.)

Carlos R. Castillo-Martinez
National Genetic Resources Center, Crops and Livestock Research Institute, Tepatitlan de Morelos; carlos.carlos@inifap.gob.mx

Jorge Cadena-Iniguez
Colegio de Postgraduados, Texcoco; jocadena@colpos.mx

Miriam Valle-Arizaga
National Genetic Resources Center, Crops and Livestock Research Institute, Tepatitlan de Morelos; valle.miriam@inifap.gob.mx

Carlos H. Avendano-Arrazate
Interdisciplinary Research Group of Sechium edule (GISeM), Taxcoco; avendano.carlos@inifap.gob.mx

Takao Niino*
University of Tsukuba, Tsukuba; niino.takao.fp@u.tsukuba.ac.jp

Mexico is the origin center of chayote, which has cultivated species (Sechium edule) and wild species (Sechium compositum). This crop has a recalcitrant seed which make impossible preservation in conventional seed storage protocol in genebank, because of high wather content, doesn’t resist desiccation or –20 °C storage temperatures, losing viability in short period of time. Because of this biological characteristics, the preservation is conducted by the National Genebank of Sechium edule (BANGESe) in Huatusco, Veracruz, Mexico, through field genebanks. However, this preservation techique has some risks for the accessions, it can be affected by natural desasters, plagues and other plant disseases. In vitro storage by slow growth method is an important alternative and commonly used to complement field genebank. Slow growth techniques allow clonal plant material to be stored under tissue culture conditions with extended subculture intervals under reduced growth conditions, resulting minimizing the manipulation, subculture and cost for the conservation. The purpose of this project is to establish the optimal minimum growth conditions for the mid-term in vitro preservation for Sechium compositum. The experiment had different variables evaluated: room temperature (12 °C, 18 °C, 24 °C), and combination of sucrose and manitol concentrations (0 and 60, 10 and 30, 15 and 20, 20 and 15, 25 and 10, 30 and 5, 60 and 0 g/L, respectively) with a MS media culture during 180 days. The evaluations showed significative differences in the growth range of the shoots as an effect for combination of all the variables, the most successful temperature observed was 18 °C and best treatment was the combination of sucrose 15 g/L and manitol 15 g/L. With this condition, the shoots can be preserved without subculture or new media culture by 9 months in the storage room. Lower temperature or higher manitol concentration caused damage on the tissue and eventualy death in only 45 days. In conclusion, the storage room temperature at 18 °C and the modificado media culture above allows longer preservation periods in accessions of wild chayote Sechium compositum, this opens an opportunity for the mid-term preservation of chayote accesiones in the genebank. This research was partially supported by JST/JICA, SATREPS.

Specified Source(s) of Funding: JST/JICA, SATREPS

(226) Mid-winter Cold Hardiness of Corylus fargesii Germplasm As Determined in Laboratory Freezing Tests

Anthony S. Aiello
Morris Arboretum, Philadelphia, PA; aiello@upenn.edu

Joseph Rothleutner
The Morton Arboretum, Lisle, IL; jrothleutner@mortonarb.org

Steve McNamara
University of Minnesota, Excelsior, MN; mcnam004@umn.edu

Stan C. Hokanson*
University of Minnesota, St Paul; hokan017@umn.edu

Farges filbert [Corylus fargesii (Franch.) C.K. Schneid.] is a large tree [to 130’(39.6 m)] that is native to China where it occurs in mountain valleys in the east/central part of the country. Described by western botanists in the late 19th century, the tree was little known in the west until it was collected under the auspices of the North American China Plant Exploration Consortium (NACPEC) in 1996 and again in 2005. The trees are characterized by a strong central leader, broad, ovate form, clean foliage, and an attractive exfoliating bark similar to river birch (Betula nigra L.). The species has been described as cold hardy to USDA Plant Hardiness Zone 5 [average minimum winter low temperature of –29 to –26 °C (–20 °F to –15 °F)] based on observations of seedlings originating from seed collected on the NACPEC expeditions now growing at several public gardens in North America. However, controlled testing of the mid-winter cold hardiness of the species has never been reported. Stem cold hardiness of 5 trees growing at the Morris Arboretum, (40 05'18"N; 75 13'16"W) and 4 trees from the Morton Arboretum (41 81'69"N; 88 06'88"W) were determined in laboratory freezer tests on February 1, 2013, and January 30, 2014 at the University of Minnesota Horticultural Research Center (HRC) in Excelsior, Minnesota. An established Corylus americana (American filbert) growing at the HRC was included in both years’ tests as a cold hardy standard and similarly, C. americana accessions from the Morris and Morton Arboretums were included in 2014. Of the nine C. fargesii accessiones tested in 2013, none were hardy beyond –30 °C (–22 °F) (USDA Plant Hardiness Zone 4b) while the C. americana accession suffered no damage at –36 °C (–33 °F) (USDA Plant Hardiness Zone 3b). In 2014, all of the Morton accessiones tested 2 °C to 4 °C hardier than in 2013, ranging from –30 °C to –32 °C (–22 to –26 °F) (USDA Plant Hardiness Zone 4b to 4a). Hardiness of the Morris accessions was more variable, ranging from –28 °C to –30 °C (–18 °F to –22 °F) (USDA Plant Hardiness Zone 5a to 4b). All three of the C. americana accessiones (HRC, Morris, and Morton) were undamaged at –36 °C (–33 °F) (USDA Plant Hardiness Zone 3b). While the laboratory test suggests C. fargesii will survive in USDA Plant Hardiness Zone 5 locations, field testing will be necessary to confirm these results.
Ornamentals/Landscape and Turf 2

(126) Evaluation of a Predetermined Fungicide Rotation for Control of Impatiens Downy Mildew in a Texas Landscape

H. Brent Pemberton*
Texas A&M AgriLife Res & Ext Center, Overton, TX; b-pemberton@tamu.edu

William R. Roberson
Texas A&M AgriLife Res & Ext Center, Overton, TX; w-roberson@tamu.edu

Impatiens ‘Impreza Red’ plants were established in 10 cm pots in a greenhouse for 5 weeks. During that time, a weekly fungicide rotation including Subdue® Maxx® plus Adorn® (week one), Dithane® plus Rainshield® (week two), MicoraTM plus Dithane® (week three), Heritage® (week four), and Vital® (week five) was applied to half the plants with the other half untreated. At the end of this period, field plots were prepared with half of the plots treated with Subdue GR. Greenhouse treated and untreated plants were then planted in factorial combination in field treated and untreated plots in early May. Full shade was simulated with 30% saran shade cloth over the field plots. One week after planting, impatiens plants that were infected with downy mildew and showing strong symptoms were planted in each field plot so that the disease pressure would be uniformly distributed. Plants were periodically rated for disease using a scale of 0 to 10 with 0 = no disease and 10 = very heavy spores on foliage with heavy leaf drop. In June, the disease was strongly evident on plants not treated in the greenhouse or field and nonexistent on plants with the other treatment combinations. Number of plants with crown rot was slightly higher for plants that did not receive any greenhouse treatment, but the differences were small. In early July, disease was still significant for the greenhouse/field untreated plants and minimal on the other treatments, but the level of disease had decreased greatly from the levels seen in June. No disease was observed in August on any of the plants. Crown rot increased from the June to the July counts and was highest for the greenhouse/field untreated plants. The decrease in IDM incidence during the summer was presumably due to the hotter and drier conditions that prevailed as the summer season advanced. Greenhouse or field treatments protected plants from downy mildew, though disease pressure decreased as the summer season progressed.

Specified Source(s) of Funding: This work was supported by Syngenta

(127) Evaluation of Ground Covers for Use in Guam Landscapes

James McConnell*
University of Guam, Mangilao; mcconnel@uguam.uog.edu

A collection of low growing native and exotic shrubs, forbs and grasses are being evaluated for an extended period for use as low maintenance ground covers in Guam landscapes. Plantings consist of nine plants of the same species planted in a gradient of three plant densities with three plants at each density. At the time of planting, water and fertilizer were applied but will be reduced as the plants establish and mature. Plants are first screened for aesthetic growth characteristics. The plant’s aesthetic characteristics are rated 1–5 on rating scale. Taxa are also screened for functional criteria including risk of invasiveness. Data collection includes measurements and ratings of survival, seasonal development, dates of flowering, and season-long aesthetic value assessment.

Specified Source(s) of Funding: USDA, Hatch

(128) Phytotoxicity of Herbicides, Fungicides, and Insecticides on Ornamental Monocot Species in Southeastern U.S. for Interregional Research Program (IR-4)

B.A. Fraelich*
USDA–ARS, Tifton, GA; Benjamin.Fraelich@ars.usda.gov

B.T. Scully
USDA–ARS, Tifton, GA; brian.scully@ars.usda.gov

C.L. Palmer
IR-4 Headquarters, Princeton, NJ; palmer@aesop.rutgers.edu

The Interregional Research Project (IR-4) is a joint USDA–ARS and Land Grant Institution program that evaluates agricultural chemicals and expands sustainable pest management technologies for growers by providing efficacy and phytotoxicity data needed for registered use on specialty crops that include floral, fruit, herb, nursery, nut and vegetables. In the last ten years, the IR-4 project on the U.S. southeastern coastal plain has completed 24 phytotoxicity experiments on five ornamental monocot species including Daylily, Hosta, Lily, Liriope, and Canna using various agricultural chemicals. Eleven herbicides were applied at label rates as either a broadcast granular or as “over-the-top” foliar sprays. Over this same period, two fungicide and one insecticide were applied to monocots using either foliar or drench applications. Field experiments were designed as randomized complete blocks with application method and pesticide treatments assigned to a specific cultivar or monocot species. Phytotoxicity was measured on a scale of 0 to 10 (0 = no injury; 10 = dead) at various intervals after each application. Plant height and width were also measured at the beginning and end of each experiment to assess any adverse chemical impact on plant growth and marketability. Data were analyzed in MS Excel or ARM using a t-test and results indicated significant differences in phytotoxicity or marketability between the controls and some of the chemical treatments. These phytotoxicity data are used to support new registration or re-registration of reduced risk pesticides on ornamental horticultural crops. Regional data are compiled from around the U.S. and ultimately submitted to the U.S. Environmental Protection Agency to facilitate the registration or re-registration of active ingredients.

An asterisk (*) following a name indicates the presenting author.
Management of an Invasive Ornamental: Suppression of *Ruellia simplex* (Mexican Petunia) by Native Species during Initial Establishment from Seed

Adrienne M. Smith*
University of Florida, Gainesville; amsmith@ufl.edu

Carrie Reinhardt-Adams
University of Florida, Gainesville; reina005@ufl.edu

Sandra B. Wilson
Indian River Research and Education Center, Fort Pierce, FL; sbwilson@ufl.edu

Christine Wiese
University of Florida, Gainesville; hibiscus@ufl.edu

Active revegetation with select native species may limit reinvasions, yet little is known about the critical stage of initial competition during revegetation with direct seeding efforts. *Ruellia simplex* (Mexican petunia) is a commonly planted ornamental known for establishing monotypic invasions along floodplains in the southeastern United States. As *R. simplex* continues to be planted in urban landscapes, propagule pressure to natural areas will persist; therefore techniques for control and management of *R. simplex* invasions are particularly urgent. We examined the role of initial competition during active revegetation between *R. simplex* and select native floodplain species: *Andropogon glomeratus* (bushy bluestem), *Juncus effusus* (soft rush), *Panicum longifolium* (redtop panicgrass), and *Solidago fistulosa* (pinebarren goldenrod). Our competition study consisted of a 2 x 2 x 3 experimental replacement design with different hydrologic regimes, native species densities, and native species compositions (*J. effusus* + *R. simplex*, *S. fistulosa* + *R. simplex*, and a broad mix of native species + *R. simplex*), in controlled greenhouse conditions. Seedling establishment and survival were collected weekly for 24 weeks. Shoot height was collected biweekly for 24 weeks. Aboveground and belowground biomass were collected at the conclusion of the study at week 24. *Solidago fistulosa* and *A. glomeratus* established rapidly, initiating germination in week 2 and reaching maximum establishment in week 4. *R. simplex* similarly initiated germination in week 2, and reached maximum establishment in week 5. Perhaps as a result of the rapid establishment of these two native species, *R. simplex* was suppressed by *S. fistulosa* and the broad mix treatments by a reduction in survival and biomass. *Ruellia simplex* was not suppressed by *J. effusus*, which did not establish rapidly. No reduction in *R. simplex* shoot height was detected when grown with natives. Instead, *R. simplex* shoot height was affected by hydrologic conditions; shoot height was greater when grown in saturated conditions. Using the results from this study, we are currently conducting a field revegetation study to assess competition in the field and potential revegetation efforts with these native species. By selecting and testing logistically feasible revegetation strategies, we aim to address land managers’ needs and concerns for control and management, while generating restoration approaches for *R. simplex* invaded lands.

Effect of Glycinebetain Seed Priming on Turfgrass Germination Under Drought, Salinity, and Sub-optimal Temperatures

Qi Zhang*
North Dakota State University, Fargo; qi.zhang.1@ndsu.edu

Kevin Rue
North Dakota State University, Fargo; kevin.rue@ndsu.edu

Glycinebetaine (GB) seed priming enhances stress tolerance in various plants during germination and seedling growth stages; however, information on turfgrass is limited. In this study, GB was used to prime turf seeds to determine its efficacy in enhancing tolerance to abiotic stresses. Unprimed and primed (5, 10, and 50 mM solution of GB or distilled water) seeds of perennial ryegrass (*Lolium perenne*) (PR), tall fescue (*Festuca arundinacea*) (TF), creeping bentgrass (*Agrostis palustris*) (CB), Kentucky bluegrass (*Poa pratensis*) (KB), bermudagrass (*Cynodon dactylon*) (BER), and zoysiagrass (*Zoysia japonica*) (ZOY) were germinated under drought (0, –0.4, –0.8, and –1.2 MPa), salinity (0, 5, 10, 15, and 20 dS·m⁻¹), or sub-optimal temperatures [optimal temperature (opt.), opt. ± 5 °C, and opt. ± 10 °C]. Tolerance to the stresses were determined as relative final germination percentage (FGP) and daily germination rate (DGR), expressed as percentage of germination under stress compared to non-stress in each species. Daily germination rate and FGP decreased with increasing stress level, except under high temperatures (opt.+5 °C and opt.+10 °C), with higher reduction in DGR. Perennial ryegrass and TF showed high tolerance to drought, salinity, and chilling temperatures (opt. +5 °C and opt. –10 °C), followed by CB, while KB, BER, and ZOY were stress sensitive. All grasses had increased DGR at opt.+5 °C compared to the non-stress condition (opt.); however, DGR decreased as the temperatures further increased to opt.+10 °C. Glycinebetaine seed priming only improved stress tolerance occasionally, suggesting that the efficacy of GB seed priming is concentration-, plant-, and stress-dependent.

Persistence of the Fungicides Chlorothalonil and Fludioxonil Under Snow Cover

Tamla Blunt*
Colorado State University, Fort Collins; tamla.blunt@colostate.edu

Galen Brunk
Colorado State University, Fort Collins; Galen.brunk@colostate.edu

Anthony J. Koski
Colorado State University, Fort Collins; tony.koski@colostate.edu

Ned Tisserat
Colorado State University, Fort Collins; ned.tisserat@colostate.edu

Typhula blight is a major problem on golf courses where snow cover persists for long periods. The disease is primarily managed by preventive fungicide applications in fall prior to winter snow
cover. However, fungicide rates necessary to control snow mold are often much higher than those needed to suppress other turf diseases during the summer. The persistence of chlorothalonil and fludioxonil residues in the turf during the winters 2005–06 through 2007–08 was measured by gas chromatography/mass spectrometry. In 2005–06, chlorothalonil concentrations decreased by approximately 50% the first week after application and then decreased at a rate of 0.7–1.0 µg·g⁻¹ tissue per day during snow cover. The rapid decrease in chlorothalonil concentration after the first week was not observed in other years. Instead, concentrations of chlorothalonil and fludioxonil in the verdure decreased at less than 1.0 µg·g⁻¹ tissue per day or remained nearly the same at most sampling dates indicating these fungicides did not dissipate rapidly under snow. Despite this, only marginal control of Typhula blight was observed in the fungicide-treated plots. The in vitro sensitivity of Typhula incarnata and T. ishikariensis isolates to chlorothalonil and fludioxonil was tested. Growth of most isolates (70%) on potato dextrose agar (PDA) amended with 1 µg per ml chlorothalonil was inhibited by more than 50% relative to growth on non-amended PDA. However, almost all isolates exhibited at least some growth at concentrations as high as 500 µg·ml⁻¹. A high proportion (85%) of isolates were inhibited by >80% to 1 µg·ml⁻¹ fludioxonil.

(132) Effects of Saline–Alkali Conditions on Turfgrass Establishment
Qi Zhang*
North Dakota State University, Fargo; qi.zhang.1@ndsu.edu
Kevin Rue
North Dakota State University, Fargo; kevin.rue@ndsu.edu

Saline and alkaline (i.e. high pH) conditions commonly coexist in nature. In addition to osmotic and ionic stresses induced by salinity, alkalinity interferes with plant nutrient uptake; thus, increasing stress severity. In this research, tall fescue, Kentucky bluegrass, creeping bentgrass, perennial ryegrass, zoysiagrass, bermudagrass, and alkali grass were germinated under 10 saline-alkali conditions [2 salinity levels (25 and 50 mM) x 5 alkali levels (pH = 7.1, 8.1, 8.8, 9.4, and 10.4)] under a controlled environment. Plants were evaluated on final germination percentage and daily germination rate. Alkali grass and Kentucky bluegrass showed the highest and lowest germination at both salinity levels. Limited variation in germination was observed in other species, except bermudagrass showing lower germination under higher salinity level (50 mM). Alkalinity had no influence on turfgrass during germination.

(133) Effect of Nitrogen Rate on Turfgrass Quality among Five Cultivars of St. Augustinegrass
Tim Pannkuk*
Sam Houston State University, Huntsville, TX; pannkuk@shsu.edu
Robert Lane
Sam Houston State University, Huntsville, TX; blane@shsu.edu

Organic nutrient sources for turfgrass fertilization continue to gain acceptance in lawn care practices. St. Augustinegrass [Stenotaphrum secundatum (Walt.) Kutze] is a common lawn grass of the southern United States. The goal of this study is to measure growth responses of five St. Augustinegrass cultivars fertilized with organic nutrient sources while implementing water conserving practices. The St. Augustinegrass cultivars Raleigh, Delmar, Captiva, Palmetto, and Amerishade were installed in a randomized complete-block design in Fall 2012. Research plots were installed in Huntsville, TX, on a Falba fine sandy loam (fine, montmorillonitic, thermic Typic Albaqualfs). An organic fertilizer source will be applied at a rate of 100, 200, and 300 kg·ha⁻¹ of N per year split over three applications with the first application in April 2014. Plots are irrigated by a sprinkler system using seasonal crop coefficients, minus rainfall, for spring, summer, and fall of 0.5, 0.6, and 0.7, respectively. Plots are mowed as needed to maintain a cutting height of 7.6 cm. Visual ratings of color and density, clipping yield, and soil chemical characteristics will be presented.

(022) Teaching Good Agricultural and Handling Practices to Mississippi Producers
Christine E.H. Coker*
Coastal Res. & Ext. Center, Biloxi, MS; cckoker@ra.msstate.edu
Barakat S.M. Mahmoud
Mississippi State University, Biloxi; bm547@msstate.edu
Gary R. Bachman
Mississippi State University, Biloxi; gbachman@ect.msstate.edu
Eric Stafne
Mississippi State University, Poplarville; estafne@ect.msstate.edu
Nicole Bell
Alcorn State University, Alcorn State, MS; nbell@alcorn.edu
Randal Coker
Mississippi State University, Biloxi; rcoker@ra.msstate.edu

Fresh fruits and vegetables most often are grown in an open environment where there are multiple opportunities for exposure to microbiological and chemical hazards. Recently, recalls and foodborne illness outbreaks linked to fresh fruits and vegetables have increased. Most of these outbreaks were associated with microbial contamination including Salmonella, E.coli O157:H7, Listeria monocytogenes, Norovirus and Hepatitis A virus. The major concerns for food safety come from human feces, animal manures, water, wildlife, and workers. Because fresh fruits and vegetables are often consumed raw, there is no absolute kill step such as cooking that ensures safe produce. Furthermore, there is no cleansing step that can remove all biological and chemical hazards. Preventing and controlling the contamination of fresh produce at the farm is the key to producing wholesome, healthy products. More companies that distribute fresh produce are becoming aware of the importance of the safety issues and are demanding mandatory third party independent audits of

An asterisk (*) following a name indicates the presenting author.
An asterisk (*) following a name indicates the presenting author.

Fresh produce operations as a prerequisite for purchasing. Good Agricultural Practices and Good Handling Practices (GAPs/GHPs) are paramount to ensuring the safety of our food system. A team of Extension professionals from Mississippi State University and Alcorn State University taught a series of four workshops across the state in the Spring of 2014. The purpose of the workshops was to introduce Good Agricultural Practices and Good Handling Practices to Mississippi’s produce industry so that producers can develop and implement farm food safety plans which prepare them for GAPs/GHPs certification. Topics included: Fresh Produce Safety and Consumer Health, Site Selection and Soil, Agricultural Water, Fertilizers: Inorganic and Organic, Animal Exclusion and Pest Control, Worker Health and Hygiene, Harvesting, Cooling, Produce Cleaning and Water Treatment, Pucking and Storage, Transportation, Facilities and Equipment Cleaning and Sanitation, Development of Sanitation Standard Operating Procedures, and USDA GAPs/GHPs audit verification. By executing and documenting GAPs and GHPs, fresh produce producers can assure government regulators and customers worldwide that the produce industry in Mississippi is diligent in its commitment to producing safe, high-quality fruits and vegetables so they can market their products with greater confidence. The target audience was farmers and producers involved with the fruit and vegetable industry in Mississippi. More than 50 producers attended the workshops. Pre- and post-tests were administered to participants to gauge the effectiveness of the workshop. Additionally, program evaluations were collected. Three participants from each workshop volunteered to have an on-farm GAP/GHP consultation.

Specified Source(s) of Funding: Southern Region Risk Management Agency

(023) Food Safety Training Adapted for Various Size Operations

Wesley L. Kline*
Rutgers Cooperative Extension, Millville, NJ; wkline@njaes.rutgers.edu

Meredith Melendez
Rutgers Cooperative Extension of Mercer County, Trenton, NJ; melendez@NJAES.Rutgers.edu

Larry Hardwick
New Jersey Department of Agriculture, Trenton, NJ; larry.hardwick@ag.state.nj.us

Foodborne Illnesses impact 1 in 6 Americans each year (48 million illnesses), 128,000 hospitalized and 3,000 deaths according to the Center for Disease Control and Prevention. This combined with consumer concerns have created a need among the agricultural community for education on Good Agricultural and Handling Practices. Since 2000, 3,800 New Jersey growers have received training in food safety with 1,241 completing third party audit trainings. These trainings have changed growers’ perspective on how crops should be fertilized, irrigated, grown, harvested, packed and handled. Rutgers Food Safety Program works with growers to develop food safety plans for their farm. Our objective is to improve food safety at the farm and distribution levels while making the process cost effective for growers. The authors have used a variety of methods to reach a diversified group of New Jersey fruit and vegetable producers. A multi-level approach has been developed to train growers including training manuals to help growers develop a food safety plan, farm plan templates, a website with educational materials, monthly news articles and weekly food safety articles in an online newsletter. Awareness among the agricultural community is the first step in getting buy-in for a food safety program. This starts with short presentations at grower meetings followed by half day and day-long sessions on specific topics. Each session is adapted to the size of the grower’s operation. The training culminates with the grower having the ability to write and carry out their own food safety program. When grower’s food safety plans are completed, one-on-one review and walk-throughs (second party audits) are available to verify compliance of risk assessments and standard operation procedures. Over 47 farm walk-throughs involving food safety questions and audit preparation have been completed in the last three years. Growers who took advantage of the consultations have passed their audits.

Specified Source(s) of Funding: USDA SCBG grant agreement number 12-25-B-1243

(024) Effect of Sanitizers on the Survival of Lactobacillus plantarum and Salmonella on Surface Inoculated, Hydrocooled Strawberries

Aswathy Sreedharan*
University of Florida, Gainesville; sreedha@ufl.edu

Oleksandr Tokarskyy
I. Ya. Horbachevsky Ternopil State Medical University, Ternopil; otokarskyy@ufl.edu

Steven A. Sargent
University of Florida/IFAS, Gainesville; sasa@ufl.edu

Keith R. Schneider
University of Florida, Gainesville; keiths29@ufl.edu

Forced-air-cooling is typically employed to cool strawberries to 3 °C to 4°C immediately after harvest. Hydrocooling in the presence of a sanitizer offers a faster and more uniform cooling of the berries, although the risk of cross-contamination has not been evaluated. This study examined the growth and survival of Salmonella (human pathogen) and Lactobacillus plantarum (proposed surrogate for Salmonella) on forced-air-cooled and hydrocooled strawberries. The second phase of this study compared the effect of sanitizers on Salmonella and Lactobacillus survival on surface inoculated strawberries subjected to hydrocooling. Methods: Intact strawberries inoculated with Lactobacillus (107 cfu/berry) were subjected to a) forced-air-cooling at 2 °C for 90 min or b) hydrocooling in water (2 °C to 5 °C) containing three different sanitizers, 100 ppm HOCl, chlorine dioxide (5 ppm) or peroxycetic acid (80 ppm). Similarly, berries inoculated with Salmonella (107 cfu/berry) were also forced-air-cooled or hydrocooled in water containing 100 or 200 ppm HOCl. The microbial populations were enumerated on multiple days post-treatment, and the experiments were performed in tripli-
cate (n = 9). Results: The survival of both *Lactobacillus* and *Salmonella* were significantly lower (*P ≤ 0.05*) on hydrocooled berries, compared to forced-air-cooled or untreated strawberries. *Lactobacillus* survival was significantly lower when the berries were treated with HOCl or peroxyacetic acid. The concentration of active chlorine (100 or 200 ppm) did not significantly affect *Salmonella* survival on strawberries. Hydrocooling significantly reduced *Lactobacillus* and *Salmonella* survival on inoculated intact strawberries compared to forced-air-cooling. Bacterial populations were significantly lower when a sanitizer was added to the hydrocooling solution.

**(025) Detection of Coliforms in Lettuce Plants**

*Lactuca sativa cv. Black Seeded Simpson*

**Grown in a Municipal Sludge Compost and Peat**

Grisselle Perez-Sanchez*

University of Puerto Rico, Mayagüez Campus; grisselle_p@hotmail.com

Maria del Carmen Libran

University of Puerto Rico, Mayagüez Campus; maria.libran@upr.edu

Lydia Rivera

University of Puerto Rico, Mayagüez Campus; lydia.rivera@upr.edu

Myrna Alameda

University of Puerto Rico, Mayagüez Campus; myrna.alameda@upr.edu

The Municipal Sludge Compost (MSC) has been used as an alternate growing media for peat and as amendment in agricultural soil. There is much skepticism for the use of MSC as substratum in fresh edible crops. Consumers have the understanding that vegetables grown in this substratum could contain human pathogenic microorganisms. Microorganisms such as, *Escherichia coli* and *Salmonella* sp., have the capacity to be transported through the interior of the plant and be found in crop tissues. There was a need to conduct research on this particular issue. The main objective of this study was to determine the presence or absence of coliform bacteria, *E. coli* and *Salmonella* sp. in lettuce plant tissues. Three treatments were evaluated, in which lettuce was grown in MSC (100), Peat (100) and a mix of MSC: Peat (25:75). These treatments were evaluated previously on ornamental crops. The methodology used to detect the presence of coliform bacteria were, through Membrane Filtration, by using Colilert® test and TECRA® *Salmonella* detection analysis. Lettuces plants were harvested 40 days after planted. Results shown, the presence of coliforms in all tissues of lettuce plants. None colonies of *E. coli* and *Salmonella* sp. were identified on any treatment. The highest number of coliform colonies were found in treatment MSC: Peat (25:75). By using BIOLOG® tests, different coliform bacteria were identified, *Enterobacter sakazakii* were found in the lettuce grown in MSC, *Pantoea dispersa* grown in Peat and *P. dispersa, P. agglomerans, and Pseudomonas mendocina* in the MSC: Peat mix. These coliforms bacteria are considered opportunistic pathogens to humans.

**(026) Watermelon-based Sunscreen Blocks UVA and UVB Light**

Penelope Perkins-Veazie*

North Carolina State University, Kannapolis; penelope_perkins@ncsu.edu

Angela Davis

HM Clause, Davis, CA; angela.davis@hmclause.com

The pigment lycopene has been demonstrated to prevent DNA damage in skin cells. The U.S. Food and Drug Administration monitors sunscreen products and has approved only five compounds as effective blocking agents against UVA and UVB light induced damage in skin. Unfortunately, these compounds have also been found to negatively affect coral reef health. The focus of this experiment was to determine if semi purified watermelon lycopene could be used as an alternative to synthetic-based sunscreens. Watermelon from high pressure pasteurized juice was centrifuged and resulting pellets mixed with a cream base at 20% w/w. Cream base, watermelon sunscreen, and commercial sunscreens were tested using a light sensitive paper in daylight with recorded UVA and UVB intensities to determine relative SPF levels. A rating of 32 SPF for both UVA and UVB for the watermelon sunscreen was done using a commercial lab with testing on skin. Results indicate that watermelon provides compounds useful in blocking UVA and UVB light damage to skin and that a simple and inexpensive system can be used as a screening system to predict relative sun blocking ability.

**(027) Sensory and Chemical Characteristics of**

*Citrus x Poncirus* **Hybrids**

Sophie Deterre

AgroParisTech, Paris; sophie.deterre@gmail.com

Greg McCollum

USDA–ARS, USHRL, Fort Pierce, FL; Greg.Mccollum@ars.usda.gov

Clotilde Leclair

ENSAT, Toulouse; Clotleclair88@yahoo.fr

John A. Manthey

USDA–ARS, USHRL, Fort Pierce, FL; john.manthey@ars.usda.gov

Jinhe Bai

USDA–ARS, USHRL, Fort Pierce, FL; jinhe.bai@ars.usda.gov

Elizabeth Baldwin

USDA–ARS, USHRL, Fort Pierce, FL; Liz.Baldwin@ars.usda.gov

Smita Raithore

USDA–ARS, USHRL, Fort Pierce, FL; smitha.raithore@ars.usda.gov

Anne Plotto*

USDA–ARS, USHRL, Fort Pierce, FL; anne.plotto@ars.usda.gov

Hybrids of *Citrus x Poncirus trifoliata* are currently receiving great interest as a possible source of genetic material for citrus breeding as they appear to be less susceptible to Huanglongbing, a deadly citrus disease caused by *Candidatus Liberibacter*. However, *Citrus x Poncirus* hybrids typically produce fruit...
Poster Presentations

with unacceptable flavor. To develop Citrus × Poncirus hybrids that are commercially acceptable, it is essential to develop an understanding of Poncirus impact on citrus flavor. Quality characteristics of six Citrus × P. trifoliata hybrids were compared with C. reticulata hybrids early (Oct.–Nov.) and late (Jan.–Feb.) in the 2012–13 season. Fruit were evaluated for overall quality by sensory and chemical analyses. Samples showed a wide range of palatability and composition, regardless of pedigree. U.S. 119 and 6-23-20 had the most similar flavor to P. trifoliata due to high bitterness and aftertaste. Volatile composition of 6-23-20 was the closest to P. trifoliata, with high amount of esters, monoterpenes and sesquiterpene hydrocarbons, followed by US 119. All P. trifoliata hybrids produced more aldehydes than fruit with no P. trifoliata in their pedigree, except for 6-23-20. Fruit of 5-18-24, 1-77-105 and ‘Fortune’ were characterized by high sourness. Fruit of 1-76-100 and 5-18-31 had the highest sweetness, floral and fruity-non-citrus flavor, and fruit of 5-18-31 had the highest tangerine flavor, indicating a potential for high quality. Sweetness and sourness were explained by sugars and acids, although some volatiles (carvone and linalool) appeared to contribute to sweetness. Bitterness was not explained by the bitter limonoids, which were the highest in the sweetest fruit (1-76-100), but it could be explained by a combination of low sugars and high monoterpenes and sesquiterpene hydrocarbons. In addition to highlighting chemical contributors to sensory descriptors in Citrus × P. trifoliata hybrids, this study provides useful information on sensory quality for future citrus breeding efforts.

Specified Source(s) of Funding: BARD, The United States – Israel Binational Agricultural Research and Development Fund, Research Grant No. IS-4368-10

(028) The Effect of Multi-wavelength Light-emitting Diode Lighting on the Growth Response of Leaf Lettuce at Different Stages
Chung-Liang Chang*
National Pingtung University of Science and Technology, Pingtung County; chungliang@mail.npust.edu.tw
Kuang-Pi Chang
National Pingtung University of Science and Technology, Pingtung County; p86301307@yahoo.com.tw

This study researches the effect of a combination with light-emitting diode (LED) of different wavelength-bands on the growth response of leaf lettuce (Lactuca sativa var crispa) at different growth stages. The wavelength-bands consist of red (R; 623-673 nm), Light red (Lr; range: 599-644 nm), blue (B; range: 427-478 nm), Light-blue (Lb; range: 435-489 nm), cyan (C; range: 466-532 nm), green (G; range: 494-564 nm), and ultraviolet-A (UV-A; range: 383-426 nm) LED lighting. The changes in the shoot dry mass, shoot fresh mass, chlorophyll content, and nitrate content of leaf lettuce are analyzed. In the experiment, a photosynthetic photon flux of 300 ± 12 standard deviation (SD) µmol·m-2·s-1 is provided for 18 h·d-1 at seedling stage and vegetative stage with such four LED sets as Lr-Lb (61.5%-38.5%), R-C-B (42.8%-30%-27.1%), Lr-Lb-G (49%-36.1%-14.9%), and R-B-UV-A (52.9%-35%-10.1%). The irradiation of different LED sets is conducted on leaf lettuce at seedling stage and vegetative stage, respectively. The air temperature, relative humidity, and CO2 levels for all treatments were maintained at 22 ± 2°C, 64 ± 8%, and 570 ± 75 ppm, respectively. In term of total shoot dry mass and shoot fresh mass, the adoption of LrLbG or LrLb with other combinations results in the worst quality of plant. Provision of UV-A and cyan irradiation during the vegetative stage can increase the shoot fresh mass and dry mass of leaf lettuce.

Specified Source(s) of Funding: The study is supported by National Science Council in Taiwan under grant NSC 102-2622-E-020-006-CC3

(029) Studying on Improving the Quality Using PGA Acid in Grape of Fujiminori Grapevines
Fundan Liu
Huazhong Agricultural University, Wuhan; liufangdan89@126.com
Liu Liu
Huazhong Agricultural University, Wuhan; 403773349@qq.com
Shuang Peng
Huazhong Agricultural University, Wuhan; ganjuli_2002@mail.hzau.edu.cn
Ling Jiang*
Huazhong Agricultural University, Wuhan; jiangling@mail.hzau.edu.cn

The project was performed concerning the impact of poly-γ-glutamic acid (PGA) synergist on the external and interior quality of Fujiminori grapevines. The results indicated that both the horizontal diameter and longitudinal diameter of berry fruit were conspicuously increased when rooted twice with separate PGA processing of 50 mg/l, 100 mg/l and 200 mg/l, specifically, the longitudinal diameter exhibited a significant difference mounting by 7.7% with the treatment of 200 mg/l PGA; The content of soluble solids of Fujiminori grapevines, had an increase of 16.17% compared with the control at the extremely significant difference level of 0.01, when 200 mg/l PGA was utilized; While treating roots with 200 mg/l PGA, the content of vitamin C surged by 62.5%, presenting a remarkable significant difference, meanwhile, the concentration of soluble protein augmented by 28.69%. In addition, the content and the variation law of the edible rate, the titratable acid, tannic acid of peel and the reducing sugar were analyzed. In short, the optimal treatment of 200 mg/l PGA escalated the berry quality, ameliorated the coloring of fruit rind and the accumulation of powder on fruit peel in Fujiminori grapevines.

Specified Source(s) of Funding: Fund from Key Project in Hubei Province of China: ZDND17

(030) Mineral and Fatty Acid Composition in Croatian Garlic (Allium sativum L.) Ecotypes
Gvozden Dumicic
Institute for Adriatic Crops and Karst Reclamation, Split; gdumicic@kr.s.hr
Chemical composition of garlic bulbs is influenced by genotype, agronomic, technological, and environmental factors. The aim of this study was to determine the mineral and fatty acid composition of garlic bulbs of 27 ecotypes collected in northeast Adriatic region (Croatia). Samples were collected from 21 different locations: Brgd, Golubic, Jezero, Konavle, Kricke, Kurtovic, Ljubivitoca, Metajna Pag, Metkovic, Miljevci, Obrovac Sinj, Opuzen, Polaca Knin, Primorski Dolac, Rastok, Stilja, Tinjan, Trnbusi, Vojnic and Zmijavci. Ecotypes Brgd, Konavle, Kurtovic, Ljubivitoca (samples Bijeli and Sarac), Primorski Dolac (sample spring), and Rastok and Vojnic had garlic bulbs with more than 40% of dry matter. The lowest bulb dry weight (less than 34.8%) was recorded in samples from Golubic (samples 1 and 2), Metajna, Polaca Knin and Primorski Dolac (sample winter). The highest bulb N concentration (41.3 g/kg DW) was recorded on location Metajna, while the lowest was on location Miljevci (13.1 g/kg DW). At the same location was recorded the lowest bulb P concentration (4.13 g/kg DW), while the highest was observed in both samples from Opuzen (6.49 and 6.53 g/kg DW). Highest bulb K concentration was recorded on sample Trnbusi 4 winter (15.3 g/kg DW), while the lowest on Brgd (7.3 g/kg DW). Lowest bulb Cu concentration was recorded on Polaca Knin (0.72 g/kg FW), whereas highest on sample Opuzen winter (4.34 g/kg FW). The highest bulb Zn concentration was recorded on sample Opuzen spring (23.1 g/kg FW), while the lowest concentrations (6.9 g/kg FW) were found in Golubic and Kurtovic. Lowest bulb Cd concentrations were found in ecotypes Ljubivitoca White and Trnbusi 3 spring (0.06 and 0.09 g/kg FW). At locations Rastok (0.44 g/kg FW), Kozica-Vojnic (0.41 g/kg FW) and Konavle (0.39 g/kg FW) were found the highest Cd concentration in the garlic bulb. Garlic bulbs contained from 29.1 to 69.4 mg/kg DW total fatty acids. Linoleic/alpha-linolenic acid ratio is considered an important dietary factor, and an alpha-linolenic acid-rich Mediterranean diet is recommended. Croatian garlic ecotypes showed great variability, with locations Brgd (5.74), Kricke (5.79) and Golubic 1 and 2 (5.81; 5.88) having the lowest linoleic/alpha-linolenic acid ratios and location Obrovac Sinj the highest (9.46). The study revealed that garlic bulbs had high levels of nutritionally important components, such as fatty acids and minerals, and that all quality components were strongly influenced by genotype and location.

Specified Source(s) of Funding: Republic of Croatia, Ministry of Agriculture

### Vegetable Breeding

#### (259) Variation in Chlorogenic Acid Content among Blueberry Cultivars, Breeding Selections and Populations Grown in North Carolina

Gad G. Yousef*
North Carolina State University, Kannapolis; ggyousef@ncsu.edu

Allan F. Brown
North Carolina State University, Kannapolis; afbrown2@ncsu.edu

Ivette Guzman
North Carolina State University, Kannapolis; herbalivette@gmail.com

James R. Ballington
North Carolina State University, Raleigh; jrbrrb@ncsu.edu

Mary A. Lila
North Carolina State University, Kannapolis; mlial@ncsu.edu

Blueberry (*Vaccinium* sp.) fruit is a rich source of chlorogenic acid (CA), among other polyphenolics, which have been reported to contribute to human health maintenance and chronic disease prevention. This study was designed to examine variation in CA among a wide range of blueberry genotypes with various background species that contributed to the current commercial cultivars. The genotypes included southern highbush and rabbiteye blueberry commercial cultivars, blueberry breeding selections, and blueberry breeding populations developed through the North Carolina State University blueberry breeding program. Fully ripe fruit was evaluated for CA concentration in 2010 and 2011 at Salisbury, NC. CA concentration ranged from 30–72 mg/100g and 46–121 mg/100 g (frozen fruit) in the southern highbush (4x) and rabbiteye (6x) blueberry commercial cultivars, respectively. In the breeding selections (4x), which comprised an expanded gene pool, the CA ranged from 34–116 mg/100 g. Further gene pool expansion associated with the establishment of the breeding populations (4x), resulted in a significant increase in CA concentration (50–143 mg/100 g) compared to current commercial cultivars (4x). The large variation in CA accumulation detected in this study indicates that significant genetic variation for CA exists among blueberry species and can be successfully utilized in breeding programs to aid in developing CA-enhanced blueberry varieties.

Specified Source(s) of Funding: University of North Carolina (UNC) General Administration Special Allocation for Collaborative Research at the North Carolina Research Campus (NCRC), NC.
(260) Genetic Diversity of the USDA Cabbage Collection Germplasm Using SSR Markers

Gad G. Yousef*
North Carolina State University, Kannapolis; ggyousef@ncsu.edu
Yang Bian
NC State University, Raleigh, NC; ybian2@ncsu.edu
Robert J. Byrd
North Carolina State University, Kannapolis; rjbyrd1@gmail.com
Allan F. Brown
North Carolina State University, Kannapolis; afbrown2@ncsu.edu

Cabbage (Brassica oleracea var. capitata) is an economically important vegetable crop across the globe. For centuries, it has been used as a staple food; however, the phytonutrient profile, comprised of glucosinolates, carotenoids, and flavonoids is associated with human health and disease prevention. This study was conducted to assess the genetic relationship among cabbage germplasm available in the U.S. Department of Horticulture, Geneva, NY. A total of 350 accessions representing over 25 countries were screened for SSR markers and phenotypic characteristics including leaf shape, color, vigor, head shape and compactness, and glucosinolate profile in 2011. Results indicated that significant genetic variation exists within the USDA germplasm collection. The neighbor-joining tree (un-rooted dendrogram) based on Dice distance of 22 SSR markers formed four major clusters each with a group of sub-clusters containing up to 15 accessions. Our results suggest that while geography plays an important role accessions from several of countries appeared closely related based on the SSR marker data. This indicates that exchange of common cabbage germplasm among different geographical locations has taken place through public and private breeder programs.

Specified Source(s) of Funding: USDA-Hatch

(261) Selection for Geosmin Production in Table Beet (Beta vulgaris sp. vulgaris)

Lynn Maher*
University of Wisconsin-Madison, Madison; lcmaher@wisc.edu
Irwin Goldman
University of Wisconsin-Madison, Madison; ilgoldma@facstaff.wisc.edu

The table beet (Beta vulgaris sp. vulgaris) is often characterized as having an earthy flavor and aroma. This is due to geosmin, C_{10}H_{12}O, a volatile terpenoid compound commonly produced by a class of soil microorganisms called actinomycetes. A survey of 11 table beet, 1 Swiss chard, 1 mangel, and 1 sugarbeet cultivar grown in autoclaved and non-autoclaved soil and in a field environment over two years revealed few significant changes in geosmin concentration rank, as measured by GC-MS, for individual cultivars across these disparate environments. These results suggest that geosmin content may be cultivar specific and may be less influenced by microbial association. These findings led to the creation of two breeding populations formed from cultivars that were highest and lowest in geosmin. Approximately 25 plants from each of the highest producing cultivars—‘Bull’s Blood’ and ‘Chioggia’ were recombined for two generations using a half-sib family structure. An identical procedure was followed for the lowest geosmin-containing cultivars ‘Touchstone Gold’ and ‘Blankoma.’ Following the recombination phase, roots from individual half-sib families were evaluated for geosmin concentration. Significant inter root variation was found within each half-sib family. The highest and lowest geosmin-containing roots were selected for recombination and are now part of an ongoing half-sib family recurrent selection scheme. To assess whether table beet is capable of endogenous geosmin production, tissue culture experiments were conducted under sterile conditions. Cultured plants were evaluated for geosmin levels.

Specified Source(s) of Funding: U.S. Department of Horticulture

(262) Combining Fruit Quality and Late Blight Resistance in Tomato

Dilip Panthee*
North Carolina State University, Mills River, NC; dilip_panthee@ncsu.edu
Ragy Ibrahem
North Carolina State University, Mills River, NC; Ragy_Ibrahem@ncsu.edu
Penelope Perkins-Veazie
North Carolina State University, Plants for Human Health Institute, Kannapolis, NC; penelope_perkins@ncsu.edu

Late blight caused by Phytophthora infestans is a devastating disease of tomato (Solanum lycopersicum L.). Three genes, Ph-1, Ph-2 and Ph-3, have been identified to confer resistance to this disease. Among these, a combination of Ph-2 and Ph-3 is effective to confer resistance to the available races of Phytophthora infestans. While there are some tomato breeding lines with combined Ph-2 and Ph-3 genes, they do not have the genes that confer other fruit quality traits that are in high demand in the market including the dark-red gel color conferred by the “crimson” gene. There is also commercial interest in tomato breeding lines with the ripening inhibitor (rin) gene combined with the crimson gene. Our objective was to combine late blight resistance genes and fruit quality related genes (crimson and rin) into a single tomato line. An F_{2} population from NC 2CELBR x NC 2rinEC was generated and inheritance and segregation analysis was performed. The Ph-2 Ph-3, crimson and rin genes were found to segregate as single genes. Several single plants with Ph-2, Ph-3, crimson and rin genes were selected at the homozygous state for field evaluation of horticultural traits in the next generation. These lines will also be evaluated for lycopene content, a highly desirable trait. Combination of these traits in tomato breeding lines should lead to a superior tomato hybrid.

(263) Studies on Heterotic Effects of Crosses of Onions with Different Skin Colored Onion Lines

Cheol-Woo Kim*
National Institute of Crop Science, RDA, Muan, Jeonnam; cwkim@korea.kr
Cowpea [Vigna unguiculata (L.) Walp.] (2n = 2x = 22) is a major crop cultivated in the tropics and sub-tropics areas including Asia, Southern Europe, Africa, southern USA, and Central and South America. It is used for human food, animal fodder, or as a cover crop. Molecular marker development is an essential part of quantitative trait loci (QTL) identification, map-based cloning, genetic diversity assessment, association mapping, and applied breeding in marker-assisted selection (MAS) schemes. Molecular markers such as EST-SSR and EST-SNP markers have advantages because they are a component of expressed genes. In this study, 187,487 expressed sequence tag (EST) sequences were downloaded from GenBank; 4,572 contigs and 2,697 singlets were created by CAP3. A total of 7,878 EST-SSRs were identified with di-, tri-, tetra-, penta-, and hexa-nucleotide repeats of 6 to 35, 4 to 29, 3 to 7, 3 to 7, and 3 to 6, respectively, using SSRLoator. Also, 7,588 SNPs were postulated among the 3,389 contigs by DNASTAR Lasergene Genomics Suite. Genome-wide SNPs were discovered through genotyping by sequencing (GBS) in 800 cowpea genotypes. SNP markers associated with morphological traits including dry pod color, pod placement, mature seed pattern and color, seed coat color, flower color, and leaf shape were identified through association mapping approaches and will be used in cowpea breeding to select morphological traits through MAS.

(265) Evaluation of Carrot (Daucus carota L.) for Traits Related to Early Seedling Establishment and Canopy Growth at Different Planting Densities

Sarah D. Turner*
University of Wisconsin-Madison; sdturner2@wisc.edu
Philipp W. Simon
USDA, Madison, WI; psimon@wisc.edu

Carrot production is limited by erratic germination, poor seedling growth, and delayed canopy establishment, all of which make weed control a major challenge. Plants with early germination, quick seedling growth, and competitive growth response are one viable option for improving weed management. Preliminary field trials have demonstrated that carrot genotypes have variable germination rates and responses to planting density, ranging from no response to an increase in canopy growth as planting density increases. This project aims to elucidate competitive growth response in carrot breeding stocks. Four genotypes with small canopy size and four with large canopy size were planted at different densities (30, 60, and 90 plants per meter) using a split-plot design with three replications. Emergence rate, canopy height, and canopy width were monitored throughout the growing season and postharvest measurements of fresh leaf weight, root weight, and dry leaf weight were taken. Current progress will be reported. Increasing planting density promoted top growth, specifically with genotypes that tended to have smaller tops.

Specified Source(s) of Funding: USDA–ARS
(266) Association Mapping of Leaf Traits of Spinach
Jianbing Ma
University of Arkansas, Fayetteville; jxm044@uark.edu

Ainong Shi
University of Arkansas, Fayetteville; ashi@uark.edu

Beiquan Mou
USDA–ARS, Salinas, CA; beiquan.mou@ars.usda.gov

Michael R. Evans
University of Arkansas, Fayetteville; mrevans@uark.edu

John R. Clark
University of Arkansas, Fayetteville; jrclark@uark.edu

Dennis Motes
University of Arkansas, Fayetteville; dmotes@uark.edu

David Brenner
Iowa State University, Ames; David.Brenner@ars.usda.gov

Haizheng Xiong
University of Arkansas, Fayetteville; heixiazi2006@sina.com

Jessica Chitwood
University of Arkansas, Fayetteville; jchitwo@email.uark.edu

Josh Campbell
University of Arkansas, Fayetteville; jacambp@uark.edu

Spinach (Spinacia sp.) is a cool-season and economically important crop and it was produced on about 18,000 ha in the U.S. in 2012 valued at $224 million, according to USDA NASS. As the latest application of next-generation sequencing technology, Genotyping by Sequencing (GBS) has relatively low cost and provides for rapid discovery of SNPs (Single Nucleotide Polymorphisms) in different crop species. In this study, 518 spinach lines, including 388 from USDA-GRIN germplasm originally collected from 24 countries, 60 commercial cultivars or F₁ hybrids, and 70 advanced lines developed by University of Arkansas were field-planted near Kibler, AR in October 2013. Leaf traits including texture, shape, petiole color and edge attributes were phenotyped in December 2013. Leaf variations included: smooth 82.0% vs semi-savoy or savoy leaf 18.0%; oval 67.3% vs. long leaf 32.7%; green 76.2% vs. purple petiole 23.8%; entire 73.6% vs. lobed leaf 26.4%. Leaf tissue was sampled from each individual line and freeze dried. Genomic DNA was extracted using the cetyltrimethyl ammonium bromide (CTAB) method. DNA sequencing is underway on each line using GBS by Illumina HiSeq 2000 Sequencing System. GBS data will be analyzed for SNPs using the DNASTAR Lasergene Genomics Suite, TASSEL, and/or the AMtools pipeline. The SNP markers associated with specific leaf traits will be identified and these markers will provide breeders with the ability to select different leaf types of spinach through marker assisted selection in spinach breeding programs.

(267) Genetic Control of Age-related Resistance to Phytophthora capsici in Cucumber
Marivi Colle
Michigan State University, East Lansing; collemar@msu.edu

Rebecca Grumet*
Michigan State University, East Lansing; grumet@msu.edu

Infection by the oomycete pathogen, Phytophthora capsici, is a major problem affecting cucumber (Cucumis sativus) production in eastern and midwestern production areas. Cucumber fruit, which are the most susceptible part of the plant, become unmarketable due to fruit rot. Our previous work showed that cucumber fruit (cv. Vlaspik) exhibit an age-related resistance (ARR) to P. capsici. Young fruits are highly susceptible, but as they reach full size [at 12–16 days post pollination (dpp)] they become resistant, exhibiting minimal or no visible pathogen growth and symptom development limited to the site of inoculation. In this study we tested whether there was genetic variation for ability to develop ARR. A set of 17 cultivars was examined for ARR by zoospore inoculation of 16dpp fruits. Three of the cultivars exhibited ARR while others remained highly susceptible. To understand the genetic basis of ARR expression, F₁ progeny from reciprocal crosses between Vlaspik (V, ARR-expressing) and Gy14 (GY, non-ARR expressing) were evaluated using a 9-point disease rating scale [(1–3 = resistant with no symptom or symptoms limited to the site of inoculation; 4–6 = moderately susceptible; 7–9 = highly susceptible)]. At 5 days post-inoculation (dpi), Gy14 had a mean disease score of 6.9 ± 0.1 while Vlaspik had a mean disease rating of 1.9 ± 0.3. The F₂ progeny responded similarly to Vlaspik with resistant mean disease scores of 2.4 ± 0.2 (V x GY) and 3.2 ± 0.4 (GY x V), suggesting that ARR may be inherited as a dominant trait. F₂ progeny are currently being tested for ARR response. Progeny that are ARR expressing and non-ARR expressing will be selected for bulked segregant QTL Seq analysis.

(268) Analysis of Genetic and Environmental Effects on Broccoli Cultigens Grown in Diverse Environments in the Eastern United States
Carl E. Sams*
University of Tennessee, Knoxville; carlsams@utk.edu

Dean A. Kopsell
University of Tennessee, Knoxville; dkopsell@utk.edu

Arnold Saxton
University of Tennessee, Knoxville; asaxton@utk.edu

Phillip Griffiths
Cornell University, Geneva, NY; pdg8@cornell.edu

Thomas Björkman
Cornell University, Geneva, NY; tnb@cornell.edu

Mark Farnham
USDA–ARS, Charleston, SC; mark.farnham@ars.usda.gov

Jeanine Davis
North Carolina State University, Mills River; Jeanine_Davis@ncsu.edu

Mark Hutton
Univ. of Maine, Monmouth, ME; mark.hutton@maine.edu

Wythe Morris
Virginia Tech, Hillsville; morrisw@vt.edu

An asterisk (*) following a name indicates the presenting author.
Glucosinolates (GS) are secondary metabolites in broccoli that break down into isothiocyanates (ITCs) with important anticarcinogenic effects in human nutrition. As part of a USDA-SCRI sponsored research project to improve the consistency and profitability of broccoli production in the eastern US, we evaluated GS content of broccoli cultigens grown in diverse environments. Three replications of six cultigens were grown in five locations (MA, NY, VA, NC, and SC) at two different production times. Floret tissue was analyzed for GS content by HPLC and quantified by authenticated standards. The genetic by environment (GxE) interactions evaluated in similar experiments are often analyzed by evaluating averages across replications for a genotype in different environments and then analyzing the means. Analysis of data from this experiment using SAS Mixed Model Procedures revealed that cultigen, location, season and their interactions significantly affected GS content. One of our goals was to determine which cultigens had a consistently high GS content across the widest range of environments. Additive Main Effects and Multiplicative Interaction (AMMI) models were used to combine the analysis of variance for additive main effects with principal component analysis for non-additive residuals. Genetic by environment interactions indicate whether a cultigen can be used over a diverse range of environmental conditions or whether separate cultigens must be developed for different environments. The data presented here compare the adaptability of six commercial cultigens across environments in the eastern US. Two of the six cultigens maintain high GS contents across five of the location/production time combinations. The other four cultigens had GS contents below the experiment overall mean in the same five location/production time combinations. Five of the location/production time combinations had lower GS content than the experimental overall mean for all cultigens. The influence of the specific environments evaluated on the GS content of the cultigens in the experiment will be discussed. Based on the results from this experiment, we plan to use a similar approach to evaluate the GxE interactions that impact GS content of new breeding lines and use that information in breeding efforts to improve future broccoli cultigens.

(269) ‘TAM Hot-Ty’—A New, Heat-tolerant Tomato Cultivar for Texas

Kevin Crosby*

Texas A&M University, College Station, TX; k-croby@tamu.edu

John L. Jifon

Texas A&M AgriLife Research, Weslaco, TX; jifon@tamu.edu

Jeremy Haralson

Texas A&M University, College Station, TX; jeremyharalson@gmail.com

Daniel I. Leskovar

Texas A&M AgriLife Research, Uvalde, TX; d-leskovar@tamu.edu

Texas A&M AgriLife Research announces the release of ‘TAM Hot-Ty,’ a new, heat-tolerant, virus-resistant, fresh-market tomato cultivar. The main impediments to tomato production in south and central Texas are high temperatures and virus infections. The Texas A&M AgriLife Research system has a long history of heat-tolerant tomato germplasm development, with several processor and fresh market cultivars released by Paul Leeper. These materials are a valuable source of heat-tolerance genes, and have been utilized by the current program to develop some virus-resistant, early maturing inbreds, with enhanced fruit quality. Extensive testing of these inbreds in F1 hybrid combinations from 2010-2013 led to the development of several candidate cultivars for production in Texas and other warm climates. ‘TAM Hot-Ty’ is the first of these to be released to the commercial seed industry. During the past three years, it has been tested against several commercial hybrid cultivars (Tycoon, Tygress, Charger) in multiple Texas locations. At three locations in the lower Rio Grande valley, Uvalde, San Antonio, and College Station, it demonstrated the earliest maturity and best fruit set under high temperatures during both spring and fall trials. Fruit size ranged from 180-210 g in the LRGV locations, and 170-190 g in the Uvalde and College Station trials. The plant has a small determinant habit, with a very concentrated set of uniformly deep red, globose fruit with very little tendency to crack, and small to medium stem scars. The fruit has a high ratio of flesh to seed locules, providing an attractive, beefsteak appearance when sliced. Firmness is good, though less than Tycoon or commercial Rin tomato cultivars. Flavor was rated highly by two separate taste panels. ‘TAM Hot-Ty’ carries the Ty-2 gene for resistance to TYLCV, and the I-2 gene for resistance to Fusarium wilt races 1.2. It also appears resistant to Stemphyllium solani leaf spot in south Texas. This new cultivar will work well for vine-ripe commercial production, organic producers, and backyard gardeners, particularly where heat-set and early maturity are important.

(270) Improving Tolerance to Bacterial Spot of Tomato through Fine Mapping of Two Quantitative Trait Loci

Jian Li*

Gulf Coast Research and Education Center, University of Florida, Wimauma; jili59@ufl.edu

Samuel F. Hutton

University of Florida, Wimauma; sfhutton@ufl.edu

Jeffrey B. Jones

University of Florida, Gainesville; jbjones@ufl.edu

Tomato (Solanum lycopersicum) is one of the most economically important vegetable crops in the United States, and annual production value is estimated over $2.5 billion (2009). Bacterial spot is caused by at least four species of Xanthomonas and is a major disease of field-grown tomatoes in many humid production regions. The disease causes defoliation and reductions in both total and marketable yields. There is no good control measure available for the disease, and host resistance is an attractive goal for disease management. Previous research determined that a quantitative trait locus (QTL) on chromosome 11 confers bacterial spot resistance, while increased susceptibility is associated with the fusarium wilt resistant gene, I-3. In this study, we are using a map-based cloning approach to fine map the chromosome 11 QTL. Approximately 40 semi-isogenic recombinant inbreds

An asterisk (*) following a name indicates the presenting author.
were developed by identifying recombinants for the chromosome 11 introgression in populations derived from the tolerant lines, Fla. 8517, Fla. 8233 and Fla. 8286; and backcrossing these recombinants three times to the highly-susceptible line, Fla. 7946. The introgression spans approximately 35 Mbp, including the centromere. Severe recombination suppression throughout much of the region has limited identification of useful recombinants. A similar approach is being employed to determine if the I-3 association with bacterial spot susceptibility is the result of pleiotropy or linkage with unfavorable alleles. I-3 is located within a 1 Mbp region on chromosome 7, and approximately 20 recombinants within this region have been identified and are being evaluated for sensitivity to bacterial spot. If the problem is due to linkage drag, the dissociation of the two traits should significantly improve breeding efforts for bacterial spot tolerance in I-3 backgrounds.

**Wednesday, July 30, 2014**

**Viticulture and Small Fruits 2**

**(333) Strawberry Virus Detection, Identification, Best Management Practice Recommendations and Information Dissemination**

Roy Flanagan  
Virginia Cooperative Extension, Virginia Beach; royf@vt.edu

Keith Starke  
City of Virginia Beach, Virginia Beach; kstarke@vbenv.gov

Charles Johnson  
Virginia Polytechnic Institute and State University, Blacksburg; spcdis@vt.edu

Barclay Poling  
North Carolina State University, Raleigh; ebp@ncsu.edu

Robert Martin  
USDA–ARS, Corvallis, OR; bob.martin@ars.usda.gov

Jayesh Samtani*  
Virginia Polytechnic Institute and State University, Virginia Beach; jsamtani@vt.edu

In Fall 2012, several strawberry producers in Southeastern Virginia experienced abnormal growth patterns in their newly transplanted strawberry crop. Roy Flanagan, Extension Agent-ANR, received multiple calls from concerned growers regarding the issue of stunted, discolored and in some cases, completely necrotic strawberry plants. Initial strawberry plant samples were collected and analyzed for plant and soil nutrient deficiencies or toxicities. Subsequent consultation with various plant specialists from Virginia, North Carolina, Oregon and Canada led to discussion of a possible virus complex that would yield the plant symptoms being observed in our local strawberry fields. Dr. Bob Martin with USDA/ARS, Corvallis, Oregon, agreed to process samples collected from farms located in and around Virginia Beach. Strawberry plant samples were collected from local affected fields and included information on transplant source (i.e. plant origin was either Prince Edward Island or Nova Scotia, Canada) and transplant cultivar (i.e. Albion, Camarosa, Camino Real, Chandler, Festival, San Andreas and Sweet Charlie). In winter 2013, almost all sampled plants from the Nova Scotia source tested positive for Strawberry mild yellow edge virus (SMYEV) and strawberry mottle virus (SMoV). Vital information regarding the discovered strawberry virus complex was sent out locally and statewide to all Virginia Cooperative Extension agents, in an effort to inform strawberry producers across Virginia. Statewide strawberry plant samples were collected and tested to verify sample results previously analyzed from Virginia Beach, Chesapeake and Suffolk, Virginia. Statewide, symptomatic samples also tested positive for SMYEV and SMoV.

Specified Source(s) of Funding: Virginia Polytechnic Institute and State University, College of Agriculture and Life Sciences

**(334) Strawberry Production in High pH Soil at High Elevation in the Southwest**

Shengrui Yao  
NMSU Alcalde Center, Alcalde, NM; yaos@nmsu.edu

Steve Guldan  
NMSU Alcalde Center, Alcalde, NM; sguldan@nmsu.edu

Robert P. Flynn  
NMSU Artesia Research Center, Artesia, NM; rflynn@nmsu.edu

In northern New Mexico, late frosts are the number one issue challenging tree fruit production. Good alternative crops with reliable yield are needed for the high pH soils, high elevations, and shorter growing seasons in northern New Mexico. Strawberries prefer slightly acid soil and exhibit leaf chlorosis in high pH soils. However, cultivars vary in their sensitivity to high pH soil based on their genetic background. In 2011, 16 strawberry cultivars were planted with two planting systems – a black plastic covered perennial system and a matted row system arranged in a split-plot block design with four replicates at the New Mexico State University Sustainable Agriculture Science Center at Alcalde, NM. Cultivars varied greatly in their yield and tolerance to high soil pH. ‘Allstar’, ‘Chandler’, and ‘Darselae’ were the three most sensitive cultivars to high soil pH among the 16 cultivars tested. ‘Wendy’, ‘Brunswick’, ‘Cavendish’, ‘Jewel’, and ‘Honeoye’ were the five most tolerant cultivars. Two to three applications of 20 g/30 m chelated iron product (FeEDDHA) per year through fertigation effectively corrected high pH (high lime) induced leaf chlorosis. After averaging the yields of 2012 and 2013, ‘Mesabi’ and ‘Kent’ had greater yield than others and twice the yield of ‘Jewel’. ‘Cavendish’ had the greatest yield in the first harvest season, but not in the second season. Early cultivars Earliglow and Annapolis, and late cultivars L’Amour and Ovation all had low yields in both years. On 16 Jan. 2013, the minimum temperature reached –21.7 °C, which caused crown winter damage to some cold-tender cultivars mainly in the black plastic covered system. ‘Wendy’, ‘Chandler’, ‘Clancy’, and ‘Jewel’ were the most cold-tender cultivars, while ‘Mesabi’, ‘Kent’, ‘Cavendish’, and ‘Honeoye’ were the hardiest cultivars among those tested. After repeated late frosts from 19 Apr. to 4 May 2013, most cultivars

An asterisk (*) following a name indicates the presenting author.

*HortScience 49(9) Supplement—2014 ASHS Annual Conference*
surprisingly produced greater yield than in 2012, with ‘Mesabi’ and ‘Kent’ being the greatest because late blooms compensated for the frost damage to early flowers and fruitlets. Growers should be selective with their cultivars, employ a fertilizer program, and use overhead sprinklers for frost protection. Strawberry production could be profitable in high pH soil at high elevation with short growing season in the Southwest.

Specified Source(s) of Funding: This project was supported by a USDA Agricultural Marketing Service Specialty Crop Block Grant through the New Mexico Department of Agriculture and New Mexico Agricultural Development and Promotion Funds Program.

(335) Extending the Season for Strawberry Production Under High Tunnels: Lessons Learned during a Harsh Winter

M. Elena Garcia*
University of Arkansas, Fayetteville; megarcia@uark.edu

Donn T. Johnson
University of Arkansas, Fayetteville; dtjohnso@uark.edu

David Dickey
University of Arkansas, Fayetteville; dadickey@uark.edu

Megan McGovern
University of Arkansas, Fayetteville; meganmcgovern3@gmail.com

Susan Frey
University of Arkansas, Fayetteville; scorey@uark.edu

At the University of Arkansas Research and Extension Center in Fayetteville, strawberries are grown under high tunnels to provide a protected environment that allows for harvest in the off-season. The high tunnel system protects berries from frost and other weather related conditions that limit the season for berries grown outdoors. For the three years prior to the 2013–14 season, this high tunnel production system has produced strawberries from late November through April. During the 2013–14 season, intermittent extreme cold events beginning in early December and continuing into March have challenged this extended season production system. Typical planting time for extended season high tunnel strawberry plugs is early September for production beginning in November and continuing into May. In December 2013 when the first extreme cold event occurred, the high tunnel strawberry plants, were beginning to bloom and set fruit. To reduce the amount of damage to plants, the high tunnel strawberry plants were covered with three protective layers—3 ml row cover, loose straw, and recycled high tunnel plastic. Weather data was collected for both outside and high tunnel strawberry plantings. This data showed that during the first December cold snap, the temperature dropped to −14 °C outside, but only reached −1 °C under the snow-covered row covers of the field planting. Weather data collected inside the high tunnels showed the low was −11 °F at 4' above the ground and 6 °C at the plant canopy under the protective covering. In late January, 2014 Fayetteville, AR, experienced another extreme cold episode with winds gusting between 40 and 60 miles per hour. During this episode, one of the high tunnels sustained some damage on the north end-wall causing the protective covering to be blown off a portion of the berry plants. The temperature outside and inside the tunnel was −8 °C when the problem with the end-wall was discovered. An assessment of the damage showed that the berries and many of the flowers were damaged. However, a crown assessment indicated not damage to the crowns. Overall, compared to previous years arthropod management was reduced whereas there was more need for disease management. No fruit was harvested during this time. This extremely cold winter has provided many insights into high tunnel strawberry temperature thresholds, as well as the type and timing of weather protection required for survival of high tunnel strawberry plants during extreme cold episodes.

Specified Source(s) of Funding: National Strawberry Sustainability Initiative

(336) Comparison of Winter Strawberry Production in a Commercial Heated High Tunnel versus a University Greenhouse

Ellen T. Paparozzi
University of Nebraska, Lincoln; etp1@unl.edu

Ryan Pekarek
Pekarek’s Produce, Dwight, NE; ryanpekarek@hotmail.com

George Meyer
University of Nebraska, Lincoln; gmeyer1@unl.edu

M. Elizabeth Conley
University of Nebraska, Lincoln; mconley2@unl.edu

Stacy Adams
University of Nebraska, Lincoln; sadams1@unl.edu

David Lambe
University of Nebraska, Lincoln; dlambe1@unl.edu

Paul Read*
University of Nebraska, Lincoln; pread1@unl.edu

Erin E. Blankenship
University of Nebraska, Lincoln; eblankenship2@unl.edu

For the past 4 years, the University of Nebraska strawberry team has developed low cost, sustainable methods for farmers and growers to produce strawberries in a greenhouse during the winter. This past year, this growing system involving 5 cultivars was transferred to a commercial grower’s heated high tunnel for the winter of 2013–14. The goal is a scale up to a farm-size demonstration that will potentially expand marketing opportunities into the winter season. Our fall/winter results indicate that over 6 weeks during October and November, our grower’s plants have produced 130 pounds of strawberries with 124.24 pounds marketable. UNL’s production system which has about 25% of the number of plants as the commercial grower had produced 22.84 pounds with 19.25 pounds rated as marketable. Berry production peaked in late November/early December and demand for the grower’s berries exceeded supply. Data collected on water usage reflected sustainability in that less than 17 gallons per day (UNL) and 20 gallons per day for the grower were being used. However, extremely low temperatures and frigid winds
have caused fuel usage at both sites to soar. How different and similar the two sites are in terms of total water and fuel usage, environmental parameters of soil moisture and temperature and light levels as well as total berry production over the 6-7 month growing season will be presented.

Specified Source(s) of Funding: This project is funded in part by a grant from the Walmart Foundation and administered by the University of Arkansas System Division Of Agriculture Center for Agricultural and Rural Sustainability.

(337) Tri-Trophic Level Interactions of T. urticae and Beneficial Inoculants in Three Strawberry (Fragaria ananassa) Varieties

Amanda McWhirt*
North Carolina State University, Raleigh; almcwhir@ncsu.edu
Michelle Schroeder-Moreno
North Carolina State University, Raleigh; michelle_schroeder@ncsu.edu
Yasmin Cardoza
North Carolina State University, Raleigh; yjcardoz@ncsu.edu
Gina Fernandez
North Carolina State University, Raleigh; gina_fernandez@ncsu.edu

Tri-trophic level interactions between beneficial soil inoculants and plant canopy arthropod pests have been established for some horticultural systems. However, the live microbial activity of these inoculants as opposed to the combined microbial and nutritional effect has not been investigated for strawberry systems. The potential for microbial activity in sustainable production systems to impact both plant growth and pest populations could be significant for strawberry growers who are able to manage these interactions to their benefit. The use of live arbuscular mycorrhizal fungi plus vermicompost (AMF+VERM) and vermicompost (VERM) singly and their respective steam-sterilized controls were used CRBD to test the microbial activity of these inoculants on strawberry plant growth and the population growth of a key strawberry pest the two spotted spider mite (Tetranychus urticae). These beneficial inoculants were incorporated into the plug media during strawberry tip establishment of the three strawberry varieties Chandler, Sweet Charlie and Albion. Each variety and soil inoculant combination later received both a spider mite (Mite+) and spider mite free (Mite-) treatment. Both the individual effects of variety and soil inoculant and their combined interaction on plant and arthropod growth were assessed. For plant growth VERM increased leaf area and total final biomass as compared to its control. AMF+VERM was not different from its control in terms of leaf area (P < 0.8595) but did have greater whole plant biomass (P < 0.0021). Besides an increase in phosphorus uptake by plants planted in AMF+VERM, soil microbes had little effect on plant nutrient uptake, which may indicate observed changes to plant growth are due to other compounds produced as a result of microbial activity. Under the conditions of our study Albion consistently supported the highest (P < 0.0001) T. urticae populations as estimated by both the calculations of cumulative mite-days and cumulative eggs. Only for Albion was a soil treatment and variety interaction detected, with AMF+VERM supporting lower cumulative mite-days (P < 0.0234) and eggs (P < 0.0061) as compared to its control, while VERM increased cumulative mite-days (P < 0.0115) and eggs (P < 0.0060) as compared to its control. For Chandler and Sweet Charlie no significant difference between live soil inoculants and their controls for cumulative mite-days or eggs was detected. For the variety Albion the addition of live AMF and vermicompost appeared to infer a negative effect on T. urticae population growth and fecundity. Further understanding of the interaction of AMF and vermicompost on T. urticae populations is required.

Specified Source(s) of Funding: North American Strawberry Growers Research Foundation

(338) The National Strawberry Sustainability Initiative: From Laboratory to Field

Curt R. Rom*
Dale Bumpers College, Fayetteville, AR; crom@uark.edu
Ronald L. Rainey
University of Arkansas, Little Rock; rrainey@uax.edu
Jennie H. Popp
University of Arkansas, Fayetteville; jhpopp@uark.edu
Heather Friedrich
University of Arkansas, Fayetteville; heatherf@uark.edu
Freeman Luke
University of Arkansas, Fayetteville; lfreeman@uark.edu

The National Strawberry Sustainability Initiative program was managed by the University of Arkansas System Division of Agriculture, Center for Agricultural and Rural Sustainability and funded by a gift of the Walmart Foundation. In Phase 1 of the program, emphasis was placed on moving research from the laboratory to demonstration. Goals of Phase 1 were to increase the local, regional and seasonal availability of strawberries, to reduce chemical, energy and water inputs in production, to reduce postharvest product loss and improve produce safety, to increase economic value of the crop through the supply chain, and to construct meaningful measurements of sustainability. Twenty grants were awarded a total of $2.6 million. Projects were required to participate in significant outreach and engage in social media. A Phase 2 of the program was initiated in 2014 with the goal of moving sustainable strawberry production from demonstration to practice engaging growers and stakeholders in the supply chain to achieve sustainability goals of the program and increase local, regional and seasonal availability of strawberries in the United States. In phase 2, $850,000 was awarded. Results of Phase 1 and projects for Phase 2 will be presented. Project results and progress can be found at the various program locations: http://strawberry.uark.edu/; http://wordpress.uark.edu/sberries/; https://www.facebook.com/StrawberrySustainabilityInitiative; https://www.youtube.com/channel/UC55G_p-ZM58goZtu_OYEtA; and http://nssi.smugmug.com/. Specified Source(s) of Funding: Walmart Foundation
Consumer Horticulture, Master Gardeners and Public Horticulture

(039) Consumer Attitudes about Biorenewable Plant-container Technology and Sustainability in Nevada

Heidi A. Kratsch*
University of Nevada Cooperative Extension, Reno; kratschh@unce.unr.edu

Hannah Mathers
The Ohio State University, Columbus; Mathers.7@osu.edu

Barrett Kirwan
University of Illinois at Urbana-Champaign; bkirwan@illinois.edu

Environmental sustainability can be defined in many ways, and consumers differ in their attitudes about product attributes they consider sustainable. Knowing the distinctions among consumers in their preference for biorenewable plant containers enables our team to better understand the market, and provides information the plant-container industry can use to develop marketing and labeling strategies. We conducted an online survey of 800 current and former consumers of University of Nevada Cooperative Extension horticultural programs. Our objectives were to: 1) determine the characteristic(s) of biorenewable plant containers deemed most desirable and 2) provide profiles of potential purchasers of biorenewable plant containers. Respondents (N = 215) were mostly homeowners, frequent plant purchasers and represented a wide range of household incomes, from under $39,000 to over $100,000. They ranged in age from 25 years to more than 60 years and were relatively educated, over half with a bachelor’s degree or greater. Their greatest environmental concerns were about use of genetically modified organism (GMOs) (74.6%; n = 178), and overuse of chemical pesticides (85.3%; n = 168) and fertilizers (78.8%; n = 156). Respondents valued plant quality over any one plant-container type, with greater than two-thirds somewhat likely to highly likely to purchase containers identified as either reusable/recyclable (73.5%; n = 150), biodegradable (76.0%; n = 152), compostable (75.8%; n = 141), or fertilizing as the plant grows (65.1%; n = 125). Overall, most were willing to purchase any of these container types, as long as it could be demonstrated that they improved or were neutral to plant health and the environment. Respondent willingness to pay extra for biorenewable plant containers was income-dependent (P < 0.05), and respondents were more willing to pay extra for a container that fertilizes the plant as it grows than for any other container type. Our data enabled us to create income-based profiles of potential purchasers of biorenewable consumers in Nevada. The Nevada survey will serve as a model for a nationwide survey to further define and segment markets for biorenewable plant containers.

Specified Source(s) of Funding: USDA National Institute of Food and Agriculture

An asterisk (*) following a name indicates the presenting author.

(040) Determining Appropriate Drying Methods and Marketability of Native Central Texas Cut Dried Floral Materials

Tina Marie (Waliczek) Cade
Texas State University, San Marcos; tc10@txstate.edu

John Montoya*
University of Hawaii, Honolulu; montoyaj@hawaii.edu

The purpose of this study was to investigate best methods of drying and the marketability of native Central Texas cut dried floral materials. Eleven native species, including both woody and herbaceous plants, were included in the study. Each of the species were subjected to four different drying techniques including air drying, submersion of stems in anti-freeze, submersion of stems in glycerin and complete burial in silica gel. Floral product surveys were distributed to students enrolled in the Floral Design course at Texas State University. The students observed the different floral products dried using different techniques and rated the quality of each cut dried floral material using a Likert scale of 1 through 5 with one being the most appealing and five being the least appealing regarding overall color, sturdiness/Intactness, design usability/usefulness, and use for potpourri. Results demonstrated drying techniques resulting in the best aesthetics for various uses for each species, as well as the overall floral product preferences of the survey respondents. Results showed the potential for marketing novel native crop products beyond typical nursery and greenhouse crops.

(041) Lunch and Lawn: Can You Have Grass and Eat Too?

Ellen Bauske*
University of Georgia, Griffin; ebauske@uga.edu

Clint Waltz
University of Georgia, Griffin; cwaltz@uga.edu

Robert Westerfield
University of Georgia, Griffin; bwestern@uga.edu

Enthusiasm for local food production and self-sufficiency, as well as concern over food safety has generated increased interest in home vegetable gardens. However, many urban dwellers have small outdoor spaces and often lawns occupy the only full sun areas of the landscape. In order to explore the possibility of using the same space for fall vegetable production and a warm-season summer lawn, Top Bunch Hybrid collards, Sweet Surprise cabbage, Kaboko cabbage, Coronado Crown Hybrid broccoli (Brassica sp.) and Butter Crunch lettuce, (Lactuca sativa) were planted into a hybrid Bermuda grass lawn in late September. Sod cutters were used to cut strips 13 cm, 18 cm, and 46 cm wide into the turfgrass. All five cultivars were planted into the strips. Broccoli, lettuce, and collards were also planted in 46 x 91 cm plots. All cultivars were also planted directly into turfgrass (61 cm apart). Plants were fertilized individually at the rate of 50 g/m² at planting and again at four weeks. Field observations were made through early December on general plant health and yield. Lettuce, collards and cabbage were successfully produced in the 18 cm row, 46 cm row and the 46 x 91 cm plots. Lettuce,
collards and cabbage were not successful in the 13 cm row or when directly planted into turfgrass. Broccoli produced edible florets in all treatments.

(042) Extension Public Gardens in Central Florida: Opportunities and Challenges
Juanita Popenoe*
University of Florida IFAS Extension, Tavares; jopopenoe@ufl.edu
Richard V. Tyson
UF/IFAS Extension Orange County, Orlando, FL; rvt@ufl.edu
Kelly Greer
UF/IFAS Extension Orange County, Orlando, FL; kg@ufl.edu

Demonstration gardens at Lake and Orange County Extension offices provide excellent opportunities for hands-on instruction. Both gardens are a little more than 3 acres divided into smaller theme gardens emphasizing low maintenance Florida-Friendly Landscaping™ principles and locally recommended plant varieties and urban farming production techniques. Horticulture Extension Agents conduct periodic plant trial projects in the garden to assess variety adaptive traits for plant material in central Florida and classes on landscape installation and food production. Ongoing hydroponic and aquaponic production systems are maintained and used as field demonstrations for local food system urban farming workshops. Initial funding was provided by the county in one instance and public/private cooperative funding in the other. Subsequent donations and in-kind support come from stakeholders and Master Gardener volunteers. It is difficult to maintain gardens of this size with volunteers. In one county, budget cuts in the last several years have reduced the paid positions and put a strain on the Master Gardener volunteers who are often older and less able to perform physically demanding tasks. The continued success of Extension demonstration gardens require County government, stakeholders and volunteer backing to survive and grow. They are an asset to the community and fundamental to Extension as an educational resource.

(043) Training and Demonstration of Best Management Practices in Vegetables and Fruits on Small Farms in North Florida
Gohar Umar*
Florida A&M University, Tallahassee; Gohar.Umar@famu.edu
Bobby Phills
Florida A&M University, Tallahassee; Bobby.Phills@famu.edu
Muhammad Haseeb
Florida A&M University, Tallahassee; Muhammad.Haseeb@famu.edu

Fruits and vegetables production in North Florida at small farms has not achieved its full potentials due to limited new knowledge and improved farm technology including new cultivars availability. To find the solution to these challenges, vegetable demonstration plots were setup with 72 raised beds in 2 blocks and 28 rows (60 feet long) in 2 blocks as a part of FAMU’s Small Fruits and Vegetables Outreach Program using best management practices. The suitable cultivars to North Florida’s ecological conditions were carefully selected. Also, selected vegetables were planted in early March to April and grown throughout summer and fall. The vegetable crops consisted of okra, mustard greens, red bell pepper, green beans, mustard, turnips, collard greens, eggplants, and tomatoes. Fruit trees were planted around vegetable production area. Fruit trees included peach, plum, nectarine, grapes, apple, pear, citrus, and persimmon. These crops were evaluated for small farm productivity and profitability for small growers. To train small farmers, extension agents, and students in horticultural best management practices, several hand-on workshop and trainings were conducted throughout the year that included workshops on soil preparation, seed sowing, fertilization, irrigation, pruning, grafting, pesticide training, and a Grape Harvest Festival. On-farm training and demonstrations were carried out to disseminate the improved technology. Also, we provided experiential learning experiences to K-12 participants. All participants received extensive hands-on experiential learning on best management practices from our trained outreach and extension faculty, collaborators and staff. The linkages and partnerships developed under this program has enhanced the extension component of the College of Agriculture and Food Sciences in serving the underserved communities in urban settings.

Specified Source(s) of Funding: USDA,NIFA Capacity Building Grants Program

Wednesday, July 30, 2014

Floriculture 2

(102) Fertilizer Rate, Soil Type, and Beneficial Microorganism Application Influenced Poinsettia Growth and Development
Corrie P. Cotton*
University of Maryland, Eastern Shore, Princess Anne; cpcotton@umes.edu
Fawzy M. Hashem
University of Maryland Eastern Shore, Princess Anne; fmhashem@umes.edu
Lurline E. Marsh
University of Maryland Eastern Shore, Princess Anne; lemash@umes.edu

Beneficial microorganisms, such Vesicular-Arbuscular Mycorrhizae (VAM) and Trichoderma fungi, have been attributed to improve plant uptake of macro and micronutrients and enhance water availability. The main objective of this study was to examine the application of VAM and a commercial product, RootShieldTM containing Trichoderma harzianum, and fertilizer rates, on the growth and development of poinsettias. The study was conducted in the greenhouse in a complete randomized block design with four treatments (Control, VAM, RootShield™, and VAM plus RootShield™); two soil media (Sunshine Mix plus vermiculite and Promix Bx Mycorise Pro plus vermiculite); and

An asterisk (*) following a name indicates the presenting author.
three fertilizer rates (recommended rate, 75% recommended rate, and 50% recommended rate), with four replications each. Poinsettia cuttings, Poi Cortez Burgundy, were obtained from Greenstreet Grower, Inc. Treatments were added at the time of transplanting. Plant height, root length, color change, and shoot and root dry weights were determined. Fertilizer rate, soil type, and treatment influenced plant growth and development. There was a significant difference in root dry weight and root length when fertilizer was applied at the 50% recommended rate, and a significant difference in shoot dry weight and shoot height when fertilizer was applied at 75% recommended rate. For shoot heights, a significant interaction between treatment and fertilizer was detected, suggesting that treatment effect depended on fertilizer rate. There was also a significant difference in plant color among soil types. Changes in color were examined 23 days earlier in plants grown in Promix Bx Mycorise Pro when compared to Sunshine Mix. More studies will be conducted to further assess the effects of reduced fertilizer rates, beneficial microorganisms, and soil type on growth and development of poinsettias.

Specified Source(s) of Funding: Evans-Allen

(103) Maintaining the Foliage of the Rootstock Impacts the Quality of the Flowering Stem Developed from the Bud Grafted in Cut Roses

Ana Maria Castillo-González*
Universidad Autonoma Chapingo, Chapingo, Mexico CP 56220; anasofiacasg@hotmail.com

Luis Alonso Valdez-Aguilar
Universidad Autonoma Agraria Antonio Narro, Saltillo; luisalonso_va@hotmail.com

Gerardo Pablo-Osorio
Universidad Autonoma Chapingo, Chapingo; pablo_8813@hotmail.com

Edilberto Avitia-Garcia
Universidad Autonoma Chapingo, Chapingo; laura_sofi1990@hotmail.com

Cut roses (Rosa L. hybrida) are acknowledged as the most popular cut flower due to its attractiveness and variety of forms and colors. Rose propagators usually remove the foliage from the rootstock as soon as it is bud-grafted, however, no research has been performed to demonstrate weather this common practice is beneficial for plant growth. If not removed, the foliage of the rootstock may be a source of photosynthates for the developing bud until the grafted plant has formed its own foliage and is able to meet its demands. The present research was performed to determine the influence of the maintaining the foliage of the rootstock for a longer period of time on the growth, nutrient status and total soluble sugars (TSS) of the flowering stem. Buds of cv. Freedom were grafted on cuttings of Rosa montezumaerooted on a volcanic rock-based medium placed on black polyethylene bags and grown in hydroponics. Treatments consisted on maintaining the foliage of the rootstock for 8, 28, 48, and 68 days after grafting (DAG). Length and diameter of the flowering stem that developed from the grafted bud was measured when the flower bud was visible; plants were harvested and separated into stems, leaves and flower buds for determination of nutrient status and TSS. Results showed that flowering stems were twice as long when the foliage of the rootstock was maintained for 68 DAG. Nitrogen, phosphorus and calcium concentration on stems, foliage and flower bud increased after 28 DAG but tended to decrease afterwards. Potassium concentration tended to decrease in stems and foliage whereas it exhibited no consistent tendency in the flower buds. Magnesium increased in the leaves from grafting time up to 48 DAG but decreased thereafter. Concentration of TDS in the stem and flower bud increased by two-old at 68 DAG. We conclude that maintaining the foliage in the rootstock for a longer period of time enhances growth of the flowering stem; nutrient status and TDS increased from grafting time up to 28 DAG while length and diameter were increased when the foliage was maintained in the rootstock for 68 DAG.

(104) Variations in Flowering Characteristics of Oncidium Intergeneric Hybrid Orchids

Xinxin Li
University of Hawaii at Manoa, Honolulu; lixinxin0476@163.com

Hye-Ji Kim*
University of Hawaii at Manoa, Honolulu; hkim2@hawaii.edu

Kenneth Leonhardt
University of Hawaii at Manoa, Honolulu; leonhard@hawaii.edu

Oncidium intergeneric hybrid orchids are popular potted flowering plants available in a huge selection of versatile colors and shapes. Twelve varieties of Oncidium intergeneric orchids were selected for potential as cut flowers and evaluated for flowering characteristics. Six month old propagules were grown in a saran greenhouse with fertigation based on recommended farm practices. Seasonal flowering behavior and flowering characteristics were assessed from October 2012 to September 2013. The majority of varieties produced flower spikes during the months of July and August, while a few varieties generated flower spikes randomly throughout the year. The maximum number of flower spikes produced per month varied by variety, ranging from 2 to 8 spikes per pot. The number of days from spike emergence to anthesis of the first flower also greatly varied by variety. Similarly, the duration from the first to the last flower opening along the spike ranged from 4 to 23 days. The large variation in seasonal flowering, and in the pattern of flower opening suggest that there is good potential to identify suitable varieties of Oncidium intergenerics for cut flower production.

(105) A Trailing, Low-temperature Tolerant, Double-flowered Interspecific Torenia

Tzu-Yao Wei*
National Taiwan University, Taipei; nehs32@gmail.com

Meng-Hua Guo
National Taiwan University, Taipei; lovemayday770324@hotmail.com

An asterisk (*) following a name indicates the presenting author.
An asterisk (*) following a name indicates the presenting author.

**(106) Photosynthesis and Vegetative Growth of Phalaenopsis ‘Hwasu 3551’ and ‘White-Red Lip’ in Response to Low Temperature during Nursery Cultivation**

Yun Yeong Hong*

Department of Horticultural Science & Biotechnology, Seoul National University, Seoul; undine42577@gmail.com

Yu Jin Park

Research Institute for Agriculture and Life Sciences, Seoul National University, Seoul; fannyujin@gmail.com

Hyo Beom Lee

Department of Horticultural Science & Biotechnology, Seoul National University, Seoul; hyobumi1003@snu.ac.kr

Ki Sun Kim

Research Institute for Agriculture and Life Sciences, Seoul National University, Seoul; kisun@snu.ac.kr

We investigated the effects of low temperature on photosynthesis and vegetative growth during nursery cultivation of two Phalaenopsis hybrids, ‘Hwasu 3551’ (HS) and ‘White-Red Lip’ (WR). One-month-old plants were grown in a growth chamber at 28/26 °C and transferred to low temperature at 21/19 °C every two weeks for 28 weeks. Diurnal net CO₂ uptake pattern of HS and WR was observed into four phases; phase I (night), phase II (early morning), phase III (morning and afternoon) and phase IV (late afternoon). Regardless of transferring time, in phase I, HS and WR reached the highest net CO₂ uptake rate of ≈6.65 µmol·m⁻²·s⁻¹, showing typical crassulacean acid metabolism (CAM) photosynthesis under both 28/26 °C and 21/19 °C. During phase II and IV, in HS and WR, CO₂ absorption rate under 28/26 °C showed C3-CAM pattern while that under 21/19 °C showed CAM. In phase III, two cultivars released CO₂ under 21/19 °C, whereas CO₂ uptake maintained at near zero under 28/26 °C. When plants were transferred at 0 week and cultivated at 21/19 °C for 28 weeks, CO₂ uptake of HS and WR during the daytime increased by 190% and 938%, respectively, compared to that of HS and WR transferred at 16 week. At 30 weeks after the treatment, when plants were transferred at 24, 26, and 28 weeks, leaf length and leaf area of HS were averagely 3.43 cm longer and 19.74 cm² larger, respectively, than those transferred at 0, 2, 4, 6, and 8 weeks. In case of WR, leaf length and leaf area of the plants transferred at 24, 26, and 28 weeks averaging 2.89 cm longer and 14.92 cm² larger, respectively, than those transferred at 4, 10, 12, 16, and 22 weeks. These results indicated that the diurnal CO₂ uptake pattern of two Phalaenopsis hybrids changed from C3-CAM to CAM pathway more rapidly when plants were transferred to low temperature regardless of transferring timing. When plants were transferred to low temperature after at least 24 weeks of warm temperature, low temperature does not significantly reduce the vegetative growth rate of Phalaenopsis hybrids HS and WR during nursery cultivation.

**Specified Source(s) of Funding:** 101-2313-B-002-004-MY3

**(107) Application of Precision Agriculture Technology to Determine N Level in Chrysanthemum**

Amir Ali Khoddamzadeh*

Oklahoma State University, Stillwater; aa.khoddamzadeh@okstate.edu

Bruce L. Dunn

Oklahoma State University, Stillwater; bruce.dunn@okstate.edu

Determination of variable-rate nitrogen (N) fertilization using optical spectrometry sensors in flowers is becoming an interesting vista for commercial growers. Nitrogen (N) is an important component of proteins and chlorophyll (Chl), and has been correlated with nondestructive reflectance sensors as a means to determine N status during crop production. In this experiment, chrysanthemums ‘Amico Bronze’ and ‘Jacqueline Yellow’ had different fertilizer treatments (0, 5, 10, 15, or 20 g of 16 N–9 P–12 K) ranging from deficient to excess with 10 replications each. Continuous response variables of Normalized Difference Vegetation Index (NDVI), Soil Plant Analytical Development (SPAD) and atLEAF sensor readings were analyzed using generalized linear mixed models methods for six weekly (10, 17, 24, 31, 38 and 45 days after adding treatments; DAT) repeated measurements. The results indicated that leaf N (LN) was correlated with N treatment in all treatments except 17 DAT. Normalized Difference Vegetation Index was correlated with LN in the early stages of plant growth as well as the final stage before flowering. Normalized Difference Vegetation Index
increased linearly up to 31 DAT for all treatments then plateaued at 45 DAT. The SPAD readings were correlated with LN as early as 24 DAT, whereas, NDVI was correlated as early as 10 DAT. Finally, after 45 DAT all sensors were correlated with LN in ‘Jacqueline Yellow’. The Atleaf sensor was not correlated with LN at any sampling date. The results of this study indicate that both SPAD and NDVI meter can be used to indicate N status in chrysanthemums.

Specified Source(s) of Funding: Oklahoma Department of Agriculture, Food & Forestry, Oklahoma Floriculture Specialty Crops

(109) Induction and Characterization of Tetraploids and Octoploids in Impatiens (Impatiens walleriana)

Weining Wang*
University of Florida, Wimauma, FL; billwang@ufl.edu

Zhanao Deng
University of Florida, Wimauma, FL; zdeng@ufl.edu

Impatiens (Impatiens walleriana) is one of the top bedding plants in the United States and is widely used in the landscape, window boxes, and hanging baskets. Commercial impatiens cultivars are diploids with \( 2n = 16 \) chromosomes. Little information is available about the effects of polyploidy on the morphology and ornamental values of impatiens. This study was conducted to induce polyploids in impatiens and to determine their morphological differences from diploids. Germinating seeds of ‘Super Elfin Lipstick’ impatiens were treated with colchicine (0.05% to 0.20%) for 2.5 days. Induced polyploids were identified through flow cytometry analysis. A total of 13 solid polyploids (9 tetraploids and 4 octoploids) were found out of 31 plants analyzed. Compared to diploids, impatiens tetraploids and octoploids exhibited thicker leaves with larger leaf blades. Microscopic observations showed that tetraploids and octoploids had fewer, but larger stomata than diploids did. Tetraploids seemed to produce fewer flowers, and octoploids produced even fewer. Octoploids also showed thicker stems and smaller branching angles, making plants look more upright. Results from this study indicate that induced polyploidy can have profound influence on impatiens’ plant morphology and garden performance.

An asterisk (*) following a name indicates the presenting author.
(323) Phenolic Content and Antioxidant Capacity of Spicebush (Lindera benzoin L.) Teas

Hideka Kobayashi*
Kentucky State University, Frankfort; hideka.kobayashi@kysu.edu
Kirk William Pomper
Kentucky State University, Frankfort; kirk.pomper@kysu.edu
George Antonious
Kentucky State University, Frankfort; george.antonious@kysu.edu

Health benefits of tea [Camellia sinensis (L.) Kuntze], especially green tea, have been found in many studies, and those include lowering low-density lipoprotein and total cholesterol levels and the risk of coronary artery disease. Reputedly, green tea also has anticancer properties, but the results have been inconclusive. Despite potential health benefits, green tea contains high amounts of aluminum, fluoride, and oxalate that can be harmful to human health at higher concentrations. In addition, imported green tea may also be contaminated with pesticides, heavy metals such as copper and lead, and other pollutants. Aside from C. sinensis, leaves and other aerial parts of many species have been used for tea. Spicebush [Lindera benzoin (L.) Blume] is native to the eastern part of the U.S. from Maine to Texas, and can be found growing abundantly. Spicebush leaves and small stems have been used as tea while its potential as a tea source has not been fully exploited. The objective of the study was to examine phenolic content and antioxidant capacity of tea processed from dried leaves of spicebush. Leaves were harvested in 2012 and 2013. Leaves were washed and lightly dried with a paper towel. After weighing samples, samples were placed in a microwavable plastic bag for 30 sec./50g samples. Immediately after steaming, samples were roasted on an electric skillet at 200 °C. Spicebush teas were brewed by placing samples in boiling water for 10 min. Teas were filtered through a filter paper, prior to analysis and stored at 4 °C. Folin-Ciocalteu assay was performed to determine phenolic content of both spicebush samples and Lipton green tea, using gallic acid as a standard. Phenolic content of green tea was 19.0, while that of spicebush tea was 1.7 g of gallic acid equivalent per 100 g of dry weight. Similarly, Ferric Reducing Antioxidant Power assay was performed to assess antioxidant capacity of these teas, determined as 1068.1 (green tea), and 263.2 (spicebush tea) expressed in mmol of Trolox® equivalent per g of dry weight. While phenolic content and antioxidant capacity of spicebush tea were less than those of green tea, domestic and sustainable production of spicebush tea may create opportunities for both farmers and health-conscious consumers.

Specified Source(s) of Funding: USDA 1890 Capacity Building Grant


John Balles*
Amway Corporation, Lakeview, CA; john.balles@amway.com
Jatinder Rana
Amway Corporation, Ada, MI; Jatinder_Rana@amway.com
Dale J. Schipper
Amway Corporation, Ada, MI; dale.schipper@amway.com
Jessica Corcorran
Amway Corporation, Ephrata, WA; jessica.corcorran@amway.com

A field experiment was initiated in 2012 at the Amway Corporation certified organic farm in eastern Washington state. Commercially available varieties (6 of each species) of Echinacea purpurea (Purple Coneflower) and Echinacea angustifolia (Narrow-Leaf Coneflower) were evaluated in a RCB, strip-split block field design, with 3 replications. Year of harvest [age of the plants at harvest] were the main blocks, with replications sub-blocked within each year, and varieties randomized within years. Individual experimental units consisted of 4 rows spaced 39 cm apart and 3 m long. For E. purpurea, the center two rows were harvested for aerial tops at an early bud stage, and roots near the end of the growing season. E. angustifolia roots were also harvested near the end of the growing season. Fresh and dry weights of aerial parts and/or roots from each experimental unit were recorded, and sub-samples collected for analytical chemistry and elemental analysis. The project will run for three years, and this report focuses on a combined analysis of the 2012 and 2013 results.

(325) An Effect of Natural Yuju Oil on Moisturizing, Erythema, Melanin, and Elastic Efficacy by Essential Oil Production Methods

Gyeong-suk Jo*
Jeollanamdo Agricultural Research & Extension Service, Najusi, Jeollanamdo; hyeong21@korea.kr
Gwang Yeon Gi
Jeollanamdo Agricultural Research & Extension Service, Najusi, Jeollanamdo; gygi4975@korea.kr
Bong gi Yun
Jeollanamdo Agricultural Research & Extension Service, Najusi, Jeollanamdo; bkyoon57@korea.kr
Jae sin Lee
Jeollanamdo Agricultural Research & Extension Service, Najusi, Jeollanamdo; olivejs7@korea.kr

To verify the skin efficacy of natural essential yuju oil extracted by a steam distillation extraction and expression method, natural essential oil diluted with 5% jojoba oil was spread on the forearm and cheek area, and then measured at 1-hour intervals for a total of 6 hours. In both men and women, the moisturizing effect improved when compared with washing face before spreading oil. As for the whitening effect, there was more reduction in expressing essential oil in forearm and distilled essential oil in cheek against melanin pigment, which showed good whitening effect. Expressing essential oil had better effect in erythema as an effect of inflammation relief. Skin pH was average 5.2~5.8 with slight acid. Elasticity increased slightly.
(326) An Effect of Native Herbal Essential Oil of Chrysanthemum boreale Makino EGG and Autonomic Nervous System Responses

Gyeong-suk Jo*
Jeollanamdo Agricultural Research & Extension Service, Najusi, Jeollanamdo; hyeong21@korea.kr

Kyeo-Ju Choi
Jeollanamdo Agricultural Research & Extension Service, Najusi, Jeollanamdo; kjchoi@korea.kr

Jeung Keun Suh
College of Bio-Resources Science, Dankook University, Cheonan-si, Chungcheongnam-do; suh6971@dankook.ac.kr

To verify the efficacy of psychological aroma therapy on natural essential yuji oil extracted by expression method, this study examined the effect on ECG and EEG responses to 20 men and women. Natural essential oil diluted with 10% ethyl alcohol was input on flavor test sheet, which the subjects smelled in 3 minutes interval randomly. It was measured with a calibrator. As a result, AFA and RFA, Upper Alpha waves that increased comfort and concentration, increased significantly. Autonomic nervous system HRV had significantly reduced sympathetic nerve that is activated at arousal and stressful situation. Accordingly, the expressing essential oil having original natural scent of yuji is assessed as having efficacy of reducing stress and of improving concentration and learning ability.

Wednesday, July 30, 2014

Plant Biotechnology

(271) Somatic Embryogenesis and Organogenesis of Rare Woody Species in Georgia, Stewartia and Franklinia

Heather J. Gladfelter*
University of Georgia, Athens; hjgladf@uga.edu

Scott A. Merkle
University of Georgia, Athens; smerkle@uga.edu

Propagation of rare and endangered plant species via seed is often challenging due to difficulties with seed collection, low seed yields and viability, and sometimes complicated requirements for germination. Also, sites for collection are few and the amounts of seed and plant material are limited. As an alternative to propagation by seed, this research investigated the use of plant tissue culture methods, specifically somatic embryogenesis and organogenesis, to enhance the populations of two rare and one extinct woody plant species in Georgia, Stewartia malacodendron Linnaeus (Silky camellia), Stewartia ovata (Mountain camellia), and Franklinia alatamaha (Franklinia), respectively. At present, only 40 populations of S. malacodendron are known to exist and they are currently located on three state conservation lands, military bases, and a few on private lands in Georgia. Franklinia has not been seen in the wild since 1804. Seeds from immature fruit capsules for each species were surface-disinfested and zygotic embryos were aseptically excised and cultured on sterile semisolid culture media supplemented with various types and concentrations of plant growth regulators (PGRs). Adventitious shoot organogenesis was induced on embryo explants of F. alatamaha and S. ovata using 0.1 mg/L Indole-3-butyric acid (IBA) and 1 mg/L 6-Benzylaminopurine (BAP). Somatic embryogenesis was induced at a very low frequency in the presence of 2 mg/L 2, 4-Dichlorophenoxyacetic acid (2, 4-D) on excised embryos with endosperm explants of S. malacodendron and S. ovata. Propagation of Stewartia and Franklinia using plant tissue culture methods demonstrates the ability to increase the populations of rare woody plant species to support conservation and restoration efforts.

(272) Genetic Transformation of Micro-Tom Tomato with a Citrus Calcium Signal Modifier Gene (CSM-1)

Eliezer Louzada*
Texas A&M University- Kingsville Citrus Center, Weslaco; eliezer.louzada@tamuk.edu

Zenaida Viloria
Texas A&M University-Kingsville Citrus Center, Weslaco; Zenaida.Viloria@tamuk.edu

Madhurababu Kunta
Texas A&M University-Kingsville Citrus Center, Weslaco; madhura.kunta@tamuk.edu

Don Henne
Texas AgriLife Research, Weslaco; dchenne@ag.tamu.edu

Candidatus Liberibacter (Ca. L.) sp. infects citrus and several members of the Solanaceae family, including tomatoes and causes reduction of productivity. In citrus, Ca. liberibacter asiaticus, causal agent of citrus greening or HLB, has been devastating the Florida citrus industry and the bacterium is already spread to several states. Ca. L. solanacearum (Lso) infects tomatoes, potatoes and other solanaceous crops. Transgenic citrus plants transformed with a calcium signal modifier (CSM-1) gene showed resistance to a bacterial and two fungal pathogens in preliminary detached leaf assays and are going to be tested for resistance to HLB. Citrus has a long juvenile period, and any unintended consequences of the overexpression of a gene will take long time to be detected. Atomato variety called Micro-Tom (MT) was used in this research as model organism to evaluate the expression of CSM-1 gene, in attempt to determine if this gene, without being codon optimized for tomato, would deliver any resistance to Lso bacterium and to evaluate any possible “side effects” of CSM-1 expression. Agrobacterium-mediated genetic transformation was performed and 18 transgenic lines were produced and expression of CSM-1 gene was verified by RT-PCR. Some transgenic MT lines produced seedless fruit; other lines produced low to moderate seeds giving a mean of 2.12 seeds per fruit and a 60% germination rate. Pollen viability was determined by germination on semi-solid medium for seedless lines and observed every 3h. Wild type MT pollen germination
An asterisk (*) following a name indicates the presenting author.

**Contributor Information**

Nanjing Forestry University, Nanjing; mengxu412@126.com
Yuan-yuan Tao
Nanjing Forestry University, Nanjing; 616290050@qq.com
Donglin Zhang
University of Georgia, Athens; donglin@uga.edu
Jun Yuan*
Hunan Provincial Cooperative Innovation Center of Non-wood Forest Cultivation and Utilization, Changsha; yuanjunchina@126.com

Gingko biloba is a tree species with high economic value and research potential. To better understand their molecular phylogeny among Gingko clones, we obtained 44068 ESTs from female strobili and 29779 ESTs from leaves and 157327 DNA sequences by 454GSFLX sequencing. A total of 562 ESTs containing SSRs in female strobili, 336 ESTs in leaves, and 3044 in the genome DNA with SSRs were discovered. We designed 556 pairs of EST-SSR primers with Primer 5.0 and 417 pairs of them could be steadily amplified. We designed 432 pairs of genomic SSR primers and obtained 132 pairs with steady amplification. Polymorphism analysis was carried on in 6 samples and 176 pairs of EST-SSR and 82 pairs of genomic SSR primers were polymorphism, accounting for 31.7% and 41.0% of the total designed primers. These primers with polymorphism could be used as molecular tools for future genetic research in Gingko biloba. With these polymorphic primers, we selected 30 pairs of EST-SSR and 10 pairs of genomic SSR primers and applied them for 48 seed produced Gingko clones. The results revealed that up to 7 alleles were detected with 40 pairs of primers in 48 clones, 3.4 markers on average at each locus. Phylogenetic relationships of 48 clones were constructed and specific bands were observed in 21 of them. All 48 clones could be distinguished completely with 5 pairs of EST-SSR and 3 pairs of genomic SSR primers selected from the above. Among these primers, Gb_gSSR38 and Gb_eSSR120 were high efficient and their combination could separate 25 clones.

**Specified Source(s) of Funding:** Partially funded by the USDA-Hispanic Serving Institutions Educ. Grants Program

**Poster Presentations**

### (273) *Camelina* Species Under Drought Stress

**Geung-Joo Lee**
Chungnam National University, Daejeon; gjlee@cnu.ac.kr

**Ka Yeon Lee**
Chungnam National University, Daejeon; gjlee@cnu.ac.kr

**Young-In Choi**
Chungnam National University, Daejeon; N/A

**Sung Jin Chung**
Chungnam National University, Daejeon; N/A

A commonly referred ‘false flax or gold-of-pleasure *Camelina sativa* has been interested as one of biofuel feedstocks. The species can grow on marginal land due to superior drought tolerance and low requirement of agricultural inputs. Use of gene-specific molecular markers is an important strategy for new cultivar development in our breeding program. Automated sequencing tool along with bioinformatics was adopted to obtain expression profiling of genes responding to drought stress in the *Camelina* species. A total of assembled loci were more than 60,000, which corresponds to about 275K transcripts for the loci. Compared to control, up-regulated genes were 107, 2,989 and 982 when the species was exposed to 10, 100 kPa, and rehydrated conditions, respectively. Similarly down-regulated genes were 146, 3,659 and 1,189 for the three drought regimes, respectively. There are some unknown genes which were highly expressed at drought condition, but already reported gene families such as senescence-associated genes, CAP160, LEA at 100 kPa soil water condition, and cysteine protease, 2OG and Fe(II)-dependent oxygenase, RAD-like 1 at rehydrated condition. Those genes will be further validated and mapped for the function and genic loci. This EST library will be favorably applied to development of gene-specific molecular markers and discovering of genes responsible for drought tolerance in the *Camelina* species.

**Specified Source(s) of Funding:** This research was supported by Bio-industry Technology Development Program(Project no.312033-5), Ministry for Agriculture, Food and Rural Affairs, Republic of Korea.

### (274) Develop Microsatellite Markers for *Ginkgo biloba* L. Clones

**Li-an Xu**
Nanjing Forestry University, Nanjing; laxu@njfu.edu.cn

**Xing-xing Wang**
Nanjing Forestry University, Nanjing; 504789048@qq.com

**Meng Xu**
Nanjing Forestry University, Nanjing; mengxu412@126.com

Offspring of transgenic MT tomato plants were infected with Lso via tomato/potato psyllid (Bactericera cockerelli) feeding and infected plants were confirmed by quantitative PCR (qPCR). CSM-1 gene copy number was determined through qPCR and verified by Southern blots for shoots excised from transgenic calli (T0 plants). Additional information will be presented.

**Specified Source(s) of Funding:** National Forestry Public Welfare Industry Research Project of China (201204403)

### (275) Molecular Regulatory Mechanism of *Ginkgo biloba* L. from Next-generation Sequencing Technology

**Hongjuan Zhang**
Nanjing Forestry University, Nanjing; zhanghj@njfu.edu.cn

**Fuliang Cao**
Nanjing Forestry University, Nanjing; flcao@njfu.edu.cn

**Donglin Zhang**
University of Georgia, Athens; donglin@uga.edu

**Jun Yuan**
Hunan Provincial Cooperative Innovation Center of Non-wood Forest Cultivation and Utilization, Changsha; yuanjunchina@126.com

*Ginkgo biloba* L. is a gymnosperm native to China and has a wide adaptability over more than 100 million years of dramatic climate changes. It is a living fossil for better understanding
An asterisk (*) following a name indicates the presenting author.

An objective of the multi-institutional RosBREED project is to develop genome scans in strawberry and other rosaceous crops and use them for identifying and validating QTL for fruit quality. Single nucleotide polymorphisms (SNPs) are useful genetic polymorphisms as they are very abundant in the genome and are amenable to high-throughput genotyping. The objective of this study was to evaluate genotyping-by-sequencing (GBS) as a genome scan in the allo-octoploid strawberry. One hundred and eighty nine individuals were chosen for GBS including: three mapping populations, cultivars and selections that are pedigree-linked to these mapping populations, and a set of diverse reference individuals with available genome-wide sequence data. The methylation-sensitive restriction enzyme ApeK1 was used to construct the GBS libraries. The first GBS library was prepared from 96 individuals and sequenced in one lane of an Illumina flow-cell using the HiSeq2000 sequencing platform. Sequences with high quality were trimmed and aligned to the strawberry \( F. \text{vesca} \) v. 1.0 genome reference using the Discovery Tassel Pipeline. The proportion of missing data in the hapmap files ranged from 14% to 100%. The missing data was > 58% in 12 samples and ranged from 25% to 58% in the next 12 samples. Two new GBS libraries being constructed include samples with > 25% missing data in the first experiment and the additional chosen strawberry individuals. We will evaluate the proportion of missing data, number of observed markers, cost efficiency, and genome coverage of markers on the physical \( F. \text{vesca} \) map and marker performance by constructing genetic linkage maps for the three mapping populations.

Specified Source(s) of Funding: RosBREED Project

(277) Rapid Assay of Tissue Specific Promoters in \( V. \text{itis} \)

Jonathan R. Jasinski
University of Florida/IFAS, Apopka; beetlebo@ufl.edu

Zhijian, T. Li
University of Florida/IFAS, Apopka; zjli@ufl.edu

Dennis J. Gray*
University of Florida/IFAS, Apopka; djg@ufl.edu

Grapevine (\( V. \text{vinifera} \)) is one of the world’s most economically valuable and prolific fruit crops with an area of 7.8 million hectares producing 65 million metric tons of fruit. Grapevine yields are negatively affected by a multitude of diseases every year requiring growers to utilize unsustainable methods of disease control such as pesticide and fungicide applications. Effective disease resistance cannot be incorporated into elite cultivars using conventional breeding due to the constraints of a long breeding cycle, self-incompatibility, and inbreeding depression. Precision breeding allows for the insertion of specific genetic elements from any cross fertile species into elite cultivars. The ability to rapidly test the expression of these genetic elements in living tissues by using particle bombardment provides a highly convenient and accurate method to determine...
the function of putative tissue specific genes, promoters, and other genetic elements. In this study, fruit-specific expression was determined by using grape berries and optimized parameters for particle bombardment. Microcarrier type, DNA concentration, rupture disk pressure, and target distance were determined using a test plasmid containing the enhanced green fluorescent protein (EGFP) gene that was overexpressed by a CaMV 35S promoter. Transient GFP expression was observed within 48 hours post-bombardment. Berries were assessed for both skin and mesocarp expression by determining the number of cells that expressed GFP. Resulting optimized bombardment parameters were subsequently used to evaluate tissue-specific expression of six putative fruit-specific promoters by comparing relative GFP expression in epidermis and mesocarp with somatic embryos, leaf, and stem tissue controls. Promoters evaluated due to their abilities to drive high levels of expression in fruit tissues included the V.vinifera thaumatin-like protein, (VvTL1) as well as orthologous fruit-specific promoters from P. pyrifolia (polygalacturonase PG2), and fruit-ripening promoters from Lycopersicum esculentum (phosphoenolpyruvate carboxylase PPC2, P119 and E8). Of these, only PG2 and VvTL1 were determined to exhibit fruit specific activity. By incorporating this rapid screening technique into precision breeding-based cultivar development, numerous genetic elements may be tested for functionality well before the trait is to be incorporated into elite cultivars.

Specified Source(s) of Funding: FDACS Viticulture Trust Fund, NIFA/USDA/SCRI

(278) Identification and Validation of Candidate Genes Affecting Volatile Compounds in Strawberry Fruits
Iraida Amaya*
University of Florida, Gainesville; iamaya@ufl.edu
Eduardo Cruz-rus
IFAPA, Malaga; eduardop.cruz@juntadeandalucia.es
Jose F. Sanchez-Sevilla
IFAPA, Malaga; josef.sanchez@juntadeandalucia.es
Kevin M. Folta
University of Florida, Gainesville; kfolta@ufl.edu

Strawberry fruit flavor is the result of a complex mix of sugars, acids, and volatile organic compounds (VOCs) synthesized from a wide range of precursors including amino acids, fenylpropanoids and fatty acids. Improvement of strawberry flavor while maintaining other important traits, such as agronomic and postharvest life, requires understanding the complexity of volatile biosynthesis. We have identified genomic regions controlling the content of several VOCs using the 232 x 1392 segregating population. In order to identify the genes responsible for the variation in some of these VOCs, we are undertaking a RNA-seq approach in selected lines of the 232 x 1392 population and by sorting RNA-seq data from a second population, Mars x Elyana, based on the content of the selected VOCs. For a cluster of four phenyl-derived esters and g-dodecalactone, in LG I-1 and LG VII-1, we have identified 3 candidate genes and are using qRT-PCR, eQTL analysis and transient RNAi-induced silencing in fruits to validate their involvement. The largest cluster of QTLs controlling 16 different volatiles was mapped to LG VI-1. We have selected two contrasting bulked pools of fruits from 10 lines each with high and low levels of the six esters with QTL with stable effects higher than 30%. To identify the determinants of these variations we aim to identify differentially expressed genes between the pools using illumina RNA-seq. Preliminary results will be presented.

Specified Source(s) of Funding: The OSU D.C. Kiplinger Endowment and OARDC SEEDS

(279) Petunia Metacaspases Are Regulated during Corolla Senescence and in Response to Abiotic Stress
Laura J. Chapin*
The Ohio State University/ OARDC, Wooster; chapin.23@osu.edu
Michelle L. Jones
The Ohio State Univ/OARDC, Wooster; jones.1968@osu.edu

Metacaspases are cysteine-dependent proteases that function during programmed cell death, stress, and cell proliferation in plants. A type I and a type II metacaspase from Petunia x hybrida (PhMC1 and PhMC2, respectively) were characterized during developmental and abiotic stress-induced senescence. Recombinant PhMC1 and PhMC2 proteins had activity against the arginine-specific cysteine protease substrate GRR (Boc-GRR-AMC). In vivo GRRase activity during flower development was highest in senescent petals, suggesting that metacaspases are involved in flower senescence. Immunodetection, with anti-PhMC1 and anti-PhMC2 antibodies, indicated that both proteins were up-regulated during petal senescence. Quantitative RT-PCR experiments to characterize gene expression showed that PhMC1 transcripts were up-regulated during petal senescence. Subsequent eQTL analysis showed that PhMC1 transcript abundance was higher than that of PhMC2 after nutrient starvation. Nitrogen and phosphorus deficiency resulted in similar increases in PhMC2 transcript abundance in leaves, while N deficiency resulted in a greater induction of PhMC1 than P deficiency. Metacaspases may be regulating programmed cell death during developmental and environmental stress induced senescence in both leaves and corollas.

Specified Source(s) of Funding: Spanish ministry of economy (grant AGL2012-40066) and European Union (IOF-328052)
(280) Transcriptomic Analysis of Cold Stress-responsive Genes in *Brassica oleracea*

Senthil Kumar Thamilarasan
Sunchon National University, Suncheon; senkuttybio@gmail.com

Jong-In Park
Sunchon National University, Suncheon; jipark@sunchon.ac.kr

Hee-Jeong Jung
Sunchon National University, Suncheon; my-656@hanmail.net

Nasar Uddin Ahmed
Sunchon National University, Suncheon; nasargpb@yahoo.com

Ill-Sup Nou*
Sunchon National University, Suncheon; nis@sunchon.ac.kr

Low temperature is one of the most severe environmental factors that encumber cabbage (*Brassica oleracea* var. *capitata*) production, especially at the seedling stage in temperate countries and cold tolerant cultivars are imperative to address this issue. To get deeper insight into its cold tolerance mechanisms of cabbage, we have analyzed transcriptomics of a cold tolerant and a cold susceptible line of cabbage after applying cold stress by Illumina Hiseq 2000 short read (paired-end) sequencing technology. A total of 58,094 unigenes were obtained by de nova assembly and were assigned Nr annotations. Functional classification revealed the involvement of unigenes in various biological processes, highly accounted with cellular process and metabolic process. We identified 12,578 unique cold-responsive candidate genes with significantly differential expression between control and treated samples. Of which, 5,792 genes were up-regulated while 6,786 genes were down-regulated. Accordingly, 19 up and down-regulated unigenes were validated by real-time PCR expression analysis in the same lines of cabbage. Thus, the transcriptome dataset of *B. oleracea* will provide valuable gene resources for future application in crop improvement. In addition, this study sets a good example for large-scale identification of cold-responsive genes in non-model organisms using the sequencing-based approach.

Specified Source(s) of Funding: This work was supported by a grant from the Next-Generation BioGreen 21 Program (Plant Molecular Breeding Center No. PJ009085022014), Rural Development Administration, Republic of Korea.

(350) Excessive Blanking in *Pistacia vera* cv. ‘Pete 1’

Cara J. Allan*
University of California, Davis, Davis, CA; callan@ucdavis.edu

There is limited breeding done to improve the commercial pistachio varieties. One promising new cultivar, ‘Pete 1’, has been planted commercially in the past 7 years. It has become a concern to growers that the nuts produced on this cultivar tend to have a high blanking percentage. Our investigation has been in response to grower’s observations of possible causes for such a widespread and economically detrimental development. In the first year, we conclusively disproved the idea that the cause of the blanking was due to insect pressures from pests such as lygus and calocoris. In this second year, we propose to investigate the fungal communities and their effects on early bloom and nut set. We will also approach the problem from a physiological point of view and perform a thinning study to see if ‘Pete 1’ is over-producing fruits to an amount which it cannot fill from a photosynthetic resource point of view.

Specified Source(s) of Funding: The California Pistachio Research Board; ‘Pete 1’ Growers

An asterisk (*) following a name indicates the presenting author.
(351) Performance of Five Pecan Cultivars and Selections as Immature Trees in Southern Georgia

Patrick Conner*
University of Georgia-Tifton Campus, Tifton; pconner@uga.edu

Eight pecan (Carya illinoiensis) genotypes were evaluated over nine years in a replicated test orchard located in southern Georgia, USA. Genotypes included one USDA selection (USDA 49-17-322) four relatively new named cultivars (Gafford, Giftpack, Headquarters and Watson) and three check cultivars (Desirable, Pawnee and Summer). Actual yields were measured for each tree in the test and a 50-nut sample was taken to determine nut quality. Trees were evaluated for leaf and nut scab (Fusicladium effusum) and black aphid (Melanocallis caryae-foliae) damage. Significant differences were not found among these young trees for yield, but there were differences in nut quality and pest resistance. ‘Gafford’ and ‘Headquarters’ were very scab resistant but nut quality was mediocre. ‘Giftpack’ had excellent kernel quality, but nut size was only medium and scab resistance was poor. USDA 49-17-322 produced a large nut with excellent kernel quality and scab was generally well controlled with fungicides. ‘Watson’ produced a large nut with average kernel quality. Pecan trees are a long-lived crop and these cultivars need to be evaluated for several more years to determine their performance as mature trees.

Specified Source(s) of Funding: Georgia Agricultural Commodity Commission for Pecan

(352) Nitrogen Fertilization of Young Chinese Chestnut Trees

Michele Warmund*
University of Missouri, Columbia; warmundm@missouri.edu

Chinese chestnut (Castanea mollissima) is a niche crop in North America. Because the industry is in its infancy, recommendations for many aspects of production are lacking, including optimal rates for nitrogen fertilization. Therefore, a study was conducted to evaluate the effect of five rates of nitrogen on ‘Peach’ Chinese chestnut trees on vegetative growth and fruiting. Young trees received similar rates of nitrogen before the study was initiated. When trees were four years-old, they were fertilized in split applications of nitrogen at 56, 84, 112, 140, or 168 kg/ha on 1 Apr. and 15 June. Treatments were applied to the soil surface below the tree canopy in the form of NH₄NO₃ in 2012 and the area beneath trees received the same treatment in 2013. Foliar sampling on 17 July revealed a linear response to nitrogen treatments. Foliar N content ranged from 2.17% for the lowest fertilization treatment to 2.47% for the 140 kg N/ha rate. Most trees began bearing in 2012 with a small crop of chestnuts (< 545 g/tree). Although nut yields were statistically similar for each year, they tended to increase with the rate of nitrogen applied to a maximum of 1347 g/tree for the 140 kg N/ha treatment in 2013. Nut numbers, terminal shoot growth, and trunk circumference were also similar among treatments in 2013.

Wednesday, July 30, 2014

Vegetable Crops Management 3

(381) A Comparison of Ca and Mg Rates in Soilless Media for Optimum Vegetable Production Irrigated with Alkaline Water

Sarah E. Bertrand
Louisiana State University, Baton Rouge, LA; sbertr2@tigers.lsu.edu

Kathryn Fontenot*
LSU AgCenter, Baton Rouge, LA; kfontenot@agcenter.lsu.edu

Edward Bush
LSU AgCenter, Baton Rouge, LA; ebush@agcenter.lsu.edu

Charles E. Johnson
LSU AgCenter, Baton Rouge, LA; cjohnson@agcenter.lsu.edu

Home gardeners residing in areas with alkaline city water sources do not have means of acidifying water for optimal vegetable production. A solution to achieving optimal yields with alkaline water is to use a specialized media; however, current media available does not meet these needs. New media recipes with varied levels (0 to 8 lbs/yd³) and sources of Ca (dolomite lime, gypsum) and Mg (dolomite lime, magnesium sulfate) were tested using alkaline irrigation water on lettuce, cabbage, and cauliflower crops under high tunnel and on can yard sites. Media treatments with the following fertilizer levels: 4 lbs/yd³ gypsum and 4 lbs/yd³ MgSO₄ (Ca/Mg); 4 lbs/yd³ dolomite lime (4L); 4 lbs/yd³ dolomite lime, 4 lbs/yd³ gypsum, and 4 lbs/yd³ MgSO₄ (4L+Ca/Mg); 8 lbs/yd³ dolomite lime (8L), outperformed a commercially available (IS) medium and the control (C) (no Ca or Mg fertilizer) medium in nearly all treatments with all crops. All crops grown on the can yard and cabbage grown under the high tunnel had significantly greater yields when grown in medium 4L+Ca/Mg (80:20 bark:peat with 12 lbs/yd³ Osmocote® Plus, 4 lbs/yd³ dolomite lime, 4 lbs/yd³ gypsum, and 4 lbs/yd³ magnesium sulfate) compared to the IS and C media (P ≤ 0.05). Media treatment 4L (80:20 bark:peat with 12 lbs/yd³ Osmocote® Plus and 4 lbs/yd³ dolomite lime) produced significantly greater yields and plant growth of all tested crops on the can yard compared to the IS and C media (P ≤ 0.05). Media longevity was tested by planting cucumber, tomato, and bell pepper into the same pots, at the same sites, during the spring with no additional pre-plant amendments added to the media. All crops grown on the can yard, and cucumber and bell pepper grown under the high tunnel, had significantly greater yields grown in media 4L+Ca/Mg (80:20 bark:peat with 12 lbs/yd³ Osmocote® Plus, 4 lbs/yd³ dolomite lime, 4 lbs/yd³ gypsum, and 4 lbs/yd³ magnesium sulfate) compared to the IS and C media (P ≤ 0.05). Home gardeners residing in areas with alkaline city water sources do not have means of acidifying water for optimal vegetable production. A solution to achieving optimal yields with alkaline water is to use a specialized media; however, current media available does not meet these needs. New media recipes with varied levels (0 to 8 lbs/yd³) and sources of Ca (dolomite lime, gypsum) and Mg (dolomite lime, magnesium sulfate) were tested using alkaline irrigation water on lettuce, cabbage, and cauliflower crops under high tunnel and on can yard sites. Media treatments with the following fertilizer levels: 4 lbs/yd³ gypsum and 4 lbs/yd³ MgSO₄ (Ca/Mg); 4 lbs/yd³ dolomite lime (4L); 4 lbs/yd³ dolomite lime, 4 lbs/yd³ gypsum, and 4 lbs/yd³ MgSO₄ (4L+Ca/Mg); 8 lbs/yd³ dolomite lime (8L), outperformed a commercially available (IS) medium and the control (C) (no Ca or Mg fertilizer) medium in nearly all treatments with all crops. All crops grown on the can yard and cabbage grown under the high tunnel had significantly greater yields when grown in medium 4L+Ca/Mg (80:20 bark:peat with 12 lbs/yd³ Osmocote® Plus, 4 lbs/yd³ dolomite lime, 4 lbs/yd³ gypsum, and 4 lbs/yd³ magnesium sulfate) compared to the IS and C media (P ≤ 0.05). Media treatment 4L (80:20 bark:peat with 12 lbs/yd³ Osmocote® Plus and 4 lbs/yd³ dolomite lime) produced significantly greater yields and plant growth of all tested crops on the can yard compared to the IS and C media (P ≤ 0.05). Media longevity was tested by planting cucumber, tomato, and bell pepper into the same pots, at the same sites, during the spring with no additional pre-plant amendments added to the media. All crops grown on the can yard, and cucumber and bell pepper grown under the high tunnel, had significantly greater yields grown in media 4L+Ca/Mg (80:20 bark:peat with 12 lbs/yd³ Osmocote® Plus, 4 lbs/yd³ dolomite lime, 4 lbs/yd³ gypsum, and 4 lbs/yd³ magnesium sulfate) compared to the IS and C media (P ≤ 0.05). Tomatoes and bell peppers grown on the can yard and under the high tunnel had significantly greater growth and yield when grown in 4L+Ca/Mg or 8L than the C media (P ≤ 0.05).

Specified Source(s) of Funding: This publication was partially supported by the Specialty Crop Block Grant Program at the

An asterisk (*) following a name indicates the presenting author.
Vidalia onions (Allium cepa) are marketed based on their characteristic sweet and mild flavor. Previous greenhouse-based research has concluded that both nitrogen and sulfur fertility have a significant impact on onion flavor potential. However, there is a lack of field-based information regarding the impact fertilizer application on quality and flavor in Vidalia onion. Therefore in the 2014 growing season, Vidalia onions were grown under five fertility programs representing high and low applications of nitrogen and sulfur fertility as well as the impact of elevated soluble calcium on onion quality and flavor characteristics. Onions, ‘Sapelo Sweet’ and ‘Goldeneye’ were transplanted on 21 Nov. 2013 at the Vidalia onion and vegetable research center in Reidsville, GA. Levels of nitrogen and sulfur fertilizer ranged from 106 to 252 kg·ha-1 and 40 to 134 kg·ha-1, respectively. An additional 280 kg·ha-1 of calcium was supplied using calcium chloride for a high-calcium treatment. Onions were grown to maturity and harvested in April 2014 with yield and grade determined. Quality characteristics measured included methyl flavor volatiles, pungency, bolting, doubles, storage quality, firmness, and disease susceptibility.

Specified Source(s) of Funding: Vidalia onion commission

(382) The Impact of Nitrogen and Sulfur Fertilization on Yield, Quality, and Flavor of Field Grown Vidalia Onion

Timothy Coolong*
University of Georgia, Tifton, GA; tcoolong@uga.edu

An asterisk (*) following a name indicates the presenting author.

Wednesday, July 30, 2014

HortScience 49(9) Supplement—2014 ASHS Annual Conference
(385) Strip-tillage and Row Cover Use in Organic and Conventional Cucurbit Crops
Jennifer Tillman*
Iowa State University, Ames; jtillman@iastate.edu
Ajay Nair
Iowa State University, Ames; nairajay@iastate.edu

Growing cucurbit crops in a more sustainable way involves multiple management practices. Cover crops are often incorporated into the soil before planting the cash crop. However, they can also be “rolled” and used as a ground cover throughout the growing season. The cash crop is then planted in small, tilled strips within the residue. This “strip-tillage” technique provides a weed-controlling, moisture-retaining mat that does not need to be removed at the season’s end, as plastic mulch does. The reduction in tillage can improve soil structure and health. Row covers can be placed over newly planted seedlings to provide a better microclimate and a physical barrier to pests. Row covers can help prevent the spread of bacterial wilt, a disease caused by the bacterium Erwinia tracheiphila, spread by cucumber beetles. This study investigated how tillage and row covers affected plant size, yield, and soil health in organic and conventionally grown summer squash (Cucurbita pepo) and muskmelon (Cucumis melo). The first year of this two-year study was conducted in 2013 at the Muscatine Island Research Farm in Muscatine, Iowa on sandy soil. We used a double split-plot, randomized design with four replications. The field treatments included two cucurbit crops (Athena muskmelon and Lioness summer squash), two farming methods (organic and conventional), two tillage treatments (conventional tillage with black plastic and strip-tillage into rolled rye), and two row cover treatments (no row covers and row covers). Row cover treatments tended to produce more plant vegetation but not higher marketable yields when compared to treatments without row covers. Row covers helped reduce the number of insecticide sprays needed in squash, and reduced the presence of bacterial wilt in melons. Strip-tillage treatments produced smaller plants and smaller marketable yields compared to conventionally tilled treatments. The effects of tillage and row cover use did not depend on the method of farming (organic versus conventional). Strip-tillage tended to reduce between-row weed pressure early in the season when compared to the conventionally tilled treatments due to the presence of the rolled rye mulch between rows in the strip-tillage treatments. Strip-tillage treatments had lower soil microbial biomass than conventionally tilled treatments. Conventional tillage with black plastic mulch increases soil temperature compared to strip-tillage into rolled rye, which likely lead to the increased growth of these warm season crops.

(386) Studies on Occurrence and Infection Time of Downy Mildew of Onion (Allium cepa) in Korea
Eom-Ji Hwang*
National Institute of Crop Science, RDA, Muan, Jeonnam; umjj60416@korea.kr

The onion (Allium cepa), together with pepper and garlic, is classified as a seasoning vegetable and it has been regarded as an important economic crop in Korea. The onion cultivation area has gradually increased from approximately 12,352 to 20,965 ha since 2003. The onion is generally direct-seeded into seedbeds between August and September and the seedlings are transplanted into fields between October and November. The harvest is completed between April and June in the next year. Global climate changes, such as the increased temperature and increased frequency of rainfall, has caused escalating outbreaks of disease in onion, especially downy mildew. An experiment was conducted to investigate damage aspect by downy mildew for some chief producing districts at onion in Korea in 2012 from 2014. In results, 26.4% and 83.6% of rate of damage fields were observed in total rice paddy and dry field, respectively. The average rate infected plants in each paddy and field where the least infection was occurred was 2.2% and 8.9%, respectively. Overall, average rate infected plants in dry field was significantly higher than that in rice paddy. The earlier the transplant was done the higher least infection rate was observed as follows; 76% at late October, 48.7% at early November, and 9.7% at mid-late November. Frequency of downy mildew appeared in early March and was maximized in mid-April on early maturing cultivar at 72%. Meanwhile, that in mid-late maturing cultivar was 42.7%. The main reason of higher frequency in early maturing cultivar would be due to the earlier transplant and thereby faster growth.

Wednesday, July 30, 2014

Weed Control & Pest Management

(302) Critical Period for Weed Control in Grafted versus Nongrafted Tomato
Sushila Chaudhari*
North Carolina State University, Raleigh; schaudh@ncsu.edu
Katie Jennings
North Carolina State University, Raleigh; kmjennings@ncsu.edu
David W. Monks
North Carolina State University, Raleigh; david_monks@ncsu.edu
Frank J. Louws
North Carolina State University, Raleigh; frank_louws@ncsu.edu

The critical period for weed control (CPWC) is an important
component to develop integrated weed management strategies. One sustainable approach to reduce CPWC could be to use grafted plants that may have enhanced competitive ability against weeds for utilizing resources and hence improve yield. The objective of this study was to determine the effect of grafting on CPWC in fresh market plasticulture tomato. Field studies were conducted in summer 2013 at the Horticultural Crops Research Station, Clinton, NC. The removal and establishment studies were conducted to determine the maximum period of weed competition and minimum weed-free period, respectively after tomato planting. Tomato plants used in the study included nongrafted Amelia and Amelia grafted onto Maxifort tomato rootstock. In the establishment study, weeds were transplanted at 1, 2, 3, 4, 5, 6 and 12 wk after tomato transplanting (WATT) and remained until tomato harvest. In the removal study, weeds were transplanted on the same day of tomato transplanting and removed at 2, 3, 4, 5, 6, 8, and 12 WATT. Weed removal at 12 WATT was considered the weedy all-season treatment and weed establishment at 12 WATT represented the weed-free treatment. Each planting hole contained one grafted or non-grafted tomato plant and six weed seedlings [2 yellow nutsedge (Cyperus esculentus), 2 common purslane (Portulaca oleracea) and 2 large crabgrass (Digitaria sanguinalis)]. The experimental design was randomized complete block with four replications. The weed above-ground biomass was measured (dried at 55 °C) at the time of weed removal from the removal study or at the end of tomato harvest from the establishment study. At 8WATT, one tomato plant per plot was harvested and dried at 55 °C to measure dry weight. In both grafted and nongrafted tomato treatments, plant biomass increased as establishment of weeds was delayed and grafted plants had significantly higher biomass at 4 and 12 WATT. However, plant biomass decreased when removal of weeds was delayed and no difference was observed between grafted and nongrafted plants at any removal time. In both grafted and nongrafted plants, the delay in establishment and removal of weeds resulted in weed biomass decrease and increase of the same magnitude, respectively. To avoid 5% yield losses, it is sufficient to keep grafted and nongrafted tomato plants weed free for first 3.25 WATT. Overall, results show that grafting does not have a positive effect in reduction of CPWC.

The treatment design was a 4 herbicide salinity treatments, plant biomass increased as establishment of weeds was delayed and grafted plants had significantly higher biomass at 4 and 12 WATT. However, plant biomass decreased when removal of weeds was delayed and no difference was observed between grafted and nongrafted plants at any removal time. In both grafted and nongrafted plants, the delay in establishment and removal of weeds resulted in weed biomass decrease and increase of the same magnitude, respectively. To avoid 5% yield losses, it is sufficient to keep grafted and nongrafted tomato plants weed free for first 3.25 WATT. Overall, results show that grafting does not have a positive effect in reduction of CPWC. The study will be repeated to confirm these findings.

(303) Effect of Increasing Spray Solution Salinity on Postemergence Herbicide Weed Control and Crop Tolerance

Peter J. Dittmar*
University of Florida, Gainesville; pdittmar@ufl.edu
Christopher E. Rouse
University of Arkansas, Fayetteville; cerouse@email.uark.edu

A greenhouse experiment was conducted to establish postemergence herbicide weed control and crop tolerance to herbicides sprayed with increasing rates of salinity. The greenhouse is at the Plant Science Research and Education Unit, Citra, FL. The treatment design was a 4 herbicide × 6 salinity levels × 5 species. Treatments were arranged in a randomized complete-block design with 3 replications. Herbicides were halosulfuron at 16 g·ha⁻¹, metribuzin at 228 g·ha⁻¹, sethoxydim at 128 g·ha⁻¹, and nontreated. Salinity levels were established as electrical conductivity (EC) at 0, 1, 2, 3, 4, and 5 ds·m⁻¹. The five species were green bean, sweet corn, tomato, large crabgrass, and goosegrass. At 4 weeks after planting, treatments were applied over the top of the plants with a backpack sprayer calibrated to 8 L·ha⁻¹. Visual ratings for crop injury (0% = no injury, 100% = complete plant death) were collected weekly for 3 weeks after treatment (WAT). At 6 WAT, plants were harvested at the soil surface and fresh and dry weights were measured. Data were analyzed using a general linear model and means were separated with Fisher’s Protected LSD. Herbicide*salinity interaction did not have significant and means were combined. Plant injury at 21 DAT was not significantly different for plant species at all salinity levels. No antagonistic or synergistic response between herbicide and salinity for fresh or dry weight salinity did not have an impact on the herbicide efficacy or crop tolerance. These treatments were applied as a single application and repeat or split applications of herbicides should be investigated further.

(304) Effect of Simulated Glyphosate Drift to Four Potato Processing Cultivars

Harlene Hatterman-Valenti
North Dakota State University, Fargo; h.hatterman.valenti@ndsu.edu
Amanda A. Crook*
North Dakota State University, Fargo; amanda.crook@my.ndsu.edu
Collin P. Auwarter
North Dakota State University, Fargo; collin.auwarter@ndsu.edu

Field research was conducted at the Northern Plains Potato Grower’s Association irrigated research site near Inkster, North Dakota, in 2012 and repeated in the same location in 2013 to evaluate the effects of simulated glyphosate drift in the current season and the effects of planting back the daughter tubers grown in the 2012 season. Treatments were applied at tuber initiation (TI), early tuber bulking (EB) and late tuber bulking (LB) stages to four potato processing cultivars: Russet Burbank, Umatilla, Ranger Russet and Bannock. During the current season glyphosate was applied at rates one-quarter, one-eighth, and one-sixteenth the lowest labeled rate in 2012, of 0.47 lb/A and respectively the standard use rate in 2013, of 0.95 lb/A during the TI and EB stages. During the LB stage of 2012, glyphosate was applied at the one-quarter, one-eighth, and one-sixteenth the standard use rate of 0.95 lb/A. Ammonium sulfate was tank mixed at a rate of 4 lbs/100 gal. The treatments were applied using a CO₂ pressurized ATV sprayer with a spray boom extended to cover treated rows. The sprayer output was 20 GPA at 40 psi using 8002 flat fan nozzles. Both years produced data that supported the Bannock variety to be the most sensitive cultivar at TI regardless of the sub-lethal rate applied. Ranger Russet appeared to be the least sensitive to the glyphosate treatments, however the variety did show a reduced marketable yield compared to the untreated when
sub-lethal rates of 0.19 and 0.095 lb/A were applied at T1. Umatilla was considered a cultivar with intermediate sensitivity to glyphosate. Russet Burbank was also considered a cultivar with intermediate sensitivity to glyphosate, however the variety did show a reduced marketable yield compared to the untreated when sub-lethal rates of 0.19 and 0.095 lb/A were applied at T1. All four varieties when treated with sub-lethal rates at the EB and LB growth stages did not show a reduction in marketable tuber yield or tuber number compared to the untreated. The number of tubers increased with Russet Burbank, Umatilla, Ranger Russet, and Bannock when treated at T1 with 0.095, 0.048, 0.19, 0.095 lb/A respectively. The plant back of daughter tubers from 2012 showed the Ranger Russet variety to be the least affected. Russet Burbank had the second highest total and marketable yields. Bannock or Umatilla seed from mother plants sprayed with sublethal glyphosate rates had the lowest total and marketable yields.

(305) Risk of Herbicide Resistance for GMO Corn in Chile
Rodrigo Figueroa*
Pontificia Universidad Católica de Chile, Santiago; rfe@uc.cl
Horacio Gilabert
Pontificia Universidad Católica de Chile, Santiago; hgilab@uc.cl
Marlene Gebauer
Pontificia Universidad Católica de Chile, Santiago; mgebauer@uc.cl
Albert Fischer
University of California, Davis; ajfischer@ucdavis.edu

Fondecyt 1110535 project was conducted between 2011 and 2014 by the research team of the School of Agronomy and Forestry at Pontificia Universidad Católica de Chile, led by the specialist, Dr. Rodrigo Figueroa and co-researchers Marlene Gebauer, Horacio Gilabert and Albert Fischer (University of California, Davis). The project objective was to determine the levels of herbicide resistance in weeds growing in genetically modified (GMO) and conventional maize crops in central Chile. Results showed the presence of herbicide resistance in the species *Sorghum halepense* (Johnsongrass) in some locations (n<20) of the central area. Additionally, it was identified the mechanism responsible for this herbicide resistance, which was associated with a change that makes the ALS enzyme insensitive to the herbicide (nicosulfuron). This resistance is due to prolonged and repeated use of the same herbicide in corn, GMO or conventional. With the information gathered in the project, weed cover maps were produced using aerial photographs and a mathematical model to estimate the risk of development of resistance according to the weed control strategy used in a particular cropping field. Results also indicate that the maize seed management in Chile has reduced the herbicide resistance problems reported in other countries, since several crop practices are implemented each season limiting the herbicide resistance phenomena.

Specified Source(s) of Funding: FONDECYT 1110535

(306) Allelopathic Effects of Horseradish Leaves
Kang Mo Ku*
University of Illinois at Urbana-Champaign; ku8@illinois.edu
John A. Juvik
University of Illinois at Urbana-Champaign; juvik@illinois.edu
Mosbah M. Kushad
University of Illinois at Urbana-Champaign; kushad@illinois.edu

Previous study revealed that allyl isothiocyanate (the hydrolysis product of the glucosinolate, sinigrin, prevalent in horseradish root and leaf tissues), has allelopathic effects on the germination of weed and crop seeds. The sinigrin in horseradish leaf tissue could be utilized as biological weed control agents. This study measured sinigrin and allyl isothiocyanate concentrations, and germination inhibitory activity on lettuce seeds of aqueous solutions of horseradish leaves from different cultivars. There was significant negative correlation between sinigrin concentrations and root growth of lettuce seeds treated with aqueous horseradish leaf extracts (AHLE) from different cultivars ($r^2 = 0.82$, $P = 0.005$, n = 7). In order to investigate the mechanism of root elongation inhibition, RNA from germinating lettuce seeds was collected at 0, 4, 8, 12, 16, and 20 hours after exposure to AHLE as well as controls. RNA transcript abundance of lettuce gibberellin 3 oxidase 2 and ACC synthase genes at 4 and 12 hours were significantly reduced in the treatment group compared to controls. In addition, genes responsible for antioxidant enzyme, Cu/Zn superoxide dismutase and glutathione peroxidase were significantly increased in the AHLE treatment group at the 16 hour exposure. This suggests that AHLE inhibits root elongation due to the retarding gibberellin and ethylene gene expression by oxidative stress induced by treatment of AHLE.

(307) Effects of Photosselective Shadehouses on Ornamental Plant Pests
Robert Leckel
University of Florida, Mid-Florida Research and Education Center, Apopka; rleckel@ufl.edu
Robert H. Stamps
University of Florida, Mid-Florida Research and Education Center, Apopka; rstamps@ufl.edu
Brian J. Pearson*
University of Florida, Mid-Florida Research and Education Center, Apopka; bpearson@ufl.edu
Steven Arthurs
University of Florida, Mid-Florida Research and Education Center, Apopka; spa@ufl.edu

An emerging approach in the production of ornamental crops is the use of photosselective (colored) and color-neutral dispersive shade netting. Unlike traditional black nets, dispersive shade nets scatter radiation, creating more diffused light that can penetrate inside plant canopies. Colored nets contain additives that selectively filter solar radiation to promote specific wavelengths of light to promote desirable plant growth characteristics. Compared with black nets of equivalent shading factor, growing ornamental, vegetable and fruit crops under...
certain colored shading nets can increase perceived aesthetic quality and yields. However, relatively little information exists regarding how this technology might affect a range of pests and disease issues in horticultural production. We surveyed insect and mite populations inside replicated shade net structures containing ornamental plants [Azalea ‘Red Ruffle’, Hibiscus (3 cultivars), Croton ‘Petra’, and Mandevilla (3 cultivars)] in 11.3-L containers between March and September in 2012 and 2013. The structures were fitted with full covering of ChromatiNet® shadecloths (50% shading factor) arranged as a randomized Latin square. The shade net colors tested included two photoselective (red and blue) and one color neutral (pearl) and black nets for comparison. The uncovered central area of each block served as a control (full sun) comparison. In both years we observed consistently higher numbers of thrips inside blue compared with other colored shadehouses, and fewest inside pearl, ostensibly due to attraction and repellency, respectively. A similar trend for blue (but not pearl) was also observed with whiteflies on plants. Interestingly, fewer plants in outside locations (sun) were infested with aphids compared with those inside shadehouses. Plant growth indices were greater for plants grown under all shade nets compared with outside, primarily due to the greater height obtained. Our results suggest that pest populations may be affected both directly, and indirectly through changes in plant physiology, in response to environmental modifications inside photoselective shade net structures.

(308) Jasmonate Application to Broccoli Plants Reduce Growth and Survival of the Insect Herbivore, *Trichoplusia ni*

Kang Mo Ku*
University of Illinois at Urbana-Champaign; ku8@illinois.edu

John A. Juvik
University of Illinois at Urbana-Champaign; juvik@illinois.edu

Lepidoptera species are some of the most serious insect pests to brassica vegetables. Larvae of many Lepidopteran insect pests typically stay on the host plant on which they hatched on due to limited dispersal capacity. For this reason, there has been interest in how jasmonate (JA) treatments to host plants may affect the development of lepidoptera larvae. Four-week-old broccoli ‘Green Magic’ and ‘VI-158’ seedlings were placed in cages (72 × 50 × 50 cm) in a greenhouse to evaluate the effect of JA plant spray treatments on the growth and development of the cabbage looper (*Trichoplusia ni*). Eight neonate cabbage looper larvae were infested on each of three different plants of each cultivar sprayed three days previously with different JA treatments (0, 100, 200, 400 µM with 0.1% Triton X-100). After five days of feeding, survival and weight of cabbage looper larvae decreased with increasing JA plant treatment applications. Significant correlations were observed between JA concentrations and the number of days to pupation in both ‘Green Magic’ (r² = 0.96) and ‘VI-158’ (r² = 0.99). The JA glucosinolates accumulation in both broccoli cultivars was measured by high performance liquid chromatography. Gluconasturtiin (r² = 0.85) and neoglucobrassicin (r² = 0.99) were increased by JA in a dose dependent manner in ‘Green Magic’ leaves, whereas glucobrassicin (r² = 0.94) was increased by JA in ‘VI-158’. These glucosinolate concentrations had significant negative correlations with weight after 5 days, survival rate at 5 days, pupa weight, and were positively correlated with days to pupation. Field application of JA to broccoli plants could induce enhanced resistance to *Tricoplusia ni* and possibly other insect pests.

(309) Induced Systemic Acquired Resistance, after Applying Two Oxidant Based Disinfectants to Kidney Beans (*Phaseolus vulgaris*) Seedlings, Followed by a Bacterial Wilt Disease Inoculation

Vanessa Sandoval*
Colorado State University, Fort Collins; Vanessa.Sandoval@rams.colostate.edu

Paul C. Freebury
USDA Animal & Plant Health Inspection Service, Fort Collins, CO; Paul.C.Freebury@aphis.usda.gov

Debra H. Newman
USDA Animal & Plant Health Inspection Service, Fort Collins, CO; debra.h.newman@aphis.usda.gov

Craig Ramsey
USDA Animal & Plant Health Inspection Service, Fort Collins, CO; craig.l.ramsey@usda.gov

Steven Earl Newman
Colorado State University, Fort Collins; steven.newman@colostate.edu

*Phytophthora ramorum* is a major risk to interstate trade of nursery stock originating in the western United States. Improving the Systemic Acquired Resistance (SAR) activities in nursery plants against *P. ramorum* fungal attacks may decrease the need for repeated fungicide applications while growing susceptible species in western nurseries. The goal of this study was to determine whether an oxidant based disinfectant would induce SAR functionality in kidney bean seedlings after inoculation with a bacterial wilt. Foliar application of a commercial ClO2 (Electro-Biocide) formulation, when combined with or without a sarcosine surfactant may induce temporal changes in plant defense/SAR biomarkers such as salicylic acid (SA), jasmonic acid (JA), superoxide dismutase (SOD), and glutathione reductase (GHR). Induced SAR responses may pre-condition plant defenses, thereby reducing the protein production cost to defend the plant and reverting resources back to plant growth and vigor after a pathogen attack. A greenhouse study was conducted to test the effects of Electro-Biocide, applied at four concentrations, for inducing SAR responses in 22 day old kidney bean seedlings. Four days after Electro-Biocide was applied the plants were inoculated with *Curtobacterium flaccumfaciens* pv. *flaccumfaciens* (CH), which is a bacterial vascular wilt disease. The plants were then sampled the following day for leaf tissue analysis for the four SAR biomarkers. Leaves were collected from each plant, at 2-hour intervals for six collection times, starting at 16 hours after the plants were sprayed with Electro-Biocide. The leaf tissue was analyzed at the Colorado State University,
Center for Environmental Medicine Laboratory. Salicylic acid and jasmonic acid proteins (free and total protein structures) were analyzed using a validated, tandem liquid chromatography, mass spectrometry/mass spectrometry instrument (LC/MS/MS) laboratory method. Superoxide dismutase and glutathione reductase were analyzed with a validated, immunoassay kit method. The leaf tissue analyses show that the total SA concentrations were higher for the control treatment, compared to the Electro-Biocide treatments. Also, the free form of SA did show a dynamic pattern of increasing then decreasing over the 12 hour leaf collection time period. The SAR biomarker tests for SOD and GHR are still being planned for Spring 2014.

Thursday, July 31, 2014

Crop Physiology

(176) Increased Fertilizer Levels Do Not Prevent ABA-Induced Chlorosis in Pansy

Jong Goo Kang*
Sunchon National University, Chonn; jgkang@sunchon.ac.kr
Rhuanito Soranz Ferrarezi
University of Georgia, Athens; rhuanito@terra.com.br
Sue Dove
University of Georgia, Athens; sdove@uga.edu
Marc van der Iersel
University of Georgia, Athens; mvanier@uga.edu

Abscisic acid (ABA), the hormone responsible for stomatal closing, has been studied for years for its potential to enhance the shelf life of ornamental plants. By inducing stomatal closure, sprays with ABA solutions can reduce plant water use and delay the onset of drought stress when plants are not watered in the retail setting. ABA has been shown to do this effectively, but can also induce unwanted side effects, including chlorosis. Pansy (Viola × wittrockiana) has been shown to be particularly susceptible to ABA-induced chlorosis. The objective of this study was to determine whether the fertilization rate affects the severity of chlorosis. Pansy ‘Delta Premium Pure Yellow’ seedlings were transplanted in 10 cm pots filled with a peat-perlite substrate. A controlled-release fertilizer (Harrell 19-4-8 with micros) was incorporated at seven rates from 0–8 g/L of substrate. When plants had reached a salable size, half the plants were sprayed with a solution containing 1,000 ppm ABA, while the other plants were sprayed with water. Plants were subirrigated daily with plain water throughout the entire study. Leaf chlorophyll was monitored for two weeks following ABA application. Plant dry weight was lowest without the addition of controlled release fertilizer to the substrate (1.47 g/plant), but similar in any of the treatments with fertilizer (2.15 g/plant). Leaf chlorophyll content increased greatly as fertilizer rate increased from 0 to 2 g/L, with little or no further increase in leaf chlorophyll at even higher fertilizer rates. ABA induced chlorosis, irrespective of the fertilizer rate. ABA also reduced the final dry weight of the shoots by 24%, regardless of fertilizer rate. This reduced dry weight as the result of ABA applications is likely due to reduced photosynthetic rates, which may be due to both reduced leaf chlorophyll content and stomatal closure limiting CO2 diffusion into the leaves. We conclude that ABA-induced chlorosis of pansy cannot be prevented by the application of additional fertilizer.

Specified Source(s) of Funding: Funding for this research was provided by USDA-NIFA-SCRI (award no. 2009-51181-05768) and CAPES Foundation - Ministry of Education, Brazil (BEX 2620/13-8).

(177) Water-deficit Priming Increases Leaf Gas Exchange of Papaya (Carica papaya L.)

Christopher I. Vincent
University of Florida, Gainesville; civince@ufl.edu
Diane Rowland
University of Florida, Gainesville FL, FL; dlrowland@ufl.edu
Bruce Schaffer*
University of Florida, Homestead; bas56@ufl.edu

Priming, the imposition of a defined duration of mild stress during early plant development, is a relatively recent focus of research with potential as a management technique for improving crop tolerance to biotic and abiotic stress. However, priming capacity has not been tested in many horticultural crops and the physiological mechanisms involved in priming have not been well described. In addition, there is little information about the priming “memory,” or the duration of the effects after the priming has been completed. Hypothesized mechanisms have included increased photosynthetic capacity, increased antioxidative capacity, and increased partitioning of carbohydrates to roots, each of which may play a different role in determining priming memory. The objectives of this study were to (1) test whether papaya (Carica papaya L.) has the potential to be primed with mild water deficit; (2) test whether priming could elicit up-regulation of leaf gas exchange of vegetative plants; and (3) determine the relative duration of priming memory in papaya. ‘Red Lady’ papaya plants in pots were subjected to one of 3 treatments: (1) early priming (EP) initiated 6 months after germination, (2) late priming (LP) initiated 7 months after germination, and (3) no unprimed control. Soil water tension in the control was maintained at an average of 4 kPa via daily irrigation. Priming treatments consisted of a 3-week period of reduced irrigation in which soil water tension averaged approximately 20 kPa, with periods of greater than 30 kPa. Leaf gas exchange variables were measured at 1-week intervals for 4 weeks, beginning 3 days after the completion of the LP treatment. Measurements included net CO2 assimilation, stomatal conductance, and transpiration. The LP treatment increased net CO2 assimilation, stomatal conductance, and transpiration, while the EP treatment decreased these variables compared with the control. On the first measurement date, net CO2 assimilation was approximately 25 percent higher for the LP treatment than the control treatment. At the end of the 4-week measurement period, all variables were identical across treatments, indicating a relatively short priming memory. Results indicate that papaya

An asterisk (*) following a name indicates the presenting author.
has the capacity to be primed using mild water deficits resulting in increased growth-related physiological processes, but that this increase is transitory. 

(178) Ecophysiological Performance, Growth, and Yield of Four Pigeonpea Varieties Under Different Planting Dates and Densities in the Southeastern United States

Chih-Li Yu  
Tennessee State University, Nashville; cyu@my.tnstate.edu

Dafeng Hui*  
Tennessee State University, Nashville; dhui@tnstate.edu

Trevor Johnston  
Tennessee State University, Nashville; tjohnsto@my.tnstate.edu

Kadijah Porter  
Tennessee State University, Nashville; kadijah_porter@yahoo.com

Corie Wilson  
Tennessee State University, Nashville; wilsoncorie@yahoo.com

Camerra Miller  
Tennessee State University, Nashville; camerramiller@yahoo.com

Suping Zhou  
Tennessee State University, Nashville; zsупing@tnstate.edu

Desh Duseja  
Tennessee State University, Nashville; dduseja@tnstate.edu

Fisseha Tegegne  
Tennessee State University, Nashville; ftegegne@tnstate.edu

As the demand of legume crops such as pigeonpea [Cajanus cajan (L.) Millsp.] is increasing in the United States, extending the growing areas and improving the yield of such crops become an important task. To understand how agricultural management could influence the ecophysiology, growth, and yield of pigeonpea, we conducted a three-year (2010–12) field experiment in Nashville, TN. We used a split-plot design considering two planting dates (main factor, early and later planting), four pigeonpea varieties (sub-plot factor, G1, G2, W1 and W3) and three plant densities (sub-plot factor, 295,500, 145,250, and 96,833 plants/ha). Maximum net leaf photosynthesis, stomatal conductance, transpiration, water use efficiency (WUE), soil respiration, plant height, plant stem diameter, leaf area index (LAI), and seed yield were measured over the three years. Results showed there were significant differences in ecophysiology, growth and yield between planting dates, among varieties, and among years. Early planting produced higher leaf photosynthesis and yield compared to late planting. Among four varieties, G2 grow shorter and had lower LAI, but produced higher seed yield compared to other varieties. W1 grew taller than G2 and produced the second highest yield. Planting date did not show significant influences on leaf physiology, LAI and yield. All variables measured showed remarkable variations among three years. Both precipitation amount and pattern during the growing season had significant influences on plant growth and yield. Our results indicated that variety selection and early planting in the southeastern United States may improve pigeonpea growth and yield. Irrigation during drought may also significantly enhance plant performance and yield.

Specified Source(s) of Funding: USDA

(179) Contrasting Responses of Corn Ecophysiological Performance and Yield to Agricultural Practices in Two Years with Different Rainfalls

Dafeng Hui*  
Tennessee State University, Nashville; dhui@tnstate.edu

Chih-Li Yu  
College of Agriculture, Human and Natural Science, Tennessee State University, Nashville; cyu@my.tnstate.edu

Junming Wang  
Center of Atmospheric Science, Illinois State Water Survey, University of Illinois at Urbana-Champaign; wangjim@illinois.edu

Camerra Miller  
Tennessee State University, Nashville; camerramiller@yahoo.com

Suping Zhou  
Tennessee State University, Nashville; zsuping@tnstate.edu

Chandra Reddy  
College of Agriculture, Human and Natural Science, Tennessee State University, Nashville; creddy@tnstate.edu

An asterisk (*) following a name indicates the presenting author.
efficiency of corn leaf was also significantly lower in the 2013 than those in 2012. Our results suggest that with increasing extreme climate conditions forecasted in the future, stability of crop performance and yield could be a serious problem in sustainable agriculture.

Specified Source(s) of Funding: USDA

(180) Low Temperature Conditioning Effect on Secondary Metabolism and Antioxidant Capacity of Garlic during Development

Jose Luis Lorenzo-Manzanarez*
Universidad Autónoma de Querétaro, Querétaro; luis_lo_manzanarez@hotmail.com

Dulce M. Rivera-Pastrana
Universidad Autónoma de Querétaro, Querétaro; dulceriverap@gmail.com

Ma Estela Vázquez-Barrios
Universidad Autónoma de Querétaro, Querétaro; tita_evb@yahoo.com

Miguel David Dufoo-Hurtado
Universidad Autónoma de Querétaro, Querétaro; grillo208@msn.com

Edmundo Mercado-Silva
Universidad Autónoma de Querétaro, Querétaro; mercasilva20@yahoo.com.mx

Garlic (Allium sativum L.) is the second most important species of the genus Allium and has gained consumer interest in recent years for both culinary and medicinal purposes. The proper sequence of photoperiod and thermoperiod during the growing season are key factors affecting the formation and differentiation of the bulbs. The storage of “seed” cloves at 5 °C for 5 weeks before planting accelerates initiation and development of bulbs compared to cloves stored at room temperature (20 °C). Previous experiments in our laboratory have shown that the conditioning at 5 °C of “seed” cloves from ‘Coreano’ variety ahead the harvest time up to two months and reduced the incidence of defects in the bulbs. Furthermore it has also been observed that this storage causes changes in the phenolic metabolism. The objective of this work was to evaluate the effect of low temperature conditioning of bulbils prior planting on the vegetative growth, activity of phenylalanine ammonia-lyase (PAL), total phenolics and antioxidant capacity during development of garlic. In plants originated from “seeds” stored at room temperature, leaf number, height and total weight of the plants were significantly higher, showing a favored vegetative growth. Significant differences were observed in enzymatic activity of PAL (μmol/ml) at the end of development (5th month), levels were 60% and 20% higher in the cataphylls and aerial leafs of garlic from storage at 5 °C, respectively. Total phenolics (mg gallic acid/gfw) and antioxidant capacity (DPPH, radical inhibition %) were also increased in garlic plants due to the conditioning treatment of the “seed” cloves at 5 °C. The highest phenolic content was found in cataphylls from cold conditioning reaching 73.8 ± 2.5 (mg gallic acid/ gfw), and the lowest was observed in aerial leafs (32.6 ± 2.1). Antioxidant capacity levels were increased more than 3 times in cataphylls and ≈ 2 % in aerial leafs of plants originated from conditioned seeds at 5 °C. The low temperature conditioning of “seeds” prior planting induced changes in the secondary metabolism and reduced vegetative growth of garlic plants while favored differentiation of bulbs.

(181) Characterization of Drought Response of Transgenic Tomato Plants Expressing Spermidine Synthase Under Constitutive or Fruit/Ethylene-specific Promoters

Raheel Anwar*
Purdue University, West Lafayette, IN; ranwar@purdue.edu

Avtar K. Handa
Purdue University, West Lafayette, IN; ahanda@purdue.edu

We have generated transgenic tomato plants expressing yeast spermidine synthase (ySpdSyn) under the control of either a constitutive (CaMV 35S) or a fruit/ethylene-specific (E8) promoter. Since polyamines have been implicated in imparting tolerance to water stress, growth and physiology of transgenic and wild-type (WT) plants was quantified after water stress and re-watering under the greenhouse environments. Under well-watered conditions, transgenic tomato plants constitutively expressing ySpdSyn accumulated 54% more spermidine than WT plants whereas putrescine and spermine contents remained unaltered. Plants expressing ySpdSyn under E8 promoter did not show any change in polyamine contents. Transgenic plants were slightly smaller than WT plants, whereas dry weight, leaf chlorophyll, photosynthesis, transpiration, leaf relative water content and electrolyte leakage remained unaltered. Water was withheld from four weeks old WT and transgenic plants for 7, 14, 18, or 26 days. Both WT and transgenic plants were able to recover after 7 days of water stress, but not thereafter as plants reached permanent wilting point. Transgenic plants maintained higher leaf relative water content (RWC) during short period of stress although other measurements were not different between transgenic and WT plants. Transgenic leaves with higher RWC also showed 30% more spermidine levels compared to WT. These results suggest that although spermidine helps maintained higher relative water content in transgenic compared to WT plants, this was not sufficient to overcome extended osmotic stress. Correlation of plant morphological and physiological responses
with endogenous polyamine levels will be discussed. Taken together, our data indicate only a slight role of spermidine in tolerating osmotic stress in tomato plants grown under greenhouse conditions.

(182) Changes in Carbohydrate Synthesis during Cold Acclimation in Cranberry (Vaccinium macrocarpon)

Faith Ndlovu*
University of Massachusetts Amherst, Amherst, MA; fnndlovu@umass.edu

Peter Jeranyama
University of Massachusetts Amherst, East Wareham, MA; peterj@umass.edu

Carolyn J. DeMoranville
University of Massachusetts Amherst, East Wareham, MA; carolynd@umass.edu

Michelle DaCosta
University of Massachusetts Amherst, Amherst, MA; mdacosta@umass.edu

Cranberry plants tend to increase cold tolerance by synthesizing protective compounds during cold acclimation. The protective compounds are associated with biochemical, structural and physiological changes that occur in the plant during acclimation, however, these have not been fully studied in cranberries. The specific objective of this study was to identify and quantify carbohydrates synthesized by four cranberry var ‘Stevens’, ‘Howes’, ‘Mullica Queen’ and ‘DeMoranville’ during cold acclimation. A completely randomized design experiment replicated four times involving temperature and cultivar treatments, was conducted in a growth chamber. Potted cranberry plants were subjected to gradual decrease in temperature, day length and light intensity: 15 °C day/night at 12-h photoperiod and photosynthetic photon flux density (PPFD) of 500 µmol·m⁻²·s⁻¹, 6 °C day/night at 10-h photoperiod and PPFD of 250 µmol·m⁻²·s⁻¹, 2 °C day/night 10-h photoperiod and PPFD of 250 µmol·m⁻²·s⁻¹ and −2 °C in total darkness for two weeks in each setting. Carbohydrates were extracted from leaf and stem tissues and analyzed using high pressure liquid chromatography (HPLC). Four, total non-structural (TNSC) sugars, sucrose, fructose and starch were identified in cranberry leaves and stems. There was a significant interaction (P < 0.001) between tissue and acclimation temperature, inferring that acclimation temperature influenced leaf and stem tissues differently. Higher TNSC were observed in leaves than stems. Sucrose, glucose and fructose and starch were identified in cranberry leaves and stems. There was a significant interaction between the cranberry cultivars at all temperature settings.

Specified Source(s) of Funding: Cape Cod Cranberry Growers’ Association (CCCGA)

(227) Candidate Genes for Ornamental Traits in Blueberry

Rupesh Gaire*
University of Georgia, Athens; rupesh.gaire1@gmail.com

Allan F. Brown
North Carolina State University, Kannapolis; afbrown2@ncsu.edu

Dayton Wilde
University of Georgia, Athens; dwilde@uga.edu

Several genes are known to play major roles in controlling architectural and flowering traits of ornamental value. We are interested in screening germplasm collections to find allelic variation in these genes that could be used for breeding. Our long-term goal is to develop native plants with ornamental traits through an ecotilling approach with species indigenous to North America. This research was initiated with highbush blueberry (Vaccinium corymbosum), a natives species with a sequenced genome and an established germplasm collection. The draft genomic sequence of diploid V. corymbosum was searched for orthologs of four genes: (1) TFL1, which is involved in repetitive flowering, (2) AG, which plays a role in double-flowering, (3) GA20ox, which controls plant stature, and (4) BRC1, which is involved in shoot branching patterns. GenSAS was used to screen Roche 454-generated sequence scaffolds for homology to genes from tomato, tobacco, grape, and rhododendron. In species where the candidate gene was a member of a multi-gene family, the functionally dominant paralog was chosen for screening. Blueberry gene sequences were identified with blastx E-values that indicated significant similarity to TFL1 (<1e-26), AG (<1e-21), GA20ox (<1e-46), and BRC1 (<1e-37). The best match of blueberry sequences to benchmark genes was determined through ClustalW2 alignment. These sequences will be used to design PCR primers to amplify genes from accessions in the USDA blueberry germplasm collection, and allelic variation will be investigated.

(228) Genetic Structure of Peach Breeding Germplasm from Embrapa, Brazil

Liane Bahr Thurow*
Federal University of Pelotas, Pelotas; lianepel@yahoo.com.br

Maria B. Raseira
EMBRAPA - Center for Temperate Climate Agricultural Research, Pelotas; maria.bassols@embrapa.br

Sandro Bonow
EMBRAPA - Center for Temperate Climate Agricultural Research, Pelotas; sandro.bonow@embrapa.br

Caroline M. Castro
EMBRAPA - Center for Temperate Climate Agricultural Research, Pelotas; caroline.castro@embrapa.br

Several genes are known to play major roles in controlling architectural and flowering traits of ornamental value. We are interested in screening germplasm collections to find allelic variation in these genes that could be used for breeding. Our long-term goal is to develop native plants with ornamental traits through an ecotilling approach with species indigenous to North America. This research was initiated with highbush blueberry (Vaccinium corymbosum), a natives species with a sequenced genome and an established germplasm collection. The draft genomic sequence of diploid V. corymbosum was searched for orthologs of four genes: (1) TFL1, which is involved in repetitive flowering, (2) AG, which plays a role in double-flowering, (3) GA20ox, which controls plant stature, and (4) BRC1, which is involved in shoot branching patterns. GenSAS was used to screen Roche 454-generated sequence scaffolds for homology to genes from tomato, tobacco, grape, and rhododendron. In species where the candidate gene was a member of a multi-gene family, the functionally dominant paralog was chosen for screening. Blueberry gene sequences were identified with blastx E-values that indicated significant similarity to TFL1 (<1e-26), AG (<1e-21), GA20ox (<1e-46), and BRC1 (<1e-37). The best match of blueberry sequences to benchmark genes was determined through ClustalW2 alignment. These sequences will be used to design PCR primers to amplify genes from accessions in the USDA blueberry germplasm collection, and allelic variation will be investigated.

An asterisk (*) following a name indicates the presenting author.
and accessions selected from populations developed by the National breeding program, adapted to subtropical climate, with low chill requirement, as well as accessions introduced from several countries. Population structure studies provide additional tools for breeding and it is valuable information for genome-wide association studies (GWAS). In this research, we used 10 SSR markers, selected by their high level of polymorphism, to investigate the genetic structure of a set of 204 accessions from the peach breeding program of the Brazilian Agricultural Research Corporation - Embrapa. PCR products were separated by vertical electrophoresis on 6.5% polyacrylamide gel using 4300 DNA Analyzer LI-COR and Saga Generation 2 software for analysis of the amplified fragments. A total of 80 alleles were obtained, giving an average of eight alleles per locus. The 10 SSR markers were able to discriminate 198 accessions of the 204 target in this study, with an overall average genetic distance of 0.62 between accessions, ranging from 0.16 to 0.97. We analyzed the data by successively increasing the number of subpopulations (K) from 2 to 10. STRUCTURE analysis assigned 162 accessions splitted into two subpopulations based mainly on their fruit traits: melting and non-melting flesh varieties. The remaining accessions, 42, could not be assigned under the 80% membership coefficient criteria. CLUMPP alignment of 20 independent solutions for K = 2 showed a similarity of 99% indicating that the assignment of accessions to the subpopulation was well correlated among runs. Melting flesh subpopulation includes also nectarines and flat peaches. Non-melting flesh subpopulation includes peach and nectarines. The foundation clones clustered together with melting and non-melting flesh peaches, indicating that this germplasm is well represented in modern cultivars. This research is a first step to apply associative mapping studies aiming to implement marker-assisted selection. Potential application of these results in the development of new peach cultivars will be discussed.

(229) Analytical and Sensory Analysis of Pepper Fresh-cut Quality Reveals Extensive Diversity within the Capsicum Genepool for Crop Improvement

John R. Stommel*

USDA–ARS, Beltsville, MD; john.stommel@ars.usda.gov

Yaguang Luo

USDA–ARS, Beltsville, MD; yaguang.luo@ars.usda.gov

Judith M. Dumm

USDA–ARS, Beltsville, MD; judith.dumm@ars.usda.gov

Anne Marie Welten

Enza Zaden Research USA, Inc., San Juan Batista, CA; anne.welten@enzausa.com

Genetic diversity present in the Capsicum genepool has been utilized extensively to improve pepper disease resistance, fruit quality and varied yield attributes. Little attention has been dedicated to genetic enhancement of pepper fresh-cut quality. We evaluated pepper fresh-cut quality in accessions with diverse fruit phenotype selected from available cultivars and the USDA–ARS Capsicum genebank. Marketable full size green fruit of 50 pepper accessions were washed, sliced and stored at 4 °C in packages with selective oxygen transmission rates. Subjective assessment of product quality and objective measurement of package atmospheric composition, product weight loss and tissue electrolyte leakage after 7, 10, and 14 days of storage, identified significant differences across as well as within sweet bell, large elongate, jalapeno and serrano fruit classes. Sweet bell and large elongate fruited accessions generally exhibited high electrolyte leakage after 10 to 14 days of storage whereas jalapeno and serrano accessions maintained stable electrolyte leakage levels up to 14 days of storage. The jalapeno and serrano fruit classes were typified by faster decline in package headspace O2 and accumulation in CO2 partial pressures in comparison to the sweet bell and large elongated fruit classes. Fresh weight loss was low for accessions in all fruit classes. Exceptional sweet bell and large elongate fruited accessions that maintained tissue integrity and favorable sensory quality after 14 days of storage and slower changes in O2, CO2 levels were identified. Accessions within jalapeno and serrano fruit classes were also identified that maintained sensory quality and stable tissue integrity throughout the storage period. Regression analysis demonstrated a relationship between overall visual quality and electrolyte leakage after 14 days of storage for accessions in the sweet bell and large elongated fruit classes, but not for accessions represented in jalapeno or serrano fruit classes. The results demonstrate that extensive genetic variation is present in Capsicum to improve pepper for fresh-cut applications and facilitate research to better understand physiological and genetic determinants of fresh-cut produce quality.

(230) Traditional Plant Breeding Approach Used by Bridgestone Americas, Inc. to Develop Guayule as a Domestic Natural Rubber Source

Sarah M Smith*

Bridgestone Americas, Inc., Eloy, AZ; SmithSarah@bfusa.com

William S Niaura

Bridgestone Americas, Inc., Mesa, AZ; niaurawilliam@bfusa.com

Currently Hevea brasiliensis, the rubber tree, is the sole source of the world’s natural rubber and is grown in southeast Asia. Because of the volatile costs of natural rubber, changes in demand of natural rubber and the threat of leaf blight (M. ulei) infecting Hevea, Bridgestone Americas Tire Operations (BATO) in collaboration with Bridgestone Japan started investigating the use of Parthenium argentatum, guayule, as a sustainable, domestic and alternative natural rubber source. A Guayule Research Farm in Eloy, AZ and a Processing Research Center in Mesa, AZ are being developed to fully understand the potential of guayule from the agronomic and industrial perspectives. Bridgestone’s agricultural research is focused on: 1) supplying guayule shrub to the Process Research Center, 2) determining best growing practices for guayule to optimize yield and rubber production and 3) increasing rubber content and improving agricultural characteristics through a traditional plant breeding approach. Mass selection will be the primary breeding strategy used to
develop guayule varieties to be grown as a commercial crop in the southwestern United States because it is a cross pollinating species, but also exhibits self incompatibility, polyploidy and apomixis. Germplasm for the breeding program originated from the National Genetic Resource Program, where approximately 69 accessions of guayule or related species are publicly available, and Bridgestone Americas, Inc. Texas Proving Grounds in Fort Stockton, TX, where *Parthenium* was planted in the 1980s and has since been open pollinating. Because guayule is still considered a “wild” species, many traits are needed to be improved, such as rubber content as well as cold, heat, water logging, drought and salt tolerance. The main focus of the breeding program consists of 1) collecting germplasm, 2) evaluating and selecting germplasm for traits of interest, 3) evaluating individuals for ploidy level, 4) making cross pollinations in the greenhouse, 5) collecting open pollinated seed between two selected lines in pollination cages and 6) planting field trials at different locations from seed collected in the greenhouse and pollination cages. In conclusion, a traditional breeding approach has been implemented to develop guayule as a commercial crop to be used as a domestic source of natural rubber. The long term goal of the guayule breeding program is to produce varieties that can be grown in the southwestern United States by commercial growers.

**(231) Genetic Resources of the Functional Food, *Teramnus labialis* (L.f.) Spreng for Improving Seed Number, Flavonol Content, Oil Percentage, and Fatty Acid Compositions**

Brad Morris*  
USDA–ARS, Griffin, GA; brad.morris@ars.usda.gov

Ming Li Wang  
USDA–ARS, Griffin, GA; MingLi.Wang@ars.usda.gov

Brandon Tonnis  
USDA–ARS, Griffin, GA; Brandon.Tonnis@ars.usda.gov

*Teramnus labialis* is used as food in India and has potential to be used as a functional food vegetable in the United States. Photoperiod-sensitive *T. labialis* accessions were grown in the greenhouse from 2010 to 2011 and evaluated for flavonol content, percentage of oil % (oil %), and fatty acid compositions. Significant variations for seed numbers produced, flavonol content, oil %, and fatty acid compositions were detected. Seed numbers ranged from 758 to 3792. More quercetin (ranging from 0.615 to 2.120 mg/g) was produced in their seeds than the other flavonols. However kaempferol and isorhamnetin content ranged from 0 to 0.066 and 0 to 0.086 mg/g (dry seed weight basis), respectively among all accessions. The oil % ranged from 2.65% to 5.64% and more oleic, linoleic, and linolenic acids ranging from 8.39% to 25.97%, 31.82% to 41.44%, and 17.7% to 28.15%, respectively, were produced among all *T. labialis* accessions. The seeds from all accessions also produced the least saturated fatty acid compositions (ranging from 0.10% to 15.36%). Several significant correlations were also detected for these traits among the accessions. Quercetin showed highly significant positive correlations with kaempferol (r = 0.72, P < 0.0001), oil % (r = 0.65, P < 0.0001), and oleic acid (r = 0.66, P < 0.0001). Quercetin also showed a significant negative correlation with linoleic acid (r = –0.37, P < 0.001) and linolenic acid (r = –0.70, P < 0.0001). These correlations are important because useful breeding procedures could be conducted on improving flavonol, oil %, and fatty acid compositions in *Teramnus labialis* accessions.

**(232) Variation of Carotenoids and Polyphenolics in Peach (*Prunus persica* L.) and Implications on Breeding for Modified Phytochemical Profiles**

Allan Brown  
NCSU-PHHI, Kannapolis; afbrown2@ncsu.edu

Gad G. Yousef*  
North Carolina State University, Plants for Human Health Institute, Kannapolis; ggyousef@ncsu.edu

Kranthi Chebrolu  
North Carolina State University, Kannapolis; kkchebro@ncsu.edu

Penelope Perkins-Veazie  
North Carolina State University, Plants for Human Health Institute, Kannapolis; penelope_perkins@ncsu.edu

Dennis Werner  
North Carolina State University, Raleigh; djw@ncsu.edu

Mike Parker  
North Carolina State University, Raleigh; mlp@ncsu.edu

Ksenija Gasic  
Clemson University, Clemson, SC; kgasic@clemson.edu

Current medical research suggests that associations between generalized plant measurements of anti-oxidant capacity and recognized human biomarkers of disease or definitive health endpoints is inconsistent and often inconclusive. Detailed information of individual constituents of known phytochemical classes may be more informative than measurements of overall antioxidant capacity. Firm ripe fruit of peach cultivars, ‘China Pearl’, ‘Contender’, ‘Carolina Gold’, and advanced breeding selections ‘NC Yellow’ and ‘NC 97-48’ were collected from established trees at 2 North Carolina locations in 2009 and 2010 and frozen in liquid nitrogen. Utilizing tandem extractions and analysis with UPLC and LCMS, 10 carotenoids and 24 phenolic compounds were quantified separately in the peel and flesh. Statistically significant differences were noted among peach cultivars and advanced selections for beta-carotene, cyanidin-3-glucoside, cyanidin-3-rutinoside, chlorogenic acid, quercetin-3-glucoside, and individual procyanidins. Peel anthocyanin (ANC) concentration ranged from 183 mg/100 g dry weight in ‘Contender’ to non-detectable levels in ‘NC97-48’ and ‘NC Yellow’. ‘China Pearl’ and ‘Carolina Gold’ produced ANC levels approximately half of ‘Contender’ and it was hypothesized they represent the heterozygous state of an ANC allele(s) present in ‘Contender’ but absent in the advanced selections ‘NC Yellow’ and ‘NC97-48’. Examination of the pedigrees of these cultivars and advanced selections provides additional support for this hypothesis. Chlorogenic acid const...
intermediate in height. 'Cascade' and 'Columbus' were the top growers more than 3 m. The remaining cultivars were generally of plant vigor and adaptability, when not under severe disease downy mildew infection. Using plant height as an indicator of production (2012) were abnormally low because of severe among these cultivars. Growth and cone yields in the second year growth, cone yield, and downy mildew infection were found statistically significant genetic variation was found for almost all compounds identified. Significant variation for location and year were detected, but they often tended to be compound specific. For chlorogenic acid, 27.7% of the phenotypic variance was explained by location (year = nonsignificant), while 40.4% of the phenotypic variation of ANC was explained by difference in genotypes. Analyzing fruit from the same environment over 2 years or from 2 locations in the same year would not have adequately accounted for the variation associated with environment. Our data show that at least one bioactive compound of interest (ANC) in peach can be followed at least in part through genetics, and that environment may play a more substantial role in accumulation of bioactives than originally thought.

(233) Evaluation of Hop Cultivars for Commercial Production in North Carolina

Jeanine M. Davis
North Carolina State University, Mills River; jeanine_davis@ncsu.edu

Kelly Gaskill
North Carolina State University, Mills River; Kelly_Gaskill@ncsu.edu

Luping Qu
North Carolina State University, Mills River; Luping_Qu@ncsu.edu

Many farmers in North Carolina have started growing hops (Humulus lupulus) or expressed interest in doing so to supply wet and dry hops to the burgeoning craft brew industry in the Southeast. In the United States, the available hop cultivars and growing information have been generated almost entirely from the relatively dry regions in the Pacific Northwest. Since hops are perennial, photoperiod sensitive plants and susceptible to several foliar fungal diseases, identifying cultivars that perform well in southern environments with higher humidity is considered essential for success in growing hops in the Southeastern United States. In 2011, ten hop cultivars, Cascade, Centennial, Chinook, Galena, Magnum, Mt. Hood, Newport, Nugget, Willamette, and Columbus (Zeus) were grown on a 6-m trellis in a replicated field trial in the southern mountains of North Carolina (Mills River). Over three years, significant variations in plant growth, cone yield, and downy mildew infection were found among these cultivars. Growth and cone yields in the second year of production (2012) were abnormally low because of severe downy mildew infection. Using plant height as an indicator of plant vigor and adaptability, when not under severe disease pressure, 'Columbus' was the most vigorous in growth (>6 m). 'Magnum' and 'Willamette' were weak all three years, never growing more than 3 m. The remaining cultivars were generally intermediate in height. 'Cascade' and 'Columbus' were the top yield performers in 2011 and 2013. Cone yields averaged over those two years were statistically the same for 'Cascade', 'Columbus', and 'Nugget'. 'Galena' yielded the same as 'Nugget' but less than 'Cascade' and 'Columbus'. Excluding the disease impacted year, there was a significant yield increase from 2011 to 2013 for the top five cultivars (Columbus, Cascade, Nugget, Galena, and Chinook); more than doubling for 'Chinook', and increasing 170% and 184% for 'Galena' and 'Nugget', respectively. Yields of the remaining cultivars (Centennial, Magnum, Mt. Hood, Newport, and Willamette) were significantly lower than the other five varieties for the two growing seasons. In 2012, when exposed to severe downy mildew, 'Cascade', 'Chinook', and 'Nugget' were the best performers, followed by 'Centennial' and 'Willamette'. 'Galena' produced the tallest plants that year, even though it had the most disease symptoms. Plant height of 'Columbus', however, was significantly reduced due to the downy mildew infection. These results will help growers in the Southeast choose hop cultivars with the best chances of success. Specified Source(s) of Funding: NC Department of Agriculture & Consumer Services Specialty Crops Block Grant

(234) Investigating Stevia Germplasm as Alternative Highly Profitable Crop for Farmers

Bipul K. Biswas*
Fort Valley State University, Fort Valley, GA; biswas@fvsu.edu

Shomari A. Johnson
Fort Valley State University, Fort Valley; shomari.ade@gmail.com

Maurice Smith
Fort Valley State University, Fort Valley, GA; smit1088@icloud.com

India Brown
Fort Valley State University, Fort Valley, GA; indiabrown88@yahoo.com

Moniece McKinney
Fort Valley State University, Fort Valley, GA; mm03937@georgiasouthern.edu

Stevia (Stevia rebaudiana Bertoni) is a perennial plant native to Paraguay. Its leaves are up to 300 times sweeter than sucrose. It is safe for diabetics and is helpful in weight and blood pressure management. As an alternative crop, stevia has a lot of potential. There is a lack of information on high yielding stevia germplasm as well as field trial for higher biomass production. Low seed germination is another problem with stevia. At the Fort Valley State University, Fort Valley, GA, we have been working to develop technology and innovative horticultural practices for profitable production of stevia. Our aim is to increase percentage of seed germination, selecting stevia cultivar with higher contents of sweet agents (Rebaudioside A) using high performance liquid chromatography and to develop eco-friendly best management practices for higher biomass production in order to meet an increasing industry demand. Sweet Green Fields, Inc. (a pioneer company working on stevia in the United States), has been supplying planting materials and seeds for this research. During this investigation we have carried out seed germination trial and have increased seed germination from 40% to 80%. We have also conducted field trials for high biomass production during
We tested the effect of six different growing media on arugula. We prepared 210 ft. long, 3 ft. wide and 1 ft. high raised beds and there was 3 ft. gap in between two beds. All beds have been covered with 20-year weed barrier ground cover to minimize the cost of cleaning. Roundup was applied to the center of each bed for weed control. It was applied with a paint brush roller to eliminate drift from wind onto the stevia plant. Stevia plants have been planted using six different planting densities. In each bed, two or three rows of plants were planted. In each row plant spacing was maintained at 6”, 9” or 18” density. Plants were planted in 2013 in the second week of September and by the end of October (after 5–6 weeks) flowering buds appeared in each plant. Stevia plant was harvested after 8 weeks of planting that was November 14, 2013, before the frost (21 °F) hit Fort Valley, GA. We measured the average plant biomass production. Results will be presented.

Specified Source(s) of Funding: Georgia Department of Agriculture.

Thursday, July 31, 2014

Growth Chambers and Controlled Environments 2

(153) Physical and Chemical Characteristics of Hydroponic Media and Their Effects on Growth of Arugula Microgreens

M. Olszewski*
Temple University, Ambler, PA; olszewsk@temple.edu

A. Brown
Temple University, Ambler; AB@jembe.com

M. Gusielmetti
Temple University, Ambler; mdg66190@gmail.com

M. Moskowitz
Temple University, Ambler; tuc25384@temple.edu

D. Parker
Temple University, Ambler; dhanparker@gmail.com

We tested the effect of six different growing media on arugula (Eruca sativa Mill.) germination and growth to identify alternative substrates for growing hydroponic microgreens. Chemical and physical properties were determined using cylinders containing perlite, fine-grade heat-expanded clay (HEC-F), 1:1 HEC-F:medium grade heat-expanded clay (HEC-FM) or 15:1:9 coarse grade coir:compost:perlite (coir-based mix). Mixes were blended (by volume) in a cement mixer for five minutes and included nutrients and a wetting agent. In addition, coir-based mix contained hydrogel. A professional peat-based seeding mix and rockwool also were evaluated. Round cylinders of 83 mL capacity were used for physical characteristic determinations and for the microgreen growth study. Seeds were covered lightly with the same material used to fill containers except for rockwool-sown seeds, which were covered using tackifier. Arugula was grown for three weeks using a hydroponic fertilizer solution and supplemental lighting (15 hours of light per day; mid-day readings of 78 to 171 µmol·m⁻²·s⁻¹). Total Porosity (TP) was highest for rockwool (92%) and peat-based seeding mix (83%) and lowest for HEC-F and HEC-FM (both 36%). Predictably, those substrates with the highest bulk density (HEC-F and HEC-FM) had the lowest TP. Aeration porosity (AP) values were lower for peat-based seeding mix, HEC-F and HEC-FM (5%, 7% and 10%, respectively) than for perlite, coir-based mix and rockwool (17%, 14%, and 17%, respectively). Determination of aeration porosity at an applied suction pressure of 7.5 kPa (AP-7.5 kPa) indicated that peat-based seeding mix, HEC-F and HEC-FM had the lowest AP-7.5 kPa (7%, 12%, and 17%, respectively) while perlite, coir-based mix and rockwool had the highest AP-7.5 kPa (26%, 24%, and 26%, respectively). Following microgreen growth study, final EC was similar for all treatments (320 to 398 µS·cm⁻¹) and reflected the influence of the hydroponic solution saturation of media. Compared to peat-based seeding mix, the use of perlite, coir-based mix and rockwool resulted in decreased shoot dry weight per seedling and number of seedlings; possibly due to aeration properties or to increased temperature exposure of seeds or seedlings resulting from the physical nature of the substrates as covering material. Compared to peat-based seeding mix, HEC-F and HEC-FM had similar shoot dry weights per shoot and number of seedlings; thus, enhanced growth and germination occurred when using media with the lowest AP and AP-7.5 kPa. In conclusion, heat-expanded clay media may be an adequate hydroponic media and suitable alternative to peat-based media for arugula grown as microgreens.

(154) Winter Season Greenhouse Production of Strawberry in Desert Southwest

Chieri Kubota*
University of Arizona, Tucson; ckubota@ag.arizona.edu

Mark A. Kroggel
University of Arizona, Tucson; kroggel@ag.arizona.edu

Ninety percent of all strawberry fruit grown in the United States is produced in coastal California, between the months of March and November. Due to limited production regions suitable for strawberry field production in winter, the total supply during the months of November, December and January is relatively low compared with other months. That allows a potentially valuable winter market season for local greenhouse production, a season which includes major holidays, not only to fill diminished supply but to provide high-quality, high flavor strawberries without concern for the shelf-life necessary for nation-wide distribution. Winter season greenhouse strawberry production is practiced widely in Asian countries and in Northern Europe, but very minimally in the United States. Very little documentation exists for methodology and practice of greenhouse strawberry production, and the development of such information is necessarily limited to the regional climates in which it is generated as

An asterisk (*) following a name indicates the presenting author.
Regional responses will be different. We have spent the last several years developing production systems and identifying important factors affecting growth and productivity in the unique semi-arid climate of the desert southwest. As a part of this study, we examined planting systems and planting density. Two standard field production cultivars, ‘Albion’ and ‘Portola’ were planted at densities of 8 and 12 plants/m² in 11-L strawberry buckets and at 8 plants/m² in continuous Styrofoam troughs in substrate consisting of 1:1:2 (peat : coco coir : perlite) and irrigated using standard Yamazaki nutrient solution with pH adjusted to result in a drainage pH of 5.5–6.5. Plants were planted, in a greenhouse covered with a single layer of F-Clean (ETFE) greenhouse glazing film with light diffusing characteristics and high UV transmission, in August 2013 and initial harvesting began in October. As of mid-February 2014 cumulative yield for ‘Albion’ at 8 plants/m² in buckets, 12 plants/m² in buckets and 8 plants/m² in Styrofoam trough was (mean ± SE) 5.0 ± 0.4, 6.2 ± 0.7 and 6.2 ± 0.3 kg·m⁻², respectively. Cumulative yield for ‘Portola’ for the same period and planting systems/densities was 7.3 ± 0.5, 9.1 ± 0.3, and 8.7 ± 0.4 kg·m⁻², respectively. Brix (TSS) was 8.6 ± 0.15 and 6.0 ± 0.08 and total acidity was 11.0 ± 0.07 and 8.9 ± 0.12 g/L citric acid equivalent for ‘Albion’ and ‘Portola’, respectively. While yields are acceptable, additional management techniques to improve fruit quality characteristics must be developed, and existing cultivars bred specifically to produce fruit with high flavor characteristics in greenhouse need to be introduced.

Specified Source(s) of Funding: National Strawberry Sustainability Initiative, Walmart Foundation

(155) Effects of Shade Cloth on Specialty Crop Production in High Tunnels

Guihong Bi*
Mississippi State University; gbi@pss.msstate.edu
Williem B. Evans
Mississippi State University, Crystal Springs; wbe1@ra.msstate.edu

Southern high tunnels can have very high heat and light loads relatively early in the spring. This study was conducted to investigate the potential of using shade cloths of different colors to modify the microenvironment within high tunnels and to evaluate their impact on crop yield and quality. Seven different types of shade clothes were tested, including Aluminet, Chromatinet Red, Chromatinet Grey, Chromatinet Blue, Chromatinet Pearl/White, Black, and White. All the shade clothes were rated to provide 50% shade. One treatment without shade cloth was also included as a control. Zinnia Benary’s Giant Mix and two cultivars of lettuce (Two Star and New Red Fire) were transplanted into three high tunnels on two transplanting dates in spring 2013. We measured how the treatments influenced air, soil, and leaf temperatures; plant growth index; number of cut flowers and cut stem length; and yield and quality of lettuce. Both presence and type of shade were influential. Soil, air, and leaf temperatures were all influenced by shade cover, and were consistently lower under shade than in the unshaded controls. We also observed differences in plant growth, lettuce yield, cut flower stem numbers and stem length, red lettuce coloration, lettuce bolting, lettuce days to maturity and even lettuce taste under different color shade.

(156) Temporary Low Temperature Accumulates Antioxidant Phenolic Compounds in Kale

Jin-Hui Lee*
Chungbuk National University, Cheongju; jhjh@cbnu.ac.kr
Myung-Min Oh
Chungbuk National University, Cheongju; moh@chungbuk.ac.kr

Various environmental factors are known to induce the accumulation of health-promoting phytochemicals in plant-based food. The objective of this study was to determine the effect of temporary low temperature on the concentration of antioxidant phenol compounds in kale (Brassica oleracea var. acephala). Fourteen day-old kale seedlings of two cultivars (‘Manchoo Collard’ and ‘TBC’) were transplanted and cultivated in a growth chamber (20 °C, 12 h photoperiod, Red:White:Blue LEDs = 8:1:1, 142 ± 10 µmol·m⁻²·s⁻¹) for 3 weeks. For low-temperature treatment, kale plants at 3 weeks of transplanting were subjected to 4 °C low temperature for 3 d and subsequently recovered for 2 d under normal growth conditions. Fresh and dry weights of shoots and roots, Fv/Fm ratio, total phenolic concentration and antioxidant capacity were measured before the treatment and 2 d of recovery. As a result, Fv/Fm ratio of kale leaves started to decrease at 15 h of low temperature treatment. No significant difference was observed between control and low temperature treatment in fresh and dry weights of shoots and roots of both cultivars. However, two cultivars showed opposite trends in total phenolic concentration and antioxidant capacity. ‘Manchoo Collard’ exposed to low temperature had 15% higher total phenolics than control, whereas TBC under low temperature showed 16% lower total phenolics than control. Similar trends were observed in antioxidant capacity. In conclusion, these results suggested that temporary low temperature treatment would be a potential strategy to improve nutritional quality of kale without growth inhibition.

(157) Air Anion Improves Lettuce Growth in a Plant Factory

So-Ra Lee*
Chungbuk National University, Cheongju; srlee@chungbuk.ac.kr
Myung-Min Oh
Chungbuk National University, Cheongju; moh@chungbuk.ac.kr
Chung-Su Han
Chungbuk National University, Cheongju; hansu@chungbuk.ac.kr
Tea-Hwan Kang
Kongju National University, Yesan; lamokth@kongju.ac.kr

Air anion is known to be beneficial for plant growth because it may improve photosynthesis and the respiration process of plants. However, there is limited information for the effect of air anion on plant growth. The objective of this study was to determine the
Effect of air anion on lettuce growth and photosynthesis under a plant factory which controls environmental conditions. Red leaf lettuce (*Lactuca sativa* L. cv. 'Jeokchima') seedlings grown under normal growth conditions (20 °C, fluorescent lamp, 150 ± 3 µmol·m⁻²·s⁻¹, 12 h photoperiod) for 18 d were transplanted to NFT systems in a plant factory equipped with LEDs (Red:Blue = 78:22, 184 ± 2 µmol·m⁻²·s⁻¹, 12 h photoperiod). Three levels of air anion (low 1×10⁴~5×10⁴, middle 7×10⁵~12×10⁵, and high 15×10⁵~20×10⁵ ION·cm⁻³) were applied to lettuce transplanted using high voltage air anion generators for 4 weeks. Lettuce plants exposed to air anion showed vigorous growth. Both middle and high air anion improved growth characteristics such as leaf area and fresh weight of shoots although there was no significant difference between air anion treatment and control in leaf shape index and SPAD value. Especially, middle level of air anion led to 64% and 44% higher shoot fresh weight and leaf area than control at harvest, respectively. In addition, the photosynthetic rate in middle level of air anion was 30% higher than that in control at 3 weeks of anion treatment, which supported the result of shoot fresh weight. Regarding energy use efficiency, middle level of air anion also showed the highest value. In conclusion, this study suggested that the application of air anion would be a useful technique for enhancing crop yield in plant factories.

**Specified Source(s) of Funding:** the Agenda Research Development Program, Rural Development Administration, and Republic of Korea

**Season Extension and Sugar Accumulation in Low Tunnel-grown Spinach**

Erin MacNeal Rehrig*
Fitchburg State University, Fitchburg, MA; errehrig@fitchburgstate.edu

Samantha Glaze Corcoran
Fitchburg State University, Fitchburg, MA; sglaze@student.fitchburgstate.edu

Season extension allows growers to continue the growing season through late fall and begin in early spring. This experiment tested the hypothesis that by using season extension in conjunction with organic and sustainable farming practices, spinach crops would be sweeter by containing higher sugar content and, therefore, would be preferred over conventionally grown plants. Spinach is a cold weather crop that has evolved an osmotic antifreeze system in which high sugar concentrations prevent death in harsh winter conditions. The sugar concentrations of store-bought spinach were compared to those of spinach grown through the winter months in two low tunnels and in cold temperature growth chambers. In addition to analyzing the sugar content, the internal temperature of the tunnels was monitored and analyzed in comparison to the outdoor temperature. Our results suggest that low tunnels can reach temperatures of more than 30 °F greater than outdoor temperatures, consistently reach warmer average daily temperatures, and yield spinach crops with higher glucose concentrations. 

**Specified Source(s) of Funding:** Fitchburg State University Special Projects and Ruth Butler Grants

---

**Ornamental Plant Breeding**

(235) Establishment of In Vitro Propagation System and Induction of Autotetraploidy in *Monarda fistulosa* and *M. punctata* (Lamiaceae)

Emily L. Moeller*
University of Guelph, Guelph, ON; emoeller@uoguelph.ca

J. Alan Sullivan
University of Guelph, Guelph, ON; asulliva@uoguelph.ca

Praveen K. Saxena
University of Guelph, Guelph, ON; psaxena@uoguelph.ca

A. Maxwell Jones
University of Guelph, Guelph, ON; amjones@uoguelph.ca

Induced polyploidy offers great potential for increasing stress tolerance, biomass, essential oil production and the ornamental appeal of plants. In our research we have been evaluating native species adapted to more northerly latitudes for potential to survive in environments characterized by low water and nutrients. *Monarda fistulosa* and *M. punctata* are two species that have great potential because they may have some level of drought tolerance but they are also valued for their production of essential oils. Polyploidy has the potential to increase both of these characters. The proposed research aims to investigate how polyploidy will affect the overall growth and essential oil production of two native ornamental species, *M. fistulosa* and *M. punctata*. Firstly, an in vitro propagation system was required for these *Monarda* species. Leaf, petiole and nodal sections were used as explant donors and placed onto a solid MS media supplemented with a range of seven BA concentrations (0-25µM). Explants were transferred to fresh media every four weeks, and after twelve weeks the total number of shoots produced per explant was examined. The nodal sections produced significantly more shoots per explant compared to leaf and petiole explant donors and 25µM of BA was determined to be the optimal hormonal concentration for shoot regeneration. *M. fistulosa* (3.4 shoots per explant) was more responsive than *M. punctata* (1.5 shoots per explant). This media was then used to grow the in vitro material for the induction of polyploidy in the two species. Oryzalin and Trifluralin are both known to interrupt spindle fiber formation resulting in increased chromosome numbers. Oryzalin and Trifluralin were dissolved in DMSO and placed directly into the solidified media in a range of eight concentrations (0, 1, 5, 15, 30, 60, 90, and 120 µM). The nodal sections were taken from in vitro cultures and placed directly onto petri plates containing the anti-mitotic media for a duration of 1, 3, or 6 days. The plates were placed in a growth cabinet at 16-h day length and a day/night temperature of 25 °C. After the period of exposure, explants were transferred to MS media without Oryzalin or Trifluralin and allowed to produce plantlets. Phenotypic traits such as leaf and stem thickness, plant vigour and stomatal characteristics will be used to screen for potential polyploid plants. Chromosome number will be verified through

---

An asterisk (*) following a name indicates the presenting author.
(236) Polyploidization in Hippeastrum Hybrids and H. papilio

Song Zhang*  
Institute for Advanced Learning and Research, Danville, VA; song.zhang@ialr.org

Jami Carey  
Institute for Advanced Learning and Research, Danville, VA; jami.carey@ialr.org

Polyploidization is being introduced into our amaryllis (Hippeastrum) breeding project in order to broaden the gene pool, and facilitate the hybrid breeding process. In vitro bulblets of several tetraploid hybrid Hippeastrum (4n = 44), Christmas Gift (CG), Orange Sovereign (OS), Red Lion (RL), and one diploid H. papilio (2n = 22), Papilio Butterfly (PB), were treated with various concentrations of colchicine (0, 0.025, 0.25, 1.25, 2.5 mM) for 23 or 30 days. Colchicine concentrations higher than 0.25 mM greatly reduced plant survival rate and plant growth. No plants in all 4 genotypes showed chromosome doubling at the lower concentration (0.025 mM) treatments either for 23 or 30 days. Colchicine concentrations between 0.25 and 1.25 mM were suitable for both plant survival and chromosome doubling. Eight plants of H. papilio out of 33 tested were shown to be tetraploid though flow cytometry analysis. In experiments with hybrid amaryllis, octoploid plants were identified though flow cytometry analysis for OS and RL, but not for CG. Additional plants are to be tested via flow cytometry, with additional confirmation using root tip chromosome counting.

(237) Pineapple Lily (Eucomis) Tissue Culture and Somatic Embryogenesis

Kedong Da*  
The Institute for Advanced Learning and Research, Danville, VA; kda@ialr.org

Samantha Smith  
The Institute for Advanced Learning and Research, Danville, VA; samantha.smith@ialr.org

Hannah Farish-Williford  
The Institute for Advanced Learning and Research, Danville, VA; mhfarish@gmail.com

Pineapple lilies (Eucomis) belong to the family Asparagaceae, subfamily Scilloideae. They are bulbous perennials with basal rosettes of leaves and stout stems covered in star-shaped flowers, similar to those of the pineapple—hence, they are commonly referred to as pineapple flowers or pineapple lilies. The Pineapple lily market share is increasing, with new pot and cut flower varieties being introduced from South Africa. We have tested various parameters and developed a highly efficient plant regeneration system with pineapple lily ‘Sparkling Burgundy’. In vitro leaves were used as explants, somatic embryos developed directly from the cut surface of the explant with a mean number of $5$ somatic embryos per cm$^2$ leaf blade explant in 30 days. Regenerated somatic embryos were matured on plantlet strength medium after additional 30 days. The well-developed plantlets were directly transplanted to peat moss : perlite : vermiculite (1:1:1) soil and kept under moisture in a growth chamber for acclimatization, and a 100% survival rate was obtained after 25 days of acclimatization. Greenhouse acclimatization is now in progress.

(238) Daytona Heat Danica Pink, Daytona Heat Petty Blue, and Daytona Heat Dale White, New Vitex Releases

Carol D. Robacker*  
University of Georgia, Griffin; croback@uga.edu

David Knauft  
Texas A&M University, College Station; dknauft@uga.edu

Vitex agnus-castus is a deciduous shrub or small tree used in landscapes. This drought-tolerant plant may be grown in cold hardiness zones 6 through 9. During cold winters in zone 6, it may die back to the ground, but will likely regrow from the roots and produce a flowering shrub during the following summer, as flower buds are formed on new growth. Interest is strong among growers and consumers for improved Vitex cultivars with more compact form, heavy blooming, repeat flowering, and novel flower colors and foliage traits. Crosses were made in the summer of 2005 among cultivars ‘Salinas Pink’, ‘Abbeville Blue’, ‘Shoal Creek’, and ‘Silver Spires’. Seedlings with desirable qualities were propagated via cuttings and planted into a field plot in Watkinsville, GA, in 2007. Following another round of selection, rooted liners were planted into a field in Griffin, GA, in 2009, where plants have been evaluated for five years. Three selections have been identified for release and patenting. Daytona Heat™ Danica Pink (code V07-2) has darker pink flowers than the industry standard, ‘Salinas Pink’. Furthermore, it is shorter in height, has a more compact, rounded form, and produces many more blooms than ‘Salinas Pink’. Daytona Heat™ Petty Blue (code V0502-33) is a unique vitex as compared to the industry standards ‘Shoal Creek’ and ‘Abbeville Blue’. It has medium blue flowers (rather than dark blue or purple) borne on compound panicles that have a greater number of secondary peduncles per panicle compared to the standards. This large panicle creates a candelabra appearance. Daytona Heat™ Dale White (code V0509A-7) is an improved white vitex, as compared to the industry standard, ‘Silver Spires’. It has upright, larger panicles with flowers borne more closely together along the rachis, creating a more striking floral display. All of these selections are easily propagated from stem cuttings.

(239) Assessment of Rosa Species Plant Architecture in the Field

Xuan Wu*  
Texas A&M University, College Station; offer10@neo.tamu.edu

Shuyin Liang  
Texas A&M University, College Station; lshyin11@hotmail.com

David H. Byrne  
Texas A&M University, College Station; d-byrne@tamu.edu

An asterisk (*) following a name indicates the presenting author.
Rosa sp. is one of the most important ornamental crops globally. Currently the annual value of garden roses in the USA is approximately $400 million and there is a need for better adapted roses. In Texas, heat stress has been reported as a predominant abiotic stress to roses which can affect plant architecture, flower intensity, and eventually plant health. The plant architecture is a crucial trait in rose breeding as it affects the ornamental appearance and flower intensity. The objective of this study is to develop a standard protocol to quantify how environmental conditions, especially heat stress, influence the architecture of roses. Four diploid populations were created by crossing heat tolerant and sensitive parents. Ten seedlings in each population were selected to evaluate in the field and under greenhouse conditions. Six components were measured on each primary, secondary and tertiary branch: branching angle, number of dormant nodes, number of nodes on vegetative part, length of vegetative part, length of reproductive part, and number of flowers on the terminal inflorescence. Additionally, the inflorescence structure type was recorded on each individual plant. The variation among these traits within the segregating populations was characterized.

(240) Phenotypic Variation of Advanced Dichroa × Hydrangea Hybrids
Lisa W. Alexander*
USDA–ARS, McMinnville, TN; Lisa.Alexander@ars.usda.gov
Sandra M. Reed
USDA–ARS, McMinnville, TN; Sandra.Reed@ars.usda.gov

Hydrangea macrophylla is the most popular Hydrangea species sold in the United States with sales of over $32 million annually in the horticulture and floriculture industries. Addition of aluminum to soilless media is required to produce highly desirable blue flowers at the point of sale, which represents increased labor costs and may lower the pH to toxic levels in the plant container. Dichroa febrifuga, a member of the Hydrangeaceae, produces blue flowers in the absence of aluminum and blue fruits that persist throughout winter. The goal of the current project is to produce and evaluate interspecific hybrids that combine the desirable traits of blue fruits, stable blue flower color, larger flowers, and evergreen foliage found in Dichroa febrifuga with cold-hardiness and the showy flowers with large sepal found in H. macrophylla. The F1 hybrid Dichroa × H. macrophylla ‘Taube’ was selected as a female parent for advanced generation hybridization due to its large flowers, compact form, and low disease incidence. Of all backcrosses to an H. macrophylla parent, the BC1 [(Dichroa × ‘Taube’) × Souvenir du President Doumir] had the highest percentage of pollinations producing fruit with seeds and the highest number of surviving seedlings per fruit. A total of 32 [(Dichroa × ‘Taube’) × Souvenir du President Doumir] BC1s were generated. All contain the dark, evergreen leaves of Dichroa and the showy sepal of the H. macrophylla male parent. Evaluation for height, form, flower color, flower size, and number of flowers is ongoing. We expect these hybrids to constitute an important source of germplasm for Hydrangea improvement.

(241) Characterization of 10 Hybrid Rose Populations for Heat Tolerance
Shuyin Liang*
Texas A&M University, College Station, TX; lshuyin11@hotmail.com
Xuan Wu
Texas A&M University, College Station, TX 77843, College Station, TX; offer10@neo.tamu.edu
D.H. Byrne
Texas A&M University, College Station; dbyrne@tamu.edu

Rose (Rosa sp.) is an important ornamental crop which is commercially utilized for garden plants, cut flower, and food/medicinal/industrial use. Heat stress is a major abiotic stress in Texas and in the world. It affects the rose appearance by causing increased flower abscission and leaf damage, and decreased flower size. This can reduce its market value. To increase the heat tolerance in rose cultivars, breeding lines derived from wild rose species Rosa wichurana were utilized as donor source in trait introgression. In this project, 10 hybrid populations were created by crossing both heat tolerant and sensitive diploid parents including TAMU breeding lines (M4-4, J06-20-14-3, DD, Rosa wichurana’Bayse’s Thornless’) and commercial cultivars (‘Red Fairy’, ‘Sweet Charriot’, ‘Vineyard Song’, ‘Old Blush’, ‘Little Chief’, ‘Ducher’). All the parents and the progenies were propagated and grown in pots under greenhouse conditions. Before giving them a heat shock treatment (44 °C for 30 minutes) the roses will be pruned uniformly to obtain synchronized flowering for the heat treatment. After the heat shock the plants along with untreated controls will be assessed for flower abscission, leaf necrosis, flower size and petal number. This growth chamber heat tolerance data will be compared to field ratings of flower intensity and plant growth of the same rose genotypes in the field over cool and warm temperature seasons.

(242) A Need for Speed: High Throughput Phenotyping for Rhododendron pH Adaptability
Alexander Susko*
University of Minnesota, St. Paul; susko004@umn.edu
Stan C. Hokanson
University of Minnesota, St. Paul; hokan017@umn.edu
Steve McNamara
University of Minnesota, Excelsior; mcnam004@umn.edu
James M. Braden
University of Minnesota, St. Paul; brade005@umn.edu
Joshua Friell
University of Minnesota, St. Paul; frie0250@umn.edu

The genus Rhododendron (Ericaceae), comprising over 1,000 species, has long been valued for its showy ornamental characteristics. Unfortunately, most cultivars lack any tolerance to neutral or high pH soils common in many parts of North America. Genetic variation for pH tolerance among cultivars or wild populations could improve the adaptability of this genus to alkaline soils where it is traditionally not well suited.

An asterisk (*) following a name indicates the presenting author.
We present a novel, colorimetric method using a MATLAB script (MathWorks, Inc.) to measure rhizosphere acidification, a candidate trait for pH tolerance, among rhododendron full and half-sib families. Half-sib progeny were obtained from an open pollinated R. catawbiense (elevated pH intolerant) plant, while full sib progeny resulted from a cross between ‘Haaga’ (elevated pH intolerant) and INKARHO® (reportedly elevated pH tolerant). All seedlings were grown on half-strength woody plant medium for three months as root systems developed. Mature seedlings were then subcultured on media with an elevated pH (7.75) and screened over a two-week period. The pH indicator phenolsulfonphthalein was incorporated into the screening media with rhizosphere acidification quantified by measuring the change in hue. Measurements were taken on a weekly basis using a digital camera and the MATLAB script mentioned above.

Root mass was weakly correlated with increased rhizosphere acidification among the ‘Haaga’ and INKARHO® full-sibs ($R^2 = 0.37$), while more strongly correlated among the R. catawbiense open pollinated half-sibs ($R^2 = 0.72$). Using linear models from one population to predict mean acidification in the other based on root mass data alone, predicted values were significantly different from those observed ($P$-values of 0.04 and 0.002 for full and half sibs, respectively). The significant differences between these two progeny sets for mean rhizosphere acidification and differing variation explained by root mass indicate a potential genetic basis for this trait, which could be used to maximize the adaptability of this valuable genus.

Specified Source(s) of Funding: American Rhododendron Society

(243) Selection, Evaluation, and Introduction of Hardy Superior Woody Plants By the NDSU Woody Plant Improvement Program

Todd P. West*
North Dakota State University, Fargo; todd.p.west@ndsu.edu

The North Dakota State University (NDSU) Woody Plant Improvement Program has been servicing the Northern Great Plains for 60 years, beginning germplasm trial evaluations in 1954. The program has evaluated 200+ genera and 3,000+ species and cultivars of trees and shrubs. In 1974, NDSU purchased an 80-acre (~32 hectares) farm to be established as the NDSU Horticulture Research Farm near Absaraka, ND and began trial plantings in fall of 1974. This research farm provides ideal horticultural soil for evaluation and breeding projects for ND. Approximately 45 acres (~18 hectares) of this farm is used for evaluation, selection and breeding of woody ornamental plants. The main portion of this research farm is the center 35-acre (~14 acres) plot dedicated as the NDSU Dale E. Herman Research Arboretum. This was named after Dr. Dale E. Herman who developed this program for nearly 40 years. This research arboretum is the most extensive collection of woody ornamental plants in North Dakota and in the Northern Great Plains. There have been over 9500+ accessions obtained, evaluated and developed since planting began in 1974. Accessions have been collected from local, regional, national and international sources. All plants are arranged alphabetically by genus with germplasm representing each letter from the alphabet from A to Z. This makes the arboretum more accessible and enhances its value for teaching, research and educational use. NDSU woody plant introductions are currently being propagated for sale by commercial wholesale firms in four countries; Australia, Canada, England, and the United States (14 states, including 35 nurseries). This project has introduced 53 superior woody plants for production and sale with increased disease tolerance and winter hardiness for landscapes. The first introduction from the program (1986) was a flower bud hardy Forsythia hybrid, ‘Meadowlark’. This was a collaborative release with SDSU, Arnold Arboretum and the USDA North Central Regional Plant Introduction Station. Some of the most promising selections include: Dakota Pinacle® Birch, Royal Splendor® Norway Spruce, Northern Acclaim® Thornless Honeylocust, Prairie Expedition® American Elm, Prairie Statesman® Swiss Stone Pine, Northern Tribute® River Birch, Northern Empress™ Japanese Elm, and Cinnamon Curls™ Dwarf Korean Birch. In 2012, several breeding programs were initiated focusing on magnolia (Magnolia sp.), lilac (Syringa sp.) maple hybridizing (Acer pseudosieboldianum × A. palmatum) and mutagenic breeding of several shrub species. The goals of the NDSU Woody Plant Improvement Program are selection, evaluation and introduction of hardy superior woody plants for the landscape industry.

(244) Boxwood Breeding at the United States National Arboretum

Richard T. Olsen
USDA–ARS U.S. National Arboretum, Beltsville, MD; richard.olsen@ars.usda.gov

Henry Guo
USDA–ARS U.S. National Arboretum, Beltsville, MD; henry.guo@ars.usda.gov

Chandra Thammina
USDA–ARS U.S. National Arboretum, Beltsville, MD; chandra.thammina@ars.usda.gov

JoAnne Crouch
USDA–ARS Systematic Mycology and Microbiology Lab, Beltsville, MD; joanne.crouch@ars.usda.gov

Margaret Pooler*
USDA–ARS U.S. National Arboretum, Beltsville, MD; margaret.pooler@ars.usda.gov

Boxwood (Buxus sp.) are slow-growing evergreen shrubs and small trees that are extensively grown as hedges and for topiary. Over 13 million boxwood plants are sold in the U.S. each year, with an annual market value of over $100 million. Boxwood blight disease caused by the ascomycete fungus Calonectria pseudonaviculata was first reported in Connecticut and North Carolina in October 2011, and later identified in many other states and several Canadian provinces. This pathogen causes severe defoliation leading to plant death in nurseries and established landscapes. In response to this problem, a boxwood breeding program was initiated in 2012 at the U.S. National Arboretum in order to develop blight-resistant cultivars. New accessions from domestic and international sources were added to the existing ...
Boxwood Accessions to Breed for Blight-tolerant Cultivars

Chandra Thammina*
USDA–ARS U.S. National Arboretum, Beltsville, MD; chandra.thammina@ars.usda.gov

Richard T. Olsen
USDA–ARS U.S. National Arboretum, Beltsville, MD; richard.olsen@ars.usda.gov

Margaret Pooler
USDA–ARS U.S. National Arboretum, Beltsville, MD; margaret.pooler@ars.usda.gov

Martha Malapi-Wight
USDA–ARS Systematic Mycology and Microbiology Lab, Beltsville, MD; martha.malapi-wight@ars.usda.gov

JoAnne Crouch
USDA–ARS Systematic Mycology and Microbiology Lab, Beltsville, MD; joanne.crouch@ars.usda.gov

Boxwood (Buxus sp., Buxaceae) are evergreen, deer-resistant and popular landscape plants in the nursery industry. There are numerous cultivars available for use in various landscape functions. Each year, more than 13 million boxwood plants are sold in the United States, with an annual market value of $103 million. Boxwood blight caused by Calonectria pseudonaviculata was first reported in Connecticut and North Carolina in October 2011, and later identified in many other states and several Canadian provinces. This fungal pathogen causes severe defoliation leading to plant death in nurseries and established landscapes. Hence, there is an urgent need to develop blight tolerant boxwood cultivars. The U.S. National Arboretum’s (USNA) National Boxwood Collection with more than 700 accessions is one of the most complete collections in the world. However, genetic relationships and diversity among these accessions has not been determined. We developed genic simple sequence repeat markers (SSRs) to evaluate genetic diversity of the USNA boxwood accessions which will aid in our overall objective of developing blight tolerant varieties.

(245) Development of Genic Microsatellite Markers for Genetic Diversity Analysis of Boxwood Accessions to Breed for Blight-tolerant Cultivars

Thursday, July 31, 2014

Vegetable Crops Management 4

(387) Light Source Effects on Hydroponically Grown Miniature ‘Pom Pom’ Lettuce

Kent D. Kobayashi*
University of Hawaii at Manoa, Honolulu; kentko@hawaii.edu

Teresita D. Amore
University of Hawaii at Manoa, Honolulu; amore@hawaii.edu

There is growing concern about food safety, environmental impact, and efficient energy usage in horticultural production systems. Producing lettuce under artificial lighting can be a solution addressing these concerns. Light-emitting diodes (LED) offer the advantages of a narrow light spectrum, low power consumption, and little heat production. Light emitting plasma (LEP) provides high light intensity, sun-like full spectrum, and long life. The objective of this study was to determine the effects of different light sources on the growth of miniature ‘Pom Pom’ loose-leaf lettuce in a noncirculating hydroponic system. Lettuce seedlings were started in Oasis cubes, which were transferred to 5.1-cm net pots and put in 1.9-L containers containing a hydroponic nutrient solution. The solution was composed of Hydro-Gardens’ Hobby Formula 10–8–22 hydroponic fertilizer and deionized water. The lettuce was grown in a lab under different light treatments—red+blue+white LEDs, light emitting plasma, and high output T-5 fluorescent lights (HO). The light level was 261 µmol·m⁻²·s⁻¹ with an air temperature 21°C. At the end of the study, plants were taller under the LEP and HO treatments than the LED treatment. The HO treatment resulted in greater partitioning of dry weight to the shoots than the LED and LEP treatments. Under the LED and LEP treatments, a greater partitioning of dry weight to the roots and a greater root-shoot ratio occurred compared to the HO treatment. SPAD readings were highest for the LED treatment. The LED treatment also produced the greatest shoot dry matter production per unit amount of nutrient solution used than the other two treatments. The LED treatment used the least amount of nutrient solution for lettuce production. The electrical conductivity of the remaining nutrient solution of the HO treatment was the highest, followed by the LEP treatment and the LED treatment. There were no significant differences in shoot dry weight, root dry weight, total plant dry weight, and the pH of the remaining nutrient solution in the containers. In conclusion, LED and LEP lights may provide alternative lighting sources to fluorescent lights for miniature lettuce.

Specified Source(s) of Funding: CTAHR Supplemental Research Funding. Hatch funding.

An asterisk (*) following a name indicates the presenting author.
The existence of a healthy growing human population is reliant on the production of high-quality food, feed, and fiber. This can be achieved by the use of intensive sustainable soilless cultures amended with symbiotic microbes. This study investigated the effects of Trichoderma on hot pepper (Capsicum chinense Jacq.) growth and root colonization at different phenological stages and on different growth media. A greenhouse study was conducted in a completely randomized block design with three treatments [control, Trichoderma harzianum (T22) and Trichoderma virens (GL13)] and three soilless media (perlite, coir, and coir:perlite) with four replications. Strains T22 and GL13 were grown separately on Biodac and applied to sterile Promix at the rate of 0.1% (v/v) at sowing of the seeds and applied to the soilless media at transplanting. The following parameters were assessed: germination percentage, days to emergence, plant height, shoot and root biomass, yield, chlorophyll content, and Trichoderma population from the non-rhizosphere (day 7–21 post-inoculation) and rhizosphere (day 28–56 post-inoculation). The study was repeated twice. Results from experiment 1 indicated that Trichoderma treatment increased seedling height. Average Trichoderma population sampled from the non-rhizosphere was 6.2 and 6.3 log_{10} CFU/g for GL13 and T22, respectively. Trichoderma population sampled from the rhizosphere was 6.4 and 6.2 log_{10} CFU/g for T22 and GL13, respectively. In experiment 2, Trichoderma treatment decreased the days to emergence, and increased seedling height, shoot and root biomass, and chlorophyll content. Trichoderma population sampled from the non-rhizosphere was 6.3 and 6.4 log_{10} CFU/g for GL13 and T22, respectively. Trichoderma population sampled from the rhizosphere was 6.9 and 6.3 log_{10} CFU/g for T22 and GL13, respectively. Root colonization on the primary and secondary root system of hot pepper seedlings were significantly (P < 0.05) greater in the Trichoderma inoculated plants than those of the control treatment. Plants grown in coir had significantly (P < 0.05) greater height, shoot, and root biomass in both experiments than plants grown in perlite. Hot pepper fruit yield was significant (P < 0.05) for plants grown in coir:perlite mixture in experiment 1. In this study, the application of Trichoderma on hot pepper seedlings demonstrated the improvement of seedling vigor and uniformity. Media type also influenced plant growth and root colonization by Trichoderma.

The existence of a healthy growing human population is reliant on the production of high-quality food, feed, and fiber. This can be achieved by the use of intensive sustainable soilless cultures amended with symbiotic microbes. This study investigated the effects of Trichoderma on hot pepper (Capsicum chinense Jacq.) growth and root colonization at different phenological stages and on different growth media. A greenhouse study was conducted in a completely randomized block design with three treatments [control, Trichoderma harzianum (T22) and Trichoderma virens (GL13)] and three soilless media (perlite, coir, and coir:perlite) with four replications. Strains T22 and GL13 were grown separately on Biodac and applied to sterile Promix at the rate of 0.1% (v/v) at sowing of the seeds and applied to the soilless media at transplanting. The following parameters were assessed: germination percentage, days to emergence, plant height, shoot and root biomass, yield, chlorophyll content, and Trichoderma population from the non-rhizosphere (day 7–21 post-inoculation) and rhizosphere (day 28–56 post-inoculation). The study was repeated twice. Results from experiment 1 indicated that Trichoderma treatment increased seedling height. Average Trichoderma population sampled from the non-rhizosphere was 6.2 and 6.3 log_{10} CFU/g for GL13 and T22, respectively. Trichoderma population sampled from the rhizosphere was 6.4 and 6.2 log_{10} CFU/g for T22 and GL13, respectively. In experiment 2, Trichoderma treatment decreased the days to emergence, and increased seedling height, shoot and root biomass, and chlorophyll content. Trichoderma population sampled from the non-rhizosphere was 6.3 and 6.4 log_{10} CFU/g for GL13 and T22, respectively. Trichoderma population sampled from the rhizosphere was 6.9 and 6.3 log_{10} CFU/g for T22 and GL13, respectively. Root colonization on the primary and secondary root system of hot pepper seedlings were significantly (P < 0.05) greater in the Trichoderma inoculated plants than those of the control treatment. Plants grown in coir had significantly (P < 0.05) greater height, shoot, and root biomass in both experiments than plants grown in perlite. Hot pepper fruit yield was significant (P < 0.05) for plants grown in coir:perlite mixture in experiment 1. In this study, the application of Trichoderma on hot pepper seedlings demonstrated the improvement of seedling vigor and uniformity. Media type also influenced plant growth and root colonization by Trichoderma.
progresses onto the storage root symmetrically. Several pathogenic (*Fusarium* sp., and *Macrophomina*) and non-pathogenic microorganisms have been isolated from symptomatic storage roots in Mississippi, however, stress-inducing factors such as ethephon appear to be involved to some extent in predisposing and/or enhancing the syndrome. Field studies were conducted to determine the interaction of biological agents with preharvest application of defoliants (ethephon and paraquat) on tip rot incidence. Plots were planted with sweetpotato slips that were dipped in biological agents and water as control. A week before harvest, plots were sprayed with ethephon or paraquat for defoliation prior to harvest. Control plots were mechanically defoliated. Storage roots were harvested and after 2 months in storage (60°F) were evaluated for rot incidence. Tip rot incidence was less than 1% in all treatments that were mechanically defoliated prior to harvest. In contrast, tip rot incidence increased for all biological agents and water control when ethephon was applied prior to harvest. Tip rot incidence also increased with paraquat applications except for the untreated water control. Results indicate that biological agents were unable to suppress this disorder and support previous studies suggesting that induced stress is a factor in predisposing and/or enhancing tip rot incidence.

Specified Source(s) of Funding: USDA-Specialty Crop Block Grant


Thomas Björkman*
Cornell University, Geneva, NY; tnb1@cornell.edu

Miguel Goméz
Cornell University, Ithaca, NY; mig7@cornell.edu

For broccoli to be a competitive crop among Eastern Vegetable growers, it needs to fit well in the rotation and be at least as profitable as alternatives. At the historic yield of 450 boxes per acre, the crop is not a strong competitor. Our crop budgets indicate that a yield of 600 boxes per acre would make a substantial difference in profit, and therefore how likely growers would be to plant broccoli. The smaller crown-cut heads (4.5–5.25 inches) currently favored by the marked is likely to have an optimal plant population higher than the historic standard of 15,20,000 plants per acre. We tested two morphologically different varieties, ‘Diplomat’, which has long branches, and BC1691, which has short branches, at populations of 26,000, 39,000, and 52,000 per acre, using production techniques intended to produce the maximum yield. The optimum both for yield and quality was 39,000 plants per acre, with an average yield of 630 boxes for the ‘Diplomat’ and 800 boxes per acre for BC1691. At the lower population, ‘Diplomat’ developed hollow stem and BC1691 became oversized quickly. At the high population, the heads in the second cutting and later were too light, making harvest more expensive, more cuttings were required to get the whole crop, the heads were difficult to find in the field, and some plants produced no head at all. At the optimal population, the net profit to the grower is predicted to be $2000 to $4000 per acre. The net profit at higher and lower populations was $300 to $1400 less.

(186) Evaluating Switchgrass Cultivars for Bioenergy Production in New Jersey

Jessica Baculis
Rutgers NJAES, New Brunswick, NJ; email4@email.com

William Hlubik*
Rutgers Coop Res Ext of Middlesex, North Brunswick, NJ; hlubik@aesop.rutgers.edu

Zane Helsel
Rutgers NJAES, New Brunswick, NJ; email5@email.com

Stacy Bonos
Rutgers University, Manalapan, NJ; bonos@aesop.rutgers.edu

Switchgrass (*Panicum virgatum*) is a perennial crop native to North America that is being considered by U.S. Department of Energy, United States Department of Agriculture (USDA), and others as a possible source for bioenergy in the Northeast. There are many different switchgrass cultivars; which are adapted to different climates and regions. Identification of the highest performing cultivars for New Jersey would increase the economic viability of this crop and allow local farmers to maximize their production. A trial was established at the Rutgers Cooperative Extension of Middlesex County in North Brunswick, NJ. The trial evaluated two ecotypes and five distinct cultivars under low-input conditions for their seedling emergence rates, survival rates and dry matter yield. The plots were organized in a randomized complete-block design with four replications for each variety. Current recommendations suggesting a single harvest per year and baling the crop were a part of the experimental procedure and the field was not irrigated. ‘Alamo’ and ‘Carthage’ had significantly greater survival than ‘Timber’ and ‘High Tide’ in year one. The average dry matter yield was significantly greater in the second year for all cultivars. ‘Carthage’ had significantly higher yields than ‘Alamo’, ‘Timber’, and ‘High Tide’ in the second year. Dry matter yields for the second harvest year were between 2.77 tons/acre and 4.97 tons/acre. Currently in NJ, the break-even price for switchgrass based on a 3 tons/acre yield non-irrigated crop is return of $163.86/acre, for 4 tons/acre the break even return is $128.69, and for 5 tons/acre the break even return is $107.59. This indicates the importance of selecting a top performing cultivar to maximize yield and ensure an adequate profit margin at each harvest.

(187) Oil Smoke Point Testing of *Camellia oleifera*

Charles B. Allen*
The University of Georgia, Athens; charlesallen00@gmail.com

John M. Ruter
University of Georgia, Athens; ruter@uga.edu

An asterisk (*) following a name indicates the presenting author.
Camellia oleifera seed extract, or tea-seed oil, has been used in China and southeast Asia for thousands of years as a cooking oil. It is commonly referred to as “eastern olive oil” due to health benefits associated with its consumption. Camellia oleifera has been found to thrive as an oilseed crop in the state of Georgia. One of many claimed characteristics of Camellia oil is its relatively high smoke point, around 250 °C, which is higher than olive oil. The smoke point has been defined as the minimum temperature at which a constant stream of smoke is emitted from a heated oil or fat. There is an abundance of claims on the smoke point temperatures of various cooking oils, however, little work has been conducted by research institutions on these smoke points and little to no research on tea-seed oil specifically. Determining the smoke point is important because when cooking oil reaches this temperature it degrades and starts to release free radicals. Oxygen derived free radicals are thought to be related to the formation of cancer, inflammation, atherosclerosis, ischemia-reperfusion injuries, aging, Alzheimer’s disease, shock, diabetes, cataracts, hypertension, cardiovascular disease, exercise related muscle damage and infertility. Seventeen oils were tested in accordance to AOCS method Cc 9a-48, or the Cleveland open cup method. Fourteen of the oils were commercial cooking oils, three being Camellia. Of the tea-seed oils, two were unrefined samples from Georgia grown bulk seed and the third sample was commercially refined. Testing found peanut and safflower oils to have the highest smoke point. Crude and centrifuged tea-seed oil had the lowest smoke points, however commercially refined tea-seed oil had a higher smoke point temperature than extra virgin olive oil by 28 °C indicating greater stability under high heat stress. Preliminary fatty acid profiling has also been conducted on bulk seed from locally adapted cultivars and the percent oleic acid compares favorably with tea-seed oil from China. Comparable fatty acid profiles suggest that Georgia grown Camellia may exhibit the same health benefits as its Asian counterpart. Further research will be conducted to determine the frying performance of Camellia oil and its characteristics when converted to biodiesel.

Specified Source(s) of Funding: The University of Georgia

(188) Salt Tolerance of Six Switchgrass Varieties
Youping Sun*
Texas A&M AgriLife Research Center at El Paso; sypyp79@gmail.com
Genhua Niu
Texas A&M AgriLife Research Center at El Paso; gniu@tamu.edu
Girisha Ganjegunte
Texas A&M AgriLife Research and Extension Center at El Paso; gkganjegunte@ag.tamu.edu
Yanqi Wu
Oklahoma State University, Stillwater; yanqi.wu@okstate.edu

Switchgrass (Panicum virgatum) varieties were evaluated for salt tolerance in a greenhouse setting. Switchgrass ‘Cimarron’, ‘NL94C2-3’, ‘NSL 2009-1’, ‘NSL 2009-2’, ‘Kanlow’, and ‘Alamo’, five seedlings per pot, were irrigated with nutrient solution at electrical conductivity (EC) of 1.2 dS·m⁻¹ (control) or salt solution at EC of 5.0 or 10.0 dS·m⁻¹ for 36 days. Plant height, leaf area, number of tillers, and dry weight were significantly different among salt treatments and among varieties, but no interactive effects occurred. Compared to control, salt solution at EC of 5.0 dS·m⁻¹ and 10.0 dS·m⁻¹ reduced the switchgrass height by 6.8% and 29.6%, leaf area by 20.8% and 55.9%, number of tillers by 14.6% and 31.3%, dry weight by 23.1% and 55.7%, respectively. Switchgrass ‘Alamo’, ‘Kanlow’, and ‘NSL 2009-2’ were taller than ‘NL94C2-3’, ‘NSL 2009-1’, and ‘Cimarron’. Tiller numbers in ‘NSL 2009-2’ and ‘NSL 2009-1’ were similar to those in ‘NL94C2-3’ and ‘Cimarron’, while higher than those in ‘Alamo’ and ‘Kanlow’. The dry weight of ‘NSL 2009-2’ was similar to that of ‘NSL 2009-1’ and ‘Kanlow’, but greater than that of ‘NL94C2-3’ and ‘Alamo’. ‘Cimarron’ had the smallest dry weight. In conclusion, salinity negatively affected the switchgrass biomass, and switchgrass ‘NSL 2009-2’ and ‘NSL 2009-1’ were more tolerant to salt than other tested varieties.

Specified Source(s) of Funding: Texas A&M AgriLife Research Bioenergy Initiatives Program, the South Central Sun Grant Program

(189) Genetic Diversity, Cytogenetics, and Biomass Yields among Arundo Species and Accessions (Arundinaceae)
Darren H. Touchell
North Carolina State University, Mills River; darren_touchell@ncsu.edu
Thomas G. Ranney*
North Carolina State University, Mills River; tom_ranney@ncsu.edu
Dilip Panthee
North Carolina State University, Mills River; dilip_panthee@ncsu.edu
Ron Gehl
North Carolina State University, Mills River; ron_gehl@ncsu.edu
Alexander Krings
North Carolina State University, Raleigh; akkrings@ncsu.edu

Genetic diversity and cytogenetics of 31 accessions of Arundo sp., collected from North America and South Asia, were characterized using 20 ISSR markers, flow cytometry and cytology. In addition, field trials of 23 Arundo donax accessions were established in 2011 and harvested annually in winter from 2012 to 2013 to assess biomass yields. Cluster analysis (UPGMA) based on Jaccard’s similarity coefficient clearly differentiated Arundo donax as the reference species and A. donax subgroups contained two subgroups representing North American and South Asian accessions. Within each Arundo donax subgroup, genetic distances were low but showed discernable variation (0.03 for North America, 0.07 for South Asia). Principle coordinate analysis further supported distinct clusters and variation within clusters. Relative genome sizes were determined using Pisum sativum as the reference genome and DAPI fluorochrome. Chromosome numbers (2n), ploidy levels, and 2C relative genome sizes ranged from 67 to 2013 to assess biomass yields. Cluster analysis (UPGMA) based on Jaccard’s similarity coefficient clearly differentiated Arundo donax as the reference species and two subgroups representing North American and South Asian accessions. Within each Arundo donax subgroup, genetic distances were low but showed discernable variation (0.03 for North America, 0.07 for South Asia). Principle coordinate analysis further supported distinct clusters and variation within clusters. Relative genome sizes were determined using Pisum sativum as the reference genome and DAPI fluorochrome. Chromosome numbers (2n), ploidy levels, and 2C relative genome sizes ranged from 67 to
Photoperiodic lighting from lamps with a moderate ratio of red (R, 600 to 700 nm) to far-red (FR, 700 to 800 nm) light effectively promotes flowering of long-day plants. Due to spectral controllability, long life span, and energy efficiency, light-emitting diodes (LEDs) have emerged as an alternative to conventional light sources, such as incandescent (INC) and high-pressure sodium (HPS) lamps. However, the efficacy of newly developed LEDs on flowering applications has not been published. We conducted a coordinated trial with five commercial greenhouse growers to investigate the efficacy of R + white (W) + FR LEDs, with an R:FR of 0.82, at regulating flowering of daylength-sensitive ornamental crops. The trial was also performed in two replicate greenhouses at Michigan State University (MSU). Ageratum (Ageratum houstonianum), calibrachoa (Calibrachoa ×hybrida), dahlia (Dahlia ×hybrida), diantus (Dianthus chinensis), two petunia (Petunia ×hybrida) cultivars, snapdragon (Antirrhinum majus), and verbena (Verbena ×hybrida) were grown under natural short days (SDs) with 4-hour night-interruption (NI) lighting provided by the R+W+FR LEDs or conventional lamps typically used by each grower. Two companies used HPS lamps while the other sites used INC lamps. In addition, a natural SD treatment, a truncated 9-hour SD treatment, and a compact fluorescent lamp treatment were delivered at three different sites. All plants were grown under similar environmental conditions following the growers’ standard production practices of watering, fertilization, and pest management. With few exceptions, time to flower and flowering percentage of the bedding plant crops tested were similar under the R+W+FR LEDs as under the conventional lamps at all sites. At MSU, ageratum, diantus, petunia, snapdragon, and verbena flowered earlier under the NI lighting treatments than under 9-hour SDs. In addition, plant height and visible flower bud or inflorescence number at flowering were similar under the R+W+FR LEDs and INC lamps for most crops. Therefore, we conclude that the R+W+FR LEDs are as effective as lamps traditionally used in greenhouses at controlling flowering of photoperiodic plants.

Specified Source(s) of Funding: The USDA National Institute of Food and Agriculture’s Specialty Crop Research Initiative and Michigan State University’s Project GREEEN

An asterisk (*) following a name indicates the presenting author.
Many plant species are prone to physiological disorders in which lesions develop on the leaf tissue. Nomenclature for such lesions has included intumescences, excrescences, neoplasms, galls, genetic tumours, enations, and oedema. Interchangeably used, these terms cause confusion as to whether they refer to the same or different disorders. Two of the most commonly used names are oedema and intumescence. The objective of this study was to characterize the development of lesions on ornamental sweetpotato (*Ipomoea batatas* ‘Blackie’), tomato (*Solanum lycopersicum* var. *hirsutum* ‘Maxifort’) and interspecific geranium (*Pelargonium* × *Caliente Coral’) to determine similarities and differences between them. Light microscopy was used to characterize differences in height, width, and area of lesions on each species. Leaf tissue samples were embedded in paraffin, and 10 µm sections were obtained and stained with toluidine blue to allow identification of specific cell layers involved with lesion development. Field emission scanning electron microscopy (FESEM) and digital photography were used to observe the micro- and macroscopic stages of lesion development, respectively, on each species. The lesions found on sweetpotato were significantly greater in height (629 µm) and area (240 x 103 µm²) than on tomato (height: 157 µm; area: 119 x 103 µm²) and geranium (height: 187 µm; area: 104 x 103 µm²). Tomato lesions had the greatest width (1137 µm), followed by geranium (808 µm) and sweetpotato (383 µm), respectively. Lesions on sweetpotato occurred on the adaxial surface of the leaf, with hypertrophy and hyperplasia of the epidermal and palisade parenchyma cell layers. The lesions on geranium and tomato predominantly occurred on the abaxial surface of the leaf. Lesions on geranium involved hypertrophy of the spongy parenchyma cells, while lesions on tomato involved hypertrophy and hyperplasia of epidermal and spongy parenchyma cells. The involvement of epidermal cells in the lesions on sweetpotato and tomato allowed for greater cell expansion, while the restriction of spongy mesophyll cell expansion by the lower epidermis on geranium ultimately resulted in epidermal tearing. Previous research indicates that light quality may be a significant factor in lesion development in tomato and sweetpotato, while plant water status is a more significant factor in geranium. Based on our observations, the two disorders are different. The term ‘intumescence’ should be used when referring to abnormal lesions on tomato and sweetpotato and the term ‘oedema’ should be used when referring to lesions on geranium.

Specified Source(s) of Funding: The Fred C. Gloeckner Foundation, Inc.

**Poster Presentations**

Irradiance, CO₂, and temperature are critical inputs for photosynthesis and crop growth. They are also environmental parameters which growers can control in protected horticulture production systems. We evaluated the photosynthetic response of 13 herbaceous ornamentals (*Begonia hiemalis, Begonia semperflorens, Catharanthus roseus, Cyclamen persicum, Euphorbia pulcherrima, Gerbera jamesonii, Impatiens hawkerii, Impatiens wallerana, Osteospermum hybrida, Pelargonium hortorum, Petunia hybrida, Verbena × hybrida, and Viola wittrockiana*) to irradiance, temperature, and CO₂. Initial growth chamber conditions were 20 °C air temperature, 300 µmol-m⁻²-s⁻¹ irradiance, and a 14 h photoperiod. Single leaf photosynthetic measurements were measured on one fully mature, non-shaded leaf per plant (5 to 7 plants per species). Cuvette set points matched chamber conditions, except for the variable of interest. Photosynthetic irradiance and CO₂ response curves were fit to the data using a non-rectangular hyperbola, and temperature response curves were fit using an asymmetric (Landsberg) function. Light compensation points varied between 24 and 52 µmol-m⁻²-s⁻¹, light saturation values ranged from 156 to 597 µmol-m⁻²-s⁻¹, and apparent quantum efficiency varied between 0.033 and 0.087. Maximum rates of net photosynthesis (A_max) at saturating irradiance varied between 5.0 and 10.5 µmol-m⁻²-s⁻¹ of CO₂, and they were 5% to 90% greater than net photosynthetic rates (A_n) at ambient irradiance. At saturating CO₂ concentrations, A_max was 5% to 90% greater than net photosynthetic rates (A_n) at ambient irradiance. At saturating CO₂ concentrations, A_max was 5% to 90% greater than net photosynthetic rates (A_n) at ambient irradiance. At saturating CO₂ concentrations, A_max was 5% to 90% greater than net photosynthetic rates (A_n) at ambient irradiance.
The first formulation was a proprietary product available as a granule that converts to a gas phase form of ClO₂ when exposed to a bisulfate activator and the second was a proprietary liquid electrobiocide (EB) at 600 ppm ClO₂. Sphagnum peat moss medium was blended with play sand at 3:1 by volume and then autoclaved at 250 °C for 30 min. There were 12 treatment combinations: ClO₂ granules blended with the medium at 1.5 and 3 g per 60 g of medium; ClO₂, sachet treatments at 3, 6, and 9 g per 60 g medium; and three volumes of EB (100, 200, and 300 ml per 60 g medium); and three untreated controls, autoclaved and not autoclaved media. The treated media and controls were then inoculated with Bacillus subtilis (ATCC #19659) spores. The final treatment was one of the three controls, autoclaved medium and not inoculated with B. subtilis. Respiration rates of the potting media were measured prior to the treatments and then 4, 8, 12, 20, 38, and 60 days after the treatments as CO₂ flux with a soil respiration flux chamber attached to a portable infrared gas analyzer (LI-6400XT, Li-Cor, Inc.). Media samples were collected 64 days after treatment to enumerate the number of viable B. subtilis spores (CFU·g⁻¹ medium) for each treatment. Sixty days after treatment, the inoculated control medium had a respiration rate of 2.96 µmol·m⁻²·s⁻¹ of CO₂. Sixty days after treatment, the granular ClO₂ formulation had the lowest respiration rate of all treatments at 0.99 µmol·m⁻²·s⁻¹ of CO₂. The chlorine dioxide granule treatment resulted in a log₁₀ reduction in viable B. subtilis spores of 28% from the initial spore counts in the liquid suspension. The respiration rates of the inoculated medium and the sporidical efficacy results show that two chlorine dioxide formulations can partially control soil-borne microorganisms after one application in sphagnum peat moss based potting medium.

(115) Postharvest Chilling and Vase Life of Herbaceous Peonies

Patricia S. Holloway*
University of Alaska Fairbanks; psholloway@alaska.edu
Melissa K. Pietila
University of Alaska Fairbanks; melisa.pietila@yahoo.com

‘Sarah Bernhardt’ and ‘Duchess de Nemours’ peonies (Paonia lactiflora) were grown since 2001 at the University of Alaska Fairbanks Georgeson Botanical Garden. Cut stems were harvested on 5-7 July, 2013 and a random sample of each cultivar, 5 single-stem reps per cultivar, were placed immediately into 8 chilling treatments: 0 to 168 hours at 24-hour intervals. Stems were wrapped in newspaper and stored dry, in the dark at 1.9 + 1.0 °C and 85 + 6.6% relative humidity. Immediately following treatment, stems were re-cut and placed in tap water-filled, clean jars (20.8 + 1.6 °C, 56.2 + 3.2% relative humidity), under a combination of natural window light and 24-hour fluorescent room fixtures. Dates were recorded daily for full bloom (guard petals at 90° to the stem) and petal wilt/abscission. In a second experiment, 73 cultivars of herbaceous and Intersectional peonies were stored under the same chilling conditions for one week and evaluated for vase life differences among cultivars and peony classes. Total vase life of ‘Duchess de Nemours’ increased linearly from 6.9 + 1.7 days with no chilling to 13.0 + 0.7 days with 168 hours of chilling. ‘Sarah Bernhardt showed the same trend from 8.2 + 0.9 days (control) to 14.2 + 1.2 days with 168 hours. Both cultivars showed the same rate of increase, but ‘Sarah Bernhardt’ had a greater total vase life at all chilling treatments than ‘Duchess de Nemours’. The greatest increase in vase life occurred between bud stage and full bloom. From full bloom to petal fall, vase life averaged 3.0 + 0.7 days for ‘Duchess de Nemours’ regardless of chilling hours. ‘Sarah Bernhardt’ vase life averaged 4.2 + 0.7 days from full bloom to 120 hours chilling after which vase life decreased. A minimum chilling period of 96 hours is recommended for ‘Duchess de Nemours’, and 120 hours for ‘Sarah Bernhardt’ for optimum vase life. Vase life for 73 peony cultivars ranged from 4.3 days to 17.5 days. Average vase life was similar for Japanese, semi-double and double peonies (9.2 + 0.5 days) whereas the Intersectional (ITOH) hybrids averaged 5.2 + 0.1 days. Only five of the 73 cultivars met USDA No 1 grading standards for stem length as well as the AAA Extra fancy Alaska Peony Growers Association standards for bud diameter: ‘Madame Emilie Debantene’, ‘Mary Brand’, ‘President Taft’, ‘Ruth Cobbs’ and ‘Sarah Bernhardt’.

Specified Source(s) of Funding: U.S.D.A. New Crops New Opportunities Grant

(116) Foliar Plant Growth Retardant Applications Suppress Height of Seed-propagated New Guinea Impatiens

Christopher J. Currey*
Iowa State University, Ames; ccurrey@iastate.edu
Nicholas J. Flax
Iowa State University, Ames; nickflax@iastate.edu

Flats of bedding impatiens (Impatiens walleriana) are one of the most popular annual bedding plants. However, recent outbreaks of impatiens downy mildew (Plasmopara obducens) are causing producers and consumers to reconsider growing and planting bedding impatiens, respectively. Seed-propagated New Guinea impatiens (Impatiens hawkeri) are a newer crop that may be able to grow and sold in large packs (i.e. 1801) within a flat. However, producing flowering New Guinea impatiens in flats with an acceptable height is a challenge. Our objectives were to quantify the efficacy of foliar plant growth retardant applications on plant height and time to flower of seed-propagated New Guinea impatiens. ‘Divine Cherry Red’, ‘Divine Scarlet Bronze Leaf’, and ‘Divine White Blush’ New Guinea impatiens seedlings were planted in 1801 cell packs. Seven days after planting, deionized water or solutions containing ancymidol (15, 30, or 60 ppm), chlormequat chloride (750, 1500, or 3000 ppm), daminozide (1250, 2500, or 5000 ppm), ethephon (250, 500, or 1000 ppm), flurprimidol (10, 20, or 40 ppm), paclobutrazol (10, 20, or 40 ppm), or uniconazole (5, 10, or 20 ppm) were applied to seedlings. Plant height was measured when plants were treated and again when the first flower opened and time to flower was calculated as the time from transplanting seedlings to the first open flower. Ancymidol, chlormequat chloride,
production in flats. Higher concentrations of ethephon resulted in some suppression of stem elongation; however flowering was also delayed. 500 ppm ethephon solutions increased time to flower of ‘Divine Cherry Red’ and ‘Divine Scarlet Bronze Leaf’ by 19 and 18 d, respectively, while 1000 ppm ethephon delayed flowering of ‘Divine Scarlet Bronze Leaf’ by 23 d. Flurprimidol, paclobutrazol, and uniconazole suppressed height at flowering of all three cultivars. For example, final height of ‘Divine Cherry Red’ ‘Divine Scarlet Bronze Leaf’, and ‘Divine White Blush’ treated with 20 ppm flurprimidol was 3.2, 3.5, and 5.0 cm shorter, respectively, than untreated plants. Foliar sprays containing 5 ppm uniconazole resulted in plants that were 4.1 cm (‘Divine Scarlet Bronze Leaf’) to 5.4 cm (‘Divine White Blush’) shorter than untreated plants. The highest concentrations of flurprimidol, paclobutrazol, and uniconazole resulted in excessive suppression of stem elongation and a delay in flowering. Foliar sprays containing flurprimidol, paclobutrazol, or uniconazole are useful to control stem elongation of seed-propagated New Guinea impatiens for production in flats.

(117) Etiolephon Applications Delay and Diminish Flowering of Streptocarpus

Christopher J. Currey*
Iowa State University, Ames; ccurrey@iastate.edu
Nicholas J. Flax
Iowa State University, Ames; nickflax@iastate.edu

Streptocarpus (Streptocarpus hybridos) are flowering potted plants that grow and flower freely in interior or shaded outdoor areas. The ‘Ladyslippers’ series is a new series of streptocarpus that are propagated through tissue culture. While these plants produce showy finished, flowering plants they flower prematurely during greenhouse production, requiring hand labor to remove inflorescences. Our objectives were to quantify the impact of foliar applications of ethephon on flowering and growth of several ‘Ladyslippers’ streptocarpus cultivars. ‘Ladyslippers Blue Halo’, ‘Ladyslippers Deep Blue Vein’, and ‘Ladyslippers Red Rose’ streptocarpus were planted in 6-in-diameter containers filled with a soilless substrate. Foliar spray applications of solutions containing 0, 125, 250, 500, or 1000 ppm ethephon were applied to 10 plants of each cultivar either two weeks after planting (one application) or two and four weeks after planting (two applications). Plants were grown in a glass-glazed greenhouse with supplemental light provided from high-pressure sodium lamps and irrigated with water supplemented with a water-soluble soluble fertilizer providing 150 ppm nitrogen. After 13 weeks the total number of inflorescences was recorded and the height from the surface of the substrate to the tallest growing point and the diameter of the plant at the widest growing point and 90° from this point were recorded and the Growth Index (GI) was calculated. The impact of ethephon sprays depended on the concentration, number of applications, and cultivar. For example, a single application of 250–1000 ppm ethephon delayed flowering of ‘Ladyslippers Deep Blue Vein’ by 9–27 d, whereas when one application of 1000 ppm was applied to ‘Ladyslippers Rose Red’ flowering was delayed by 9 d. Similarly, two applications of any ethephon concentration delayed flowering of ‘Ladyslippers Deep Blue Vein’ by 13–37 d, while flowering of ‘Ladyslippers Red Rose’ was delayed by 17 d when 1000 ppm was applied. The GI of ‘Ladyslippers Deep Blue’ and ‘Ladyslippers Red Rose’ was unaffected by ethephon and, while the GI of ‘Ladyslippers Blue Halo’ was smaller than untreated plants when one or two applications of 500 or 1000 ppm ethephon was applied, these smaller plants were still of marketable size and quality. Based on our data, we conclude that ethephon may be used to delay the onset of flowering and reduce the number of inflorescences formed prior to finishing with minimal impact on finished plant size.

Thursday, July 31, 2014

Organic Horticulture 2

(051) On-farm Research Using Soil Amendments for Soil Quality and Disease Suppression in Organic Vegetable Systems

Lori Hoagland
Purdue University, West Lafayette, IN; lhoaglan@purdue.edu
Elizabeth T. Maynard*
Purdue University, Valparaiso, IN; emaynard@purdue.edu
Natasha Cerruti
Purdue University, West Lafayette, IN; ncerruit@purdue.edu
Dan Egel
Purdue University, West Lafayette, IN; egel@purdue.edu
Amy Thompson
Purdue University, West Lafayette, IN; athompson@purdue.edu

The demand for organic vegetables continues to rise yet growers struggle to effectively manage nutrients and plant disease. Soil microbes regulate nutrient cycling and help plants resist pathogens through intimate associations with plant roots. The composition and activity of these communities is influenced by organic fertility amendments as well as site-specific soil and environmental conditions. The objectives of this research project are to: 1) identify soil amendments that improve soil quality and increase crop productivity on organic vegetable farms, 2) identify how resident microbial communities interact with soil amendments to regulate nutrient cycling and suppress plant pathogens, and 3) demonstrate and increase the practice of on-farm research. Growers and researchers participated in a workshop in Spring 2013 to develop a research plan. Annually repeated applications of four organic soil amendments (pelletized chicken manure, animal byproducts, mixture of animal and plant byproducts, and vermicompost) are being evaluated on three farms in Indiana and Ohio over a period of three years using a randomized complete-block design with four replicates. In 2013, cabbage was grown in the plots and evaluated for stand establishment, disease incidence and severity, leaf nutrients, yield and size. Impacts of treatments on soil quality were evaluated using laboratory assays to determine nutrient availability, labile...
carbon, microbial activity, and microbial community diversity; and pathogen bioassays are on-going. On-farm assays were used to determine water infiltration and soil respiration. An organic soil management workshop and accompanying field day were held at one of the farms in July 2013 to discuss soil quality and on-farm research. Results from the first year show large differences in soil quality between the three farms, but little effect of soil amendment. Black rot (*Xanthomonas campestris*) was greater in the treatment that received vermicompost + pelletized chicken manure relative to the treatment that received a mixture of plant and animal byproducts across the three farms, and at one farm this reduced crop yield. Acorn squash is being grown in these plots in 2014 and a solanaceous crop will be grown in 2015. Field days will be held at the other farms in 2014 and 2015, and all collaborators will share their experience with participatory on-farm research in a workshop at a state-wide conference in 2016.

Specified Source(s) of Funding: The Ceres Trust

(052) Engaging Stakeholders to Refine Research Objectives for Grant Proposals

Carlene A. Chase*
University of Florida, Gainesville; cachase@ufl.edu

Marilyn E. Swisher
University of Florida, Gainesville; mesw@ufl.edu

Xin Zhao
University of Florida, Gainesville; zxin@ufl.edu

Oscar E. Liburd
University of Florida, Gainesville; oeliburd@ufl.edu

Zhifeng Gao
University of Florida, Gainesville; zgao@ufl.edu

The mission of the Center for Sustainable and Organic Food Systems at the University of Florida is to assist in the development of sustainable and organic food systems, with an emphasis on local and regional systems. One of the ways of so doing has been to facilitate collaboration among researchers in complementary fields to form interdisciplinary teams that address problems facing our stakeholders. In 2012, a team with expertise ranging from the biological sciences of entomology, horticulture and weed science to social sciences related to rural community development and food and resource economics coalesced to prepare a research proposal. Addressed at developing organic strawberry cropping systems that are more environmentally and economically sustainable and are resilient to weeds, pests, and diseases, the proposal targeted the USDA NIFA Organic Research and Extension Initiative (OREI) program and was highly regarded but not funded. In an effort to increase the likelihood of obtaining funding at resubmission, the team sought input from industry stakeholders utilizing a focus group format. The results of the focus group were used to craft a second proposal that resulted in a year of funding from the National Sustainable Strawberry Initiative that has allowed the team to generate preliminary data. Additionally, the outreach and evaluation component of the project included a strong emphasis on stakeholder input, which was obtained through focus groups at a regional growers’ conference, and at the research trial locations—a research station and a collaborating grower’s farm. The information gained will be invaluable for preparation of the revised OREI 2014 grant proposal.

Specified Source(s) of Funding: This project is funded by a grant from the Walmart Foundation and administered by the University of Arkansas System Division of Agriculture Center for Agricultural and Rural Sustainability

(053) Cover Crop Value as Perceived by Organic Vegetable Growers

Shasha Li
Purdue University, West Lafayette; li264@purdue.edu

Brent Gloy
Purdue University, West Lafayette, IN; bgloy@purdue.edu

Thomas Björkman*
Cornell University, Geneva, NY; tbl@cornell.edu

The agronomic benefits of using summer cover crops are well established in the academic literature, but how farmers perceive the economic incentives or disincentives of adoption is still less well understood. This study examines these perceptions in order to identify areas where further education may enhance adoption of summer cover crops. Nearly all respondents (95%) perceived a positive net economic value of growing summer cover crop, but few respondents were willing to estimate the exact size of the benefit. Eighty-seven percent of respondents thought growing summer cover crops helped increase in cash crop yields. The percentage of respondents who perceived summer cover crops having benefits of improving soil condition, weed suppression, reducing plant disease, and decreasing insect pest population were 97%, 97%, 80%, and 43% respectively. Very few were able to quantify these benefits. For instance, the value of weed control—the biggest challenge for most organic growers—was not estimated by 65% of respondents; of those who provided an estimate, 25% put it as low (< $25/ac) and 10% were more optimistic ($200–$500). Respondents also identified major obstacles of growing summer cover crops: hindering fall planting and disturbing timeliness of cash crop operations. Also a substantial number of respondents (63%) identified issues related to difficulty in preparing the seedbed as a result of cover crop. Respondents also estimated that control—the biggest challenge for most organic growers—was not estimated by 65% of respondents; of those who provided an estimate, 25% put it as low (< $25/ac) and 10% were more optimistic ($200–$500). Respondents also identified major obstacles of growing summer cover crops: hindering fall planting and disturbing timeliness of cash crop operations. Also a substantial number of respondents (63%) identified issues related to difficulty in preparing the seedbed as a result of cover crop use as either a large or moderate problem. Helping farmers to place a value of the various benefits associated with cover crops should speed adoption.

(054) Evaluation of Organic Alternatives for Weed Management in Pulasan (*Nephelium ramboutan-ake*)

Virgilio Olivera-Olivera*
University of Puerto Rico-Mayaguez Campus; virgilio.olivera@upr.edu

J. Pablo Morales-Payan
University of Puerto Rico-Mayaguez Campus; morales.payan@upr.edu

An asterisk (*) following a name indicates the presenting author.

S392
In Puerto Rico, most fruit crop growers use post-emergence synthetic herbicides as a major component of their weed management programs. Organic growers are not allowed to use synthetic herbicides, hence there is a need to develop alternative weed management strategies for current and prospective organic fruit growers. Pulasan (Nephelium ramboutan-ake, Sapindaceae), a relatively new crop in Puerto Rico with high economic potential, was used as a model to evaluate practices for weed control acceptable to organic systems as alternative to synthetic herbicides. Research was conducted in 2013 in a commercial orchard in the mountains east of Mayaguez, Puerto Rico. The treatments were (1) living ground cover of Mucuna pruriens under the tree, (2) living ground cover of Aranchis pintoi under the tree, (3) ground cover with sacks of jute (Corchorus olitorius) under the tree, (4) using a hand-held trimmer on weeds up to 30-cm tall, (5) a 20% organic acetic acid formulation sprayed on weeds up to 30-cm tall, (6) a 10% organic limonene formulation sprayed on weeds up to 30-cm tall, and, as the check treatment used by growers (7) a 1% solution of glyphosate sprayed on weeds up to 30-cm tall. Sorgum halepense was the most abundant weed during the experiment. By 60 days after implementing the treatments, weed dry weight accumulation above-ground was statistically the same in plot managed with acetic acid, trimmer, ground cover of A. pintoi, ground cover of M. pruriens, or glyphosate. Plots with jute ground cover accumulated significantly less (approximately 50%) weed dry weight above-ground than plots where glyphosate was used, while plots sprayed with limonene accumulated significantly more weed dry weight above-ground than glyphosate-treated plots and approximately three times as much weed dry weight as jute-covered plots. These results indicate that jute ground cover may be a more efficacious and environmentally friendly alternative to glyphosate in pulasan orchards, and that trimming, postemergence application of acetic acid, and living ground covers of M. pruriens and A. pintoi may be as efficacious as glyphosate for weed suppression.

Specified Source(s) of Funding: NSF-LSAMP

(055) Organic Mulch as an Alternative to Black Plastic Mulch

Gladis Zinati*
Rodale Institute, Kutztown, PA; gladis.zinati@rodaleinstitute.org

Organic vegetable growers use plastic mulch to conserve water and control annual weeds. However, black plastic mulch costs producers $250 to $300 per acre and generates 100–120 lb/acre of un-recyclable petroleum-based waste that goes to landfills each year. By comparison, municipal leaf mulch is readily available in many municipalities and can be relatively inexpensive, and sometimes free to growers. In this study, we are assessing the effect of three mulch types: black plastic mulch, leaf mulch, leaf +straw mulch on tomato marketable yield, number of marketable fruits, and soil nutrients. Soil nutrients were assessed at the beginning and end of the season. Leaf mulch has 11 lignin, 4.7% hemicellulose and 30.4% cellulose. Carbon to nitrogen ratio is 20.7. Weeds were suppressed in leaf and leaf+straw for the first 8 weeks similarly to black plastic. Tomato ‘Black Cherry’ marketable yield is accumulation of five harvests. Tomato plants in leaf +Straw were the highest yielding plants throughout the season reaching 16.8 tons/ha followed by leaf mulch and plastic mulch each at 12.0 tons /ha. Tomato fruit number averaged 111 per plant in either leaf or leaf+straw whereas 95 tomato fruits/plant in plastic mulch. The organic mulch of leaf + straw can be considered a viable alternative to black plastic mulch to grow organic specialty tomato crop successfully.

Specified Source(s) of Funding: NSF-LSAMP

(056) Effects of Cover Crops and Vermicompost on Strawberry Production in the Southeastern United States

John E. Beck*
North Carolina A&T State University, Greensboro; jebeck@ncat.edu

Michelle Schroeder-Moreno
North Carolina State University, Raleigh; michelle_schroeder@ncsu.edu

Gina Fernandez
North Carolina State University, Raleigh; gina_fernandez@ncsu.edu

Julie M. Grossman
North Carolina State University, Raleigh; julie_grossman@ncsu.edu

Nancy G. Creamer
North Carolina State University, Raleigh; nancy_creamer@ncsu.edu

Cultural practices, including cover crop rotations and vermicompost addition, are important aspects of sustainable and low-input strawberry production systems. The objective of this study was to examine the effects of summer cover crops with vermicompost and organic fertilizers on strawberry plant growth, yield, and soil nitrogen levels in a two-year field experiment. The experiment design was a split plot randomized complete block. The main plot factor was a cover crop treatment (six factors) and a vermicompost treatment (two factors) was the sub-plot, split factor. Cover crop treatments consisted of 1) pearl millet [Pennisetum glaucumgenus] (L.) cv. Tifleaf 3]; 2) soybean [Glycine max (L.) Merrill cv. Laredo], 3) Cowpea [Vigna unguiculata (L.) Walp. cv. Iron & Clay]; 4) pearl millet/soybean and 5) pearl millet/cowpea, and 6) a no cover crop control treatment. Vermicompost treatments consisted of vermicompost (VERM) added at planting or not (CONTROL). ‘Camarosa’ (2009) and ‘Chandler’ (2010) strawberry plugs were transplanted into plasticulture beds. Cover crop and vermicompost treatments were assessed for their impact on plant growth and yield, weed abundance, and inorganic NO3-,-N and NH4+-N levels. While cover crops had no effect on yield either year, the amount of N supplied through cover crops with reduced rates of strawberry season applied fertilizers appeared to balance the effect of using supplemental fertilizers only in a
production system using organic practices. Use of vermicompost improved strawberry biomass and yield, and soil N content. Based on our findings, fertilizer application rates recommended for conventional production in the southeastern United States exceed the N requirements for strawberries when cover crops and organic amendments are used.

(057) On-farm Soil Quality Testing in Organic, Integrated, and Conventional Peach Orchard Systems
Esther Thomsen*
Utah State University, Logan; ethomse1@gmail.com
Mae Culumber
Utah State University, Logan; mae.culumber@usu.edu
Jennifer Reeve
Utah State University, Logan; Jennifer.Reeve@usu.edu

Soil quality problems such as erosion, depleted soil organic matter, nutrient reserves and reduced water holding capacity are of increasing concern to farmers in the Intermountain West. Marginal soils require more amendments and fertilizers to meet crop needs. As input costs rise and water resources are increasingly limited, effective methods of evaluating soil quality and fertility is of growing importance. Soil quality testing is not routine on commercial farms, as current recommendations are time consuming and confusing to interpret. Standard commercial tests typically quantify soil nitrogen, phosphorus, potassium, pH and salinity. These factors alone are not sufficient to predict the long term effect of management practices on soil quality. This study will determine the accuracy, efficiency and the ease of using simple chemical, biological, and physical soil quality indicator tests that can be completed on-site. Indicative on-site soil tests will be used to measure aggregate stability, water infiltration, decomposition rates, macroflora, macronutrients, and pH, and then compared to comparable lab analyses. The trend in enhancement or degradation of soil quality by current management practices will be estimated. Soil samples will be collected from two experimental peach orchards located on the Utah State University Research farm in Kaysville, UT. The orchards consist of 12 replicated orchard floor treatments with documented differences in soil quality. The goal of this study is to increase the participatory role of farmers in the maintenance and health of their soils, which could potentially reduce nutrient overload, soil erosion and degradation of ecosystem services on and off-site.

Specified Source(s) of Funding: Utah Specialty Crop Block Grant Program

(394) Organic Mulchings and Their Effects on Development, Fruit Yield and Quality in Watermelon
Francisco Radillo-Juárez
Universidad de Colima, Tecomán, Colima; radillo55@hotmail.com
Sergio Aguilar-Espinosa
Universidad de Colima, Tecomán, Colima; saguilar@ucol.mx

Jaime Molina-Ochoa*
Universidad de Colima, Coordinación General de Investigación Científica, Tecomán, Colima; jmolina18@hotmail.com
Maria del Rocío Flores-Bello
Universidad de Colima, Tecomán, Colima; rflores@ucol.mx
Ana Belem Padilla-Díaz
Universidad de Colima, Tecomán, Colima; abpadilladia@hotmail.com
John E. Foster
University of Nebraska, Lincoln; jfoster@unl.edu

The acreage of watermelon in Mexico has increased, mostly for exportation during the last years. The use of plastic mulching is a strategy to increase the yield crop. However, the plastic mulching wastes cause contamination. In order to reduce this problematic situation, an alternative is the use of plant wastes to produce organic mulching. Organic mulching has a faster degradation and easy incorporation to soil. The objective was to evaluate the effect of plant wastes used as organic mulching on the development, yield and quality of fresh watermelon. The organic mulching were made from sugarcane foliage, banana leaves, rice straw, coconut leaves, coconut fiber, and Tanzania grass. The treatments were distributed in a complete randomized block design, and data were processed for ANOVA, and means separated by Tukey test ($P \leq 0.05$). Significant differences between treatments were obtained for the variables: length shoot, equatorial diameter, fruit weight, yield per plant, and fruit yield per hectare. The longest length shoot was obtained with the Tanzania mulching with 5.02 m; however, the sugarcane foliage produced the highest values in polar perimeter with 71.2 cm, 7.0 Kg fruit weight, 35 Kg of fruit yield per plant and highest fruit yield per hectare with 100.1 Ton/ha. Non significant differences were obtained for days to blooming, number of fruits per plant, polar perimeter, and °Brix. Our results sustain that the organic mulching made with sugarcane foliage produced the best plant performance and fresh fruit production in watermelon. Organic mulching is a friendly strategy for the watermelon production.

Thursday, July 31, 2014

Plasticulture

(183) Providing an Online Library and Grower Network to Support High Tunnel Production in the United States and Abroad
Kimberly Oxley
Kansas State University, Olathe; koxley@ksu.edu
Lani Meyer*
Kansas State University, Olathe; lj77888@ksu.edu
Cary Rivard
Kansas State University, Olathe; crivard@ksu.edu

The website, www.hightunnels.org, was created in 2004 to provide information about high tunnel production and was funded by a USDA–IFAFS project that was awarded to Kansas State University and several collaborators from surrounding states.
Currently, www.hightunnels.org represents a partnership of researchers and other collaborators nationwide that work in the area of high tunnel production. The website was renovated during summer 2013 in order to update the format and content. The goal of the site is to provide an online resource where growers can access information related to high tunnel production from across the United States. An organic module was added as well as a searchable supplier directory. During the first month after the re-launch of the site, there were 1562 visits with 15% of the audience characterized as returning visitors. During this period, 10% of the visits were made in a language other than English, and website visitors originated in 71 countries. Website visitor traffic and geographic diversity has continued to increase since this time. From 1 Mar to 1 Apr 2014, there were 5518 visits to the website, with 21.2% characterized as returning visitors. 19% of the viewers visited the site in a language other than English, and visits were made from 111 different countries. Similarly, from 1 Mar to 1 Apr 2014, website visitors from the United States represented 69.5% of the total with Turkey having the second highest number of visitors at 11.1%. Visitors from Canada accounted for 3.6% whereas visitors to the site originating from Iran and South Africa represented 1.5% and 1.4%, respectively. The remaining 13.1% of website traffic came from 106 various countries including but not limited to Australia, the United Kingdom, India, the Philippines, and the Netherlands. In addition to providing access to educational materials about high tunnel production, the website serves as a meeting place where growers can join the [hightunnels] email listserv. The listserv comprises over 850 members, most of which are growers in high tunnels. By joining this group, individuals can learn what growers are doing with high tunnels, what crops and varieties grow best, and what practices have been successful on local farms. Members of the listserv span the United States and include very experienced growers as well as those new to vegetable production. With the increasing use of high tunnels across the United States and globally, the www.hightunnels.org website will be an instrumental component for improving specialty crop production worldwide.

(184) Managing Winter Injury for Annual Strawberry Plasticulture Production Systems in the Great Plains
Kimberly Oxley
Kansas State University, Olathe; koxley@ksu.edu
Molly Fusselman*
Kansas State University, Olathe; mfusselman@ksu.edu
Mykel Taylor
Kansas State University, Manhattan, KS; mtaylor@agecon.ksu.edu
Megan Kennelly
Kansas State University, Manhattan; kennelly@ksu.edu
Debra Pryor
Kansas State University, Manhattan, KS; dp pryor@ksu.edu
Marlin Bates
Kansas State University Research and Extension, Lawrence, KS; batesm@ksu.edu

Local production of strawberries in the Great Plains is limited due to poor performance of traditional perennial production systems. Growing strawberries using annual plasticulture production systems has been widely adopted in the Southeastern United States. However, one barrier to successful adoption of this system in Kansas is the proper recommendations for application timing and thickness of row cover to reduce winter injury. The goal of this work is to determine optimum row cover management strategies to reduce winter damage and subsequently increase yield in annual strawberry production systems. Trials were conducted from the 2011–12 to the 2013–14 growing seasons at Wohletz Farm Fresh. A second on-farm trial location, Gieringer’s Orchard, was added for the 2013–14 season. The trials were located within production acreage and were treated identical to the rest of the field. A randomized complete-block design was utilized with four replications. Typically, row covers are applied after 30 days/ nights with < 30 °F temperatures. In this study, we applied row covers after 25 and 35 days to determine how timing affects crop yield. We also utilized two thicknesses of row cover (1.0 oz/yd and 1.2 oz/yd) comprising a total of four treatments. In the 2013–14 trials, an additional row cover treatment (1.5 oz/ yd) was implemented at both locations. Yield data from the two growing seasons (2011-2013) showed inconsistent results, probably due to the contrasting environmental conditions. 2011-12 was a particularly mild growing season. During the mild winter, the 1.0 oz/yd fabric had higher yield, although results were not statistically significant. In 2012, the 1.2 oz/yd fabric performed better and had higher early yield. Our data showed that row cover timing had little effect on berry yield, but applying earlier (25 d) was advantageous during the colder winter (2012–13). Microclimate data showed that soil temperatures were highly affected by row cover application timing. Applying the row cover had immediate effects at maintaining soil temperatures and higher temperatures were seen among the 25 day treatments regardless of the row cover thickness. Interestingly, it took approximately 14 days for soil temperatures to become similar after row cover was applied to the late treatment. Both row cover types provided excellent protection to the crop during < 10 °F temperatures and minimum temperatures under the covers were never less than 25 °F. Our results suggest that growers in the Great Plains should use thicker row covers and apply them earlier compared to recommendations for the Southeastern United States.

Specified Source(s) of Funding: National Strawberry Sustainability Initiative

(185) Evaluation of Season Extension Covers in Higher Elevation (6500+ ft.) Growing Areas
Yvette Henson*
Colorado State University Extension, Norwood; Yvette.Henson@colostate.edu
Steven Earl Newman
Colorado State University, Fort Collins; steven.newman@colostate.edu
There is an increased demand for local food production at the home gardener and commercial levels. There is also increasing concern about food insecurity in the mountains of Colorado. Rural communities and those in areas with extremely short growing seasons rely almost exclusively on fresh produce and other food items trucked into the area. Increasing local production of crops will make areas more food secure. Season extension techniques will play a large role in crop production at high elevation areas with extremely short (~60-120 day) growing seasons depending on elevation and microclimate. Three season extension techniques were compared in three high elevation counties (Eagle, San Miguel, and Teller counties). Raised beds (>22 inches tall, 4’ wide x 12’ long) were used at all locations. Crop yields under flexible 3.5 mm polyethylene covers with automatic vents, and mini-hoops covered with an under layer of spun-bonded polypropylene row cover fabric and a top layer of polyvinyl alcohol film were compared to an uncovered bed. Plants tested in 2011 through 2013 included lettuce and transitioned to cold-hardy greens (spinach or kale) in the fall. Fresh yield weights were recorded and monthly photographs taken of each test plot. Air temperature and soil temperature in each test plot were monitored for the length of the trial using automated data loggers. Overall, yield and quality were highest in lettuce grown under the double layer of spun-bound polypropylene row cover fabric and polyvinyl alcohol film. Results for yield and quality for fall and winter greens are not conclusive for either treatment.

Specified Source(s) of Funding: Colorado State University Extension Innovation Grant

(396) Effect of Colored Plastic on Growth and Yield of Two Cultivars of Eggplant (Solanum melongena L.) in Dry Tropics

Francisco Radillo-Juárez
Universidad de Colima, Tecomán, Colima; radillo55@hotmail.com

Jaime Molina-Ochoa*
Universidad de Colima, Coordinación General de Investigación Científica, Tecomán, Colima; jmolina18@hotmail.com

José Francisco Valdez-Pérez
Universidad de Colima, Tecomán, Colima; jfvaldezperez@hotmail.com

John E. Foster
University of Nebraska Lincoln; jfoster@unl.edu

Eggplant is a very important crop in Mexico, due to the fact that all the production is exported and thereby generates economic benefits to the producers. The present work was conducted to evaluate the effects of several different colors of plastic mulch on the performance and yield of two varieties of eggplant. The varieties were ‘Chinese Long’ and ‘Ovigerum’ (pear type). The plastic colors were gray, white, black/silver, brown, red and black (witness), in a randomized block design with three replications. The results showed that plastic color had a significant effect on plant growth. With the black/silver and gray plastic, ‘Chinese Long’ flowered in 80 days; and with red and black/silver plastic, ‘Ovigerum’ flowered in the same number of days. Plant height for ‘Chinese Long’ was 107.6 and 103.00 cm with black/silver and brown plastic, respectively. For ‘Ovigerum’, plant height was 110.00 and 103.0 cm with black/silver and Brown plastic, respectively. ‘Chinese Long’ yielded 30.78 and 51.65 ton/ha with the black/silver and gray mulches, respectively; and ‘Ovigerum’ yielded 50.8 and 35.97 ton/ha with black/silver and red mulch, respectively. It is concluded that the color of plastic mulch has a significant effect on plant growth and yield.
(354) Developing Mechanical Harvesting for California Black Ripe Table Olives: *Olea europaea* cv. ‘Manzanillo’

Louise Ferguson*
University of California, Davis; lferguson@ucdavis.edu

John A. Miles
University of California, Davis; JAMiles@UCDavis.edu

William H. Krueger
University of California Cooperative Extension, Orland; whkrueger@ucdavis.edu

Elizabeth J. Fichtner
University of California Cooperative Extension, Tulare; EIFichtner@UCANR.edu

Sergio Castro-Garcia
University of Cordoba; SCastro@uco.es

Turksar Saracoglu
Faculty of Agriculture, Aydin; Turkersar@hotmail.com

Francisco Jimenez
University of Cordoba; Francisjimenez2@gmail.com

Francisco J. Romacho
IFAPA, Granada; Franciscoj.romacho.ext@juntadeandalucia.es

The *Olea europaea* cv. “Manzanillo” destined for “California Black Ripe” table olive processing is harvested before fully mature with fruit detachment forces over 5.0 N. Superficial bruises but not those extending into the flesh, are masked by the processing methods as the immature fruit is oxidized to black during processing. A jatropha canopy contact harvester was modified to adapt the density and length of the radiating tines to extend into the 1.0 m olive canopy depth. Preliminary studies determined a head speed of 300 rpm and 12.5 cm displacement and 91.5 cm tine length is most suitable for table olive harvest. In the first of two field experiments a 19-year old 4 x 8 m hedge- row orchard with an 18.5 ton/ha crop was harvested with 92% average efficiency versus an 81% efficiency for a hand pruned conventional control orchard with 32.58 ton/ha crop. The same harvester achieved 81% efficiency in a 12-year-old, 3.7 x 5.5 m mechanically pruned hedgerow orchard with a 14.53 ton/ha crop and 80% efficiency in a hand pruned hedge row orchard with a 12.93 ton/ha crop.

Specified Source(s) of Funding: California Olive Committee

(355) Cactus Virus X (CVX) a New Threat to Pitahaya/Dragon Fruit (*Hylocereus* Species) Production in California

Jose Fernandez de Soto
University of California, Santa Paula; jfdesoto@ucanr.edu

Ramiro Lobo*
University of California, San Diego; relobo@ucanr.edu

Jose Luis Aguilar
University of California, Indio; jlaguiar@ucanr.edu

Deborah M. Mathews
University of California Riverside, Riverside; dmathews@ucr.edu

Gary Tanizaki
University of California, San Diego; gtanizaki@ucanr.edu

Pitahaya or dragon fruit (*Hylocereus* sp. and *Selenicereus* *megalanthus*), is the name of a vining cactus and the fruit it produces. Pitahaya adapts well to various climates and can be a profitable alternative for growers in Southern Coastal California Counties, where a growing interest, particularly among small-scale producers looking for profitable alternatives, has increased and so has the acreage planted to this crop. Field plots were established in three different California locations to address research issues identified as critical for commercial production. However, as the number of commercial growers, the number of acres and the geographic dispersion of the crop increases, so do the challenges for commercial production. Cactus Virus X (CVX), whose presence on pitahaya was first reported in Taiwan in 2003, is an example of these new challenges. CVX is found worldwide and it infects many species in the Cactaceae family (Cereus, Saguaro, Opuntia, Zygocactus and Hylocereus). Infected plants can be asymptomatic or show symptoms like distorted aureoles, deformed spines, necrosis, mottling, and reddening of the stems. Virus-like symptoms were first observed/documemted at the UC South Coast REC in early 2011 and the presence of CVX in Pitahaya was first reported in California later that year. A set of 54 samples was analyzed/screened by a private laboratory using a Polymerase Chain Reaction (PCR) test and the virus was present in an estimated 90% of the samples analyzed. The availability of an ELISA test to screen for CVX allowed the analysis of an additional 200 samples in a more rapid and cost effective way with the majority of them being positive for the virus. Although the effect/impact of the virus for commercial production is still not clear, it represents a significant threat to the growth of this crop. Three main strains of CVX have been identified to date. There are no known vectors for the virus and its transmission occurs primarily by mechanical means, including but not limited to cultural practices like pruning, harvesting and propagation. Additionally, the virus can be transmitted naturally through plant contact and root grafting beneath the soil. We will discuss/present guidelines for field identification and best management practices commercial pitahaya growers can use to manage CVX and prevent further contamination once present in their production fields.

Specified Source(s) of Funding: UC Thelma Hansen Fund

(356) Floral Visitors to Chinese Date (*Ziziphus jujuba*) in New Mexico and Their Potential Role in Pollination

Tessa R. Grasswitz
New Mexico State University, Los Lunas; tgrasswi@nmsu.edu

Shengrui Yao
New Mexico State University Alcalde Center; yaos@nmsu.edu

The Chinese date or jujube (*Ziziphus jujuba* Miller) is a drought-tolerant fruit tree that grows well in the southwestern United States. Its small flowers produce copious nectar in ring-shaped nectaries that are readily accessible to a wide range of insects.
In China, where the species originated, it is pollinated mainly by the Asian honeybee (Apis cerana), which is absent from the United States. Here, domesticated European honeybees (Apis mellifera) are not strongly attracted to jujube flowers, and the principal pollinators are unknown. In order to investigate the role of various potential pollen vectors, three studies were conducted at two sites in New Mexico (Los Lunas and Alcalde) from 2012–13. Preliminary collections of insect visitors to jujube flowers were made at both sites in 2012 and the pollen load on each insect was determined by collecting the pollen with a glycerin gel containing basic fuchsin; microscope slides were prepared from these samples and the pollen grains counted under 100x magnification. In 2013, timed collections of floral visitors were made throughout the day on two separate days at each site and the pollen load analysis repeated as above. In addition, an exclusion study was conducted at Los Lunas to determine the relative importance of nocturnal insects (e.g. night-flying moths) versus diurnal insects as pollinators, and to calculate the pollination efficiency of individual (diurnal) insects by capturing the first insect to visit a previously bagged flower and measuring the pollen load on both the insect and floral stigma after the visit. Our results indicate that diurnal insects are more effective pollinators than are nocturnal visitors and that a wide range of insects are capable of effecting pollination. Predatory wasps (both solitary and social species) from five families (Sphecidae, Pompilidae, Vespidae, Cabronidae, and Thynnidae) were the dominant insect visitors at each site, although the predatory ladybeetle Hippodamia convergens (Coccinellidae) and various Diptera (including species of Bombyliidae, Tachinidae and Syrphidae) were also common. Relatively few bees were collected: of the native species, most were members of the family Halictidae, including species of Bombyliidae, Tachinidae and Syrphidae) were the dominant insect visitors at each site, although the predatory ladybeetle Hippodamia convergens (Coccinellidae) and various Diptera (including species of Bombyliidae, Tachinidae and Syrphidae) were also common. Relatively few bees were collected: of the native species, most were members of the family Halictidae, while the few A. mellifera collected appeared to be mainly naïve (newly emerged) bees, with sparse pollen loads. The range of insect taxa collected differed at the two sites, and it seems likely that, in the United States, the principal pollinators of jujube vary with location, with the differing pollination efficiencies of individual species being offset by the wide taxonomic range and high numbers of insects attracted to jujube flowers.

Specified Source(s) of Funding: This work was supported in part by the New Mexico State Agricultural Experimental Station via Hatch federal appropriation GR0004026 to T.R.G.

(357) Incidence of Phyllosticta Fungal Spot and Cracking Prevalence in the Fruit of Sixteen Pawpaw (Asimina triloba) Varieties

Jeremiah Lowe*
Kentucky State University, Frankfort; jeremy.lowe@kysu.edu
Sheri B. Crabtree
Kentucky State University, Frankfort; sheri.crabtree@kysu.edu
Kirk William Pomer
Kentucky State University, Frankfort; kirk.pomer@kysu.edu

A leaf and fruit fungal spot consisting of a complex of Myco-centrospora asiminae, Rhopaloscytium asiminae Ellis and Morg, and Phyllosticta asiminae Ellis and Kellerm. has been observed in pawpaw. Symptoms include tan spots with dark brown borders on leaves, and dark brown to black superficial spots on the fruit epidermis. Leaves displaying these symptoms were collected from plantings at the Kentucky State University Research Farm and positively identified as Phyllosticta leaf spot by the University of Kentucky Plant Diagnostic Lab. Pawpaw fruit occasionally exhibit cracking, and field observations suggest cracking may vary by variety. It was hypothesized that there may be a correlation between incidence of Phyllosticta fruit spot on pawpaw and fruit cracking, due to epidermal damage by the fungus. The objective of this study was to determine if Phyllosticta fruit spot and cracking incidence varied by cultivar, and if there was any correlation between fruit spot occurrence and fruit cracking. Ripe fruit were harvested three times per week from a mature pawpaw planting consisting of sixteen pawpaw cultivars and advanced selections (G4-25, G5-23, G6-120, G9-111, Haz-1, Haz-1.5, Haz-2, Hi 1-4, Hi 4-1, Hi 7-5, 7-90, KSU-Atwood, NC-1, Mitchell, Sunflower, and Wabash). Percent coverage by Phyllosticta fruit spot was visually estimated, and fruit cracking was evaluated for each fruit harvested. Fruit weight, Phyllosticta coverage, and cracking all varied significantly by variety. A positive correlation was found between cracking and Phyllosticta coverage as well as fruit weight and cracking. Hi 1-4 had the largest fruit size, highest incidence of Phyllosticta, and highest prevalence of cracking. Hi 7-5 exhibited a large fruit size, low Phyllosticta coverage, and no fruit cracking. Other factors could also be related to fruit cracking, such as firmness and thickness of the epidermis. Hi 7-5 shows potential for a new cultivar release that produces large high quality fruit with no fruit cracking and low incidence of Phyllosticta. Future studies are needed to determine the relationship between Phyllosticta fungal fruit spot and fruit cracking in pawpaw, and to determine varietal resistance to this fungus and possible control measures.

(358) Identification of Blooming Type, Blooming Process, and Pollen Germination Rate of Jujube (Ziziphus jujuba Mill.) in New Mexico

Shengrui Yao
NMSU Alcalde Center, Alcalde, NM; yaos@nmsu.edu
Junxin Huang*
New Mexico State University, Las Cruces, NM; hjunxin@nmsu.edu

Jujube (Ziziphus jujuba Mill.) cultivars were imported into the United States about 100 years ago. Jujube is recognized as functional food because it has high value on both nutritional and medicinal perspectives. Even though the acreage is limited, jujubes are widely distributed in the United States, and they grow and produce well especially in the Southwest. But, few cultivars are commercially available. To recommend more cultivars for growers and consumers for different uses, the NMSU Sustainable Agriculture Science Center collected and imported a total of over 50 cultivars. One of our objectives is to identify the blooming type, pollen germination and self-fertility for each cultivar which would be useful for cultivar recommendation and future breeding purposes. In this study, 55 jujube cultivars were examined for their blooming type and forty-one cultivars were
studied for pollen germination. According to the sepal slitting time, jujube cultivars can be classified as morning blooming type or afternoon blooming type. Twenty-four of them belonged to morning type with sepal slitting between 5:00–8:00 am. The other thirty-one belong to afternoon blooming type with sepal slitting between 1:00–3:00 pm. Sepal slitting time varied by cultivar and was affected by weather conditions, but blooming type for each cultivar in general was consistent across the season. For the morning blooming type cultivars, pollen releasing reached a peak between 10:00 am to 2:00 pm, while the afternoon blooming type cultivars released pollen after 3:00 pm and continued to 8:00–10:00 am the next day. Hourly pictures of jujube flowers for three cultivars were taken under dissecting scope from 6:00 am to 5:00 pm. Each flower experienced sepal slitting, sepal flatting, petal flatting, anther petal separation, anther flatting and stigma browning stage within 1–2 d. For pollen germination study, 9–12 flowers from each cultivar were collected and directly inoculated into media, which consisted of 15% sucrose, 1% agar, and 0.01% boric acid. Cultivars can be classified as high, medium or low in pollen germination rate. ‘September Late’, ‘Shuimen’, and ‘Fitzgerald’ had high pollen germination rate, while Sherwood was low in germination rate. The low pollen germination rate cultivars are not suitable as pollinizers and require pollination cultivars in production. One cultivar had extremely low pollen number which would be useful for breeding purposes. This project is supported by a USDA Agricultural Marketing Service Specialty Crop Block Grant through the New Mexico Department of Agriculture.

Specified Source(s) of Funding: USDA Agricultural Marketing Service Specialty Crop Block Grant through the New Mexico Department of Agriculture.

(359) Unique Pawpaw Germplasm Selections in the Kentucky State University Repository Collection

Kirk William Pomper*  
Kentucky State University, Frankfort, KY; kirk.pomper@kysu.edu  
Sheri B. Crabtree  
Kentucky State University, Frankfort, KY; sheri.crabtree@kysu.edu  
Jeremiah Lowe  
Kentucky State University, Frankfort, KY; jeremy.lowe@kysu.edu

The pawpaw [Asimina triloba (L.) Dunal] is a tree-fruit that is in the early stages of commercial production. Pawpaw fruit have fresh market appeal for farmers markets, community supported agriculture, and organic markets. This fruit also has processing potential for frozen pulp production. New high yielding cultivars with excellent fruit quality would further assist in the development of the pawpaw industry. Kentucky State University serves as the National Clonal Germplasm Repository for Pawpaw.

Two goals of the Repository research efforts are germplasm acquisition and evaluation. The repository contains over 2000 accessions from 16 different states; additionally, both open pollinated seedlings from superior genotypes and crosses of superior selections have been incorporated into the repository collection. Two selections, Hi1-4 and Haz-1.4, have been identified in the Repository collection with unique fruit types and promising new characteristics as new potential cultivars. Pawpaw varieties with fruit weights over 120 g per fruit are considered to have a large enough fruit size for commercial sale and processing. The selection Hi1-4 has a pleasing orange flesh, and large fruit size (361 g). The selection Haz-1.4 has a pleasing orange flesh that would be excellent for processing and large fruit size (201 g). These two selections, Hi1-4 and Haz1.4, will be propagated via chip budding onto seedling rootstocks. Yield and fruiting characteristics will be examined for these selections.

(360) Does Rootstock and Fertilizer Choice Affect Apple Orchard Productivity and Soil Community Ecology?

Ashley A. Thompson*  
Virginia Tech, Blacksburg; aat1986@vt.edu  
Gregory Michael Peck  
Virginia Tech, Winchester; greg.peck@vt.edu

Rootstock genotype and soil fertility management practices in apple (Malus domestica Borkh.) orchards impacts soil health and nutrient status, plant associated soil microbial communities, and tree growth and yield. Growers select specific apple rootstocks for use in their orchard systems to confer beneficial traits, including size control, precocity, and pest and disease resistance. Rootstock genotypes confer some of these traits through interactions with the soil microbiome. Such interactions may alter soil microbial community structure, resulting in changes to tree growth and yield. Nitrogen (N) fertilizers may improve fruit yield and quality. However, in excess of tree requirements nitrogen fertilizers may reduce crop yield and quality, and may cause environmental problems such as the contamination of ground and surface waters. The addition of carbon-based amendments, such as compost, have been shown to reduce N and water loss, while improving soil structure and making certain mineral nutrients more available to plants and microorganisms. In 2013, a pot-in-pot study was implemented to determine the effects of different composts (yardwaste and chicken litter), calcium nitrate (CaNO₃) fertilizer, and combinations of compost and CaNO₃ fertilizer on apple tree growth and nutrient status, soil health and microbial activity. For this study, ‘Gala’ scions were grafted to five rootstocks, ‘Budagovsky 9’, ‘Malling 9’, ‘Geneva 41’, ‘G. 214’, and ‘G. 935’. Four individual tree replicates of each rootstock were treated with 40 kg·ha⁻¹ N from either chicken litter compost, yard waste compost, CaNO₃ or a combination of 20 kg·ha⁻¹ N from compost and 20 kg·ha⁻¹ from CaNO₃. There was also an unfertilized control. After one growing season, there was no significant differences in leaf N status among all fertilizer treatments. However, microbial respiration was greater in soils treated with yardwaste compost compared with other treatments and the control, indicating an increase in microbial activity in this treatment. Throughout the next two years, leaf N and microbial respiration will continue to be monitored in addition to trunk cross sectional area, soil...
carbon to nitrogen ratios, microbial biomass, and microbial community composition. Understanding the effects of fertilization practices on orchard productivity and edaphic factors will allow us to develop more efficient fertilizer practices for high-density apple orchards.

(361) New Rootstocks for Florida Peach Production: Horticultural Evaluation of Two New Rootstocks With Potential Resistance to the Peach Root-Knot Nematode

Mary Ann D. Maquilan*
University of Florida, Gainesville; memetmaq@ufl.edu
Mercy A. Olmstead
University of Florida, Gainesville; mercyl1@ufl.edu
José X. Chaparro
University of Florida, Gainesville; jaguey58@ufl.edu
Donald W. Dickson
University of Florida, Gainesville; dwd@ufl.edu
Thomas G. Beckman
USDA–ARS, Byron, GA; tom.beckman@ars.usda.gov

Peach production acreage in Central Florida is steadily expanding with the availability of new, high-quality, and low-chill requirement peach cultivars adapted to the region's subtropical climate. Florida's well-drained sandy soils are ideal for peach production except that they are also inhabited by plant pathogenic nematodes. ‘Flordaguard’ peach rootstock is recommended for commercial utilization because it is well-adapted to Florida’s acidic soils and exhibits good resistance to the endemic peach root-knot nematode, *Meloidogyne floridensis* (Mf). Additional nematode-resistant rootstocks are being identified to diversify the panel of improved rootstocks for the expanding peach industry. Two new rootstocks, ‘MP-29’ and ‘P-22’ (T. G. Beckman, USDA–ARS Byron, GA) offer potential for peach production in Central Florida. ‘MP-29’ is “pleach”, a hybrid between a red-leaved peach rootstock breeding selection and ‘Edible Sloe’ plum. The rootstock selection ‘P-22’ is a hybrid of ‘Guardian’ and ‘Flordaguard’ peach and is under consideration for release. A rootstock trial was planted at Citra, FL during the Spring of 2012 to test horticultural performance of these rootstocks with ‘Flordaguard’ in the presence of Mf. ‘Okinawa’ peach and is under consideration for release. Further evaluation is required to validate the effect of rootstocks on yield efficiency and resistance to Mf.

Specified Source(s) of Funding: USDA Specialty Crop Block Grant Program

(362) Physical and Chemical Attributes of Pomegranate (*Punica granatum* L.) Fruit Grown in Georgia

Juan Carlos Diaz-Perez*
University of Georgia, Tifton; jc.diaz@uga.edu
Anthony Bateman
University of Georgia, Tifton; batema@uga.edu
Gunawati Gunawan
University of Georgia, Tifton; gunawan@uga.edu
Sarah Workman
University of Georgia, Athens; sworkman@uga.edu
Smiljana Goreta Ban
Institute of Adriatic Crops and Karst Reclamation, Split; Smiljana.Ban@krs.hr
Mira Radunic
Institute of Adriatic Crops and Karst Reclamation, Split; Mira.Radunic@krs.hr
Erick Smith
University of Georgia, Tifton; ericks@uga.edu

Pomegranate is a non-climacteric fruit consumed fresh as whole fruit or arils or used for production of juice, wine, and syrup. Pomegranate is popular due to its health benefits. In the U.S. it is grown primarily in California and other semiarid regions. ‘Wonderful’ is a widely grown cultivar in California. Preliminary research has shown, however, that ‘Wonderful’ produces low yields in Georgia, indicating the need to identify cultivars better suited to warm and humid conditions, such as those of the southeastern U.S. The objectives were to determine the physical and chemical quality of pomegranate cultivars grown in Georgia. Pomegranate fruit harvested in Sept.–Oct. 2013 from a grower’s orchard (Alma, GA, 5 cvs.), and Ponder Farm, Univ. of Georgia (TyTy, GA; 20 cvs.), and UGA Tifton Campus (Tifton, GA; 22 cvs.). Individual fruit weight ranged from 335 g (‘Pink’) to 119 g (‘Utah Sweet’); aril weight from 0.63 g (‘Cloud’) to 0.17 g (‘Utah Sweet’); aril weight relative to fruit weight from 65.9% (‘Medovyi Vahsha’) to 44.8% (‘DSN’); total soluble solids from 14.0% (‘Azadi’) to 10.9% (‘R-16’); titratable acidity from 7.8% (‘Sakerdze’) to 0.48% (‘King’); arils a* value from 21.1 (‘Crab’) to 0.3 (‘Cloud’); arils b* value 14.2 (‘Cloud’ and ‘Sirenevy’) to 10.9 (‘Sirenevy’); and fruit juice volume from 0.51 mL/g (‘Pink’) to 0.15 mL/g (‘Wonderful-Tifton’). Across cultivars, individual fruit weight

An asterisk (*) following a name indicates the presenting author.

S400
HortScience 49(9) Supplement—2014 ASHS Annual Conference
increased linearly with increasing number of arils. Aril number was more important in determining fruit weight compared to aril size.

Specified Source(s) of Funding: NIFA-ISE GEOE-2009-00966

(363) Tropicalized Peaches Can Be Produced in Central Mountainous Region of Puerto Rico

Maria del Carmen Libran*
University of Puerto Rico -Mayagüez Campus; maria.libran@upr.edu

Robert E. Rouse
SW Florida Res. & Ed. Ctr., Immokalee, FL; rer@ifas.ufl.edu

Hernandez Evelio
University of Puerto Rico, Mayaguez; email7@email.com

In the central mountainous region of Puerto Rico coffee, citrus crops and banana are the main crops. Fruits crops contributed $30.3 million to PR agricultural gross income in fiscal year 2004-2005. As an alternative to coffee production, we evaluated the adaptability of four low-chilled peach cultivars (Flordaprince, TropicBeauty, Flordaglo, and UFGold) to conditions of the central mountainous region during 2002 to 2005. These four cultivars were evaluated in two sites, Beneficiado and Montaña, in the Agricultural Experiment Station of the University of Puerto Rico in Adjuntas, PR. Number of fruits, fruit growth and weight were evaluated. Temperature was measured at both sites and chilling units calculated using established chilling unit models. Trees were artificially defoliated by spraying with zinc sulfate (20%) during the first week of January to induce dormancy and flower induction. Flowering began in late January and early February depending on cultivar, first fruits appeared at the beginning of March. Three of the cultivars evaluated had optimum growth and yield during the last harvest season of 2005. Fruits maturing stage was from April to May, with fruits from 5 to 8 cm diameter weighing 80 to 140 grams during the optimum market window. Data gathered at the two sites in Adjuntas shown, being cultivars Tropic Beauty, Flordaprince, and Flordaglo had higher number of fruits at Montaña site than at Beneficiado, but fruits were smaller. Cultivar UFGold did not flower well and fruit set was very low. In conclusion, cultivars Tropic Beauty, Flordaprince, and Flordaglo showed adaptability to climatic conditions of the central mountainous region of Puerto Rico and should be considered as an alternative commercial crop for this area.

Specified Source(s) of Funding: University of Florida, University of Puerto Rico. USDA CRIS

(364) Rootstock Testing of Prunus Species Hybrids for Peach in South Carolina

Gregory L. Reighard*
Clemson University, Clemson, SC; grghrd@clemson.edu

David R. Ouellette
Clemson University, Clemson; dolltt@clemson.edu

Eighteen Prunus rootstocks budded with ‘Redhaven’ peach were planted near Clemson, SC in Jan. 2009. The rootstocks tested included 6 interspecific Prunus hybrids and seedlings of 3 Prunus species. After five growing seasons, significant differences among rootstocks were found for survival, root suckers, growth, bloom date, fruit maturity date, fruit size, cumulative yield, and yield efficiency. Tree survival was high (100%) in all but 4 rootstocks. ‘Imperial California’ had the lowest overall survival (38%) followed by P. americana seedling and ‘Controller™ 5’ (both 75%). Rootstock suckering was excessive on Prunus americana seedlings and Krymsk®1. Tree TCSAs were largest on ‘Mirobac’ (aka ‘Replantpac’) followed by Guardian®, ‘Viking’, ‘Bright’s Hybrid #5’ and ‘Atlas’, whereas TCSAs of trees on Krymsk®1 and P. americana were the most dwarving. ‘Controller™ 5’ and ‘Empyrean® 3’ (aka ‘Tetra’) were semi-dwarfing, and ‘Fortuna’ and ‘Imperial California’ had compatibility and disease issues, respectively. The earliest bloom by 1-1.5 d occurred on ‘Krymsk® 86’ and KV010127 rootstocks. Trees on P. americana and ‘Fortuna’ bloomed 1-3.5 d later than the average in 2011, 2012 and 2013. Fruit maturity dates varied by 10 d if ‘Imperial California’ (5 d early) and ‘Fortuna’ (5 d late) were included though both were weak rootstocks for peach. Otherwise, ‘Redhaven’ fruit from ‘Empyrean® 3’ and ‘Krymsk® 1’ trees ripened 3 to 3.5 d earlier than Lovell, the standard. Fruit size was largest on ‘Imperial California’ trees but was due to very low crop load. ‘Fortuna’ produced the smallest fruit. Cumulative yields were highest on the vigorous peach and peach hybrid rootstocks. Rootstocks with the highest yield efficiency were semi-dwarfing such as ‘Krymsk® 1’, ‘Controller™ 5’, ‘7’ & ‘8’, P. americana and ‘Empyrean® 2’ (aka ‘Penta’).

Specified Source(s) of Funding: USDA-SCRI
(366) Surveying the Research and Extension Needs of U.S. Cider Apple Growers and Cider Makers

Gregory Michael Peck*
Virginia Tech, Winchester; greg.peck@vt.edu

Carol A. Miles
Washington State University, Mount Vernon; milesc@wsu.edu

Since 2011, commercial cider producers throughout the United States have gathered at an annual trade show and educational conference in Chicago, IL, called CiderCON. In both 2013 and 2014, university researchers have attended CiderCON to present findings from their research programs and to survey cider makers and cider apple growers about their research and extension needs. These surveys were conducted during the opening Plenary Session with the use of TurningPoint (Turning Technologies, Youngstown, OH), a PowerPoint-based, real-time survey instrument. One representative from each prospective or existing orchard and cider company was provided a clicker and asked to respond to multiple-choice questions that were projected on large screens. Other attendees, such as vendors, media representatives, researchers, and support staff did not participate in the survey but everyone was able to see the response to each question. Respondents were first trained in the use of the clickers with a sample question and given the opportunity to resolve technical issues before the actual survey began. In 2013 there were 64 respondents, and in 2014, there were 105 respondents. Survey questions were only slightly modified between 2013 and 2014, so that year-to-year trends could be monitored. Averaged over the two year, we found that 90% of respondents indicated they would like more research by university scientists into cider/perry production, 91% were willing to participate in research experiments in their orchard or cidery, and 56% were willing to fund research that targeted their needs. Respondents felt the research that would most benefit their business included fermentation issues (18%), final product quality evaluation (15%), storage and packaging techniques and management (13%), cultivar and rootstock trials (13%), cider orchard management (11%), juice quality improvement (11%), and economic feasibility and consumer preference (8%). When seeking technical information about growing apples or making cider, the majority of respondents searched the internet (25%) or contacted a colleague (25%), referred to their reference books (16%), contacted a university specialist (11%), posed questions to listervises (10%), or contacted a private consultant (6%). Respondents felt their business would benefit most from workshops on cider fermentation (26%), workshops on growing apples (16%), printed university information (13%), visits with university specialists (18%), university websites (17%), and private consultants (11%). Our findings show that the needs of this burgeoning industry are diverse, strengthening our need to use a multi-disciplinary team of researchers and extension specialists.

(339) Determination of Cultivar-specific Threshold Temperatures and Heat Requirements for Prediction of Budbreak, Full Bloom, and Veraison in Wine Grape

Diana M. Zapata*
Washington State University, Prosser; diana.zapatarojas@email.wsu.edu

Melba Salazar
Washington State University, Prosser; m.salazar-gutierrez@wsu.edu

Bernardo Chaves
Washington State University, Prosser; b.chavescordoba@wsu.edu

Lynn Mills
Washington State University, Prosser; ljmills@wsu.edu

Markus Keller
Washington State University, Prosser; mkeller@wsu.edu

Gerrit Hoogenboom
Washington State University, Prosser; gerrit.hoogenboom@wsu.edu

Weather conditions have a significant impact on crop growth and development. The main controlling factor is temperature which affects plant development and many other plant processes. Phenological models such as thermal time or Growing Degree Day model have been widely applied to predict the development of many species. These concepts can also be applied for grapevine. In addition to being used as a tool for decision making for grapevine management and site selection, phenological models can be used to optimize vineyard production systems for cost, quality, and environment to improve the overall long-term sustainability of the grape production system. So far the use of a Degree Day model that has the same based temperature for all cultivars is common. The goal of this study was to evaluate the threshold temperature and heat requirements for the prediction of three growing stages for four Vitis vinifera L. cultivars. Historical phenological data for 20-years was used to estimate heat requirements for individual consecutive growing stages were used to develop a model for budbreak, blooming and veraison prediction in Prosser (WA). Model performance was evaluated for the interaction of different threshold temperatures and heat requirements. Significant differences were found in heat demand among cultivars and developmental stages for early and late cultivars. The threshold temperature increased along wine grape development from budbreak to veraison. The threshold temperatures for budbreak ranged from 6.5 °C for the early cultivars such as Chardonnay to 8.3 °C for the late cultivars such as Cabernet Sauvignon. The highest requirements were obtained for the growth stages of bud burst to first bloom and full bloom to veraison where major changes in phenology occurred during the transition period from vegetative to reproductive. The preliminary results obtained provide valuable information to determine the start of grapevine development based on local weather data. The initial results are now being evaluated with
(340) ‘Noiret’ Winegrape Bud Cold Hardiness: Effects of Temperature, Month, and Black Rot Severity
Eric Stafne*
Mississippi State University, Poplarville; estafne@ext.msstate.edu
Damon Smith
University of Wisconsin, Madison; dsmith@plantpath.wisc.edu
Becky Carroll
Oklahoma State University, Stillwater; becky.carroll@okstate.edu
Black rot infections during the summer and bud cold hardiness in the winter are both constant management issues in Oklahoma viticulture. Black rot infections could be a cause of vine stress, leaf drop, and rotten fruit, potentially compromising overall vine ability to prepare for cold temperatures. However, no studies have targeted bud cold hardiness in relation to severity of previous season black rot infection. Thus, in 2012, ‘Noiret’, a hybrid winegrape, was subjected to four black rot control treatments [conventional (C), organic 1 (O1), organic 2 (O2), and no spray (N)]. Leaves and fruit were scored in late June for lesion severity. The O1 and N treatments had the highest level of leaf and fruit lesion severity and were not significantly different. The C treatment had the least amount of leaf and fruit lesion severity and the O2 treatment was intermediate and significantly different from the O1 and N grouping, as well as the C treatment. After the acclimation period in fall and early winter, bud samples were taken in January and March and exposed to subzero temperatures (−5 °C, −10 °C, −15 °C, −20 °C) in an ethylene glycol bath to assess if previous season black rot infection had any impact on bud hardiness. Five bud samples replicated four times for each month and temperatures were taken. A significant Month * Temperature interaction indicated the number of live buds decreased as temperature decreased. At −5 °C and −10 °C in January nearly all buds were still alive (4.9 for both), and not significantly different from March −5°C, −10 °C, and −15 °C. Lower temperatures of −20 °C in March (3.6) and January (3.0) and −15 °C in January (3.5) were not significantly different. The black rot control treatments were not a statistically significant factor in the bud hardness experiment. This could be due to black rot severity being below a critical threshold for impact or that the vines had enough time to recover in late summer and fall to reach full mid-winter hardiness.

(341) Freezing Tolerance of Vitis vinifera Cultivars New to Northeastern United States
Imed E. Dami
Ohio State University, Wooster; dami.1@osu.edu
Shouxin Li
Ohio State University, Wooster; li.3018@buckeyemail.osu.edu

Yi Zhang*
California State University at Fresno; yzhang@csufresno.edu

Grapes are temperate crops and are most frequently damaged by freezing temperatures. The severe economic losses that result from the freezing injury continue to be a major constraint to the growth of the grape and wine industries in cold regions. The long-term goal of this project is to identify cultivars that are adapted to the weather conditions in Northeastern United States. In this study, the freezing tolerance (FT) of more than 20 Vitis vinifera cultivars was determined at two sites for two seasons in Ohio. Buds were collected periodically between September and April and then subjected to controlled freezing tests. FT was determined by thermal analysis and expressed as LT50 in °C (temperature that kills 50% of the primary buds). The maximum bud FT (minimum LT50) was reached in December–January and ranged between LT50 = −15 °C (‘Durif’, most cold-sensitive) and LT50 = −25 °C (‘Gamay noir’ and ‘Pinotage’, most cold hardy). The rates of cold acclimation (transition from a cold sensitive to a cold hardy) and deacclimation (transition from a cold hardy to a cold sensitive state) for each cultivar were also estimated and showed cultivar differences. It is concluded that the knowledge of freezing tolerance of each cultivar reported in this study will aid growers make objective decisions on cultivar selection in cold regions.

Specified Source(s) of Funding: USDA-NIFA, Ohio Grape Industries Program, Ohio Agricultural Research and Development Center

(342) Managed Canopies of Norton Grape Reduced Juice Acidity and Berry Rot
Martin L. Kaps*
Missouri State University, Mountain Grove; martinkaps@missouristate.edu
Staci Rather
Missouri State University, Mountain Grove; stacirather@missouristate.edu
Kathy Schreiner
Missouri State University, Mountain Grove; kathyschreiner@missouristate.edu
Xinyi Zhang
Missouri State University, Mountain Grove; xinyizhang@missouristate.edu

Norton (Vitis aestivalis Michx.) is a vigorous grape cultivar with a dense canopy. The fruiting zone is often shaded resulting in poor juice quality. A horizontally divided canopy will reduce shade; however, Norton is often grown as a nondivided vertical canopy in Missouri because of its suitability for mechanical harvest. In several studies, Norton canopies were managed by manually positioning shoots, and removing leaves and summer lateral shoots. All treatments decreased canopy density and increased sunlight penetration. In 2010, yield per vine, average cluster weight, and juice soluble solids, pH, and potassium were not significantly different in managed versus unmanaged vines. Cane pruning weight and juice titratable acidity decreased in
managed vines. In 2011, similar results were found. This could be advantageous, because Norton grape has high acidity in most harvest years. It was noted that late season berry rot also decreased in managed vines. In 2012, yield per vine, average cluster weight, and juice soluble solids, pH, potassium and malic acid were not significantly different in managed versus unmanaged vines. Much like in 2010–11, cane pruning weight and juice titratable acidity decreased in managed vines. Finished wine made from the grapes of managed vines showed no significant differences although a trend toward a decrease in pH and potassium and an increase in total anthocyanin was noted in 2010 and 2012. Leaf and summer lateral removal were equally effective at decreasing canopy density in Norton vines. Leaf removal often showed greater effect and it was faster to implement. A combination of both leaf and summer lateral removal could result in fruit sunburn.

(343) Effects of Substrate pH on Growth of Vaccinium arboreum from Different Provenances

James D. Spiers*
Auburn University, Auburn, AL; jds0001@auburn.edu
Jonathan Meador
Auburn University, Auburn, AL; meadojc@auburn.edu
Elina D. Coneva
Auburn University, Auburn, AL; edc0001@auburn.edu
Rebecca L. Darnell
University of Florida, Gainesville; rld@ufl.edu
Jeff Sibley
Auburn University, Auburn, AL; jsibley@auburn.edu

Alkaline soil pH is a limiting factor in commercial blueberry production and tolerance of these growing conditions would benefit growers in areas with higher pH soils, as well as expand the amount of available land that is suitable for growing blueberries. Vaccinium arboreum is native to the southeastern United States and has been found growing in soils with a pH as high as 7. Coupled with its alkaline soil tolerance, sparkleberries also exhibit other characteristics that make it a suitable species for use as a rootstock, such as a monopodial trunk and excellent drought resistance. The purpose of this 2-year experiment was to determine the effects of substrate pH on growth characteristics of open-pollinated populations of sparkleberry seedlings from different provenances. Plants were placed into a deep-water culture hydroponic system containing a nutrient solution buffered to a pH level of 5.5, 6.0, 6.5, or 7.0. In the first year, a chelated iron source was included in the nutrient solution and final fresh weight increased linearly with increasing pH. Provenance and pH were significant main effects. In the second experiment, a different iron source was used and there were more pronounced differences between provenances. The final fresh weight of three of the four provenances decreased linearly in response to increasing pH. The final fresh weight of one provenance exhibited a significant quadratic trend with greatest fresh weight obtained at pH 6.5. The interaction of pH x provenance affected final fresh weight, root fresh weight, and the root dry weight. The main effects of pH and provenance affected root:shoot ratio and photosynthesis. Results of this study indicate that provenance does affect the growth of V. arboreum in different substrate pH levels.

(344) Spatial Distribution of Iowa Vineyards

Kevin Duerfeldt*
Iowa State University, Ames; kduerf@iastate.edu
Cynthia Haynes
Iowa State University, Ames; chaynes@iastate.edu
Jennifer Bousselot
Colorado State University, Fort Collins; jmbouss@iastate.edu
Jennifer Bousselot
Colorado State University, Fort Collins; jmbouss@iastate.edu

From 2004 to 2011 the number of Iowa vineyards grew from 165 to 301. In 2011 the wine and vineyard industry had a 234.3 million dollar impact on Iowa’s economy. A spatial evaluation of current vineyard sites may assist with management of vineyards; lead to new generalizations that can be used to create prescriptive models for selecting sites for future vineyards. To achieve these goals we developed 3 spatial questions: 1) How are vineyards distributed in Iowa? 2) Are there statistically significant clusters of vineyards? 3) What are site characteristics of vineyards? We created maps of existing Iowa vineyards beginning by geocoding addresses of vineyards from extension specialists client lists, and government agencies. Political boundaries, land cover, and infrastructure data were obtained from the Iowa Department of Natural Resources via the Iowa Geospatial Data Clearinghouse. We used ArcGIS, GeoDa, and Microsoft Excel to analyze the data and run statistical analyses. The number of vineyards per county was calculated and a box plot map showed higher concentrations of vineyards across the center of the state, particularly around larger populations, and revealed three upper outliers. While regression analysis of county population to the number of vineyards in the county showed \( r^2 = 0.20 \). A test for spatial autocorrelation using univariate Moran’s I showed \( I = 0.32 \), two counties that are clusters of low-low (counties with low numbers of vineyards surrounded by counties with low numbers of vineyards), and four counties that are clusters of high-high (counties with high numbers of vineyards surrounded by counties with high numbers of vineyards) at pseudo \( P = 0.001 \). Data was extracted from raster layers depicting topography and land cover to compare current vineyard, recommended, and typical Iowan site characteristics. Vineyards are more likely to be located near a river. Sixty-six percent are within 2.41 kilometers compared to 49% of Iowa land, Chi square = 47.65 at \( P = 0.0001 \). We found that while 57% of vineyards are located on recommended eastern or southern aspects and 33% on moderate slopes of 5% to 15%, there are no statistical differences between the percent of vineyards located on these slopes and the percent of total Iowa land matching these conditions. Meaning these results could be an artifact of Iowa’s landscape, not deliberate site planning. These results are likely due to a number of reasons including suitable conditions for growing grapes, criteria for other uses such as facility rentals, and competition from other land uses.

An asterisk (*) following a name indicates the presenting author.
(345) Characterizing the Profiles and Relationships of Sugars and Anthocyanins in Strawberry Cultivars and Selections from the North Carolina Breeding Program

Penelope Perkins-Veazie*
North Carolina State University, Plants for Human Health Institute, Kannapolis; penelope_perkins@ncsu.edu

Jeremy A. Pattison
Driscoll Strawberry Associates, Inc., Watsonville, CA; jeremy.pattison@driscolls.com

Guoying Ma
North Carolina State University, Kannapolis; gma@ncsu.edu

Elizabeth Clevinger
North Carolina State University, Kannapolis; elizabeth_clevinger@ncsu.edu

James R. Ballington
Dept. of Horticultural Science, North Carolina State University, Raleigh, NC; jim_ballington@ncsu.edu

In North Carolina, strawberry breeding objectives are to develop cultivars suitable for the climatic conditions encountered in the USDA hardiness zones 5 to 8 (western mountains to eastern shoreline) for use with the annual plasticulture production system. The California varieties Chandler and Camarosa are still used for much of the short day acreage in the mid-South and genetic improvements in agronomic performance and fruit quality are industry requirements. Fruit from the most promising North Carolina selections, and of ‘Chandler’, ‘Camarosa’, and ‘Benicia’ were harvested weekly from trials at the Piedmont Research Station in Salisbury, NC, for three weeks during the spring of 2013. At each harvest date, 10 marketable fruit per genotype (free from rot and malformations, over 15 g fruit weight and uniform ripeness determined by full color development) were combined for each weekly sample. Fruit were freeze dried and fruit powder (excluding achenes) was used to determine sugar and flavonoid composition using HPLC equipped with diode array. Of the 61 NC selections, 14 had 20% or more sucrose, as did ‘Chandler’ and ‘Camarosa’, and 17 selections had less than 10% sucrose. The remaining 30 selections and ‘Benicia’ were intermediate in sucrose (10% to 20% of total sugars). When expressed as a percentage of total sugars, percent sucrose was positively and linearly related to the total amount of sucrose. However, the percent soluble solids content could not be used to predict percent sucrose in strawberry germplasm, or total sugar content. Five selections per low, medium, and high sucrose category and total anthocyanin. Our results indicate that North Carolina strawberry selections show a range of sucrose accumulation, which may be helpful in selection of flavor, and that sucrose content may play a role in strawberry anthocyanin profile.

Specified Source(s) of Funding: University of Arkansas-Walmart Strawberry Grower Grant

(346) Influence of High Tunnel and Shade on Blackberry Yield and White Drupelet Disorder

James D. Spiers*
Auburn University, Auburn, AL; jds0017@auburn.edu

James A. Pitts
Alabama Agriculture Experiment Station, Clanton, AL; pittsja@auburn.edu

Robert T. Boozer
Alabama Agriculture Experiment Station, Clanton, AL; boozert@auburn.edu

John R. Clark
University of Arkansas, Fayetteville; jrclark@uark.edu

This 2-year study was arranged in a split-split-plot design to determine effects of shade and/or high tunnel on yield and incidence of white drupelets on ‘Kiowa’, a florican-fruited blackberry, and ‘Prime-Jan’, a primocane-fruited blackberry. Yield, berry weight, and the number of fruit with white drupelets per 25-berry sample was recorded. Total yield was variable in 2012, but was much greater inside high tunnel in 2013. Berry size was not influenced by high tunnel or shade. ‘Kiowa’ berry weight was approximately twice that of ‘Prime-Jan’ in both years. In both years, the incidence of white drupelets on both cultivars was reduced under shade inside and outside of high tunnel. Yield was not affected by shade in this 2-year study.

(347) Analysis of the Other Half: Root Morphology of a Segregating Backcross Population between Vaccinium corymbosum and V. arboreum

Hilda Patricia Rodriguez-Armenta*
University of Florida, Gainesville; hildap@ufl.edu

James W. Olmstead
University of Florida, Gainesville; jwolmstead@ufl.edu

The blueberry industry is based in the asexual propagation of outstanding genotypes by rooting of vegetative parts. However, rooting percentage is often reduced when wild material has been introgressed. In blueberry, high rooting percentage of softwood cuttings will ensure that a potential selection fits the standard propagation protocols necessary for commercialization. Vaccinium arboreum, commonly known as sparkleberry, is widely adapted to sandy Floridian soils and the root morphology as well as plant architecture are traits of interest in breeding with cultivated blueberry. Unfortunately, V. arboreum has had a very low rooting percentage using standard softwood cuttings for propagation. Thus we established two experiments to evaluate rooting percentage and root morphology of a segregating backcross population between ‘Southern Belle’, a cultivated...
blueberry (V. corymbosum) and selection FL08-467, a hybrid between ‘Primadonna’ and V. arboreum selection FL06-753. ‘Southern Belle’ showed 90% rooting of softwood cuttings after eight weeks of establishment. FL06-753 and FL08-467 had 0% and 25% rooting, respectively, while 87 genotypes of the backcross population ranged from 0% to 100%. There was a positive correlation between leaf retention and rooting (R²=0.72). Root morphology analysis included root exploration depth and width 10 weeks after rooting of softwood cuttings, as well as root analysis by image acquisition and analysis using WinRhizo® software. Attributes measured included root surface area, volume, length, and number of tips on different diameter categories, as well as number of links and average link length. Among seventy six genotypes of the backcross population, 17% presented higher root density, length, surface area, and volume than the cultivated parent, while almost half of the population presented equal or higher values than the hybrid parent. The data suggested that low softwood cutting rooting percentages as a result of using V. arboreum can be increased in just one generation of backcrossing.

(348) A Comparison of Blackberry Cultivars for a High-elevation Arid Climate

Brent Black*
Utah State University, Logan; brent.black@usu.edu

Thor Lindstrom
Utah State University, Logan; thor.lindstrom@usu.edu

Blackberries are only marginally hardy to the high-elevation valleys of the Intermountain West, but growers are interested in blackberries as a diversification opportunity to capitalize on increased interest in local produce. A planting was established in 2006 at the Utah State University research farm in Kaysville, UT, (41.01 N latitude, 1330 m elevation) to evaluate 21 blackberry cultivars for suitability to commercial production in the region. Each cultivar was planted in at least two replicate plots with 2 to 3 plants per plot. Winter cane injury was visually evaluated each spring, and ripe fruit harvested to determine yield, production season, and fruit size. The winters from 2008 to 2012 presented a wide contrast in winter conditions that provided a good test for hardiness. Except for the two fall-bearing cultivars, yield was closely correlated with winter cane survival. Illini Hardy consistently had the highest winter survival. Among the thornless semi-erect types, ‘Chester’ showed the highest winter survival followed by ‘Triple Crown’ and ‘Hull’. ‘Triple Crown’ had the highest average yields. Among the erect types, ‘Apache’, ‘Arapaho’, and ‘Navajo’ showed the best winter survival and most consistent yields, while ‘Kiowa’ had the lowest winter survival and yields. None of the trailing types had adequate winter survival or yields to be recommended. Semi-erect types and the more cold-hardy erect types are recommended for the Intermountain West.

Specified Source(s) of Funding: Utah Agricultural Experiment Station
# Index of Authors and Moderators for Oral and Poster Presentations

<table>
<thead>
<tr>
<th>A</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Abbas, Tahira</td>
<td>S236, S237</td>
</tr>
<tr>
<td>Abdelghafar, Asma</td>
<td>S218</td>
</tr>
<tr>
<td>Acharya, Ram</td>
<td>S318</td>
</tr>
<tr>
<td>Acosta, Marina</td>
<td>S162</td>
</tr>
<tr>
<td>Adams, Anna F.</td>
<td>S327</td>
</tr>
<tr>
<td>Adams, Stacy</td>
<td>S352</td>
</tr>
<tr>
<td>Aguiar, Jose Luis</td>
<td>S397</td>
</tr>
<tr>
<td>Aguilar-Espinosa, Sergio</td>
<td>S280, S294</td>
</tr>
<tr>
<td>Ahmad, Ifitkhar</td>
<td>S182</td>
</tr>
<tr>
<td>Ahmed, Nasar Uddin</td>
<td>S364</td>
</tr>
<tr>
<td>Aiello, Anthony S.</td>
<td>S339</td>
</tr>
<tr>
<td>Ajwa, Husein</td>
<td>S192</td>
</tr>
<tr>
<td>Alamed, Myrna</td>
<td>S344</td>
</tr>
<tr>
<td>Alem, Peter Otiendo</td>
<td>S122, S165</td>
</tr>
<tr>
<td>Alexander, Laurel</td>
<td>S385</td>
</tr>
<tr>
<td>Alexander, Lisa W.</td>
<td>S382</td>
</tr>
<tr>
<td>Alff, Emily</td>
<td>S145</td>
</tr>
<tr>
<td>Ali, Abbas</td>
<td>S358</td>
</tr>
<tr>
<td>Ali, Gul S.</td>
<td>S207</td>
</tr>
<tr>
<td>Allan, Cara J.</td>
<td>S133, S364</td>
</tr>
<tr>
<td>Allen, Charles B.</td>
<td>S386</td>
</tr>
<tr>
<td>Almeida, Rangel de Feijo</td>
<td>S193</td>
</tr>
<tr>
<td>Almenar, Eva</td>
<td>S188</td>
</tr>
<tr>
<td>Almutairi, Khalid</td>
<td>S214</td>
</tr>
<tr>
<td>Alosaimi, Areej Ahmed</td>
<td>S281</td>
</tr>
<tr>
<td>Al-Redhaianman, Khalid</td>
<td>S139</td>
</tr>
<tr>
<td>Al Shoffe, Yosef</td>
<td>S202, S203, S259</td>
</tr>
<tr>
<td>Altamimi, May Elfar</td>
<td>S279, S283</td>
</tr>
<tr>
<td>Altland, James</td>
<td>S257</td>
</tr>
<tr>
<td>Amadeu, Rodrigo</td>
<td>S249</td>
</tr>
<tr>
<td>Amador, Jose A.</td>
<td>S320</td>
</tr>
<tr>
<td>Amaya, Iraida</td>
<td>S117, S267, S363</td>
</tr>
<tr>
<td>Ames, Zilfina Rubio</td>
<td>S228, S229</td>
</tr>
<tr>
<td>Amore, Teresita D.</td>
<td>S325, S384</td>
</tr>
<tr>
<td>Anciso, Juan R.</td>
<td>S266</td>
</tr>
<tr>
<td>Andersen, Peter C.</td>
<td>S278</td>
</tr>
<tr>
<td>Anderson, Aaron M.</td>
<td>S159</td>
</tr>
<tr>
<td>Anderson, Michael</td>
<td>S300</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Andersen, Michael</td>
<td></td>
</tr>
<tr>
<td>Anderson, Jeffery A</td>
<td>S213</td>
</tr>
<tr>
<td>Angers, Paul</td>
<td>S310</td>
</tr>
<tr>
<td>Antonious, George</td>
<td>S310, S359</td>
</tr>
<tr>
<td>Anwar, Raheel</td>
<td>S373</td>
</tr>
<tr>
<td>Aquel, Muhammad</td>
<td></td>
</tr>
<tr>
<td>Anjum</td>
<td>S236, S237</td>
</tr>
<tr>
<td>Arancibia, Ramon A</td>
<td>S294, S385</td>
</tr>
<tr>
<td>Archbold, Douglas</td>
<td>S224</td>
</tr>
<tr>
<td>Arnold, Michael A.</td>
<td>S225</td>
</tr>
<tr>
<td>Arpaia, Mary Lu</td>
<td>S190</td>
</tr>
<tr>
<td>Arrington, Matthew</td>
<td>S158</td>
</tr>
<tr>
<td>Arthus, Steven</td>
<td>S369</td>
</tr>
<tr>
<td>Arul, Joseph</td>
<td>S310</td>
</tr>
<tr>
<td>Arvizu-Medran, Maria Sofia</td>
<td>S260</td>
</tr>
<tr>
<td>Asatryan, Armine</td>
<td>S150</td>
</tr>
<tr>
<td>Atterberry, Kelly A</td>
<td>S164, S318</td>
</tr>
<tr>
<td>Auwarter, Collin P.</td>
<td>S311, S368</td>
</tr>
<tr>
<td>Avendano-Arrazate, Carlos H.</td>
<td>S339</td>
</tr>
<tr>
<td>Avitia-Garcia, Edelberto</td>
<td>S328, S356</td>
</tr>
<tr>
<td>Ayala-Silva, Tomas</td>
<td>S169</td>
</tr>
<tr>
<td>Ayars, James E.</td>
<td>S264</td>
</tr>
<tr>
<td>Bachman, Gary R</td>
<td>S342</td>
</tr>
<tr>
<td>Baculis, Jessica</td>
<td>S386</td>
</tr>
<tr>
<td>Bai, Jinhe</td>
<td>S174, S175, S177, S188, S203, S204, S247, S344</td>
</tr>
<tr>
<td>Bak, Geon Ho</td>
<td>S260</td>
</tr>
<tr>
<td>Balal, Rashad M</td>
<td>S236, S237</td>
</tr>
<tr>
<td>Balci, Yilmaz</td>
<td>S226</td>
</tr>
<tr>
<td>Baldwin, Brian S</td>
<td>S183</td>
</tr>
<tr>
<td>Baldwin, Elizabeth</td>
<td>S174, S188, S203, S204, S247, S344</td>
</tr>
<tr>
<td>Balestri, Frank D</td>
<td>S334</td>
</tr>
<tr>
<td>Balgopal, Meena</td>
<td>S206</td>
</tr>
<tr>
<td>Bali, Khaled M</td>
<td>S130</td>
</tr>
<tr>
<td>Ballen, Fredy</td>
<td>S178</td>
</tr>
<tr>
<td>Balles, John</td>
<td>S186, S187, S359</td>
</tr>
<tr>
<td>Ballington, James R</td>
<td>S346, S405</td>
</tr>
<tr>
<td>Bamka, William</td>
<td>S284</td>
</tr>
<tr>
<td>Ban, Smiljana Goreta</td>
<td>S118, S400</td>
</tr>
<tr>
<td>Barbosa, Caio Morais de Alcântara</td>
<td>S258</td>
</tr>
<tr>
<td>Barickman, T. Casey</td>
<td>S154, S295, S296</td>
</tr>
<tr>
<td>Barkley, Noelle A</td>
<td>S244</td>
</tr>
<tr>
<td>Barkley, Susan</td>
<td>S194</td>
</tr>
<tr>
<td>Barnhill, Michael</td>
<td>S309</td>
</tr>
<tr>
<td>Barranco, Diego</td>
<td>S151, S364</td>
</tr>
<tr>
<td>Barrett, Charles</td>
<td>S193</td>
</tr>
<tr>
<td>Barthe, Gary</td>
<td>S170, S246</td>
</tr>
<tr>
<td>Bartoshuk, Linda</td>
<td>S291</td>
</tr>
<tr>
<td>Basden, Tom</td>
<td>S366</td>
</tr>
<tr>
<td>Baser, K. Husnu Can</td>
<td>S358</td>
</tr>
<tr>
<td>Bassil, Nahla</td>
<td>S117, S168, S233, S248, S267, S268, S298, S362</td>
</tr>
<tr>
<td>Basso, Carmen</td>
<td>S293</td>
</tr>
<tr>
<td>Basundari, Fransiska R.A.</td>
<td>S271</td>
</tr>
<tr>
<td>Basyouni, Rania</td>
<td>S165</td>
</tr>
<tr>
<td>Bateman, Anthony</td>
<td>S400</td>
</tr>
<tr>
<td>Bates, Marlin</td>
<td>S321, S395</td>
</tr>
<tr>
<td>Bates, Todd</td>
<td>S318</td>
</tr>
<tr>
<td>Bauerle, Taryn</td>
<td>S313</td>
</tr>
<tr>
<td>Bauerle, William</td>
<td>S313</td>
</tr>
<tr>
<td>Bauske, Ellen</td>
<td>S222, S354</td>
</tr>
<tr>
<td>Bautista, Jesus</td>
<td>S210, S331</td>
</tr>
<tr>
<td>Bautista, Nelida</td>
<td>S332</td>
</tr>
<tr>
<td>Bayer, Amanda</td>
<td>S226</td>
</tr>
<tr>
<td>Bayo, Deanna</td>
<td>S333</td>
</tr>
<tr>
<td>Beamer, Kenneth</td>
<td>S329</td>
</tr>
<tr>
<td>Beasley, J.</td>
<td>S332</td>
</tr>
<tr>
<td>Beasley, Jeff</td>
<td>S136</td>
</tr>
<tr>
<td>Beaudry, Randolph</td>
<td>S139, S188, S189, S191, S202</td>
</tr>
<tr>
<td>Beaulieu, John C.</td>
<td>S141</td>
</tr>
<tr>
<td>Beaulieu, Justine</td>
<td>S226</td>
</tr>
<tr>
<td>Beckerman, Janna</td>
<td>S156</td>
</tr>
<tr>
<td>Becker, Talon M.</td>
<td>S299</td>
</tr>
<tr>
<td>Beckford, Cadien K.</td>
<td>S289</td>
</tr>
<tr>
<td>Beck, John</td>
<td>S278</td>
</tr>
</tbody>
</table>
# Index of Authors and Moderators (Poster and Oral Presentations)

<table>
<thead>
<tr>
<th>Author</th>
<th>Page Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beck, John E.</td>
<td>S393</td>
</tr>
<tr>
<td>Beckman, Thomas</td>
<td>S219, S270, S400</td>
</tr>
<tr>
<td>Beck, Emily E.</td>
<td>S271</td>
</tr>
<tr>
<td>Beeks, Stephanie</td>
<td>S213</td>
</tr>
<tr>
<td>Beeson Jr., Richard C.</td>
<td>S179</td>
</tr>
<tr>
<td>Beeson, Richard C.</td>
<td>S180, S254, S265</td>
</tr>
<tr>
<td>Behe, Bridget</td>
<td>S319</td>
</tr>
<tr>
<td>Behe, Bridget K.</td>
<td>S177</td>
</tr>
<tr>
<td>Belayneh, Bruk</td>
<td>S226, S313</td>
</tr>
<tr>
<td>Belayneh, Bruk E.</td>
<td>S123, S136, S137</td>
</tr>
<tr>
<td>Bell, Nicole</td>
<td>S342</td>
</tr>
<tr>
<td>Bello, Nora</td>
<td>S198</td>
</tr>
<tr>
<td>Bell, Rebecca</td>
<td>S131</td>
</tr>
<tr>
<td>Bell, Richal L.</td>
<td>S271</td>
</tr>
<tr>
<td>Benedict, Chris</td>
<td>S242, S320</td>
</tr>
<tr>
<td>Benes, Bedrich</td>
<td>S401</td>
</tr>
<tr>
<td>Benjamin, Tamara</td>
<td>S207</td>
</tr>
<tr>
<td>Bennett, Alexandra Amanda</td>
<td>S299</td>
</tr>
<tr>
<td>Bennett, Mark A.</td>
<td>S124</td>
</tr>
<tr>
<td>Bennett, Pamela J.</td>
<td>S142, S143</td>
</tr>
<tr>
<td>Benzrihem, Katrina</td>
<td>S291</td>
</tr>
<tr>
<td>Ben Zvi, Michal Moyal</td>
<td>S181</td>
</tr>
<tr>
<td>Bernier, Ulrich R.</td>
<td>S358</td>
</tr>
<tr>
<td>Berry, Adrian D.</td>
<td>S204, S263</td>
</tr>
<tr>
<td>Bertrand, Sarah E.</td>
<td>S365</td>
</tr>
<tr>
<td>Bessin, Ricardo</td>
<td>S215</td>
</tr>
<tr>
<td>Bett-Garber, Karen L.</td>
<td>S141</td>
</tr>
<tr>
<td>Betz, Drew</td>
<td>S164</td>
</tr>
<tr>
<td>Bevington, Rosa Kim</td>
<td>S208, S211, S284</td>
</tr>
<tr>
<td>Blakeslee, Joshua</td>
<td>S124</td>
</tr>
<tr>
<td>Blankenship, Erin E.</td>
<td>S352</td>
</tr>
<tr>
<td>Bliss, Chris</td>
<td>S278</td>
</tr>
<tr>
<td>Bloodnick, Ed</td>
<td>S234</td>
</tr>
<tr>
<td>Bluhm, Burton H.</td>
<td>S269</td>
</tr>
<tr>
<td>Blunt, Tamla</td>
<td>S283, S341</td>
</tr>
<tr>
<td>Blythe, Eugene K.</td>
<td>S300, S358</td>
</tr>
<tr>
<td>Boldt, Jennifer K.</td>
<td>S389</td>
</tr>
<tr>
<td>Boman, Brian</td>
<td>S176</td>
</tr>
<tr>
<td>Bonos, Stacy</td>
<td>S386</td>
</tr>
<tr>
<td>Bonow, Sandro</td>
<td>S374</td>
</tr>
<tr>
<td>Boot, Willem</td>
<td>S220</td>
</tr>
<tr>
<td>Boozer, Robert T.</td>
<td>S405</td>
</tr>
<tr>
<td>Bordier, Adeline</td>
<td>S201</td>
</tr>
<tr>
<td>Boudreau, Stéphanie</td>
<td>S185</td>
</tr>
<tr>
<td>Boulanger, Jason R.</td>
<td>S159</td>
</tr>
<tr>
<td>Bourgeois, Gaeten</td>
<td>S288</td>
</tr>
<tr>
<td>Bousbolat, Jennifer</td>
<td>S319, S404</td>
</tr>
<tr>
<td>Boyer, Cheryl R.</td>
<td>S313</td>
</tr>
<tr>
<td>Boyle, Daniel L.</td>
<td>S388</td>
</tr>
<tr>
<td>Bradeen, James M.</td>
<td>S382</td>
</tr>
<tr>
<td>Brashid, Christine M.</td>
<td>S248, S298</td>
</tr>
<tr>
<td>Braman, Kris</td>
<td>S300</td>
</tr>
<tr>
<td>Brandenberger, Lynn P.</td>
<td>S287</td>
</tr>
<tr>
<td>Brand, Mark H.</td>
<td>S247</td>
</tr>
<tr>
<td>Brecht, Jeffrey K.</td>
<td>S188, S262, S263</td>
</tr>
<tr>
<td>Brenner, David</td>
<td>S349</td>
</tr>
<tr>
<td>Bridgen, Mark</td>
<td>S143</td>
</tr>
<tr>
<td>Brindley, Julie</td>
<td>S227</td>
</tr>
<tr>
<td>Briske, David</td>
<td>S208</td>
</tr>
<tr>
<td>Brodbeck, Brent V.</td>
<td>S278</td>
</tr>
<tr>
<td>Broderick, Shaun R.</td>
<td>S138</td>
</tr>
<tr>
<td>Brouwer, Brook</td>
<td>S318</td>
</tr>
<tr>
<td>Brown, A.</td>
<td>S378</td>
</tr>
<tr>
<td>Brown, Allan F.</td>
<td>S336, S346, S347, S374, S376</td>
</tr>
<tr>
<td>Brown, Eric</td>
<td>S131</td>
</tr>
<tr>
<td>Brown, India</td>
<td>S377</td>
</tr>
<tr>
<td>Brown, Rebecca N.</td>
<td>S119, S320</td>
</tr>
<tr>
<td>Bruch, Megan</td>
<td>S145</td>
</tr>
<tr>
<td>Brumfield, Robin G.</td>
<td>S179, S184, S185</td>
</tr>
<tr>
<td>Brunk, Galen</td>
<td>S341</td>
</tr>
<tr>
<td>Bryant, Douglas</td>
<td>S233</td>
</tr>
<tr>
<td>Bryla, David</td>
<td>S214, S215, S277</td>
</tr>
<tr>
<td>Brym, Zachary</td>
<td>S156, S157</td>
</tr>
<tr>
<td>Brzozowski, Lauren</td>
<td>S127</td>
</tr>
<tr>
<td>Buchanan, David</td>
<td>S189</td>
</tr>
<tr>
<td>Buck, Jennifer L.</td>
<td>S217</td>
</tr>
<tr>
<td>Buck, Johanna</td>
<td>S273</td>
</tr>
<tr>
<td>Buckley, Blair</td>
<td>S244</td>
</tr>
<tr>
<td>Buechel, Troy</td>
<td>S234</td>
</tr>
<tr>
<td>Buitrago, Jessica</td>
<td>S115</td>
</tr>
<tr>
<td>Bullen, S. Gary</td>
<td>S129</td>
</tr>
<tr>
<td>Bumgarner, Natalie R.</td>
<td>S273</td>
</tr>
<tr>
<td>Burnett, Stephanie</td>
<td>S217, S230, S358</td>
</tr>
<tr>
<td>Burrows, Colleen L.</td>
<td>S159</td>
</tr>
<tr>
<td>Burrows, Rhoda L.</td>
<td>S314</td>
</tr>
<tr>
<td>Bushakra, Jill M.</td>
<td>S233, S248, S298</td>
</tr>
<tr>
<td>Bush, Edward</td>
<td>S136, S227, S365</td>
</tr>
<tr>
<td>Buttaro, Donato</td>
<td>S167</td>
</tr>
<tr>
<td>Byrd, Robert J.</td>
<td>S347</td>
</tr>
<tr>
<td>Byrne, David H.</td>
<td>S148, S268, S381</td>
</tr>
<tr>
<td>Byrne, D.H.</td>
<td>S147, S382</td>
</tr>
</tbody>
</table>

**C**

<table>
<thead>
<tr>
<th>Author</th>
<th>Page Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cadena-Iniguez, Jorge</td>
<td>S339</td>
</tr>
<tr>
<td>Cade, Tina Marie (Waliczek)</td>
<td>S354</td>
</tr>
<tr>
<td>Cahn, Michael D.</td>
<td>S120</td>
</tr>
<tr>
<td>Cai, Neng</td>
<td>S296</td>
</tr>
<tr>
<td>Cai, Xiaodong</td>
<td>S146</td>
</tr>
<tr>
<td>Calderone-Ripak, Nancy</td>
<td>S302</td>
</tr>
<tr>
<td>Calovic, Milica</td>
<td>S246</td>
</tr>
<tr>
<td>Calvo, Milica</td>
<td>S320</td>
</tr>
<tr>
<td>Campbell, Ben</td>
<td>S177</td>
</tr>
<tr>
<td>Campbell, Josh</td>
<td>S349</td>
</tr>
<tr>
<td>Campbell, Richard J.</td>
<td>S135</td>
</tr>
<tr>
<td>Campos-Herrera, Raquel</td>
<td>S171</td>
</tr>
<tr>
<td>Cao, Fuliang</td>
<td>S361</td>
</tr>
<tr>
<td>Cao, Muming</td>
<td>S230</td>
</tr>
<tr>
<td>Cao, Zhe</td>
<td>S146, S297</td>
</tr>
<tr>
<td>Capik, John M.</td>
<td>S125, S168</td>
</tr>
<tr>
<td>Caple, Adam D.</td>
<td>S304</td>
</tr>
<tr>
<td>Cardoza, Yasmin</td>
<td>S353</td>
</tr>
<tr>
<td>Carey, Jamara</td>
<td>S381</td>
</tr>
</tbody>
</table>
Index of Authors and Moderators (Poster and Oral Presentations)

Carlson, Alicain S. ... S181, S182, S183
Carnelossi, Marcelo A.G. ... S204
Carroll, Becky ... S403
Carroll, Juliet E. ... S159
Carvalho, Lívia C. ... S305
Carvalho, Sofia D. ... S272
Carver, Sean T. ... S225
Case, Luke ... S194
Casamali, Bruno ... S161
Castagnoli, Steven P. ... S271
Castillo-González, Ana Maria ... S328, S356
Castillo-Martinez, Carlos R. ... S337, S339
Castro, Caroline M. ... S374
Castro-Garcia, Sergio ... S397
Cater, Melissa ... S144
Cellon, Catherine ... S249
Cerruti, Natasha ... S391
Chagas, Edvan Alves ... S324
Chaloupka, Kira L. ... S216
Chaney, Will ... S201, S297
Chang, Chung-Liang ... S345
Chang, Kuang-Pi ... S345
Chang, Shen-Kuen ‘Jack’ ... S327
Chang, Xiaoxiao ... S138
Chaparro, José ... S219, S246, S250, S271, S400
Chaparro, J.X. ... S270
Chapin, Bridgett ... S207
Chapin, Laura J. ... S363
Chappell, Matt ... S313
Chase, Carlene A. ... S392
Chase, Christine D. ... S234, S272
Chater, John M. ... S324
Chaudhari, Sushila ... S194, S367
Chaves, Bernardo ... S402
Chavez, Alberto Alvarado ... S332
Chavez, Dario J. ... S219, S250
Cheah, Kheng T. ... S304
Chebrolu, Kranthi ... S376
Chen, Chuxian ... S148, S174, S247, S272
Chen, Fur-Chi ... S317
Chen, Hong ... S177
Chen, Hui-Mei ... S163
Chen, Jianjun ... S282, S296
Chen, Nancy Jung ... S262
Chen, Qiaowei ... S258
Chen, Xinyu ... S323
Chen, Yihua ... S317
Chiebao, Helena Pontes ... S288
Chiebao*, Helena Pontes ... S262
Chitwood, Jessica ... S244, S245, S294, S348, S349
Choi, In-Hu ... S348, S367
Choi, Jong Myung ... S257, S303
Choi, Keun-Jin ... S168
Choi, Kyeong-Ju ... S360
Choi, Min-Seon ... S348
Choi, Young-In ... S361
Choquette, Danielle ... S288
Chowdhury, Md. Gomal Ferdous ... S262
Christensen, Laura ... S321
Chung, Sung Jin ... S361
Chung, Sun Woo ... S223
Chun, Min Kyo ... S223
Chu, Qingquan ... S130
Cisneros-Zevallos, Luis ... S235
Clardy, Arvazena E. ... S143
Clark, David G. ... S116, S191
Clark, John R. ... S149, S244, S266, S267, S268, S269, S312, S348, S349, S405
Clem, Taylor B. ... S163
Clevinger, Elizabeth ... S405
Cobb, Gillian ... S319
Cochran, Diana ... S251
Cochrane, Ellen F. ... S123
Coelho, Viviane Amaral Toledo ... S258
Coker, Christine E.H. ... S342
Coker, Randal ... S342
Colinas-Leon, Maria T. ... S328
Colle, Marivi ... S349
Collins, Pamela ... S301
Collins, Ray J. ... S205
Colquhoun, Thomas A. ... S116, S191, S196, S272
Coneva, Elina D. ... S225, S309, S328, S404
Conley, Marnie ... S326
Conley, M. Elizabeth ... S352
Conner, Patrick ... S365
Conrad, Rachel ... S123
Contreras, Carolina ... S139
Conversa, Giulia ... S286
Cook, Michael ... S212
Coolong, Timothy ... S265, S366
Coop, Leonard ... S141
Corcoran, Samantha Glaze ... S380
Corcorran, Jessica ... S359
Cordasco, Kim ... S262
Corson-Lassiter, Jane ... S255
Cory, Wendy ... S336
Coss, Stephanie ... S249
Cotton, Corrie P. ... S126, S279, S289, S355, S385
Cowgill, Winfred ... S115
Crabtree, Sheri B. ... S312, S398, S396, S399
Craver, Joshua K. ... S198, S326, S388
Crawford, Lauren ... S313
Creamer, Nancy G. ... S393
Creech, Matthew R. ... S172
Critzer, Faith ... S145
Crook, Amanda A. ... S368
Crospy, D. Camille ... S309
Croisy, Kevin ... S120, S350
Crossman, Stafford M.A. ... S366
Crouch, JoAnne ... S383, S384
Crumley, Jennifer ... S186, S187
Cruz-rus, Eduardo ... S363
Cui, Song ... S334
Culumbe, Mae ... S394
## Index of Authors and Moderators (Poster and Oral Presentations)

<table>
<thead>
<tr>
<th>Name</th>
<th>Page Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dewdney, Megan M.</td>
<td>S190, S305</td>
</tr>
<tr>
<td>DeVore, Jeremiah J.</td>
<td>S198, S205, S231, S390, S391</td>
</tr>
<tr>
<td>Denoyes, Beatrice</td>
<td>S149, S150</td>
</tr>
<tr>
<td>Denny, Geof</td>
<td>S118, S165, S210, S286, S331, S346, S400</td>
</tr>
<tr>
<td>Dicke, David</td>
<td>S277, S352</td>
</tr>
<tr>
<td>Dickson, Donald W.</td>
<td>S400</td>
</tr>
<tr>
<td>Dickson, Ryan W.</td>
<td>S232</td>
</tr>
<tr>
<td>Díez, Concepcion M.</td>
<td>S151</td>
</tr>
<tr>
<td>Di Gioia, Francesco</td>
<td>S167</td>
</tr>
<tr>
<td>Dinkins, David</td>
<td>S155</td>
</tr>
<tr>
<td>Dir, Matt</td>
<td>S147</td>
</tr>
<tr>
<td>Dittmar, Peter J.</td>
<td>S193, S368</td>
</tr>
<tr>
<td>Doane, Sam</td>
<td>S179</td>
</tr>
<tr>
<td>Dobres, Michael</td>
<td>S145</td>
</tr>
<tr>
<td>Doerflinger, Franziska C.</td>
<td>S259</td>
</tr>
<tr>
<td>Dole, John M.</td>
<td>S182, S183, S232, S317, S326</td>
</tr>
<tr>
<td>Dong, Caixia</td>
<td>S257, S258</td>
</tr>
<tr>
<td>Dong, Jinying</td>
<td>S281</td>
</tr>
<tr>
<td>Dong, Q.</td>
<td>S147</td>
</tr>
<tr>
<td>Dong, Xiaoying</td>
<td>S308</td>
</tr>
<tr>
<td>Donnelly, Linda</td>
<td>S138</td>
</tr>
<tr>
<td>Doron, Moshe</td>
<td>S155</td>
</tr>
<tr>
<td>dos Santos, Gabriel</td>
<td>S193</td>
</tr>
<tr>
<td>Dossett, Michael</td>
<td>S233, S298, S299</td>
</tr>
<tr>
<td>Doud, Melissa</td>
<td>S175</td>
</tr>
<tr>
<td>Dougher, Tracy A.O.</td>
<td>S217</td>
</tr>
<tr>
<td>Dove, Sue</td>
<td>S122, S230, S264, S371</td>
</tr>
<tr>
<td>Dreyer, Eric Q.</td>
<td>S191</td>
</tr>
<tr>
<td>Driggers, Randall</td>
<td>S175</td>
</tr>
<tr>
<td>Duan, YongPing</td>
<td>S174, S175</td>
</tr>
<tr>
<td>Duan, Y-P</td>
<td>S170</td>
</tr>
<tr>
<td>Ducharme, Diane</td>
<td>S131</td>
</tr>
<tr>
<td>Duferldt, Kevin</td>
<td>S162, S207, S319, S404</td>
</tr>
<tr>
<td>Dufoo-Hurtado, Miguel David</td>
<td>S373</td>
</tr>
<tr>
<td>Dukes, Michael D.</td>
<td>S137</td>
</tr>
<tr>
<td>Dumitic, Gvozden</td>
<td>S118, S345</td>
</tr>
<tr>
<td>Dunn, Judith M.</td>
<td>S375</td>
</tr>
<tr>
<td>Duncan, Larry</td>
<td>S171</td>
</tr>
<tr>
<td>Dunn, Bruce L.</td>
<td>S165, S166, S357</td>
</tr>
<tr>
<td>Duseja, Desh</td>
<td>S372</td>
</tr>
<tr>
<td>Dutt, Manjul</td>
<td>S117, S170, S171, S246</td>
</tr>
<tr>
<td>Dzakovich, Michael</td>
<td>S133</td>
</tr>
<tr>
<td>D'Acqui, Luigi Paolo</td>
<td>S283</td>
</tr>
<tr>
<td>E</td>
<td>S149, S150</td>
</tr>
<tr>
<td>Eatkes, Donald J.</td>
<td>S216, S282</td>
</tr>
<tr>
<td>Eaton, Raphael A.</td>
<td>S159</td>
</tr>
<tr>
<td>Eaton, Touria E.</td>
<td>S286</td>
</tr>
<tr>
<td>Egel, Dan</td>
<td>S391</td>
</tr>
<tr>
<td>Egilla, Jonathan N.</td>
<td>S166</td>
</tr>
<tr>
<td>Eguchi, Tomomi</td>
<td>S332</td>
</tr>
<tr>
<td>Einhorn, Todd</td>
<td>S158, S271</td>
</tr>
<tr>
<td>Ekinci, Neslihan</td>
<td>S190</td>
</tr>
<tr>
<td>El-Borai, Fahiem</td>
<td>S171</td>
</tr>
<tr>
<td>Elia, Antonio</td>
<td>S286</td>
</tr>
<tr>
<td>Elibox, Winston</td>
<td>S184</td>
</tr>
<tr>
<td>Ellingsworth, Alicia</td>
<td>S321</td>
</tr>
<tr>
<td>Elliott, Nancy A.</td>
<td>S209</td>
</tr>
<tr>
<td>Ellison, Eric</td>
<td>S155, S304</td>
</tr>
<tr>
<td>ELsysy, Mokhles A.</td>
<td>S158</td>
</tr>
<tr>
<td>Emanuel, Kenya</td>
<td>S125</td>
</tr>
<tr>
<td>Enciso, Juan</td>
<td>S266</td>
</tr>
<tr>
<td>Erich, Susan</td>
<td>S330</td>
</tr>
<tr>
<td>Erwin, John E</td>
<td>S389</td>
</tr>
<tr>
<td>Espino-Diaz, Miguel</td>
<td>S306, S307</td>
</tr>
<tr>
<td>Estrada, Alejandro</td>
<td>S138</td>
</tr>
<tr>
<td>Etxeberria, Edgardo J.</td>
<td>S246</td>
</tr>
<tr>
<td>Evans, Edward</td>
<td>S177, S178</td>
</tr>
<tr>
<td>Evans, Michael R.</td>
<td>S245, S294, S349</td>
</tr>
<tr>
<td>Evans, William B.</td>
<td>S155, S214, S379</td>
</tr>
<tr>
<td>Evelio, Hernandez</td>
<td>S401</td>
</tr>
<tr>
<td>Evelyn, Sarah</td>
<td>S184</td>
</tr>
<tr>
<td>F</td>
<td>S149, S150</td>
</tr>
<tr>
<td>Fallahi, Bahar</td>
<td>S156</td>
</tr>
<tr>
<td>Fallahi, Esmaeil ‘Essie’</td>
<td>S156</td>
</tr>
<tr>
<td>Fan, Shufang</td>
<td>S282</td>
</tr>
<tr>
<td>Fan, Xiaoli</td>
<td>S274</td>
</tr>
<tr>
<td>Fargione, Michael J.</td>
<td>S158</td>
</tr>
<tr>
<td>Farish-Williford, Hannah</td>
<td>S235, S381</td>
</tr>
<tr>
<td>Farnham, MarkS211, S242, S336, S349</td>
<td></td>
</tr>
<tr>
<td>Farooq, Qurrat-ul-Ain</td>
<td>S221</td>
</tr>
<tr>
<td>Farrell, Aidan</td>
<td>S184</td>
</tr>
</tbody>
</table>

---

**S410** HortScience 49(9) Supplement — 2014 ASHS Annual Conference
Index of Authors and Moderators (Poster and Oral Presentations)

Fatima, Shazia ........................................... S373
Faust, Jim .............................................. S232
Fava, Edwin M. ......................................... S320
Favero, Bruno T. ......................................... S182
Fazio, Gennaro ........................................... S150
Febres, Vicente J. ......................................... S126
Feibert, Erik B.G. ......................................... S187
Felter, Liz .................................................. S137, S207
Ferdosia, Malik ............................................ S156
Ferguson, Louise .......................................... S133, S397
Fernandez, Gina .......................................... S248, S298, S353, S393
Fernandez, Rodney Thomas .............................. S179
Fernandez-Salvador, Javier S215, S277
Ferrarezi, Rhuano Soranz ................................ S165, S230, S239, S264, S371
Fichtner, Elizabeth J. ..................................... S397
Fidelibus, Matthew W. ................................... S314
Fields, Jeb S. ............................................. S227
Figueroa, Julio ............................................. S135
Figueroa, Rodrigo .......................................... S369
Filichkin, Sergei ........................................... S233
Finn, Chad E. ............................................. S117, S233, S248, S267, S298, S362
Fischer, Albert ............................................ S369
FiGar, Marek ............................................... S401
Fisher, Paul R. ............................................. S121, S232, S304, S389
Flanagan, Roy ............................................. S351
Flax, Nicholas J. .......................................... S390, S391
Fleener, Ann W. .......................................... S216
Fletcher, Bobby ........................................... S144
Fleurissaint, Angie ........................................ S333
Flore, James A. ............................................ S213
Flores-Bello, Maria ....................................... S394
Florian, Traci Armstrong ................................... S162
Flynn, Robert P. .......................................... S351
Folta, Kevin .............................................. S116
Folta, Kevin M. ............................................ S272, S363
Fonsah, E. Greg ........................................... S309
Fonsah, Greg E. ........................................... S329
Fontenot, Kathryn ........................................ S216, S332, S365
Forbes, Vanessa .......................................... S279
Forge, Tom .............................................. S299
Forney, Charles F. ......................................... S310
Foster, John E. ............................................ S248, S280, S323, S394, S396
Fox, Janet ................................................ S144
Fraelich, B.A. ............................................. S340
Fraisee, Clyde ............................................ S193
Franco, Jose G. ........................................... S208
Frasca, Aline Coelho ...................................... S129
Freeburg, Paul C. ......................................... S180, S370
Fresnodo, Jonathan ....................................... S268, S269
Frett, Terrence ............................................ S148, S266, S268, S269
Frey, Susan .............................................. S352
Friedrich, Heather ......................................... S276, S353
Friel, Joshua ............................................. S382
Froelich, Dan ............................................ S303
Fuentes, Corina .......................................... S266
Fukui, Kuniaki ........................................... S337
Fulcher, Amy F. ........................................... S251, S253, S254
Fung, Whitney M. ......................................... S162
Fusselman, Molly ......................................... S321, S395
Gaire, Rupesh ............................................. S374
Gajanayake, Bandara ..................................... S294
Galainato, Suzette P. ..................................... S275
Gallardo, R. Karina ....................................... S177, S275
Ganjegunte, Girisha ...................................... S387
Gao, Haiyan .............................................. S259
Gao, Rongfu ............................................. S212
Gao, Suduan ............................................. S192
Gao, Zhifeng ............................................ S275, S392
Gapper, Nigel E. .......................................... S189, S202
Garces, Javier ........................................... S217
Garcia, Enrique Anibal Proano ........................... S225
Garcia, Karla Patricia .................................... S321
Garcia, M. Elena ......................................... S277, S352
Gardner, Alicia M. ....................................... S336
Garrett, Karen A. ......................................... S288
Gasic, Ksenija ............................................ S149, S218, S268, S269, S362, S376
Gaskill, Kelly ............................................ S377
Gazula, Himabindu ........................................ S317
Gebauer, Marlene ......................................... S369
Gegogeine, James ......................................... S317
Gehl, Ron ................................................ S387
Geiger, Thomas .......................................... S279
Geneve, Robert L. ......................................... S251
Geng, Fang ............................................... S124
Gerik, James ............................................. S192
Germishuizen, Peter ..................................... S210
Getlawi, Ahmed O.M. .................................... S292
Gi, Gwang Yeon .......................................... S359
Gibson, Kevin D. ......................................... S156, S206
Gil, Pilar M. ............................................... S291
Gilabert, Horacio ......................................... S369
Gilbert, Jessica L. ......................................... S191
Gimenez, Gustavo ......................................... S235
Giovanonni, James ....................................... S189, S202
Giurcanu, Mihai .......................................... S193
Gladfelter, Heather J. .................................... S360
Glenn, D. Michael ......................................... S238
Gloy, Brent ............................................... S392
Gmitter, Fred ............................................. S174, S176, S247, S272
Goad, Carla ............................................... S165, S166
Goenaga, Ricardo ......................................... S153, S249, S324, S393
Gohil, Hemant ............................................ S160
Goldman, Irwin ........................................... S127, S347
Gomez, Celina ........................................... S238, S273
Goméz, Miguel ........................................... S274, S386
González-Aguilar, Gustavo A. ........................... S307
Gonzalez-Blanco, Pedro .................................. S246
Gonzalez-Buesa, Jaime .................................. S188
González, Miriam ......................................... S189
González-Torres, Abel .................................... S323
Gordon, Tavia ............................................ S127
Gosney, Michael ......................................... S373
Gozlekci, Sadiye .......................................... S170
Gradziel, Thomas ......................................... S268
Index of Authors and Moderators (Poster and Oral Presentations)

Grahn, Charlene Margaret S242, S320
Grainger, Chelsea Y. S290
Grant, Trudi S117, S172
Grasswitz, Tessa R. S397
Gravel, Valerie S201, S241
Graves, Leila Anne S206
Graves, William R. S151, S198, S231, S280, S334
Gray, Dennis J. S117, S125, S172, S362
Greene, Duane W. S156
Greer, Kelly S355
Greene, Lane S314
Grelen, Lori S294
Grewell, David S198, S231
Griegoschewski, Katy S385
Griffin, Jason J. S288
Griffin, Whitney S136
Griffis, John L. S304
Griffiths, Phillip S242, S299, S349
Grimm, Casey C. S141
Gross, Jude S171
Grosser, Jude W. S170, S176, S234, S246, S272
Grosser, Melinda S272
Grossman, Julie M. S393
Gruber, Barrett S176
Grumet, Rebecca S349
Gu, Sanjun S278
Gu, Sanliang S159, S160, S230
Gu, Yu S317
Guan, Wenjing S322
Gubbuk, Hamide S169
Guglielmetti, M. S378
Guiltinan, Mark S324
Guldau, Steve S351
Gunawan, Gunawati S400
Gunduz, Kazim S117, S267
Gunter, Chris S131
Gunter, Christopher C. S128
Guo, Chunhua S302
Guo, Henry S383
Guo, Meng-Hua S356

Gupta, Goutam S170
Guiterrez, Carla S306
Guiterrez, Osman A. S328
Guiterrez-Uribe, Janet A. S286
Gutierrez, Esmeralda J. Cruz S337
Guzman, Ivette S346

H

Habteselassie, Mussie S301
Hains, Bryan S327
Hall, Caitlyn S199
Hall, Charles R. S173, S177, S225
Hall, Clifford A. S186
Hall, David S175
Hamilton, Wendy V. S314
Han, Chung-Su S379
Han, NaRae S260
Han, Seung Hyun S305
Hancock, James F. S117, S267, S362
Handa, Avtar K. S373
Handley, David S331
Hanson, Bradley D. S192
Hao, Guixia S170
Hao, Xiuming S240, S316
Haralson, Jeremy S350
Hardwick, Larry S343
Harkess, Richard L. S181, S183, S286
Harris, Bethany S300, S301
Hartmann, Timothy P. S148
Hart, Sam S333
Hartz, Timothy K. S120
Haseeb, Muhammad S127, S355
Haselhuhn, Laura S319
Hashem, Fawzy M. S126, S279, S289, S290, S355, S385
Hasing, Tomas S116
Hatterman-Valenti, Harlene S311, S368
Haubrich, Kyle S231
Hawkins, Susan M. S146
Hayes, Ryan J. S152
Haynes, Cynthia S162, S207, S319, S404

He, Chenyi S275
He, Dongxian S212
Hearn, Jack S175
Heath, Hilary Omega S216
Heiniger, Ronnie S128
Hellier, Barbara S242
Hellier, Barbara C. S154
Helsel, Zane S386
Henne, Don S360
Henrichs, Heidi M. S159
Henry, Mary E. S162, S314
Hensley, David S244, S348
Henson, Yvette S395
Hernandez, Gabriela S309
Hernández, Ricardo S238, S289
Hernández-Fuentes, Luis Martín S248
Herrnstadt, Zachary B. S159
Hertog, Maarten S189
Hirst, Peter M. S157, S158, S401
Hlubik, William S115, S284, S386
Hoagland, Lori S391
Hodgson-Kratky, Katrina S335
Hodkinson, Trevor R. S199
Hokanson, Stan C. S339, S382
Holland, Renee S161
Holloway, Patricia S. S390
Hong, Chuan S195
Hong, Jee-Hwa S168, S219
Hong, Yun Yeong S357
Honig, Josh S125, S134, S168
Hoogenboom, Gerrit S402
Horton, Anna S214
Hoskins, Tyler C. S227
Hossain, Macseleya S261
Hought, Joy S322
Howard, Philip H. S159
Hoying, Stephen A. S158
Hu, Jared S313
Hu, Bizhen S124
Hu, Cuiying S261
Hu, Jinguo S243
<table>
<thead>
<tr>
<th>Name</th>
<th>Page Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hu, Xijun</td>
<td>S233</td>
</tr>
<tr>
<td>Huang, Danqiong</td>
<td>S139, S171</td>
</tr>
<tr>
<td>Huang, Junxin</td>
<td>S398</td>
</tr>
<tr>
<td>Hubbard, Calvin</td>
<td>S247</td>
</tr>
<tr>
<td>Huber, Donald J.</td>
<td>S262, S306, S308</td>
</tr>
<tr>
<td>Hughes, Harrison</td>
<td>S206, S292</td>
</tr>
<tr>
<td>Hui, Dafeng</td>
<td>S256, S372</td>
</tr>
<tr>
<td>Hurr, Brandon M.</td>
<td>S306</td>
</tr>
<tr>
<td>Hutchinson, Mark</td>
<td>S330, S331</td>
</tr>
<tr>
<td>Hutton, Mark</td>
<td>S242, S330, S331, S349</td>
</tr>
<tr>
<td>Hutton, Samuel F.</td>
<td>S350</td>
</tr>
<tr>
<td>Hwang, Eom-Ji</td>
<td>S348, S367</td>
</tr>
<tr>
<td>I</td>
<td></td>
</tr>
<tr>
<td>Ibanez, Facundo</td>
<td>S235</td>
</tr>
<tr>
<td>Ibrahim, Ragy</td>
<td>S347</td>
</tr>
<tr>
<td>Ibrahim, Amir</td>
<td>S120</td>
</tr>
<tr>
<td>Iezzoni, Amy F.</td>
<td>S117, S149, S150, S267, S271, S362</td>
</tr>
<tr>
<td>Inch, Sharon</td>
<td>S176</td>
</tr>
<tr>
<td>Infante-Casella, Michelle L.</td>
<td>S284</td>
</tr>
<tr>
<td>Inglis, Debra A.</td>
<td>S195</td>
</tr>
<tr>
<td>Ingram, Dewayne L.</td>
<td>S173, S251</td>
</tr>
<tr>
<td>Irish, Brian</td>
<td>S153, S249</td>
</tr>
<tr>
<td>Islam, Shahidul</td>
<td>S236</td>
</tr>
<tr>
<td>Isweiri, Hanan</td>
<td>S294</td>
</tr>
<tr>
<td>Iwasaki, Izumi</td>
<td>S131</td>
</tr>
<tr>
<td>Iwuzo, Stephen</td>
<td>S256</td>
</tr>
<tr>
<td>Iyer-Pascuzzi, Anjali</td>
<td>S156</td>
</tr>
<tr>
<td>Izumi, Hitkami</td>
<td>S131</td>
</tr>
<tr>
<td>J</td>
<td></td>
</tr>
<tr>
<td>Jackson, Brian</td>
<td>S217</td>
</tr>
<tr>
<td>Jahed, Khalil R.</td>
<td>S157</td>
</tr>
<tr>
<td>Jahnke, Nathan</td>
<td>S335</td>
</tr>
<tr>
<td>Jairam, Preyesh</td>
<td>S373</td>
</tr>
<tr>
<td>James, Susan</td>
<td>S211</td>
</tr>
<tr>
<td>James, Terri</td>
<td>S142</td>
</tr>
<tr>
<td>Jamieson, Andrew R.</td>
<td>S266</td>
</tr>
<tr>
<td>Janke, Rhonda</td>
<td>S279, S283, S285</td>
</tr>
<tr>
<td>Jasinski, Jonathan R.</td>
<td>S117, S172, S362</td>
</tr>
<tr>
<td>Javad, M.M.</td>
<td>S236, S237</td>
</tr>
<tr>
<td>Jayachandran, Krish</td>
<td>S333</td>
</tr>
<tr>
<td>Jaykus, Lee-Ann</td>
<td>S131</td>
</tr>
<tr>
<td>Jeannette, Karen</td>
<td>S143</td>
</tr>
<tr>
<td>Jelenko, Gojko</td>
<td>S115</td>
</tr>
<tr>
<td>Jenkins, David</td>
<td>S327</td>
</tr>
<tr>
<td>Jenkins, Paul</td>
<td>S314</td>
</tr>
<tr>
<td>Jennings, Katie</td>
<td>S194, S367</td>
</tr>
<tr>
<td>Jenni, Sylvie</td>
<td>S288</td>
</tr>
<tr>
<td>Jeranyama, Peter</td>
<td>S374</td>
</tr>
<tr>
<td>Jett, Lewis</td>
<td>S366</td>
</tr>
<tr>
<td>Jian, Dawei</td>
<td>S282</td>
</tr>
<tr>
<td>Jiang, Cai-Zhong</td>
<td>S138</td>
</tr>
<tr>
<td>Jiang, Haibo</td>
<td>S257</td>
</tr>
<tr>
<td>Jiang, Ling</td>
<td>S345</td>
</tr>
<tr>
<td>Jiang, Nan</td>
<td>S270</td>
</tr>
<tr>
<td>Jiang, Peng</td>
<td>S317</td>
</tr>
<tr>
<td>Jifon, John L.</td>
<td>S350</td>
</tr>
<tr>
<td>Jima, Tigist</td>
<td>S256</td>
</tr>
<tr>
<td>Jimenez, Francisco</td>
<td>S397</td>
</tr>
<tr>
<td>Jin, Xiaoling</td>
<td>S147, S233, S281</td>
</tr>
<tr>
<td>Jin, Yong Wook</td>
<td>S121</td>
</tr>
<tr>
<td>Jo, Gyeong-suk</td>
<td>S359, S360</td>
</tr>
<tr>
<td>Johnson, Charles E.</td>
<td>S332, S351, S365</td>
</tr>
<tr>
<td>Johnson, Denise</td>
<td>S143</td>
</tr>
<tr>
<td>Johnson, Donn T.</td>
<td>S277, S352</td>
</tr>
<tr>
<td>Johnson, Gordon C.</td>
<td>S128</td>
</tr>
<tr>
<td>Johnson, Kenneth B.</td>
<td>S150</td>
</tr>
<tr>
<td>Johnson, Lisa K.</td>
<td>S157</td>
</tr>
<tr>
<td>Johnson, Shomari A.</td>
<td>S377</td>
</tr>
<tr>
<td>Johnson, Timothy S.</td>
<td>S196</td>
</tr>
<tr>
<td>Johnston, Jason</td>
<td>S189</td>
</tr>
<tr>
<td>Johnston, Trevor</td>
<td>S372</td>
</tr>
<tr>
<td>Jones, A. Maxwell</td>
<td>S380</td>
</tr>
<tr>
<td>Jones, Jeffrey B.</td>
<td>S350</td>
</tr>
<tr>
<td>Jones, Michelle L.</td>
<td>S138, S363</td>
</tr>
<tr>
<td>Joyce, Daryl C.</td>
<td>S205</td>
</tr>
<tr>
<td>Jumperon, Ari</td>
<td>S288</td>
</tr>
<tr>
<td>Jung, Hee-Jeong</td>
<td>S364</td>
</tr>
<tr>
<td>Juvik, John A.</td>
<td>S132, S299, S336, S369, S370</td>
</tr>
</tbody>
</table>

K

<table>
<thead>
<tr>
<th>Name</th>
<th>Page Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kacira, Murat</td>
<td>S199</td>
</tr>
<tr>
<td>Kahn, Brian A.</td>
<td>S287</td>
</tr>
<tr>
<td>Kaiser, Ceri</td>
<td>S141, S159</td>
</tr>
<tr>
<td>Kaminski, Chelsea</td>
<td>S188</td>
</tr>
<tr>
<td>Kandel, Ramkrishna</td>
<td>S298</td>
</tr>
<tr>
<td>Kang, Jin Ho</td>
<td>S139</td>
</tr>
<tr>
<td>Kang, Jong Goo</td>
<td>S230, S371</td>
</tr>
<tr>
<td>Kang, Tea-Hwan</td>
<td>S379</td>
</tr>
<tr>
<td>Kanazaki, Shinny</td>
<td>S297</td>
</tr>
<tr>
<td>Kaps, Martin L.</td>
<td>S310, S403</td>
</tr>
<tr>
<td>Kardos, Josh</td>
<td>S147</td>
</tr>
<tr>
<td>Karlsson, Meriam</td>
<td>S287</td>
</tr>
<tr>
<td>Kawabata, Andrew F.</td>
<td>S304</td>
</tr>
<tr>
<td>Kawamura, Ken</td>
<td>S220</td>
</tr>
<tr>
<td>Keele, Lisa</td>
<td>S327</td>
</tr>
<tr>
<td>Keller, Markus</td>
<td>S402</td>
</tr>
<tr>
<td>Kelley, Karen</td>
<td>S308</td>
</tr>
<tr>
<td>Kelly, James D.</td>
<td>S293</td>
</tr>
<tr>
<td>Kelly, Lelia Scott</td>
<td>S142</td>
</tr>
<tr>
<td>Kemble, Joseph M.</td>
<td>S309, S328</td>
</tr>
<tr>
<td>Kempler, Chaim</td>
<td>S299</td>
</tr>
<tr>
<td>Kennedy, James A.</td>
<td>S212</td>
</tr>
<tr>
<td>Kennelly, Megan</td>
<td>S288, S395</td>
</tr>
<tr>
<td>Ker, Kevin</td>
<td>S314</td>
</tr>
<tr>
<td>Kerman, Arizt</td>
<td>S158</td>
</tr>
<tr>
<td>Kerr, Susan</td>
<td>S164</td>
</tr>
<tr>
<td>Kessler, Raymond</td>
<td>S282, S309</td>
</tr>
<tr>
<td>Khachatrian, Hayk</td>
<td>S177</td>
</tr>
<tr>
<td>Khan, Ikhas A.</td>
<td>S358</td>
</tr>
<tr>
<td>Khan, Muhammad Mumtaz</td>
<td>S237</td>
</tr>
<tr>
<td>Khoddamzadeh, Amir Ali</td>
<td>S357</td>
</tr>
<tr>
<td>Khosla, Shalin</td>
<td>S240</td>
</tr>
<tr>
<td>Kim, Cheol-Woo</td>
<td>S347, S367</td>
</tr>
<tr>
<td>Kim, Daell</td>
<td>S116</td>
</tr>
<tr>
<td>Kim, Doo-Hwan</td>
<td>S219</td>
</tr>
<tr>
<td>Kim, Hye-Ji</td>
<td>S231</td>
</tr>
<tr>
<td>Kim, Jin Heung</td>
<td>S121</td>
</tr>
<tr>
<td>Kim, Jongkee</td>
<td>S260</td>
</tr>
<tr>
<td>Name</td>
<td>Page Numbers</td>
</tr>
<tr>
<td>-----------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Kim, Ki Sun</td>
<td>S357</td>
</tr>
<tr>
<td>Kim, Lorraine De Jesus</td>
<td>S327</td>
</tr>
<tr>
<td>Kim, Min Hee</td>
<td>S180</td>
</tr>
<tr>
<td>Kim, Soo-Hyung</td>
<td>S238</td>
</tr>
<tr>
<td>Kim, Wan Soon</td>
<td>S315</td>
</tr>
<tr>
<td>Kim, Won Bae</td>
<td>S121, S154</td>
</tr>
<tr>
<td>King, Andrew R</td>
<td>S225</td>
</tr>
<tr>
<td>King, Dennis</td>
<td>S173, S313</td>
</tr>
<tr>
<td>King, Stephen R</td>
<td>S208</td>
</tr>
<tr>
<td>Kirkbride, Joseph H</td>
<td>S219</td>
</tr>
<tr>
<td>Kirst, Mattias</td>
<td>S168</td>
</tr>
<tr>
<td>Kirwan, Barrett</td>
<td>S354</td>
</tr>
<tr>
<td>Kisha, Theodore J</td>
<td>S154</td>
</tr>
<tr>
<td>Kitada, Kosuke</td>
<td>S131</td>
</tr>
<tr>
<td>Kjelgren, Roger</td>
<td>S265</td>
</tr>
<tr>
<td>Klassen, Trudy Naugler</td>
<td>S303</td>
</tr>
<tr>
<td>Kleinhnenz, Matthew D</td>
<td>S124</td>
</tr>
<tr>
<td>Klett, James E.</td>
<td>S179, S220, S221, S222, S302</td>
</tr>
<tr>
<td>Kline, Wesley L</td>
<td>S343</td>
</tr>
<tr>
<td>Knauf, David</td>
<td>S381</td>
</tr>
<tr>
<td>Knepper, Caleb</td>
<td>S295</td>
</tr>
<tr>
<td>Knerr, Anne J.</td>
<td>S253</td>
</tr>
<tr>
<td>Knobloch, Neil</td>
<td>S327</td>
</tr>
<tr>
<td>Knox, Gary W.</td>
<td>S302</td>
</tr>
<tr>
<td>Kobayashi, Hideka</td>
<td>S359</td>
</tr>
<tr>
<td>Kobayashi, Kent D.</td>
<td>S325, S384</td>
</tr>
<tr>
<td>Koch, Carol</td>
<td>S299</td>
</tr>
<tr>
<td>Kohanbash, David</td>
<td>S123, S136, S137, S131</td>
</tr>
<tr>
<td>Komar, Stephen J.</td>
<td>S284</td>
</tr>
<tr>
<td>Kong, Ping</td>
<td>S195</td>
</tr>
<tr>
<td>Kopsell, Dean A.</td>
<td>S290, S295, S296, S330, S349</td>
</tr>
<tr>
<td>Kornegay, Julia</td>
<td>S317</td>
</tr>
<tr>
<td>Koroch, Adolfina</td>
<td>S245</td>
</tr>
<tr>
<td>Koryzma-Zepp, Jaecy</td>
<td>S291</td>
</tr>
<tr>
<td>Kotski, Anthony J.</td>
<td>S179, S220, S222, S341</td>
</tr>
<tr>
<td>Kovaleski, Alisson Pacheco</td>
<td>S228</td>
</tr>
<tr>
<td>Kratsch, Heidi</td>
<td>S231, S354</td>
</tr>
<tr>
<td>Kreeft, Harry</td>
<td>S130</td>
</tr>
<tr>
<td>Kressin, Jonathan P.</td>
<td>S153</td>
</tr>
<tr>
<td>Kring, Alexander</td>
<td>S387</td>
</tr>
<tr>
<td>Krishnamurthy, Aparna</td>
<td>S235, S236</td>
</tr>
<tr>
<td>Krishnan, Sarada</td>
<td>S220</td>
</tr>
<tr>
<td>Kroogel, Mark A.</td>
<td>S378</td>
</tr>
<tr>
<td>Krueger, William H.</td>
<td>S397</td>
</tr>
<tr>
<td>Kruse, Raymond</td>
<td>S119</td>
</tr>
<tr>
<td>Ku, Kang Mo</td>
<td>S132, S336, S369, S370</td>
</tr>
<tr>
<td>Kubota, Chieri</td>
<td>S199, S238, S289, S321, S332, S378</td>
</tr>
<tr>
<td>Kuehn, Jeff</td>
<td>S227</td>
</tr>
<tr>
<td>Kuhn, David</td>
<td>S169, S328</td>
</tr>
<tr>
<td>Kumar, Lala</td>
<td>S321</td>
</tr>
<tr>
<td>Kunta, Madhurababu</td>
<td>S360</td>
</tr>
<tr>
<td>Kurfurl, S. Kaan</td>
<td>S211, S212, S229, S230</td>
</tr>
<tr>
<td>Kushad, Mosbah M.</td>
<td>S369</td>
</tr>
<tr>
<td>Kwon, Yong-Sham</td>
<td>S168, S219</td>
</tr>
<tr>
<td>Kwon, Young-Seok</td>
<td>S348, S367</td>
</tr>
<tr>
<td>Labate, Joanne A.</td>
<td>S151, S152</td>
</tr>
<tr>
<td>LaComb, Caitlin</td>
<td>S126</td>
</tr>
<tr>
<td>Lambe, David</td>
<td>S352</td>
</tr>
<tr>
<td>Lane, Robert</td>
<td>S342</td>
</tr>
<tr>
<td>Langello, Gail</td>
<td>S142</td>
</tr>
<tr>
<td>Langlois, Scott</td>
<td>S250</td>
</tr>
<tr>
<td>Lass, Daniel</td>
<td>S252, S301</td>
</tr>
<tr>
<td>Lea, Jeane M.</td>
<td>S141</td>
</tr>
<tr>
<td>Lea-Cox, John D.</td>
<td>S123, S136, S137, S226, S313</td>
</tr>
<tr>
<td>Leckel, Robert</td>
<td>S369</td>
</tr>
<tr>
<td>Leclair, Clotilde</td>
<td>S344</td>
</tr>
<tr>
<td>Lecompte, Judson</td>
<td>S286</td>
</tr>
<tr>
<td>Ledesma, Noris</td>
<td>S135</td>
</tr>
<tr>
<td>Ledo, Ana S.</td>
<td>S335, S338</td>
</tr>
<tr>
<td>Lee, Chiwon W.</td>
<td>S186, S201, S257, S303</td>
</tr>
<tr>
<td>Lee, Eul-Tai</td>
<td>S348, S367</td>
</tr>
<tr>
<td>Lee, Eun Jin</td>
<td>S305</td>
</tr>
<tr>
<td>Lee, Geung-Joo</td>
<td>S361</td>
</tr>
<tr>
<td>Lee, Han Jun</td>
<td>S305</td>
</tr>
<tr>
<td>Lee, Hee Jae</td>
<td>S223</td>
</tr>
<tr>
<td>Lee, Hei Soo</td>
<td>S257</td>
</tr>
<tr>
<td>Lee, Hyo Beom</td>
<td>S357</td>
</tr>
<tr>
<td>Lee, Jae sin</td>
<td>S359</td>
</tr>
<tr>
<td>Lee, James H.</td>
<td>S262, S309</td>
</tr>
<tr>
<td>Lee, Jin Su</td>
<td>S306</td>
</tr>
<tr>
<td>Lee, Jin-Hui</td>
<td>S379</td>
</tr>
<tr>
<td>Lee, Jinwook</td>
<td>S188, S189</td>
</tr>
<tr>
<td>Lee, Jungmin</td>
<td>S233, S298</td>
</tr>
<tr>
<td>Lee, Ka Yeon</td>
<td>S361</td>
</tr>
<tr>
<td>Lee, Luke O.</td>
<td>S290, S385</td>
</tr>
<tr>
<td>Lee, Myung-jin</td>
<td>S274</td>
</tr>
<tr>
<td>Lee, Seul Ki</td>
<td>S315</td>
</tr>
<tr>
<td>Lee, So-Ra</td>
<td>S379</td>
</tr>
<tr>
<td>Lefstrud, Mark</td>
<td>S201, S211, S241</td>
</tr>
<tr>
<td>Leigh, Deanna</td>
<td>S159</td>
</tr>
<tr>
<td>Leisso, Rachel</td>
<td>S189</td>
</tr>
<tr>
<td>Lenhardt, Matt</td>
<td>S220, S221, S222</td>
</tr>
<tr>
<td>Leonhardt, Kenneth</td>
<td>S180, S356</td>
</tr>
<tr>
<td>Leonhardt, Ken W.</td>
<td>S145, S169, S220</td>
</tr>
<tr>
<td>Leskovar, Daniel I.</td>
<td>S120, S350</td>
</tr>
<tr>
<td>Leva, Annarita</td>
<td>S283</td>
</tr>
<tr>
<td>Levine, Howard G.</td>
<td>S200</td>
</tr>
<tr>
<td>Levy, Sarah E.</td>
<td>S336</td>
</tr>
<tr>
<td>Lewis, Claire E.</td>
<td>S163</td>
</tr>
<tr>
<td>Li, He</td>
<td>S281</td>
</tr>
<tr>
<td>Li, Jian</td>
<td>S350</td>
</tr>
<tr>
<td>Li, Shasha</td>
<td>S392</td>
</tr>
<tr>
<td>Li, Shouxin</td>
<td>S403</td>
</tr>
<tr>
<td>Li, T.</td>
<td>S117, S362</td>
</tr>
<tr>
<td>Li, Tongyin</td>
<td>S181</td>
</tr>
<tr>
<td>Li, Wenyue</td>
<td>S199</td>
</tr>
<tr>
<td>Li, XinXin</td>
<td>S231, S315, S356</td>
</tr>
<tr>
<td>Li, Yingzi</td>
<td>S177</td>
</tr>
<tr>
<td>Li, Yongxin</td>
<td>S296</td>
</tr>
<tr>
<td>Li, Yuncong</td>
<td>S129</td>
</tr>
<tr>
<td>Li, Zhihui</td>
<td>S147, S255, S281</td>
</tr>
<tr>
<td>Li, Zhijian T.</td>
<td>S172</td>
</tr>
<tr>
<td>Liang, Chih-Chao</td>
<td>S357</td>
</tr>
</tbody>
</table>
Index of Authors and Moderators (Poster and Oral Presentations)

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liang, Shuyin</td>
<td>S381, S382</td>
</tr>
<tr>
<td>Liang, Yinghai</td>
<td>S171</td>
</tr>
<tr>
<td>Libran, Maria del Carmen</td>
<td>S344, S401</td>
</tr>
<tr>
<td>Liburd, Oscar E.</td>
<td>S392</td>
</tr>
<tr>
<td>Lichtenberg, Erik</td>
<td>S173, S313</td>
</tr>
<tr>
<td>Lichte, Joanne</td>
<td>S388</td>
</tr>
<tr>
<td>Lila, Mary A.</td>
<td>S346</td>
</tr>
<tr>
<td>Lim, Sooyeon</td>
<td>S305</td>
</tr>
<tr>
<td>Lindell, Catherine</td>
<td>S159</td>
</tr>
<tr>
<td>Lindstrom, Thor</td>
<td>S406</td>
</tr>
<tr>
<td>Lineberger, R. Daniel</td>
<td>S217</td>
</tr>
<tr>
<td>Lingenfelser, David</td>
<td>S145</td>
</tr>
<tr>
<td>Ling, Peng</td>
<td>S272</td>
</tr>
<tr>
<td>Ling, Peter P.</td>
<td>S124</td>
</tr>
<tr>
<td>Linz, George M.</td>
<td>S159</td>
</tr>
<tr>
<td>Little, Celeste</td>
<td>S240, S316</td>
</tr>
<tr>
<td>Litvin, Alexander G.</td>
<td>S213</td>
</tr>
<tr>
<td>Liu, Fandan</td>
<td>S345</td>
</tr>
<tr>
<td>Liu, Guodong</td>
<td>S155</td>
</tr>
<tr>
<td>Liu, Jiangang</td>
<td>S130</td>
</tr>
<tr>
<td>Liu, Liu</td>
<td>S345</td>
</tr>
<tr>
<td>Liu, Nian</td>
<td>S302</td>
</tr>
<tr>
<td>Liu, Wei</td>
<td>S302</td>
</tr>
<tr>
<td>Lloyd, Steven W.</td>
<td>S141</td>
</tr>
<tr>
<td>Lobo, Ramiro</td>
<td>S397</td>
</tr>
<tr>
<td>Lobos, Gustavo</td>
<td>S189</td>
</tr>
<tr>
<td>Locke, James C.</td>
<td>S257</td>
</tr>
<tr>
<td>Lockwood, David W.</td>
<td>S145</td>
</tr>
<tr>
<td>Loehrlein, Marietta</td>
<td>S316</td>
</tr>
<tr>
<td>Loesch, Wayne H.</td>
<td>S293</td>
</tr>
<tr>
<td>Lollar, Matthew C.</td>
<td>S207</td>
</tr>
<tr>
<td>Lombardini, Leonardo</td>
<td>S235</td>
</tr>
<tr>
<td>Lombard, Kevin</td>
<td>S318</td>
</tr>
<tr>
<td>Long, Hong-xu</td>
<td>S270</td>
</tr>
<tr>
<td>Long, Rebecca J.</td>
<td>S119, S320</td>
</tr>
<tr>
<td>Longstroth, Mark A.</td>
<td>S159</td>
</tr>
<tr>
<td>López-Escudero, Francisco J.</td>
<td>S151, S364</td>
</tr>
<tr>
<td>López-Manzanarez, Jose Luis</td>
<td>S373</td>
</tr>
<tr>
<td>Loseke, Benjamin A.</td>
<td>S311</td>
</tr>
<tr>
<td>Lott, Cecilia</td>
<td>S360</td>
</tr>
<tr>
<td>Louws, Frank J.</td>
<td>S153, S244, S367</td>
</tr>
<tr>
<td>Louzada, Eliezer</td>
<td>S360</td>
</tr>
<tr>
<td>Lowe, Jeremiah</td>
<td>S312, S396, S398, S399</td>
</tr>
<tr>
<td>Lowery, Heather D.</td>
<td>S290</td>
</tr>
<tr>
<td>Lu, Huangjuei</td>
<td>S298</td>
</tr>
<tr>
<td>Luby, James</td>
<td>S177</td>
</tr>
<tr>
<td>Luke, Freeman</td>
<td>S276, S353</td>
</tr>
<tr>
<td>Luo, Feng</td>
<td>S175</td>
</tr>
<tr>
<td>Luo, Yaguang</td>
<td>S375</td>
</tr>
<tr>
<td>Luo, Zhengrong</td>
<td>S297</td>
</tr>
<tr>
<td>Lusch, David P.</td>
<td>S159</td>
</tr>
<tr>
<td>M</td>
<td></td>
</tr>
<tr>
<td>Ma, Guoying</td>
<td>S248, S405</td>
</tr>
<tr>
<td>Ma, Jianbing</td>
<td>S244, S294, S348, S349</td>
</tr>
<tr>
<td>MacDonald, Joanne E.</td>
<td>S253</td>
</tr>
<tr>
<td>Machado, Caroline A.</td>
<td>S338</td>
</tr>
<tr>
<td>Mackowiak, Cheryl L.</td>
<td>S278</td>
</tr>
<tr>
<td>Madbouly, Samy</td>
<td>S231</td>
</tr>
<tr>
<td>Maher, Lynn</td>
<td>S347</td>
</tr>
<tr>
<td>Mahmoud, Barakat S.M.</td>
<td>S342</td>
</tr>
<tr>
<td>Mahoney, Jonathan D.</td>
<td>S334</td>
</tr>
<tr>
<td>Mahoney, Lise L.</td>
<td>S266</td>
</tr>
<tr>
<td>Main, Jeffrey L.</td>
<td>S294, S385</td>
</tr>
<tr>
<td>Majsztiri, John</td>
<td>S172, S173, S313</td>
</tr>
<tr>
<td>Makani, Mildred N.</td>
<td>S202</td>
</tr>
<tr>
<td>Makus, Donald J.</td>
<td>S264</td>
</tr>
<tr>
<td>Malapi-Wight, Martha</td>
<td>S384</td>
</tr>
<tr>
<td>Malladi, Anish</td>
<td>S157, S213</td>
</tr>
<tr>
<td>Mallory, Ellen</td>
<td>S330</td>
</tr>
<tr>
<td>Mancero-Castillo, Daniel A.</td>
<td>S270</td>
</tr>
<tr>
<td>Mangandi, Jozer</td>
<td>S115</td>
</tr>
<tr>
<td>Manners, Malcolm M.</td>
<td>S304</td>
</tr>
<tr>
<td>Manns, David Christopher</td>
<td>S299</td>
</tr>
<tr>
<td>Mansfield, Anna Katharine</td>
<td>S299</td>
</tr>
<tr>
<td>Manthey, John A.</td>
<td>S344</td>
</tr>
<tr>
<td>Manzanilla-Ramírez, Miguel Ángel</td>
<td>S248</td>
</tr>
<tr>
<td>Maquilan, Mary Ann D.</td>
<td>S400</td>
</tr>
<tr>
<td>Marks, Bradley</td>
<td>S191</td>
</tr>
<tr>
<td>Marois, James J.</td>
<td>S278</td>
</tr>
<tr>
<td>Marquez, Rocio</td>
<td>S327</td>
</tr>
<tr>
<td>Marshall, Kate</td>
<td>S330</td>
</tr>
<tr>
<td>Marsh, Lurline E.</td>
<td>S126, S279, S290, S355</td>
</tr>
<tr>
<td>Martin, Amanda L.</td>
<td>S216</td>
</tr>
<tr>
<td>Martínez-Pérez, Juan Socorro</td>
<td>S280</td>
</tr>
<tr>
<td>Martini, Nicole</td>
<td>S144</td>
</tr>
<tr>
<td>Martin, Robert</td>
<td>S351</td>
</tr>
<tr>
<td>Marutani, Mari</td>
<td>S142</td>
</tr>
<tr>
<td>Masabni, Joseph</td>
<td>S208</td>
</tr>
<tr>
<td>Massa, Gioia D.</td>
<td>S200</td>
</tr>
<tr>
<td>Mathers, Hannah</td>
<td>S194, S354</td>
</tr>
<tr>
<td>Mathews, Deborah M.</td>
<td>S397</td>
</tr>
<tr>
<td>Mathey, Megan M.</td>
<td>S117, S267</td>
</tr>
<tr>
<td>Matsumoto, Toshikazu</td>
<td>S337</td>
</tr>
<tr>
<td>Mattera, Robert</td>
<td>S168</td>
</tr>
<tr>
<td>Mathieis, James</td>
<td>S189</td>
</tr>
<tr>
<td>Matthysse, Ann G.</td>
<td>S182</td>
</tr>
<tr>
<td>Mattia, Matthew R.</td>
<td>S243</td>
</tr>
<tr>
<td>Mattson, Neil</td>
<td>S181, S196, S213, S236, S237</td>
</tr>
<tr>
<td>Maurer, Michael</td>
<td>S196, S315</td>
</tr>
<tr>
<td>Maximova, Siela</td>
<td>S324</td>
</tr>
<tr>
<td>Maynard, Elizabeth T.</td>
<td>S391</td>
</tr>
<tr>
<td>Mazhar, Muhammad S.</td>
<td>S205</td>
</tr>
<tr>
<td>McAfee, Jason</td>
<td>S276</td>
</tr>
<tr>
<td>McAuslane, Heather</td>
<td>S298</td>
</tr>
<tr>
<td>McAvoy, Eugene</td>
<td>S129</td>
</tr>
<tr>
<td>McCabe, Kenneth</td>
<td>S198, S231</td>
</tr>
<tr>
<td>McCarver, Katie</td>
<td>S318</td>
</tr>
<tr>
<td>McCollum, Greg</td>
<td>S177, S204, S344</td>
</tr>
<tr>
<td>McConnell, James</td>
<td>S329, S340</td>
</tr>
<tr>
<td>McCracken, Vicki</td>
<td>S177</td>
</tr>
<tr>
<td>McCurdy, James</td>
<td>S313</td>
</tr>
<tr>
<td>McDaniel, Stuart F.</td>
<td>S219</td>
</tr>
<tr>
<td>McFerson, James R.</td>
<td>S178</td>
</tr>
<tr>
<td>McGovern, Megan</td>
<td>S352</td>
</tr>
<tr>
<td>McKeon-Bennett, Michelle M.P.</td>
<td>S199</td>
</tr>
<tr>
<td>McKinney, Moniece</td>
<td>S377</td>
</tr>
</tbody>
</table>
Index of Authors and Moderators (Poster and Oral Presentations)

<table>
<thead>
<tr>
<th>Author Name</th>
<th>Session Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>McLaughlin, Mike</td>
<td>S146</td>
</tr>
<tr>
<td>McNamara, Steve</td>
<td>S339, S382</td>
</tr>
<tr>
<td>McWhirt, Amanda</td>
<td>S353</td>
</tr>
<tr>
<td>Meador, Jonathan</td>
<td>S404</td>
</tr>
<tr>
<td>Mecham, Brent</td>
<td>S265</td>
</tr>
<tr>
<td>Meland, Mejkell</td>
<td>S314</td>
</tr>
<tr>
<td>Melendez, Meredith</td>
<td>S343</td>
</tr>
<tr>
<td>Mello, Simone</td>
<td>S304</td>
</tr>
<tr>
<td>Meng, Qingwu</td>
<td>S197, S388</td>
</tr>
<tr>
<td>Mercado-Silva, Edmundo</td>
<td>S260, S261, S373</td>
</tr>
<tr>
<td>Merhaut, Donald J.</td>
<td>S324</td>
</tr>
<tr>
<td>Merkle, Scott A.</td>
<td>S360</td>
</tr>
<tr>
<td>Meyer, George</td>
<td>S352</td>
</tr>
<tr>
<td>Meyer, Lani</td>
<td>S262, S288, S394</td>
</tr>
<tr>
<td>Meyer, Mary Hockenberry</td>
<td>S302, S326</td>
</tr>
<tr>
<td>Meyer, Paul</td>
<td>S199</td>
</tr>
<tr>
<td>Meyers, Stephen</td>
<td>S194</td>
</tr>
<tr>
<td>Mbengeh-Ezeri,</td>
<td></td>
</tr>
<tr>
<td>Josephine Udodirim</td>
<td>S150</td>
</tr>
<tr>
<td>Michaud, Dominique</td>
<td>S310</td>
</tr>
<tr>
<td>Michel-Rosales, Arnoldo</td>
<td>S323</td>
</tr>
<tr>
<td>Mickelbart, Michael V</td>
<td>S205</td>
</tr>
<tr>
<td>Mickelbart, Mike</td>
<td>S373</td>
</tr>
<tr>
<td>Mikkelsen, Robert</td>
<td>S165</td>
</tr>
<tr>
<td>Miles, Carol A.</td>
<td>S164, S195, S242, S275, S318, S320, S402</td>
</tr>
<tr>
<td>Miles, John A.</td>
<td>S397</td>
</tr>
<tr>
<td>Miller, Camera</td>
<td>S372</td>
</tr>
<tr>
<td>Miller, Chad T.</td>
<td>S198, S206, S388</td>
</tr>
<tr>
<td>Miller, Erica</td>
<td>S190</td>
</tr>
<tr>
<td>Million, Jeff</td>
<td>S252</td>
</tr>
<tr>
<td>Mills, Elizabeth</td>
<td>S253</td>
</tr>
<tr>
<td>Mills, Lynn</td>
<td>S402</td>
</tr>
<tr>
<td>Mills, Sarah A.</td>
<td>S259</td>
</tr>
<tr>
<td>Minami, Keigo</td>
<td>S304</td>
</tr>
<tr>
<td>Miranda-Sazo, Mario</td>
<td>S158</td>
</tr>
<tr>
<td>Mitchell, Cary A.</td>
<td>S133, S238, S273</td>
</tr>
<tr>
<td>Mitchell, Karen A.</td>
<td>S156</td>
</tr>
<tr>
<td>Mix, Ken</td>
<td>S303</td>
</tr>
<tr>
<td>Mockler, Todd</td>
<td>S233</td>
</tr>
<tr>
<td>Moeller, Emily L.</td>
<td>S380</td>
</tr>
<tr>
<td>Moeller, Emily L.</td>
<td></td>
</tr>
<tr>
<td>Molina-Corral, Javier</td>
<td>S306, S307</td>
</tr>
<tr>
<td>Molina-Ochoa, Jaime</td>
<td>S248, S280, S323, S394, S396</td>
</tr>
<tr>
<td>Molnar, Thomas J.</td>
<td>S125, S134, S168</td>
</tr>
<tr>
<td>Monagh, Paul F.</td>
<td>S137, S163</td>
</tr>
<tr>
<td>Monks, David W.</td>
<td>S367</td>
</tr>
<tr>
<td>Montilla, Carlos</td>
<td>S366</td>
</tr>
<tr>
<td>Montoya, John</td>
<td>S354</td>
</tr>
<tr>
<td>Montri, Adam</td>
<td>S319</td>
</tr>
<tr>
<td>Montri, Dru</td>
<td>S319</td>
</tr>
<tr>
<td>Mookerjee, Sonali</td>
<td>S117</td>
</tr>
<tr>
<td>Moon, Youyoun</td>
<td>S259</td>
</tr>
<tr>
<td>Moore, Aaron</td>
<td>S278</td>
</tr>
<tr>
<td>Moore, Gloria A.</td>
<td>S126</td>
</tr>
<tr>
<td>Moore, Jennifer</td>
<td>S215</td>
</tr>
<tr>
<td>Moore, Kimberly K.</td>
<td>S302</td>
</tr>
<tr>
<td>Morales, Cecilia Espinoza</td>
<td>S206, S327</td>
</tr>
<tr>
<td>Morales-Payn, J. Pablo</td>
<td>S278, S330, S392</td>
</tr>
<tr>
<td>Moran, Renae</td>
<td>S124</td>
</tr>
<tr>
<td>Morey, Kaitlin</td>
<td>S125, S134</td>
</tr>
<tr>
<td>Morgan, Alan</td>
<td>S216</td>
</tr>
<tr>
<td>Morgenstern, Thayara B.</td>
<td>S190</td>
</tr>
<tr>
<td>Morris, Brad</td>
<td>S376</td>
</tr>
<tr>
<td>Morris, Wythe</td>
<td>S349</td>
</tr>
<tr>
<td>Morrow, Robert C.</td>
<td>S200, S330</td>
</tr>
<tr>
<td>Moskowitz, M.</td>
<td>S378</td>
</tr>
<tr>
<td>Motes, Dennis</td>
<td>S244, S245, S294, S348, S349</td>
</tr>
<tr>
<td>Motsenbocker, Carl</td>
<td>S214</td>
</tr>
<tr>
<td>Mou, Beiquan</td>
<td>S244, S245, S294, S295, S348, S349</td>
</tr>
<tr>
<td>Moulton, Gary A.</td>
<td>S271</td>
</tr>
<tr>
<td>Moya, Alejandra</td>
<td>S189</td>
</tr>
<tr>
<td>Moyer, Michelle</td>
<td>S314</td>
</tr>
<tr>
<td>Muehlbauer, Megan</td>
<td>S125, S133, S134</td>
</tr>
<tr>
<td>Mueller, Lukas A.</td>
<td>S152</td>
</tr>
<tr>
<td>Mukherjee, Amrita</td>
<td>S263</td>
</tr>
<tr>
<td>Mullins, C.</td>
<td>S135</td>
</tr>
<tr>
<td>Mullins, Christopher</td>
<td>S187</td>
</tr>
<tr>
<td>Munoz, Patricio</td>
<td>S249</td>
</tr>
<tr>
<td>Murata, Mayara</td>
<td>S234</td>
</tr>
<tr>
<td>Murray, Seth C.</td>
<td>S148</td>
</tr>
<tr>
<td>Mutukwa, Itai</td>
<td>S186</td>
</tr>
<tr>
<td>N</td>
<td></td>
</tr>
<tr>
<td>Naasz, Rémi</td>
<td>S234</td>
</tr>
<tr>
<td>Naj, Ajay</td>
<td>S367</td>
</tr>
<tr>
<td>Nair, Ajay</td>
<td>S118, S119</td>
</tr>
<tr>
<td>Nambuthiri, Susmitha</td>
<td>S251, S265</td>
</tr>
<tr>
<td>Nandwani, Dilip</td>
<td>S279</td>
</tr>
<tr>
<td>Narciso, Jan</td>
<td>S203</td>
</tr>
<tr>
<td>Nardini, Viviani</td>
<td>S190</td>
</tr>
<tr>
<td>Nartea, T.J.</td>
<td>S135</td>
</tr>
<tr>
<td>Nascimento, Paloma A.M.</td>
<td>S305</td>
</tr>
<tr>
<td>Navia, Pablo</td>
<td>S210</td>
</tr>
<tr>
<td>Naznin, Most Tahera</td>
<td>S211, S241</td>
</tr>
<tr>
<td>Ndlovu, Faith</td>
<td>S374</td>
</tr>
<tr>
<td>Neal, Catherine</td>
<td>S251, S252, S301</td>
</tr>
<tr>
<td>Needham, Douglas C.</td>
<td>S326</td>
</tr>
<tr>
<td>Neff, Michael</td>
<td>S326</td>
</tr>
<tr>
<td>Neily, Will</td>
<td>S253, S385</td>
</tr>
<tr>
<td>Nelson, Shad D.</td>
<td>S266</td>
</tr>
<tr>
<td>Newby, Adam F.</td>
<td>S223</td>
</tr>
<tr>
<td>Newman, Debra H.</td>
<td>S180, S370, S389</td>
</tr>
<tr>
<td>Newman, Steven Earl</td>
<td>S135, S181, S370, S389, S395</td>
</tr>
<tr>
<td>Nguyen, Kathy</td>
<td>S222</td>
</tr>
<tr>
<td>Niaura, William S.</td>
<td>S375</td>
</tr>
<tr>
<td>Nichols, Ben</td>
<td>S291</td>
</tr>
<tr>
<td>Nicolaí, Bart</td>
<td>S189</td>
</tr>
<tr>
<td>Nielslen, Anne</td>
<td>S215</td>
</tr>
<tr>
<td>Niemiera, Alexander X.</td>
<td>S227</td>
</tr>
<tr>
<td>Niino, Takao</td>
<td>S337, S339</td>
</tr>
<tr>
<td>Nitzsche, Peter</td>
<td>S115</td>
</tr>
<tr>
<td>Niu, Fanghua</td>
<td>S255</td>
</tr>
<tr>
<td>Niu, Genhua</td>
<td>S212, S237, S387</td>
</tr>
<tr>
<td>Nixon, Katie</td>
<td>S321</td>
</tr>
<tr>
<td>Nock, Jacqueline F.</td>
<td>S202, S203, S259</td>
</tr>
<tr>
<td>Nolte, Kurt D.</td>
<td>S132, S208, S209, S210, S211, S284</td>
</tr>
</tbody>
</table>

HortScience 49(9) Supplement—2014 ASHS Annual Conference
Index of Authors and Moderators (Poster and Oral Presentations)

Norikane, Joey ...........................S235
Norrie, Jeffrey ............................S253
Nou, Ill-Sup. ...............................S364
Nuessly, Gregg ............................S298
Nunez, Gerardo H. .........................S154
Nuske, Stephen T. ..........................S160
Nyirakabibi, Isabelle ........................S166
O
Obae, Samuel G. ............................S247
Obenland, David ............................S190
O’Connor, Alison Stoven ........................S179, S220, S222
Odom, Rachel ...............................S246, S271
Ogutu, Rose ................................. S127, S128, S166
Oh, Chi-Ok ................................. S159
Oh, Myung-Min .............................S274, S379
Okie, William R. ............................S148
Olczyk, Teresa ...............................S129
Oleksyk, Taras ...............................S249
Olivas, Guadalupe Isela ..........................S306, S307
Oliveira, Sueyde .............................S304
Olivera-Olvera, Virgilio ............................S392
Olmstead, James W. ..........................S154, S191, S249, S405
Olmstead, Mercy A. ..........................S229, S400
Olsen, Richard T. ............................S219, S383, S384
Olson, Britanny Korynta ..........................S311
Olson, Stephen M. ............................S278
Olszewski, M. ...............................S378
Omar, Ahmad A. .............................S234
Ong, K. ............................... S147
Oraguzie, Nnadozie ..........................S149, S150
Orbovic, Vladimir .............................S246, S247
Ortiz-López, Jesús Alberto ........................S248
Orvis, Kathryn S. ............................S206, S326
Oseto, Chris ................................. S207
Osorio, Dagoberto ............................S303
Osorio, Luis F. ...............................S116
Osuna-Garcia, Jorge A. ..........................S262
Ouellette, David R. ...........................S401
Owen, James S. ...............................S122, S227
Owen, W. Garrett .............................S200, S240
Owings, Allen ............................... S216
Oxley, Kimberly ..............................S394, S395
Özkan, Burhan ............................... S185
Ozones-Hampton, Monica ............................S129, S209
O’Meara, Carol ...............................S283
P
Pablo-Osorio, Gerardo ..........................S356
Padilla-Díaz, Ana Belem ..........................S394
Page, Natalie ............................... S188
Palma, Marco ............................... S120, S225
Palmer, C.L. ................................. S340
Pannukkuk, Tim ............................... S342
Pant, Archana ............................... S255
Panthee, Dilip ............................... S153, S244, S347, S387
Paparozzi, Ellen T. ...........................S352
Papineau, Amy ............................... S251, S252, S301
Paranhos, Lucas ..............................S193
Park, Jong-In ............................... S364
Park, Suejin ................................. S259
Park, Won-Heum ..............................S219
Park, Yu Jin ................................. S357
Parke, Jennifer L. ............................S121
Parker, D. ................................. S378
Parker, Mike .................................S376
Pasa, Mateus Da Silveira ..........................S158
Pasqual, Moacir ..............................S324
Pastrana, Dulce Rivera ..........................S260
Patel, Ashvi ................................. S334
Patterson, Paul M. ............................S216
Pattison, Jeremy A. ..........................S405
Paull, Robert E. ..............................S246
Payton, Adam C. ..............................S219
Peace, Cameron ..............................S117, S149, S150, S267, S268, S269, S362
Pearson, Brian J. .............................S205, S207, S290, S369
Peck, Gregory Michael ..........................S399, S402
Peeples, Michael .............................S246
Pekarek, Ryan ............................... S352
Pemberton, H. Brent ...........................S225, S340
Peng, Shuang ............................... S345
Pennisisi, Svoboda V. ..........................S300, S301
Peres, Natalia A. ..............................S115
Perez-Sanchez, Grisselle ..........................S344
Perkins-Veazie, Penelope ............................S131, S248, S329, S344, S347, S376, S405
Perrotte, Justine ..............................S117
Peterson, Bryan J. ............................S151
Peterson, Mary ............................... S298
Petriavich, Alan D. ............................S196, S197
Pettus, Hanna J. ..............................S223
Phillips, Nathan C. ............................S125, S334
Phillips, Bobby ............................... S127, S355
Pieper, Jeff ................................. S119
Pietila, Melissa K. ............................S390
Pinto, Jose Maria ..............................S130
Pio, Rafael ................................. S258, S324
Pisani, Cristina ...............................S327
Pitchay, Dharma ..............................S165
Pitchay, Dharmalingam ..........................S143
Pittenger, Dennis R. ...........................S265
Pitts, James A. ............................... S225, S405
Platten, Mark ............................... S396
Pliakoni, Eleni D. .............................S262, S285, S288
Ploetz, Randy C. ..............................S328
Plotto, Anne ................................. S174, S203, S247, S328, S344
Poling, Barclay ............................... S192, S351
Pommer, Kirk William ..........................S312, S359, S396, S398, S399
Pooler, Margaret .............................S383, S384
Poor, Henry W. ...............................S135
Popenoe, Juanita ..............................S207, S355
Poplawski, Laura E. ...........................S125
Popp, Jennie H. ...............................S276, S353
Porter, Kadijah ...............................S372
Possinger, Angela R. ...........................S320
Potluri, Devi Prasad V. ..........................S334
Poudel, Ravin ...............................S288
Pounders, Cecil ............................... S300
Index of Authors and Moderators (Poster and Oral Presentations)

<table>
<thead>
<tr>
<th>Authors</th>
<th>Page Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preece, John E</td>
<td>S218, S322, S324</td>
</tr>
<tr>
<td>Price, Elizabeth</td>
<td>S173</td>
</tr>
<tr>
<td>Proano, Carla</td>
<td>S227</td>
</tr>
<tr>
<td>Pryor, Debra</td>
<td>S395</td>
</tr>
<tr>
<td>Pyne, Robert</td>
<td>S245</td>
</tr>
<tr>
<td>Qian, Yaling</td>
<td>S294</td>
</tr>
<tr>
<td>Qiao, Zhongquan</td>
<td>S296</td>
</tr>
<tr>
<td>Qin, Ruijun</td>
<td>S192</td>
</tr>
<tr>
<td>Qu, Luping</td>
<td>S377</td>
</tr>
<tr>
<td>Rabin, Jack</td>
<td>S284</td>
</tr>
<tr>
<td>Radillo-Juárez, Francisco</td>
<td>S280, S323, S394, S396</td>
</tr>
<tr>
<td>Radunich, Mira</td>
<td>S400</td>
</tr>
<tr>
<td>Rafie, Reza</td>
<td>S135, S187</td>
</tr>
<tr>
<td>Rafique, Tariq</td>
<td>S337</td>
</tr>
<tr>
<td>Raghothama, Arvind</td>
<td>S373</td>
</tr>
<tr>
<td>Rahim, Ibl-Raqib</td>
<td>S187</td>
</tr>
<tr>
<td>Rainey, Ronald L</td>
<td>S353</td>
</tr>
<tr>
<td>Rai thore, Smita</td>
<td>S344</td>
</tr>
<tr>
<td>Rallo, Luis</td>
<td>S151</td>
</tr>
<tr>
<td>Ramírez-Sánchez, Maricruz</td>
<td>S308</td>
</tr>
<tr>
<td>Ramos, Humberto</td>
<td>S261</td>
</tr>
<tr>
<td>Ramos, Semiramis R.R.</td>
<td>S338</td>
</tr>
<tr>
<td>Ramsey, Craig</td>
<td>S135, S181, S370, S389</td>
</tr>
<tr>
<td>Rana, Jatinder</td>
<td>S359</td>
</tr>
<tr>
<td>Randall, Wesley</td>
<td>S239, S274</td>
</tr>
<tr>
<td>Rangel, Ana Caren Rivera</td>
<td>S260</td>
</tr>
<tr>
<td>Ranney, Thomas G</td>
<td>S387</td>
</tr>
<tr>
<td>Rao, Jing-Ping</td>
<td>S308</td>
</tr>
<tr>
<td>Raseira, Maria B</td>
<td>S374</td>
</tr>
<tr>
<td>Rather, Staci</td>
<td>S403</td>
</tr>
<tr>
<td>Rat hinasabapathi, Bala</td>
<td>S236, S291</td>
</tr>
<tr>
<td>Raudales, Rosa E</td>
<td>S121</td>
</tr>
<tr>
<td>Rauh, Bradley</td>
<td>S218, S362</td>
</tr>
<tr>
<td>Ravelonandro, Michel</td>
<td>S171</td>
</tr>
<tr>
<td>Ray, Dennis T</td>
<td>S323</td>
</tr>
<tr>
<td>Read, Paul</td>
<td>S123, S311, S352</td>
</tr>
<tr>
<td>Rebolledo-Domínguez, Oscar</td>
<td>S323</td>
</tr>
<tr>
<td>Reddy, Chandra</td>
<td>S256, S372</td>
</tr>
<tr>
<td>Reddy, K. Raja</td>
<td>S294</td>
</tr>
<tr>
<td>Reeder, Jean D</td>
<td>S283</td>
</tr>
<tr>
<td>Reed, Sandra M</td>
<td>S382</td>
</tr>
<tr>
<td>Reed, Stewart</td>
<td>S333</td>
</tr>
<tr>
<td>Reeve, Jennifer</td>
<td>S394</td>
</tr>
<tr>
<td>Rehrig, Erin MacNeal</td>
<td>S380</td>
</tr>
<tr>
<td>Reid, Michael S</td>
<td>S138, S263</td>
</tr>
<tr>
<td>Reighard, Gregory L</td>
<td>S218, S258, S271, S324, S401</td>
</tr>
<tr>
<td>Reinhardt-Adams, Carrie</td>
<td>S341</td>
</tr>
<tr>
<td>Reiter, Mark</td>
<td>S255</td>
</tr>
<tr>
<td>Reiter, Sara</td>
<td>S255</td>
</tr>
<tr>
<td>Resende, Marcio</td>
<td>S168</td>
</tr>
<tr>
<td>Revord, Ronald Scott</td>
<td>S325</td>
</tr>
<tr>
<td>Reyes-Barraza, Eleazar</td>
<td>S286</td>
</tr>
<tr>
<td>Reyes-Cabrera, Joel</td>
<td>S202</td>
</tr>
<tr>
<td>Reynolds, Sarah</td>
<td>S155, S214</td>
</tr>
<tr>
<td>Reza zadeh, Amir</td>
<td>S183</td>
</tr>
<tr>
<td>Rhea, Alice</td>
<td>S145</td>
</tr>
<tr>
<td>Rhodus, Tim</td>
<td>S285</td>
</tr>
<tr>
<td>Ribera, Luis</td>
<td>S266</td>
</tr>
<tr>
<td>Riddle, LeeAnne</td>
<td>S164</td>
</tr>
<tr>
<td>Rihn, Alicia L</td>
<td>S174</td>
</tr>
<tr>
<td>Rijal, Ishara</td>
<td>S213</td>
</tr>
<tr>
<td>Rinaldi, Laura M.R.</td>
<td>S283</td>
</tr>
<tr>
<td>Rinehart, Timothy A</td>
<td>S115, S118, S219</td>
</tr>
<tr>
<td>Ristvey, Andrew</td>
<td>S226, S313</td>
</tr>
<tr>
<td>Ritenour, Mark A</td>
<td>S261, S328</td>
</tr>
<tr>
<td>Rivard, Cary</td>
<td>S262, S285, S288, S321, S394, S395</td>
</tr>
<tr>
<td>Rivera, Lydia</td>
<td>S344</td>
</tr>
<tr>
<td>Rivera-Pastrana, Dulce M</td>
<td>S261, S373</td>
</tr>
<tr>
<td>Robacker, Carol D</td>
<td>S146, S381</td>
</tr>
<tr>
<td>Roberson, Kyle</td>
<td>S322</td>
</tr>
<tr>
<td>Roberson, William R</td>
<td>S340</td>
</tr>
<tr>
<td>Robertson, Larry D</td>
<td>S152</td>
</tr>
<tr>
<td>Roberts, Pamela D</td>
<td>S261</td>
</tr>
<tr>
<td>Robinson, Carolyn W</td>
<td>S216, S223</td>
</tr>
<tr>
<td>Robinson, Terence Lee</td>
<td>S150, S158</td>
</tr>
<tr>
<td>Robles-Vazquez, Wifredo</td>
<td>S393</td>
</tr>
<tr>
<td>Rock, Channah M</td>
<td>S132, S284</td>
</tr>
<tr>
<td>Rodriguez-Armenta, Hilda Patricia</td>
<td>S405</td>
</tr>
<tr>
<td>Rodríguez, Gustavo</td>
<td>S293</td>
</tr>
<tr>
<td>Rodriguez, H. German</td>
<td>S276</td>
</tr>
<tr>
<td>Rodriguez, Lorraine</td>
<td>S248</td>
</tr>
<tr>
<td>Rogers, Katie L</td>
<td>S126</td>
</tr>
<tr>
<td>Rogers, Mary A</td>
<td>S145, S213, S215</td>
</tr>
<tr>
<td>Rohla, Charles</td>
<td>S201, S297</td>
</tr>
<tr>
<td>Romacho, Francisco J</td>
<td>S397</td>
</tr>
<tr>
<td>Rom, Curt R</td>
<td>S276, S294, S353</td>
</tr>
<tr>
<td>Rosales-Serna, Rigoberto</td>
<td>S286</td>
</tr>
<tr>
<td>Rose, Ann</td>
<td>S228</td>
</tr>
<tr>
<td>Rossouw, Stephanus J</td>
<td>S201</td>
</tr>
<tr>
<td>Rosyara, Umesh</td>
<td>S149, S150</td>
</tr>
<tr>
<td>Rothleutner, Joseph</td>
<td>S339</td>
</tr>
<tr>
<td>Rothwell, Nikki Lynn</td>
<td>S159</td>
</tr>
<tr>
<td>Rouse, Christopher E</td>
<td>S368</td>
</tr>
<tr>
<td>Roux, Robert E</td>
<td>S401</td>
</tr>
<tr>
<td>Roux, Nicolas</td>
<td>S153</td>
</tr>
<tr>
<td>Rowland, Diane</td>
<td>S371</td>
</tr>
<tr>
<td>Roy, Sutapa</td>
<td>S224</td>
</tr>
<tr>
<td>Rozum, Jane</td>
<td>S221, S302</td>
</tr>
<tr>
<td>Rudell, David R</td>
<td>S189</td>
</tr>
<tr>
<td>Rueda, Janice</td>
<td>S164</td>
</tr>
<tr>
<td>Rue, Kevin</td>
<td>S341, S342</td>
</tr>
<tr>
<td>Runkle, Erik S</td>
<td>S197, S388</td>
</tr>
<tr>
<td>Ruter, John M</td>
<td>S146, S226, S386</td>
</tr>
<tr>
<td>Ryser, Elliot</td>
<td>S188</td>
</tr>
<tr>
<td>Sá, Francielen Paola</td>
<td>S338</td>
</tr>
<tr>
<td>Saavedra-García, Rossana</td>
<td>S260, S261</td>
</tr>
<tr>
<td>Saavoss, Monica</td>
<td>S173</td>
</tr>
<tr>
<td>Saba, Mahmoud</td>
<td>S202</td>
</tr>
<tr>
<td>Sabuwalla, Adnan</td>
<td>S160</td>
</tr>
<tr>
<td>Sadler, Brandi</td>
<td>S333</td>
</tr>
<tr>
<td>Salas, Andrea</td>
<td>S169, S170</td>
</tr>
<tr>
<td>Salazar, Melba</td>
<td>S402</td>
</tr>
<tr>
<td>Salgado, Alejandra A</td>
<td>S148, S266, S267, S268, S269</td>
</tr>
</tbody>
</table>
Index of Authors and Moderators (Poster and Oral Presentations)

Salinas-Aponte, Natalia ...............S116, S267, S362
Samarakoong, Uttara C .................S232
Sams, Carl E ............................S290, S295, S296, S330, S349
Samtani, Jayesh ........................S351
Sanagorski, Laura A .....................S163
Sanchez, Charles A .....................S155, S303, S304
Sanchez, Luis ............................S160
Sanchez-Sevilla, Jose F .................S363
Sandefur, Paul ..........................S148, S268, S269
Sandoval, Vanessa .....................S370
Sandoya, German ........................S152, S168
Sanon, Dakson ...........................S210
Santamaria, Pietro ......................S167
Santana, Jose P ..........................S289
Saracoglu, Turksar ......................S397
Sardos, Julie .............................S153
Sargent, Daniel J ........................S117, S267, S362
Sargent, Steven A .......................S202, S204, S263, S291, S343
Sato, Akihiko ............................S297
Satpute, Aditi ...........................S234
Satpute, Aditi D ........................S272
Saxena, Praveen K ......................S380
Saxton, Arnold .........................S349
Scalera, Sally A ........................S221
Schaffer, Bruce .........................S291, S293, S371
Schaffer, Robert J .......................S189
Schall, Carly M ..........................S334
Scheerens, Joseph C ....................S248, S298
Scheiber, Michele .......................S145
Schilling, Brian ........................S284
Schipper, Dale J .........................S359
Schmitt, Kyle ............................S128
Schneider, Keith R ......................S343
Schrader, James .........................S231
Schrader, James A ........................S198
Schreiner, Kathy .........................S403
Schroeder-Moreno, Michelle ..........S353, S393
Schultheis, Jonathan R .................S128, S194
Schumann, Arnold W ..................S176
Schwalb, Michael .......................S241
Schweiterman, Michael L ............S116, S196, S272
Scorza, Ralph ...........................S171
Scott, John W ............................S129, S243
Scully, B.T ...............................S340
Seavert, Clark F ........................S203
Sebolt, Audrey ..........................S271
Seguine, Ed ..............................S324
Seifert, Donald ..........................S128
Selpulveda, David ......................S306, S307
Serio, Francesco ........................S167
Serna-Guerrero, Delia .................S286
Serna-Saldivar, Sergio .................S286
Shaaban, Mona ..........................S191
Shahba, Ahmed ..........................S292
Shahid, Muhammad Adnan ..........S236, S237
Shane, William W ........................S271
Shankar, Alka ...........................S246
Shao, Xingfeng ..........................S259
Sharma, Sat Pal ........................S120
Shave, Megan E ..........................S159
Shaw, Nancy .............................S187
Shellie*, Krista C .........................S310
Shen, Changwei ..........................S258
Shetty, Kalidas ...........................S309
Shi, Aiong ...............................S244, S245, S294, S348, S349
Shi, Biying ..............................S401
Shi, Dongxue .............................S123
Shi, Liyun .................................S316
Shock, Byron ............................S130
Shock, Clinton C .........................S130, S187
Shoemaker, Candice ...................S285, S321
Shreffler, James W ......................S287
Shwiff, Stephanie A ....................S159
Sibley, Jeff ..............................S223, S329, S404
Sierra, Arturo Duarte ...................S310
Signore, Angelo .........................S167
Silva, Ana Veruska Cruz .............S335, S338
Silva, Dilma D ...........................S172
Silva, Dilma Daniela ...................S254
Silverman, Emily J ......................S153
Simmons, Otto ...........................S131
Simon, James E ..........................S245
Simon, Philipp W .......................S348
Sims, Charles A ........................S116, S191, S275
Singh, Raghuwinder ....................S227
Singleton, Paul W .......................S388
Sinkovic, Lovro ..........................S346
Siritunga, Dimuth .......................S248, S327
Skinkis, Patricia A ......................S314
Small, Mary ..............................S283
Smart, David ............................S256
Smiley, E. Thomas .....................S216, S218
Smith, Adrienne M ......................S341
Smith, Brant .............................S269
Smith, Brett D ...........................S279, S290
Smith, Damon ...........................S403
Smith, Erick .............................S161, S400
Smith, Jenny .............................S322
Smith, Maurice ..........................S377
Smith, Powell ...........................S211
Smith, Richard F ........................S120
Smith, Richard M .........................S290
Smith, Samantha .........................S234, S381
Smith, Sarah M ..........................S375
Snodgrass, Crystal A ....................S209
Snow, Rebecca ...........................S235
Solis-Perez, Alma .......................S120
Son, Insook ..............................S131
Souza, Filipe Bittencourt Machado ..S258, S324
Spanier, Adam ...........................S322
Spiers, James D ..........................S404, S405
Spika, Maja Jukic .......................S346
Spotts, Robert ...........................S271
Spriego, Poliana C .......................S188
Sreedharan, Aswathy ....................S343
Srinivasan, Gowrishankar ............S198, S231
Stafne, Eric .............................S314, S342, S403
Index of Authors and Moderators (Poster and Oral Presentations)

<table>
<thead>
<tr>
<th>Name</th>
<th>Page Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teixeira, Gustavo H.A.</td>
<td>S190, S305</td>
</tr>
<tr>
<td>Stamps, Robert H.</td>
<td>S369</td>
</tr>
<tr>
<td>Stanley, Craig</td>
<td>S129</td>
</tr>
<tr>
<td>Stanphill, Stephen</td>
<td>S166</td>
</tr>
<tr>
<td>Stansell, Zach</td>
<td>S211</td>
</tr>
<tr>
<td>Stansell, Zachary</td>
<td>S242, S336</td>
</tr>
<tr>
<td>Starke, Keith</td>
<td>S351</td>
</tr>
<tr>
<td>Starry, Olyssa</td>
<td>S136</td>
</tr>
<tr>
<td>Stauderman, Karen M.</td>
<td>S172, S222</td>
</tr>
<tr>
<td>Steen, Cole</td>
<td>S323</td>
</tr>
<tr>
<td>Steensma, Karen M.M.</td>
<td>S159</td>
</tr>
<tr>
<td>Stegmeir, Travis</td>
<td>S271</td>
</tr>
<tr>
<td>Stein-Chisholm, Rebecca E.</td>
<td>S141</td>
</tr>
<tr>
<td>Stomme, John R.</td>
<td>S375</td>
</tr>
<tr>
<td>Stoven, Heather M.</td>
<td>S179</td>
</tr>
<tr>
<td>Stover, Ed</td>
<td>S170, S175, S176, S328</td>
</tr>
<tr>
<td>Strahan, Ron E.</td>
<td>S332</td>
</tr>
<tr>
<td>Strang, John G.</td>
<td>S312</td>
</tr>
<tr>
<td>Strickler, Susan R.</td>
<td>S352</td>
</tr>
<tr>
<td>Strik, Bernadine C.</td>
<td>S214, S215, S277</td>
</tr>
<tr>
<td>Strove, Daniel K.</td>
<td>S220</td>
</tr>
<tr>
<td>Subbarao, Krishna V.</td>
<td>S152</td>
</tr>
<tr>
<td>Suh, Jeung Keun</td>
<td>S360</td>
</tr>
<tr>
<td>Sullivan, J. Alan</td>
<td>S380</td>
</tr>
<tr>
<td>Summerville, Adam</td>
<td>S315</td>
</tr>
<tr>
<td>Sun, Xiuxiu</td>
<td>S203</td>
</tr>
<tr>
<td>Sun, Youping</td>
<td>S233, S237, S387</td>
</tr>
<tr>
<td>Susko, Alexander</td>
<td>S382</td>
</tr>
<tr>
<td>Swisher, Marilyn E.</td>
<td>S392</td>
</tr>
<tr>
<td>Tabanca, Nurhayat</td>
<td>S358</td>
</tr>
<tr>
<td>Takeda, Fumiomi</td>
<td>S228</td>
</tr>
<tr>
<td>Tanizaki, Gary</td>
<td>S397</td>
</tr>
<tr>
<td>Tanner, Carolyn D.</td>
<td>S283</td>
</tr>
<tr>
<td>Tan, Xiaofeng</td>
<td>S256, S270</td>
</tr>
<tr>
<td>Tao, Yuan-yuan</td>
<td>S361</td>
</tr>
<tr>
<td>Taylor, Matthew D.</td>
<td>S197</td>
</tr>
<tr>
<td>Taylor, Mykel</td>
<td>S395</td>
</tr>
<tr>
<td>Teetor, Valerie H.</td>
<td>S323</td>
</tr>
<tr>
<td>Tegegne, Fisseha</td>
<td>S372</td>
</tr>
<tr>
<td>Teixeira, Gustavo H.A.</td>
<td>S190, S305</td>
</tr>
<tr>
<td>Tel-Zur, Noemi</td>
<td>S150</td>
</tr>
<tr>
<td>Tewolde, Haile</td>
<td>S155</td>
</tr>
<tr>
<td>Thamilarasan, Senthil Kumar</td>
<td>S364</td>
</tr>
<tr>
<td>Thammina, Chandra</td>
<td>S383, S384</td>
</tr>
<tr>
<td>Thiesen, Maureen</td>
<td>S136</td>
</tr>
<tr>
<td>Thomas, Franklin Jason</td>
<td>S318</td>
</tr>
<tr>
<td>Thomas, Paul</td>
<td>S122, S313</td>
</tr>
<tr>
<td>Thompson, Amy</td>
<td>S391</td>
</tr>
<tr>
<td>Thompson, Ashley A.</td>
<td>S399</td>
</tr>
<tr>
<td>Thomsen, Esther</td>
<td>S394</td>
</tr>
<tr>
<td>Thornton, Tom</td>
<td>S320</td>
</tr>
<tr>
<td>Thorp, Kelly</td>
<td>S130</td>
</tr>
<tr>
<td>Thurow, Liane Bahr</td>
<td>S149, S374</td>
</tr>
<tr>
<td>Tian, Tian</td>
<td>S230</td>
</tr>
<tr>
<td>Tillman, Jennifer</td>
<td>S119, S367</td>
</tr>
<tr>
<td>Tindall, Terry</td>
<td>S155, S304</td>
</tr>
<tr>
<td>Tisserat, Ned</td>
<td>S341</td>
</tr>
<tr>
<td>Tokarskyy, Oleksandr</td>
<td>S343</td>
</tr>
<tr>
<td>Tonnis, Brandon</td>
<td>S376</td>
</tr>
<tr>
<td>Touchell, Darren H.</td>
<td>S387</td>
</tr>
<tr>
<td>Towers, Victoria</td>
<td>S312</td>
</tr>
<tr>
<td>Trader, Brian</td>
<td>S217, S326</td>
</tr>
<tr>
<td>Tran, Diep</td>
<td>S202</td>
</tr>
<tr>
<td>Tran, Hoa</td>
<td>S297</td>
</tr>
<tr>
<td>Trapero, Carlos</td>
<td>S151, S364</td>
</tr>
<tr>
<td>Traub, Jesse</td>
<td>S293</td>
</tr>
<tr>
<td>Treadwell, Danielle D.</td>
<td>S208, S210, S329</td>
</tr>
<tr>
<td>Trigiano, Robert N.</td>
<td>S125, S185</td>
</tr>
<tr>
<td>Tripepi, Robert R.</td>
<td>S253, S281</td>
</tr>
<tr>
<td>Tu, Hung-Ming</td>
<td>S163</td>
</tr>
<tr>
<td>Tully, Maureen A.</td>
<td>S141</td>
</tr>
<tr>
<td>Turner, Janet D.</td>
<td>S271</td>
</tr>
<tr>
<td>Turner, Sarah D.</td>
<td>S348</td>
</tr>
<tr>
<td>Tyson, Richard V.</td>
<td>S355</td>
</tr>
<tr>
<td>U</td>
<td></td>
</tr>
<tr>
<td>U, Wunna</td>
<td>S337</td>
</tr>
<tr>
<td>Umar, Gohar</td>
<td>S127, S355</td>
</tr>
<tr>
<td>Ummarat, Nittaya</td>
<td>S190</td>
</tr>
<tr>
<td>Urbina, Daniela</td>
<td>S139</td>
</tr>
<tr>
<td>Urlic, Branimir</td>
<td>S118, S346</td>
</tr>
<tr>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Vaiciunas, Jennifer</td>
<td>S168</td>
</tr>
<tr>
<td>Valdez-Aguilar, Luis Antonio</td>
<td>S328, S356</td>
</tr>
<tr>
<td>Valdez-Pérez, José Francisco</td>
<td>S396</td>
</tr>
<tr>
<td>Valencia, Elide</td>
<td>S329</td>
</tr>
<tr>
<td>Valle-Arizaga, Miriam</td>
<td>S337, S339</td>
</tr>
<tr>
<td>Vallejos, Eduardo C.</td>
<td>S306, S308</td>
</tr>
<tr>
<td>van de Weg, Eric</td>
<td>S117, S168, S267, S269, S362</td>
</tr>
<tr>
<td>van der Zet, Tom</td>
<td>S271</td>
</tr>
<tr>
<td>van Dijk, Thijs</td>
<td>S117</td>
</tr>
<tr>
<td>van Iersel, Marc</td>
<td>S121, S122, S166, S213, S226, S230, S239, S255, S264, S313, S358, S371</td>
</tr>
<tr>
<td>Van Zyl, Sonnet</td>
<td>S223, S224, S312</td>
</tr>
<tr>
<td>VanSickle, John</td>
<td>S193</td>
</tr>
<tr>
<td>Vargas, Ana I.</td>
<td>S293</td>
</tr>
<tr>
<td>Vázquez-Barrios, Ma Estela</td>
<td>S260, S261, S373</td>
</tr>
<tr>
<td>Vázquez-Celestino, Dalia</td>
<td>S261</td>
</tr>
<tr>
<td>Velasco, Gloria</td>
<td>S307</td>
</tr>
<tr>
<td>Verma, Sujeet</td>
<td>S168, S269</td>
</tr>
<tr>
<td>Vidrih, Rajko</td>
<td>S346</td>
</tr>
<tr>
<td>Vieira, Marcela</td>
<td>S305</td>
</tr>
<tr>
<td>Vijayan, Grijja</td>
<td>S165</td>
</tr>
<tr>
<td>Villarino, Gonzalo</td>
<td>S196</td>
</tr>
<tr>
<td>Viloria, Zenaida</td>
<td>S360</td>
</tr>
<tr>
<td>Vincent, Christopher I.</td>
<td>S371</td>
</tr>
<tr>
<td>Vining, Kelly</td>
<td>S233, S266, S362</td>
</tr>
<tr>
<td>Vinson, Edgar</td>
<td>S328</td>
</tr>
<tr>
<td>Vitória, Marina F.</td>
<td>S335, S338</td>
</tr>
<tr>
<td>Volder, Astrid</td>
<td>S208</td>
</tr>
<tr>
<td>Volenec, Jeff</td>
<td>S156</td>
</tr>
<tr>
<td>Voss, Ronald E.</td>
<td>S263</td>
</tr>
<tr>
<td>W</td>
<td></td>
</tr>
<tr>
<td>Wadl, Phillip A.</td>
<td>S185</td>
</tr>
<tr>
<td>Wagner, Callie</td>
<td>S286</td>
</tr>
<tr>
<td>Waldo, Eric</td>
<td>S303</td>
</tr>
<tr>
<td>Walgenbach, Jim</td>
<td>S215</td>
</tr>
<tr>
<td>Walter-Peterson, Hans</td>
<td>S314</td>
</tr>
<tr>
<td>Waltz, Clint</td>
<td>S222, S354</td>
</tr>
<tr>
<td>Author</td>
<td>Page Numbers</td>
</tr>
<tr>
<td>-----------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Zhang, Lu</td>
<td>S140</td>
</tr>
<tr>
<td>Zhang, Ning</td>
<td>S134</td>
</tr>
<tr>
<td>Zhang, Qi</td>
<td>S341, S342</td>
</tr>
<tr>
<td>Zhang, Song</td>
<td>S381</td>
</tr>
<tr>
<td>Zhang, Xinyi</td>
<td>S403</td>
</tr>
<tr>
<td>Zhang, Zejin</td>
<td>S212, S403</td>
</tr>
<tr>
<td>Zhao, Peng</td>
<td>S257</td>
</tr>
<tr>
<td>Zhao, Wei</td>
<td>S204</td>
</tr>
<tr>
<td>Zhao, Xiaofan</td>
<td>S224</td>
</tr>
<tr>
<td>Zhao, Xiaojie</td>
<td>S181</td>
</tr>
<tr>
<td>Zhao, Xin</td>
<td>S275, S322, S333, S392</td>
</tr>
<tr>
<td>Zhao, Yuyang</td>
<td>S149, S150</td>
</tr>
<tr>
<td>Zheng, Jie</td>
<td>S131</td>
</tr>
<tr>
<td>Zheng, JingMing</td>
<td>S240, S316</td>
</tr>
<tr>
<td>Zhen, Shuyang</td>
<td>S238, S239</td>
</tr>
<tr>
<td>Zhijian</td>
<td>S117, S362</td>
</tr>
<tr>
<td>Zhou, Lijing</td>
<td>S186, S187</td>
</tr>
<tr>
<td>Zhou, Lijuan</td>
<td>S175</td>
</tr>
<tr>
<td>Zhou, Suping</td>
<td>S256, S317, S372</td>
</tr>
<tr>
<td>Zhu, Heping</td>
<td>S251, S254</td>
</tr>
<tr>
<td>Zhu, Sijie</td>
<td>S224</td>
</tr>
<tr>
<td>Zimmerman, Thomas W.</td>
<td>S125, S366</td>
</tr>
<tr>
<td>Zinati, Gladis</td>
<td>S393</td>
</tr>
<tr>
<td>Zona, Scott</td>
<td>S135</td>
</tr>
<tr>
<td>Zotarelli, Lincoln</td>
<td>S184, S193, S202, S210</td>
</tr>
</tbody>
</table>
Appendix
Presentations Listed by Title
Annual Conference of the American Society for Horticultural Science
July 28–31, 2014, Orlando, Florida

COLLOQUIA

Recent Advances in Perennial Berry Crop Nutrition and Directions for Future Research ............................................. S68
An Introduction to Regional Nutrient Management of Berry Crops ................................................................. S68
Understanding the Physiological Response of Perennial Strawberry to Nitrogen Limitations and Developing Nutrient Management Practices to Improve Plant Growth and Productivity .................................................. S68
Uptake and Partitioning of Nutrients in Blackberry and Raspberry and Evaluating Plant Nutrient Status for Accurate Assessment of Fertilizer Requirements ........................................... S68
Nutrient Assimilation in Southern Highbush Blueberry and Implications for the Field ........................................... S69
Fertilizer and Soil Management Practices for Improving the Efficiency of Nutrient Uptake and Use in Northern Highbush Blueberry ................................................................. S69
Target Compost Analytical Values for Application to Highbush Blueberry ........................................................ S70
Cranberry Nutrient Management in Southeastern Massachusetts: Balancing Crop Production Needs and Water Quality ............................................................... S70
Panel Discussion, Q&A .................................................. S71

The Importance of Light Quality for High Value Plant Products ............................................................. S71
Introduction to the Colloquium ............................................ S71
Light Control of Consumer-desired Traits in High-value Produce ................................................................. S71
LED Light Impacts on Specialty Crops ....................................... S71
LEDs Create a Less Stressful Light Environment and Increases in Higher-energy Blue Wavelengths will Increase Production of Nutritionally Important Metabolites in Specialty Vegetable Crops ............................................ S72
Developing Photosynthetic, Photomorphogenic, and Photoperiodic LED Lighting Applications for Floriculture Crop Production ................................................................. S72
The Potential of LEDs in Plant-based Bio-pharmaceutical Production .......................................................... S72


Toward Globalized Horticulture: Impact of Tropical Fruits and Vegetables in U.S. Agriculture .............................................. S73
Introduction to Globalized Tropical Horticulture ................ S74
Global Challenges and Opportunities for Tropical Fruits and Vegetables as Functional Foods ................................ S74
Tropical Medicine: Combatting the Global Epidemic of Chronic Diseases .......................................................... S74
Tropical Horticulture—Trade and Investment Opportunities for U.S. Growers ..................................................... S74
Challenges in Postharvest Procedures for Maintenance of Quality of Tropical Fruits and Vegetables ..................... S75
Opportunities for Farmers to Grow Tropical Vegetables in the Northeastern United States ................................ S75
Partial Rootzone Drying as a Water Conservation Strategy for Tropical Citrus Production ..................................... S76
Panel Discussion: Addressing the Challenges and Identifying the Opportunities for Advancement of Tropical Horticulture in the United States ........................................ S76

WORKSHOPS

Peer Review of Non-journal Article Teaching or Extension Tools: Should We, Shouldn’t We, Could We? ........................................................................ S76

Indigenous Herbal Medicine of Florida and Recent Developments in Cannabis Regulation and Cultivation ............................................. S76
A Dozen Native Medicinal Plants of the Deep South .... S77
The Movement to Medicinal Cannabis ............................. S77
Organic Hemp Research at Kentucky State University ... S77
Hemp Construction in the United States and Efforts to Grow the Raw Material Here ......................................... S77
Technological Innovations in Smart Device and Computer Usage for Extension and Teaching .......................................................... S77
Back Pocket Grower—A Customizable Training Website for Mobile Devices .................................................................................. S78
e-GRO—Electronic Grower Resources Online ......................................................................................................................... S78
Tools for Enhancing the Development and Delivery of Online Courses .................................................................................. S78
Using Web-based Assignments to Enhance Student Learning and Productivity ........................................................................ S79

USDA–ARS: Highlights on Citrus Research in Florida .................................................................................................................. S79
Effect of Greening or Hunaglongbing (HLB) Disease on Orange Fruit and Juice Flavor ................................................................. S79
Estimation of Relative Abundance of 16S rDNA of Candidatus Liberibacter asiaticus by Comparison to Host Cytochrome Oxidase DNA in Orange Juice ................................................................. S79
The Pharmacokinetics and Health Benefits of Orange Peel Compounds ......................................................................................... S79
Transmission of Candidatus Liberibacter asiaticus to 16 Citrus Cultivars by Asian Citrus Psyllids in a Greenhouse Study ......................................................................................................................... S80

Gateways to International Horticulture—Potentials and Challenges ......................................................................................... S80
How to Find an International Horticulture Opportunity That Fits Your Experience ........................................................................ S80
The Role of the Horticulture Lab in International Horticulture .................................................................................................... S80
International Collaboration on Teaching, Research, and Extension ......................................................................................... S81
Benefits of Studying Abroad from Global Perspective ........................................................................................................ S81

Graduate Student Tool Kit ................................................................................................................................. S81
Professional Skills to Help You Succeed in Graduate School ........................................................................................................ S81
Developing a Reputation, CV, and Portfolio for a Successful Career ................................................................................................. S81
Creative Writing Tips to Help You Get Published .................................................................................................................. S81
Graduate Student Panel ......................................................................................................................................................... S81

Nickolai Ivanovich Vavilov: Plant Genetic Resources Pioneer and Hero .......................................................................................... S81
Nickolai Ivanovich Vavilov: Plant Geographer, Geneticist, Martyr of Science .................................................................................. S82
Molecular Mechanisms and the Laws of Homologous Variation ................................................................................................. S82
Vavilovian Centers of Diversity: Implications and Impacts ........................................................................................................ S82
Vavilov’s Centers of Crop Origins versus Centers of Diversity: Why Does That Distinction Matter? ........................................ S82

Promoting Horticulture: A New National Initiative to Recruit the Next Generation of Horticulture Professionals .................... S83
Discussion with all the speakers .................................................................................................................................... S83
The Need for a National Promotion of Horticulture ............................................................................................................. S83
Ideas from Academia ................................................................................................................................................ S83
Ideas from Public Gardens ........................................................................................................................................ S83
Ideas from Industry ................................................................................................................................................ S83

Climate Change and the Role of Plasticulture to Help Mitigate the Impact on the Production of Vegetables and Berries .......... S83
Row Covers are a Weather Risk Management Tool in Plasticulture Strawberries ........................................................................ S84
High Tunnel Production of Organic Strawberry in Northern Florida: Opportunities and Challenges ........................................... S84
Plasticulture and Protected Agriculture: Current Status and Prospects for the Sahelian Region of West Africa ............................................. S84
Shading Nets Reduce Heat Stress and Incidence of Phytophthora Blight (Caused by Phytophthora capsici) and Fruit Yield in Bell Pepper (Capsicum annum L.) ................................................................................................................................. S84

Two-minute Teaching Tips ............................................................................................................................................. S85
Hot Topic Workshop ................................................................................................................................................ S85

Advancing Worldwide Research, Education, and Outreach with Massive Open Online Courses—How Does It Work? ......................................................................................................................... S85
A Mooc Point: Collision or Collaboration ................................................................................................................................. S85
“My and My MOOC”—An Online University of Florida Class in Global Sustainable Energy .......................................................... S85
Sustainable Agricultural Land Management, an Agricultural Course Offering with Coursera.org ................................................................................................. S86

ASHS meets SWD: A New Pest of Small and Stone Fruits ............................................................................................................. S86
Spotted Wing Drosophila: A Major Threat to Small and Stone Fruit Production in the United States ........................................ S86
SWD in Florida: Monitoring, Alternative Hosts, Management, and Outreach ................................................................................................. S87
Hands-on Teaching: Identifying and Monitoring SWD Adults and Larvae .................................................................................. S87
Managing SWD Using Reduced Spray Strategies ........................................................................................................ S87
Comparing Pesticide Delivery Methods for SWD Control ............................................................................................................... S87
Integrating Alternative SWD Management Practices .................................................................................................................. S88
Appendix: Presentations Listed by Title

A Research Update on the Use of Rootstocks in Fruit and Vegetable Crop Production..............S88

Categories of Citrus Rootstocks and Their Effects on Tree Size, Yield, Fruit Quality, Adaptation and Disease Resistance ..........................................................S88

Rootstock Influence on the Performance of Peach Scions and Overall Tree Survival in the Southeastern United States .................................................................S89

Effect of Rootstocks on Watermelon Quality and Composition .............................................S89

Effects of Different Tomato Mosaic Virus Resistance in Grafted Tomato Scions and Rootstocks........S89

Toward More Effective Selection of Tomato Rootstock and Scion Varieties for Use in U.S. Soil-Based Production, Including Organic .................................................S90

Grafted Tomato Production Under Different Planting Densities ..............................................S90

Nuts and Bolts of Postharvest Shipping Around the World ......................................................S90

Introductory Remarks ..................................................S91

Harvesting, Shipping & Handling Concerns in International Perishable Shipping ......................S91

Conducting Transportation Research ..........................................................S91

International Shipping & Container Technologies—Latin America/United States ..................S91

Interaction of the Custom and Border Protection, Quarantine Treatments and APHIS Requirements, and Food Safety Modernization Act in International Shipping .............S91

Production Water Impact on Produce Safety and Ways to Reduce Risks ...............................S91

Microbial Risk Assessment During Flooding Events: Focus on LGMA Metrics and the Presence/Absence of Indicator Microorganisms and Human Pathogens ..............S91

Transfer and Survival of Organisms to Cantaloupe and Lettuce from Surface Irrigation Water in the Southeast ..........................................................S91

Survey of Mid-Atlantic Farms for Foodborne Pathogens in Tomatoes, Leafy Greens, Irrigation, Water, and Soil ...........................................................S91

Irrigation Water Remediation: Treatment Options ..................................................S91

Resources for Growers: Decision Trees for Prioritizing Produce Safety Risk Reduction Strategies on the Farm ..........................................................S91

Advances in Commercial-ready LED Technologies for Horticulture ...............................S91

Impact of Utilizing Biodegradable Containers in Ornamental Crop Production Systems ..........S92

Impact of Biocontainers on Plant Performance and Container Decomposition in the Landscape ..........................................................S92

Impact of Alternative Materials on Container Physical Properties and Substrate Temperature ..........................................................S92

Water Use of Nursery Plants Grown in Alternative Containers: Implications for Sustainability ..................................................S93

Economics of Utilizing Biodegradable Containers in Ornamental Crop Production Systems ..........S93

Biocontainer Use in Petunia (Ruellia simplex) Greenhouse Production—A Cradle-to-Gate Carbon Footprint Assessment of Secondary Impacts .........................................S94

Use of Fiber Containers in Pot-in-Pot System for a Two-year Nursery Production of Birch ..........S94

Invasive Plant Management and Restoration: Florida Regulations and Experiences ..........S95

Evaluating the Invasion Risk of Non-native Plants in Florida’s Natural Areas ..........................S95

Making a List, Checking It Many, Many Times: How Species are Added to the Florida Noxious Weed and Invasive Plant List ..........................................................S95

Is Invasive Species Control the Goal or Just the First Step in Restoration of the Native Plant Community? Mexican Petunia (Ruellia simplex) Invaded-forest Floodplains as a Case Study ..........................................................S96

The Current Status of Precision Nutrition in Apples and Stone Fruit .................................S96

Precision in Irrigation Water and Nitrogen Application for Optimizing Yield, Fruit Quality, and Mineral Nutrients in Apples ..........................................................S96

Nutrient Management in Apple ......................................S96

Nutrition of Tart Cherry for Optimum Production ..........................................................S97

Nitrogen Requirements of Low-chill Peaches in a Subtropical Environment ...........................S97

Type, Quality, and Quantity of Data Collection in Vegetable Cultivar Trials ..........................S97

Principles of Developing Cultivar Trials ..........................................................S97

Data Collection Beyond Harvest: Simple and Rapid Ways to Collect Information on Produce Composition, Storage Life, and Phytochemicals ..........................................................S97

Participatory Approach to Variety Selection Using Tomato as a Model ..................................S98

Efficient Evaluation of Qualitative Traits in Multisite Trials ................................................S98

Bridging the Gap Between the Grower and the Consumer: The Role of Sensory Analysis in Cultivar Trials ..........................................................S98

Applying Sensory Aspects in Plant Breeding ..........................................................S98
Appendix: Presentations Listed by Title

Flavor Aspects in Modern Plant Breeding — An Overview .................................................. S99
Pleiotropy in Breeding for Flavor in Vegetables ................................................................. S99
Breeding Mandarins That Consumers Cannot Resist ....................................................... S99
Sensory-assisted Strawberry Breeding ............................................................................. S99
Catering to the Contemporary Floral Consumer Using Genetics, Biochemistry, and Psychophysics ..................................................................................... S99
Using Consumer Panels to Discover Seasonality and Acceptability of Avocado ............. S99

Improving Organic Vegetable Systems: Production Scale, Nutrient Management, and Integrated Approaches ................................................................. S99
Large-scale Organic Vegetable Production in Florida ...................................................... S99
Best Management Strategies for Organic Snap Bean Production in Wisconsin ................ S100
Sweet Onion Yield as Affected by Organic Fertilization Rate ........................................ S100
Using Anaerobic Soil Disinfection in Organic Vegetable Production ........................... S100
Cover Crop, Mulch, and Organic No-till Effects on Organic Vegetable Production Systems ........................................................................................................ S101

Advances/Challenges in Plant Biotechnology for Horticultural Crop Improvement .... S101
Biotechnological Approaches for the Development of Improved Citrus Cultivars .......... S101
Biotechnology and Enhanced Pro-health Nutrient Metabolome of Fruit ......................... S101
Germplasm Enhancement of Woody Species through Biotechnology ............................ S101
Challenges in Biotechnology Biosafety for Horticultural Crop Improvement ................ S101
Rethinking Biotechnology Communication ..................................................................... S101

Artificial Seed and Cryopreservation in Horticultural Crops ........................................ S102
Artificial Seed Production and Cryopreservation ............................................................. S102
Cryopreservation of Orchid Seeds, Protocorms, and Pollen .......................................... S102
Potential Health Benefits Derived from Components in Seeds ...................................... S102
Bioreactor Technology for Mass Propagation of Plants ................................................ S103

The Fate of Fertilizer Formulations and Fertilizer Applications for Nurseries and Landscapes Under Increasing Composition— and Use-restrictions Imposed by Governmental Agencies in Florida and Beyond: Problems, Perspectives, and Solutions ........................................ S103
Background Information on the Concerns of Nutrient Runoff to Sensitive and Protected Water Body Ecosystems in Florida ......................................................... S104
Representing Florida’s Landscape and Nursery Industry’s View Point on Fertilizer Restrictions ..................................................................................................... S104
Representing the Fertilizer Industry’s View Point on Fertilizer Restrictions .................... S104
Opportunities and Implications of Current Containerized Ornamental Crop Nutrient Management Practices and Subsequent Nutrient Use Efficiency .................. S104
An Overview of Water Treatment Technologies for Remediating Runoff Water of Excess Nutrients ................................................................................................. S104

Presentations on Use of Mutation Breeding in Cultivar Development ....................... S104
User of Mutation Breeding to Create New Hybrids ....................................................... S104
Mutation Breeding ......................................................................................................... S104

Extension Outreach for Irrigation Management of Horticultural Crops ..................... S104
Extension Education Opportunities for Irrigation With Small and Beginning Farmers ........................................................................................................ S105
Florida Extension Programs Fine Tune Irrigation and Nutrient Management in Plasticulture ........................................................................................................ S105
Partnering with Commercial Growers to Implement Sensor-based Irrigation Control .......... S105
Field Experiences with Soil Moisture Monitoring Techniques in Commercial Vegetable Production .................................................................................................. S105

New Innovations in Commercial Horticultural Applications ....................................... S106
Performance Specifications of New Controlled Environment ........................................ S106
I. Wireless Sensor Networks (for Remote Analysis of Environmental Data) ................... S106
II. Cloud-Based, Real-Time Data Analysis Tool ............................................................. S106
LAI-2200C Plant Canopy Analyzer ................................................................................ S106
Using ARM Software to Plan Experiments Based on Required Precision ..................... S106
The Advantages of Measuring Ethylene Using the CI-900 Portable Ethylene Analyzer .................................................................................................................. S106

Student Career Workshop: ......................................................................................... S106
Speed-dating on Career Options: 2nd Edition ................................................................ S106
Appendix: Presentations Listed by Title

Cultivating Horticulture as a National Priority ........................................... S107
Cultivating Horticulture as a National Priority:
Björkman ................................................. S107
Moore ..................................................... S107
Lea-Cox ................................................... S107

Unique Blueberry Production Practices for Subtropical and Tropical Climates .......... S107
An Overview of the Blueberry Industry in Florida .................................. S107
Prospects for Low-chill Blueberry Cultivars with High Fruit Quality ......................... S107
Role of Plant Growth Regulators in Blueberry Production Under Low-chill Conditions ......................................................... S107
Mitigating the Effects of Insufficient Chilling Using Novel Cultural Practices .................. S108
Blueberry Chilling Model Dilemmas .................................................. S108

Spotlight on Centers for Innovation in Research and Development .......... S108
The Florida Innovation Hub—Making Today’s Idea Tomorrow’s Business .................. S108
OBIC 2.0 and the Biobased Product Ecosystem .................................... S108
You Can’t Just DISCOVER; You Have to DELIVER: Tales from the North Carolina Research Campus ......................................................... S108
Vineland: A New Innovation Model for Horticulture.......................... S108

The Role of Qualitative Research to Further the Understanding of the Horticultural Lived Experience ............................................. S108
Qualitative Research in Consumer Horticulture and Focus Groups ....................... S108
Qualitative Data Used to Reinforce Quantitative Data ................................ S108

The Science of Consumer Horticulture ............................................. S109
Funding Challenges and Open Discussion of Options and Opportunities .............................. S109
Defining Research Goals: An Interview with Dr. Tom Bewick, National Program Leader, Horticulture USDA–NIFA ................................................. S109
Getting Started: Landscapes and Gardens for Better Living Southern Region Research Activity and Open Discussion of Research Objectives ......................................................... S109

Eye Tracking Technology Revolutionizes Horticultural Consumer Research ........ S109
Eye Tracking Equipment for Consumer Research .................................. S110

Literature, Findings, and Lessons from Non-horticultural Uses of Eye Tracking .............................. S110
Eye Tracking Data Extraction Triumphs and Challenges .............................. S110
Ascertaining the Influence of Water Conservation Signage on Plant Purchasing Behavior ......................................................... S110
What Does Eye Tracking Reveal About the Effects of Buying Impulsiveness on the Horticultural Choice? .................. S110
Price Signs to the Left of Center Have More Visual Activity Than Signs to the Right of Center ......................................................... S110

Irrigation Systems and Current Technologies Available for Use in Vegetable Crop Production ........................................................................ S110
Irrigation Systems for Vegetable Production in Florida: The Good, the Bad, and the Ugly ......................................................... S110
Seasonal Climate Review and Outlook: Possible Vegetable Production Impacts ......................................................... S111
Agroclimate Web and Smartphone Tools for Vegetable Production .................. S111
Economics of Alternative Irrigation Technologies in Florida Vegetable Production ......................................................... S111
Irrigation and Salinity Problems in Vegetable Production .................................. S111
Strategies for Conversion of Seepage to Drip Irrigation: Cabbage Case Study ......................................................... S111
Irrigation Scheduling and the Use of Soil Moisture Sensor on Vegetable Crops ......................................................... S111
Smartphone App for Irrigation on Vegetable Crops ................................ S111

Index of Authors, Moderators for Colloquia and Workshops ...................... S112

ORAL PRESENTATIONS

Fruit Breeding 1 ..................................................... S115
The Evaluation and Release of New Strawberry Selections for the Eastern Region of the United States ................................................. S115
Identifying Sources and Mechanisms for Resistance to Colletotrichum gloeosporioides in Strawberry ............................................. S115
A Genetic Analysis of Fruit Firmness in Strawberry ................................ S116
Effects of Strawberry Volatiles on Consumer Sensory Responses ......................................................... S116
Validating Microsatellite Markers Linked to Remontancy in Octoploid Strawberry ......................................................... S116
The Application of Precision Breeding for Crop Improvement Is Fully Consistent with the Plant Lifecycle: The Utility of PB for Grapevine ......................................................... S117
Appendix: Presentations Listed by Title

Transcriptome Data for Rabbiteye Blueberry (Vaccinium virgatum 'Premiere') from Tissue and Developmental Timepoints ...................................................... S118

**Vegetable Crops Management 1** ............... S118

Tomato Yield and Aerial Pests Populations Affected by Grafting, Nitrogen Rate and Ratio of NO₃⁻:NH₄⁺ in Hydroponic Cultivation .............................................. S118

Soil Organic Matter Solutions for Peri-urban Market Farms ..................................................................................................................... S119

Summer Cover Crops and Plastic Mulch Affect Fall Lettuce (Lactuca sativa L.) Production ..................................................... S119

Water Saving Strategies for Leafy Greens in Southwest Texas .............................................................................................. S120

Leaf Gas Exchange and Growth Adjustments in Reticulates and Inodorus Melons Under Deficit Irrigation .............. S120

Monitoring Nutrient Uptake and Growth Patterns of Onion Crops to Improve Fertilizer and Water Management ... S120

Growth and Yield of Chinese Cabbage by Soil Application of Microbe Complex Fluid .............................................. S121

**Water Utilization and Management 1** .................. S121

Chlorine Efficacy to Control Phytophthora nicotianae in Solutions Containing Peat Particles or Nitrogen Salts .................................................................................. S121

Hydraulic Properties of Peat-based Substrates: The Importance of Hydraulic Conductance .......................... S122

Modeling Water Use of Bedding Plants as a Function of Light Interception ......................................................... S122

Scaling Sensor Networks to Estimate Horticultural Crop Water Use in a Watershed in Ecuador ....................... S123

**Propagation** .............................................. S123

Alternative Application of Plant Growth Regulators to Optimize Rooting in Citrus .................................................. S123

Effects of Culture Media and Plant Growth Regulators on Micropropagation of Hazelnut (Corylus colurna) and Willow (Salix matsudana) .......................................................... S123

A New Protocol May Help Reveal Pre- and Postgrafting Environment Effects on Early-phase Healing in Grafted Tomato Seedlings ........................................................................ S124

In Vitro Apple Shoot Proliferation and Shoot Elongation Using Growth Regulators .............................................. S124

**Undergraduate Student Oral Competition .S125**

Induction of Somatic Embryos in Five Varieties of Hibiscus sabdariffa ..................................................... S125

Assessment of Extracellular Enzymes Produced by Fungi Isolated from Muscadine Grapes ................................ S125

Genetic Characterization of Eastern Filbert Blight-resistant Hazelnut Seedlings from Turkey, Latvia, and Lithuania .................................................. S125

Influence of Vesicular-Arbuscular Mycorrhizae on Growth, Development, and Nutrient Absorption of Sunflower ................................................................................. S126

Manipulating Flowering Time in Citrus Using a TAL-based Effector Switch ........................................................... S126

In Situ Vernalization: A Novel Method for Accelerated Biennial Vegetable Crop Seed Production.................. S127

**Vegetable Crops Management 2** ...................... S127

Vegetable Pest Management Strategies in North Florida ............................................................................................... S127

Hollow Heart in Triploid Watermelons ................................ S128

High Tunnel, Early Spring Production of Five Varieties of Tomato Using Three Different Trellising Systems ..... S128

Yield and Economic Considerations for Planting Density of Sweet Corn (Zea mays) ........................................................... S128

Variety Evaluation of Compact Growth Habit Tomatoes with Jointless Pedicels for the Florida Mature-green Fresh Market .................................................................................................................. S129

Soil Management to Improve the Sustainable Productivity of Winter Fresh Market Vegetable Crops in North Carolina ........................................................................ S129

Mechanical Thinning versus Hand Thinning in Lettuce S130

**Produce Quality, Safety, and Health Properties** ...................................................... S130

Surface Irrigation Systems That Deliver Bacteria to Vegetable Crops ......................................................................... S130

Survival of E. coli on Onions during Curing ................................ S130

Detection and Characterization of Salmonella Species and Correlation with Microbial Indicators in North Carolina Tomato Production Environments ........................................ S131

Survival of Microorganisms Isolated from Fresh Produce and Production Fields and Inoculated into Pesticide Solutions ........................................................................................................ S131

The Five-year Anniversary of the Arizona Leafy Green Marketing Agreement: What Works and What Doesn’t ............................................................................................................... S132

Exogenous Methyl Jasmonate Treatment Increases Glucosinolate Biosynthesis and Quinone Reductase Activity in Kale Leaf Tissue ................................................................. S132

Exploring Plant-UV Interactions with Greenhouse Tomatoes: Stress, Flavor, and Phytochemicals .......... S133

**Temperate Tree Nut Crops and Tropical Horticultural Crops** ...................................................... S133

Physiology of Fruit Growth as a Function of Heat in...
Appendix: Presentations Listed by Title

Commercial *Pistacia vera* Species ........................................... S133
Flow Volume and Carbohydrate Composition of Late Winter
Xylem Sap Influences Subsequent Crop Load in
Pecan ................................................................. S134
Genetic Diversity of *Anisogramma anomala* and Its
Implications for Breeding Eastern Filbert Blight Resistant
Hazelnuts .......................................................... S134
Floral Morphology of Seven *Mangifera* Species ...........S135
High Tunnel Green Papaya Production in Southern
Virginia .............................................................. S135

**Water Utilization and**
**Management 2**............................................... S135

Improved Foliar Physiology and Drought Tolerance for Two
Legumes after Application of Magnetized, Chelated Iron
Fertilizer Application ........................................... S135
A New Automated Irrigation System Reduces Irrigation
Consumption and Leachate in a Commercial Nursery
Production Facility .............................................. S136
Using Scaled Sensor Networks to Estimate Green Roof
Stormwater Runoff .............................................. S136
Scaling Sensor Networks for Scheduling Irrigations in a
Commercial Pot-in-Pot Nursery .............................. S137
Why is the Irrigation Running in the Rain? ............... S137

**Plant Biotechnology 1**........................................ S138

A HD-ZIP Transcription Factor Regulates Flower
Senescence via Ethylene and ABA Cross-talks in
Petunia ............................................................. S138
Identifying Genes Involved in Pollination-induced Corolla
Senescence in Petunia ........................................... S138
Over-expression of an ABA Biosynthesis Gene (NCED)
with a Stress-inducible Promoter Improves Drought
Tolerance in Petunia (*Petunia hybrida*) ....................... S138
Expression and of Putative Lipoxygenase (LOX) Genes
Relative to LOX-dependent Aroma Volatile Emissions in
Apple Fruit ........................................................ S139
Response of Iron Regulated-transporter Genes (IRT) to
Iron Deficiency in *Populus tremula* L. ....................... S139

**Pomology 1** .................................................. S139

Date Palm Cultivation in Saudi Arabia: Current Status and
Future Prospects for Development .......................... S139
Applications of ReTain Reduce Ovule Senescence and
Improve Fruit Set in Sweet Cherry .......................... S140
Assessing the Pistil’s Role in Sweet Cherry Cultivars
Exhibiting Variable Fruit Set ................................ S140
Developing a Robust, Predictive Model for Sweet Cherry
(*Prunus avium* L.) Flowering, Comparing Eastern Oregon
and Mesic Nordic Climates ................................. S141
Changes in Not-from-concentrate ‘Wonderful’ Pomegranate
Juice through Pilot Plant Pressing, Ultrafiltration, and HTST
Pasteurization and Storage .................................. S141
Vitamin C Content of Jujube Fruit and Its Changes during
Fruit Development and Processing ........................ S142

**Consumer Horticulture and Master**
**Gardeners**.................................................. S142

Selection of Horticultural Crops for a Small-scale Integrated
Farm System in the Tropical Environment of Guam ...S142
The Extension Master Gardener National Committee:
History, Structure, and Status ................................ S142
Implementing the eXtension Ask an Expert Program with
Master Gardener Volunteers ................................. S143
Developing and Implementing a Community Garden at
Tennessee State University .................................. S143
WSU Master Gardener Online Training ..................... S144
An Analysis of Gardening Interest among Students
Involved in a School Gardening Project .................. S144
SproUTing Growers: A Train-the-Trainer Program for
Extension Professionals Working with Beginning Growers
of Specialty Crops ................................................ S145

**Ornamental Plant Breeding**............................ S145

Breeding and Introduction of Hardy Perennials and Shrubs
at Star Roses and Plants .................................... S145
Polyploid Initiation in Hawaii Tree Species ............... S145
Relationships among Caladium Species: New Insights from
Cytological and Molecular Marker Analyses ................ S146
Interspecific and Intergeneric Hybridization in *Baptisia*
and *Thermopsis* ............................................... S146
Induction, Regeneration and Characterization of Tetraploids
in Caladium ....................................................... S146
Identification of Partial Resistance to Black Spot in an
Incomplete Diallel Diploid Rose Population ................. S147
Clone Variation and Taxon Discrimination of *Distylium*
Using ISSR Markers .......................................... S147

**Fruit Breeding 2**......................................... S148

Assessment of Long-term Peach Evaluation Data Reveals
Fruit Trait Distribution and Selection Tendencies .......... S148
Heritability and Phenotypic Correlations in Peach .......... S148
Harnessing the Power of RosBREED: Development,
Validation, and Application of DNA Tests for Predicting
Peach Fruit Quality, Disease Resistance, and Other
Valuable Traits for Rosaceae Tree Fruit ................... S148
Identification of QTL Underlying Soluble Solids
Content and Titratable Acidity in Sweet Cherry (*Prunus*
avium L.) ......................................................... S149
Identification of QTL Underlying Powdery Mildew and Bacterial Canker Infection in Sweet Cherry (Prunus avium L.) .............................................S150
Interspecific Crosses in Ziziphus Species ...............S150
Relationships of Apple Rootstock Mediated Nutrient Concentrations in Leaves and Fruit of Gala Apples ....S150
Selecting Verticillium Wilt-resistant Olive Genotypes by Classical Breeding .............................................S151

Genetics and Germplasm 1 .........................S151
Faster and Cheaper Microsatellite Projects with Plants .................................................................S151
Delayed Wilt Symptoms Caused by Verticillium dahliae As a Resistance Characteristic in Iceberg Lettuce (Lactuca sativa) .................................................................S152
Genomic Diversity of Four Closely Related Wild Tomato Species As Revealed by Genotyping-by-sequencing ...S152
Tomato Rootstock Resistance to Bacterial Wilt (Ralstonia solanacearum): Effects of Genotype and Cold Stress on Epidemic Profile ..................................................S153
Evaluation and Characterization of a Genetically Diverse Musa Germplasm Core Subset ......................S153
Genetic Diversity of Suksdorf’s Desert Parsley [Lomatium suksdorfit (S. Watson) J.M. Coul. & Rose] in the Columbia Gorge .................................................................S154
External Morphology Analysis and Intraspecific Variations among Habitats of Allium victorialis var. platyphyllum in Korea .................................................................S154

Plant Nutrient Management 1 .....................S154
Plant–Microbe Partnerships in the Southern Highbush Blueberry Rhizosphere: The Case of Iron Nutrition ....S154
Controlled Release N Fertilizer for Irrigated Arid-land Vegetable Crops: A Decade of Research .............S155
Soil Surfactant Increases Nutrient Use Efficiency and Yield of Potato Grown on Sandy Soil in Florida ........S155
Machine that Bands Compost Shows Promise in Sweet Corn (Zea mays L.) and Tomato (Lycopersicon lycopersicum) .................................................................S155
The Effect of Biochar on Root Growth of Large Crabgrass .................................................................S155
Effect of Foliar Application of Micronutrients (Zn & B) on Vegetative and Reproductive Growth of Mango (Mangifera indica L.) var. Langra .............................................S156

Pomology 2 (Oral Session) ......................S156
The Use of 1-Aminocyclopropane-1-carboxylic Acid and System-Cal™ for Post-bloom Thinning of Apples ....S156
Effects of Pollen Source and Seed Number on Fruit Set, Fruit Quality, and Flower Initiation of Apple .............S157
Evaluating Scaling Relationships of Branching Structure and Biomass Partitioning in Managed Orchard

Viticulture and Small Fruits 1 .................S159
Bird Management in Fruit Crops: Economic, Consumer, and Biological Perspectives ..................................S159
Comparison of Growing Degree Hours Based on Hourly Average Temperatures with Growing Degree Days Based on Daily Minimum and Maximum or Average Temperatures to Interpret Heat Summation ........S160
A Comparison of Non-destructive Imaging and Destructive Load Cells for Grape Yield Estimation ..................S160
Crafted Blueberries: An Option for Mechanical Harvest? ....................................................................S161
Harvest Method and Packing Line Impact on Rabbiteye [V. virgatum (syn. V. ashei)] Blueberry Cultivars Brightwell and Powder Blue ..........................................................S161

Local Food Systems and Human Issues in Horticulture ...............................................................S162
Healthy, Local Food For All: Joining SNAP Education and Agroecology .................................................S162
Assessing the Strengths and Weaknesses of Polk County Food Systems Security ....................................S162
The EARTH (Education and Resiliency through Horticulture) Program After Four Years .........................S162
Effects of Horticultural Therapy on Cancer Patients’ Psychological Well-being in Different Therapeutic Environments ...............................................................S163
An Investigation of How Perceptions of Florida-friendly Landscapes Could Influence Acceptance and Agreement Between Homeowners and Home Owner Association Boards ...............................................................S163
School Garden-based Pulse Biology and Nutrition Education to Increase Consumption of Targeted Foods in K-12 Students ..........................................................S164

Plant Nutrient Management 2 .................S165
Could Leaf SPAD Values (Chlorophyll index) Compliment Nitrogen, Phosphorus, Potassium, Calcium, Sulfur,
Magnesium, and Iron Nutrient Status in Romaine Lettuce (*Lactuca sativa*) ........................................... S165

The Use of Nondestructive Sensors to Assess Nitrogen Needs of Greenhouse Plants .......................... S165

Prediction of Pore Water Electrical Conductivity Using Real Dielectric and Bulk Electrical Conductivity in Soilless Substrates ................................................................. S165

Leaf Growth and Nutrient Element Uptake by Adventitious Roots of Collards in Hydroponic Solution of Variable Composition ............................................................ S166

Determining Variability within Leaf Analysis and Reflectance Sensor Sampling Methods .................. S166

Boron and Salinity Stress Interaction and Effects on Grafted and Ungrafted Tomato Plants ............... S167

**Genetics and Germplasm 2** ........................................... S168

Construction of SSR Profile Database for Cultivar Identification of Apple and Their Applicability to Distinctness Examination in Korea ................................................................. S168

A Comparison of Genome-wide SNP Markers in Octoploid Strawberry Between the Affymetrix IStraw90 Axiom® Array and a Targeted Sequencing Approach .......................... S168

A Comparative Genetic Diversity Analysis of Big-bracted Dogwoods .................................................. S168

Autopolyplploid Induced Sterility in the African Tulip Tree (*Spathodea campanulata*) ......................... S169

Morphological and Physio-chemical Characterization of Five Canistel Accessions at the Subtropical Horticulture Research Station in Miami Florida ........................................ S169

Characterization and Evaluation of Five Jaboticaba Accessions at the Subtropical Horticulture Research Station in Miami, Florida ............................................................. S169

**Plant Biotechnology 2** .................................................. S170

Production of Transgenic Citrus Resistant to Citrus Canker and Huanglongbing Diseases .................. S170

Transgenic *Citrus sinensis* Trees Expressing the Arabidopsis NPR1 Systemic Acquired Resistance Gene Demonstrates Enhanced Tolerance to Huanglongbing (HLB) .................. S170

RNA Interference Provides High-level, Stable Resistance to Plum Pox Virus ....................................... S171

Identification of Candidate Genes Associated with X-disease Resistance in Chokecherry (*Prunus virginiana*) through Comparative Genomics .................................................. S171

Engineering Tolerance to the Diaprepes Root Weevil (*Diaprepes abbreviates*) through Expression of the Snowdrop Lectin (*Galanthus nivalis agglutinin; GNA*) in Citrus ............................................. S171

Fungal and Bacterial Disease Resistance Conferring by Endogenous VvPR1 Genes in Grapevine and Tobacco Under Greenhouse and Field Conditions in Aid of Precision Breeding .................................................. S172

**Marketing and Economics 1** ........................................ S172

Queens (Crowns) & Characters—Using State Partners in Programs .............................................. S172

How Much Are Ornamental Growers Willing to Pay for Irrigation Technology? ............................ S173

Public Benefits of Wireless Sensor Irrigation Network Adoption ..................................................... S173

The Relationship Between Costs and the Carbon Footprint of Flowering Trees and Shrubs ................... S173

Impact of Consumers’ Visual Attention to Product Attributes on their Willingness-to-pay for Apple Juice ............................................................. S174

**Citrus Crops** ............................................................... S174

Development of Molecular Markers for Mandarin Flavors and Colors Using a High-throughput Goldengate Assay ............................................................. S174

Thermodilution and the Molecular Mechanism Behind the Success of Heat Treatment for the Control of Citrus Huanglongbing ................................................................. S175

Breeding “Sweet Oranges” at the USDA U.S. Horticultural Research Laboratory ................................ S175

Advanced Production Systems for Fresh Citrus in Florida ............................................................. S176

Evaluation of Commercial Citrus Cultivars for Field Tolerance/Resistance to Huanglongbing in East Central Florida ............................................................. S176

Impacts of HLB Disease on Citrus Fruit Preharvest Drop .................................................................. S177

**Marketing and Economics 2** ........................................ S177

Price Signs to the Left of Center Get More Visual Activity ............................................................. S177

Estimating Market Equilibrium Values of Fruit Traits for Peach and Sweet Cherry Using Choice Experiments with Consumers and Producers ............................................... S177

Assessing the Intensity of Market Competition in the U.S. Papaya Import Market ............................. S178

Competitive Behavior in the U.S. Green-skinned Avocado Market .................................................... S178

Cost Analysis of Recycling Water in Greenhouses ................................................................. S179

**Nursery Crops 1** ............................................................. S179

Using RFID for Inventory Tracking in Container and Field Nursery Operations ............................ S179

Container Type Affects Irrigation Requirement of *Viburnum trilobum* ‘Compactum’ .......................... S179
Appendix: Presentations Listed by Title

Isohydric versus Anisohydric Tree Species: Do They Need Different Irrigation Strategies to Maximize Growth during Production? .................................................................S180

Influence of Soilless Substrates on Irrigation Frequency and Plant Growth of Leucospermum .................................................................S180

Increased Chlorophyll Efficiency of Dark-adapted Camellia Foliage When Treated with Chlorine Dioxide or Hydrogen Peroxide and Blended with an Ionic Surfactant .................S180

Nitrogen Rate, Irrigation Frequency, and Container Type Effect Plant Growth and Nutrition Uptake of Encore Azalea ‘Chiffon’ .................................................................S181

Floriculture 1 ..................................................................................S181


Vase Water Bacteria Isolations and Their Effects on Vase Life of Cut Zinnia elegans .................................................................S182

Efficacy of GA4+7 + BA or Commercial Pulsing Solutions on Postharvest Longevity, Quality and Leaf Chlorosis of Cut Lilium and Gladiolus .................................................................S182

PGRs Improve the Postharvest Performance, but Not Ethylene Sensitivity, of Potted Ornamental Plants and Plugs .................................................................S182

Effects of Plant Growth Regulators on Plant Height Control in Purple Firespike (Odontonema callistachyum) ..........S183

PGR Drenches Control the Growth and Flowering of Potted Eucomis ‘Leia’ .................................................................S183

Understanding the Link Between Water Relations and Vase-life in Anthurium andraeanum (Hort.) .................................S184

International Horticulture and Issues ........ S184

Simulation of Optimum Sowing Dates for Dry-bean Cultivated in Central Region of Brazil .........................S184

Research: The Key to Sustainable Management of Peatlands in Canada .................................................................S185

Scientific Writing: From Concept to Publication for International Audiences .................................................................S185

An International Study Abroad Project to Empower Women Farmers in Turkey .................................................................S185

Herbs, Spices, and Medicinal Plants ........ S186

Preservation Treatments Affect Sensory Quality of Oyster Mushroom .................................................................S186

Seed Size Does Not Affect Germination or Vigor of Echinacea angustifolia .................................................................S186

Influence of Seed Source on Chemical Composition of Echinacea purpurea and Echinacea angustifolia Grown as Medicinal Herbs in Two Environments .................................................................S187

Four Native Wildflower Species Differ in Their Seed Yield Response to Irrigation .................................................................S187

Comparison of High Tunnel and Field Grown Ginger Roots for Yield and Quality in Southern Virginia ...............S187

Postharvest 1 ..................................................................................S188

Volatile Profile Changes and Visual Appearance of Tomatoes after Low Temperature Storage .....................S188

Interactions Between Atmospheres and Sanitizers and Their Effect on the Quality and Safety of Packaged Fresh-cut Celery (Apium graveolens L.) .................................................................S188

Real Time-based Targeted Metabolomic Approach as Risk Assessment Tools for Controlling Superficial Scald in ‘Granny Smith’ Apples during Storage .................................................................S189

De Novo Fatty Acid Biosynthesis Contributes to Ester Formation in Some, but not All, Fruits .................................................................S189

Sensory Quality and Physiological Responses in Two Mandarin Varieties Differing in Ethanol Accumulation after Waxing and Storage .................................................................S190

Non-destructive Determination of Soluble Solids Content of Intact Jaboticaba Fruit [Myrciaria cauliflora (Mart.) Berg, cv. Açú] in Three Maturity Stages by Means of Near Infrared Spectroscopy .................................................................S190

Effects of Location and Harvest Time on Sensory Properties of Southern Highbush Blueberries .................................................................S191

Modeling of Heat Profile in Bulk Storage of Fresh Crop .................................................................S191

Plasticulture ..................................................................................S192

Soil Fumigation Applied through Deep Drip Tapes in Totally Impermeable Film Mulched Raised-bed Systems for Strawberry Production .................................................................S192

Row Covers as a Weather Risk Management Tool in Plasticulture Strawberries .................................................................S192

Nitrogen Uptake, Use Efficiency, and Yield in Plasticulture Grown Cabbage .................................................................S193

Effect of Cabbage Planting Dates and Plant Population on Plant Water Use, Biomass Accumulation, and Yield ....S193

Weed Control & Pest Management .................................................................S194

Fomesafen Herbicide Programs for Palmer Amaranth Control in Sweetpotato .................................................................S194

Efficacy and Phototoxicity Evaluations of Marengo G and BroadStar G .................................................................S194

Effects of Water Quality on Survival of Zoosporic Oomycetes and Implications .................................................................S195

Evaluation of Watermelon Rootstocks for Resistance to Verticillium Wilt in Northwestern Washington State .................................................................S195

Floriculture 2 ..................................................................................S196

Shade Cloth Impact on Field Grown Lilium Hybrids for Cut Flower Production .................................................................S196
Appendix: Presentations Listed by Title

Lilium Floral Fragrance: A Biochemical and Genetic Resource for Aroma and Flavor ........................................ S196
Sodium Chloride Salinity Using High Throughput RNA Sequencing ................................................................. S196
Preservation of Rare Chrysanthemums at Longwood Gardens ........................................................................... S197
Mixing Blue, Red, and Far–Red Light for Night-interruption Lighting of Short-day Plants .............................................. S197
UVB Radiation Affects Intumescence Development in Ornamental Sweet Potato (Ipomoea batatas) ....... S198
Soy-based Biocontainers Allow for Reduced Fertilizer Inputs .................................................................................. S198

Growth Chambers and Controlled Environments 1 .......................................................... S199
Use of Sphagnum Moss As a New Growth Medium in Advanced Life Support Systems ................................................. S199
Lettuce Growth and Morphology in a Red-rich Low PAR Light Environment in a Greenhouse .............................................. S199
Large Plant Growth Chambers: Flying Soon on a Space Station Near You! .............................................................. S200
Quantifying Flowering Responses of Bedding Plant Species Under LED Day Extension Photoperiodic Lighting with or without Far–Red Light .................................................................................... S200
A Novel Organic Substrate Based on Hemp (Cannabis sativa) or Flax (Linum usitatissimum) Fibre for Hydroponic Systems .............................................................. S201
Evaluation of Colored Shade Cloth on Tomato Production in Oklahoma .......................................................................... S201
Enrichment of Tissue Iron (Fe) Contents of Leaf Lettuce Grown Hydroponically ................................................................. S201

Postharvest 2 ........................................................ S202
1-Methylcyclopropene (1-MCP) Effects on Ethylene Biosynthesis in Relation to Flesh Browning of ‘Empire’ Apple Fruit ........................................................................................................................................... S202
Yield and Postharvest Quality of Tablestock Potato (Solanum tuberosum L.) in Response to Irrigation Method and Harvest Time .............................................................................................................................. S202
Conditioning of ‘Honeycrisp’ Apple to Prevent Injury by Controlled Atmosphere Storage: Testing a Matrix of Temperatures and Exposure Durations .................................................................................. S202
Bitter Pit and Soft Scald in ‘Honeycrisp’ during Cold Storage .................................................................................. S203
Humidity-efficient Clamshells to Decrease Moisture Loss and Extend Storage Life of Small Fruits ....................... S203
High Incidence of Diplodia Infection in HLB Symptomatic Orange Fruit and Its Implication in the Preharvest Fruit Drop ......................................................................................................................................... S204

Hydrocooling, Forced-air Cooling and Hydrocooling Plus Forced-air Cooling of Two Southern Highbush Blueberry Cultivars and Effects on Fruit Quality .............................................................................. S204
Bruising in Avocado (Persea americana M.) ‘HASS’ Supply Chains in Queensland Australia: Ripener to Retailer ............................................................................................................................................. S205

Teaching Methods .................................................. S205
Total Crop Management Improves Students’ Understanding of Greenhouse Crop Production ............................................................. S205
A Case Study Evaluation of Edible Plants Curriculum Implemented in an Elementary School .............................................. S206
Do High School Students Who Participate in State FFA Career Development Events Matriculate at the Host University? A Case Study with Horticulture CDEs at Kansas State University .............................................................................. S206
Evaluating Difficult Plant Science Concepts in an Introductory Horticulture Course Using Conceptual Maps as Assessment Tools ................................................................................................................ S206
Multicultural Student Perspectives on a Study Abroad Course in Costa Rica .............................................................................. S206
Service Learning Program Changes Perspectives and Impacts Professional Skills .................................................... S207
Socratic, Traditional, and Experiential Instructional Methods for Adult Learners Enrolled in a Plant Production Extension Program ................................................................................................................ S207
Extending Research Impacts to a General Audience via Video: The Good, The Bad, and The Ugly ....... S208

Vegetable Crops Management 3 .................. S208
Plant Functional Diversity Leads to Increased Yields in a Low-input Organic Intercropping System .................. S208
Evaluation of Tomato Yellow Leaf Curl Virus Resistant (TYLCV-R) Varieties and Advanced Breeding Lines in Florida ............................................................................................................................................. S209
Enhanced Forage Production from Triticale and Triticale–Pea Mixtures .............................................................................. S209
Evaluation of Summer Cover Crops Sorghum [Sudangrass Sorghum Bicolor L. (Moench) x Sorghum sudanense)] and Pigeon Pea (Cajanus cajan L.) Management on Fall Cabbage (Brassica oleracea L. ‘Capitata’) .......... S210
Large Bed Vegetable Cropping Systems Enhance Productivity and Water Conservation ................................................. S210
Broccoli (Brassica oleracea) Yields and Size of Flowering Head as Affected by Planting Distance .................. S210
Maximizing Plant Density Affects Broccoli Yield and Quality ........................................................................ S211
Appendix: Presentations Listed by Title

Using Grower Friendly, Web-based Mapping to Share Field Isolations within a Global Agricultural Community ........................................... S211

**Crop Physiology** .................................................. S211

The Effect of Small Interval Wavelengths Using LEDs on Photosynthetic Rates of Tomato Plants S211

Response of CO2, Exchange Pattern and Chlorophyll Fluorescence Property in Dendrobium Officinalis to Drought Stress and Rewatering ........................................... S212

Flavonol and Anthocyanin Biosynthesis in Grapevine Berry is Ameliorated by Early Season Light Quantity, Not Irrigation Restriction in Warm Climate ........................................... S212

Mist Cooling to Delay Bloom and Prevent Frost Damage—Old Idea, New Technology ........................................... S212

Daily Water Use of Tomato Plants as Affected by Environmental Conditions and Plant Age ........................................... S213

**Organic Horticulture** ........................................... S213

Temperature Effects on Tomato Growth and Nutrient Release in Substrates Amended with Organic and Conventional Fertilizers ........................................... S213

Does Position in the Canopy Affect Fruit Bud and Berry Development in Highbush Blueberry? ........................................... S214

Summer Sorghum Cover Crop Reduces Fall Lettuce Growth and Yield ........................................... S214

Biological Control and Exclusion of Brown Marmorated Stink Bug in Organic Crops ........................................... S215

Impact of Liquid Fertilizers on Plant Growth, Yield, Fruit Quality, and Fertigation Management in an Organic Processing Blackberry Production System ........................................... S215

**Public Horticulture** ........................................... S216

A Novel Approach to Vertical Gardening: An Inexpensive Vertical Growing Structure ........................................... S216

Evaluating Recruitment within the Green Industry ........................................... S216

Creating Butterfly Gardens Across Louisiana through Enhanced Extension Agent Training ........................................... S216

An Analysis of American Public Horticulture Internship Programs ........................................... S217

An Overview of Two Community Garden Projects in Central Florida ........................................... S217

Tree Risk Assessment: A Component of Managing Trees in Public Spaces ........................................... S218

**Genetics and Germplasm 3** ........................................... S218

Antioxidant Capacity and Phytochemical Content of Modern Peach Germplasm ........................................... S218

Comprehensive Genotyping of the Peach Collection at the National Clonal Germplasm Repository in Davis ........................................... S218

From Population to Association Genetic Analyses in *Prunus umbellata* Elliot, Can GBS Do It All?—A Comparison of SSR and SNP Markers ........................................... S219

Genetic Relationship of Peach (*Prunus persica* (L.) Batsch) Cultivars using SSR Markers and Correlation between SSR Markers and Morphological Characteristics ........................................... S219

Genetic Diversity and Distribution within Cultivated Gene Pools of *Chionanthus retusus* (Oleaceae) in the United States ........................................... S219

Polyploidy as a Potential Erythrina Gall Wasp Management Strategy ........................................... S220

Gene Characterization of * Coffea arabica* ‘Geisha’ from Panama and Ethiopia ........................................... S220

**Turf and Landscape** ........................................... S220

Turf Fertilization Effects on Nitrogen Status of Kentucky Bluegrass and ‘Autumn Blaze’ Maple Growing in a Mixed Landscape ........................................... S220

Characterization of Warm-season Turfgrasses Against Drought ........................................... S221

Irrigation Effects on Growth and Visual Quality of Three Ornamental Grass Species ........................................... S221

My Brevard Yard: Residential Education for the Protection of the Indian River Lagoon ........................................... S221

Green Beer & Brew: Using Themed-styled Trainings to Increase Participation and Knowledge Gain ........................................... S222

Irrigation Contractors in Georgia Offer Many Systems and Many Prices ........................................... S222

Container Type Affects Landscape Establishment and Growth of Chanticleer Pear ........................................... S222

Performance of Elm Taxa in Auburn, AL ........................................... S223

**Viticulture and Small Fruits** ........................................... S223

Transcriptional Changes of Anthocyanin Metabolism during Fruit Ripening in Highbush Blueberry (*Vaccinium corymbosum* L.) ........................................... S223

Comparative Analysis of Polyphenolic Content and Gene Expression Patterns of Key Flavonoid Biosynthetic Genes in *Fragaria* Species Color Mutants ........................................... S224

The Effects of Foliar Potassium Applications on Table Grape Quality ........................................... S224

Fruit Quality of Pierce’s Disease Resistant 87.5% *Vitis vinifera* Selections ........................................... S225

Investigating Possible Causes of Concord Grape Replant Disorder ........................................... S225

**Nursery Crops 2** ........................................... S225

Influence of Provenance on Acute Drought Tolerance of Four Native Texas Groundcover Species ........................................... S225
Appendix: Presentations Listed by Title

Elongation of *Hibiscus acetosella* ‘Panama Red’ in Well-watered and Water-stressed Conditions .................. S226
Investigating Alternative Pathogen Management through Sensor-driven Irrigation .......................... S226
Isolating Crown Rot Disease Organisms in a Nursery Production System ................................................. S227
Solute Transport Through a Pine Bark Substrate ........ S227

**Viticulture and Small Fruits 2** ............... S228
Effect of Timing and Severity of Summer Pruning on Vegetative and Reproductive Traits of Southern Highbush Blueberry .......................................................... S228
Productivity of Pruned and Unpruned ‘Triple Crown’ Blackberry Plants on the Rotating Cross-arm Trellis System .................................................................................................................. S228
The Effect of Shoot and Cluster Thinning on Vine Performance and Fruit Quality of ‘Blanc Du Bois’ .... S229
Syrah Cultivar Under Mechanical Canopy Management ............................................................................ S229
Chemical Removal of Primary Inflorescence and Mature Leaves to Force Vine Regrowth and Fruiting in a Warmer Region for Winegrape Production .................................................. S230

**Floriculture 3** ........................................ S230
Automated Fertigation and Irrigation Control Based on Measurements of Substrate Water Content and Pore Water EC .......................................................... S230
Evaluation and Classification of Bioplastic Plant Containers ........................................................................ S231
Effects of Reduced Phosphorus on Plant Growth and Flowering of Lantana .................................................. S231
Involvement of Calcium and Boron in the Development of Brown Spots on the Leaves of Oncidium Sharry Baby .......................................................... S232
Quantifying the Effects of Preharvest Calcium Nutrition on the Toning of Unrooted Cuttings ................ S232
Plant Species Effects on Acidity or Basicity of Hydroponic Solutions .......................................................... S232

**Plant Biotechnology 3** ................................ S233
Building the Genomic Infrastructure in Black Raspberry ........................................................................... S233
Somatic Embryogenesis and Histological Analysis of *Zelkova schneideriana* Hand.-Mazz .......................... S233
Production of Three New Grapefruit Cybrids to Improve Citrus Canker Resistance ................................ S234
Growing Media Amended with Beneficial Microorganisms to Improve Growth Stimulation and Plant Protection .... S234
Oriental Lily Tissue Culture Somatic Embryogenesis .......................................................... S234
Development and Optimization of *Nicotiana benthamiana* Seed Production for Biopharmaceutical Applications .. S235

**Environmental Stress Physiology** ............ S235
Controlled Mechanical Wounding Applied on Leaves during Preharvest As an Innovative Way to Increase the Levels of Bioactive Phytochemical in Fruits .................................................. S235
Overexpression of Glutaredoxins in Transgenic Rice to Improve High Temperature Stress Tolerance .......... S236
Mitigation of Stress Induced by Salinity and Nickel in Pea (*Pisum sativum* L.) by Exogenous Application of Synthetic Proline and Proline-enriched *Lolium perenne* (L.) Leaf Extract ............................................ S236
Foliar Spray of Phyto-extracts Supplemented with Silicon: An Efficacious Strategy to Extenuate the Salinity-induced Deleterious Effects in Pea (*Pisum sativum* L.) .................. S237
Growth and Physiological Responses of Cotton Genotypes to Controlled Drought Using an Automated Irrigation System .......................................................... S237
Climate Drivers of Crop Carbon Gain and Water Use in Apple Between Western and Eastern States ........ S238

**Growth Chambers and Controlled Environments 2** .......... S238
Are Light-emitting Diodes a Viable Supplemental Lighting Alternative to Grow Greenhouse Tomatoes in a Northern Climate? .......................................................... S238
Blue Light Dose-response of Growth and Morphology of Cucumber Seedlings Under Different Blue and Red Photon Flux Ratios Using LEDs .......................................................... S238
Chlorophyll Fluorescence of Three Species with Different Light Requirements: A Tool to Optimize Supplemental Lighting Efficiency? .......................................................... S239
Comparing Supplemental and Sole-source Lighting for Bedding Plant Seedling Production .......................... S239
End-of-Production Supplemental Lighting from Red and Blue Light-emitting Diodes Increases Leaf Pigments of *Lactuca sativa* L. ‘Cherokee’ and ‘Vulcan’ in the Greenhouse .......................................................... S240
Effects of LED Interlighting on Plant Growth, Fruit Yield, Quality, and Energy Use Efficiency in Greenhouse Mini-cucumber Production .......................................................... S240
Determine the Effect of Different Ratios of Red and Blue LED Light on Commercial Plants Production .......... S241
Determination of the Effect of Red and Blue Ratios of LED Light on Plant Photosynthesis .......................... S241

**Vegetable Breeding** ................................. S242
Screening the USDA Lettuce Germplasm Collection for Rapid Germination Rate Under Cold Conditions .......... S242
Appendix: Presentations Listed by Title

Using Regional Broccoli Trial Data to Select Experimental Hybrids for Input into Advanced Yield Trials .......... S242
Colorful and Nutritious Vegetable Genetic Resources in the USDA/ARS National Plant Germplasm System .......... S243
Inheritance of Immature Tomato Fruit Shoulder Color Phenotypes and Their Effect on Yellow Shoulder Disorder and Soluble Solids Content of Ripe Tomatoes .......... S243
Molecular Breeding in Cowpea .................................. S244
Screening of Tomato (Solanum lycopersicum L.) Lines for Bacterial Spot (Xanthomonas Species) Resistance ...... S244
SSR Discovery in Common Dandelion (Taraxacum officinale) from EST Sequence Databases .................. S244
Inheritance of Resistance to Basil Downy Mildew (Peronospora belbahrii) ........................................ S245

**Poster Presentations**

**Citrus Crops** .................................................. S246
(311) Inheritance of Resistance to *Elsinoe fawcettii* (Citrus Scab) in Citrus ........................................... S246
(312) Production and Characterization of Transgenic Citrus Plants Carrying p35 Anti-apoptotic Gene .......... S246
(313) Mature Citrus Transformation to Combat Diseases in Florida .................................................. S246
(314) Development of Molecular Markers for Fresh Mandarin Flavors and Colors Using a High-throughput Goldengate Assay ........................................ S247

**Genetics and Germplasm 1** ................................. S247
(201) Analysis of Ploidy, Genetic Diversity and Speciation of the Genus Aronia .................................... S247
(202) Assessment of Genetic Diversity of Sweetpotato (*Ipomoea batatas* L.) In Puerto Rico .................. S248
(203) Black Raspberry Fruit Composition from Seedling Populations Planted at Multiple Locations .......... S248
(204) Morphological Characterization of Soursop (*Annona muricata* L.) Germplasm Cultivated in Colima, Mexico .................................................................................. S248
(205) Characterization of Naturalized Cacao Populations in Puerto Rico ........................................... S249
(206) Pedigree Relationships in the University of Florida Southern Highbush Blueberry Germplasm ........ S249
(207) The Phylogeny of the North American Plums (*Prunus* Species) .................................................. S250

**Nursery Crops** .................................................. S250
(082) Measuring the Effect of Hand Protection on Worker Effort When Moving Small Container Plants .......... S250
(083) Improving Spray Quality and Disease Control with a Laser-guided Air-assisted Sprayer for Multi-row Nursery Production ............................................................ S251
(084) Impact of Cyclic Irrigation Timing on Plant Growth and Daily Water Use in Eastern Redbud Grown in a Pot-in-Pot Container Nursery .................................................. S251
(085) Growth and Root Characteristics of Trees in Three Northern Nursery Production Systems .............. S251
(086) Container Plant Species Water Use .................................. S252
(087) Root Zone Temperatures and Growth Responses of River Birch (Betula nigra) in Five Above-ground Pot Production Systems ......................................................... S252
(088) Early Rooting Response of Choke Cherry Seedlings to a Commercial Extract of the Marine Alga *Ascophyllum nodosum* ............................................................... S253
(089) Changes in Chemical and Physical Properties of Soilless Potting Mixes Amended with Composted Dairy Manure of Varying Maturities ........................................... S253
(090) In Vitro Propagation, Not Plant Growth Regulators or Pruning, Increases Branch Number, Canopy Density, and Visual Plant Quality in *Clethra alnifolia* ‘Hummingbird’ ........................................ S253
(091) Characterizing Spray Penetration Following Insecticide Application in Dense and Sparse Oakleaf Hydrangea ‘Alice’ .......................................................... S254
(092) Development of Shoot Architecture of *Ligustrum japonicum* Thunb. in Response to Soil Moisture ...... S254
(093) Physical and Chemical Properties of Peat-based Substrate as Affected by Volcanic Cinder Amendment S255

**Plant Nutrient Management 1** ........................... S255
(281) Morphological Response of Eucalyptus Seedlings to Phosphorus .............................................. S255
(282) Utilization of Manure to Energy Co-products as a Fertilizer Source ............................................ S255
(283) Effects of No-tillage and Improved Fertilizer Management on Corn Yield and Soil N2O Emission in Middle Tennessee .................................................. S256
(284) Camellia oleifera Abel Utilized Phosphorus from Aluminum-bound Phosphate ............................. S256
(285) Influence of the Composition and Nitrogen Concentration of Fertilizer Solution on the Growth and Tissue Nutrient Content of ‘Goha’ Strawberry ................ S257
(286) Steel Slag Affects pH and Si Content of Container Substrates ..................................................... S257
(287) The Characteristic of Seasonal Nitrogen Absorption and Distribution in Pear Trees from N Fertilizers Applied at Different Growing Stages ...................... S257
Appendix: Presentations Listed by Title

(288) Quantification of Nutrients Lost during Annual Pruning, Leaf Abscession, and Fruit Harvest in Pear Trees ................................................................. S258

(289) Mineral Composition of Macronutrients in Shoots of Blackberry Plants Under Nutritional Deficiencies S258

Postharvest 1 ............................................. S259

(001) DA Meter Readings and Chlorophyll Content on the Blushed and Unblushed Sides of Nine Apple Cultivars ............................................................. S259

(002) Effects of Antitranspirants on Enhancing Temporary Drought Tolerance in Bedding Plants ................................................................. S259

(003) Effects of Modified Atmospheres Packaging, Oxygen Permeable Films and Storage Temperatures on the Quality of Minimally Processed Jicama (Pachyrhizus erosus) ......................................................... S260

(004) Application of 1-MCP and Plastic Film Packaging for Extending Shelf Life of Cluster Type Tomatoes ................................................................. S260

(005) Effect of Wax Coatings on Postharvest Quality and Shelf Life of Mango (Mangifera indica L.) cv. ‘Manila’ ................................................................. S261

(006) Postharvest Heated Fungicide Treatments to Control Citrus Black Spot (Guignardia citricarpa) on Citrus Fruits ................................................................. S261

(007) Microbial Biocontrol of Postharvest Papaya Diseases ................................................................. S262

(008) Modulation of 1-MCP Efficacy in Mango and Papaya Fruit by Quarantine Hot Water Treatment ................................................................. S262

(009) Shelf Life and Quality of High Tunnel and Open-field Tomatoes ................................................................. S262

(010) Small-scale Storage of Horticultural Crops in Bangladesh ................................................................. S263

(011) Commercial Scale Hydrocooling of Fresh Market Strawberry ................................................................. S263

Water Utilization and Management ............ S264

(297) Influence of White Plastic and Water Replacement Rates on Pomegranate Orchard Phenology, Fruit Yield, and Quality ................................................................. S264

(298) A Low Cost, Arduino-based System for Monitoring and Controlling Substrate Water Content ................................................................. S264


(300) Relationship Between Temporal Patterns of Soil Moisture and Microclimatic Conditions in Plasticulture Grown Poblano Pepper Under Tensiometer-scheduled Irrigation ................................................................. S265

(301) Comparing Water Use Efficiency in South Texas Furrow and Drip Irrigated Cabbage ................................................................. S266

Fruit Breeding ............................................. S266

(246) Verticillium Wilt Resistance Varies within Ploidy Levels in Strawberry (Fragaria Species) ................................................................. S266

(247) Characterization of Crispy Selections of the Arkansas Blackberry Breeding Program ................................................................. S266

(248) Validating Markers Linked to Soluble Solids Content in Octoploid Strawberry ................................................................. S267

(249) Softening Rate and Ethylene Fruit Production of Different Flesh Textures of Arkansas Peach and Nectarine Germplasm ................................................................. S267

(250) Incorporation of Marker-Assisted Breeding (MAB) in the University of Arkansas and Three Other RosBREED Demonstration Peach Breeding Programs ................................................................. S268

(251) Pedigree Based QTL Analysis (PBA) for Fruit Traits in the University of Arkansas Peach Breeding Program ................................................................. S269

(252) Functional Allele Validation for Bacterial Spot (Xanthomonas arboricola pv. pruni (Xap)) Fruit Resistance in Peach [Prunus persica (L.) Batsch] ................................................................. S269

(253) Evaluation of Peach x Almond Hybrids for Fungal Gummosis Resistance ................................................................. S270

(254) Identifying Sand Pear Cultivar S-genotypes Using Gene Chips ................................................................. S270


(256) Marker-Assisted Seedling Selection in Sour Cherry for Fruit Color and Cherry Leaf Spot Resistance ................................................................. S271

(257) Selection of SSR Markers for the Identification of Zygotic Seedlings in Citrus Rootstock ................................................................. S271

(258) Cybrids between Dancy Tangerine (Citrus reticulata Blanca) and Grapefruit (Citrus paradisi Mafc.) for Improvement of Citrus Fruit Traits ................................................................. S272

Growth Chambers and Controlled Environments 1 ............................................. S272

(147) Creating Novel Basil (Ocimum basilicum) Flavors and Aromas with Light-emitting Diodes ................................................................. S272

(148) Growth Responses of Greenhouse Tomato Seedlings to Different Spectra of Supplemental Lighting Are Season-specific in a Northern Climate ................................................................. S273

(149) Evaluation of Light-emitting Diode and Metal Halide Supplementation Lighting for Greenhouse Bibb Lettuce Production in the Midwest United States ................................................................. S273

(150) End-of-day Manipulation of Phytochrome and Chryptochrome Using Light-Emitting Diodes Has Limited Effect on Bedding Plant Seedling Stem Elongation ................................................................. S274

(151) Ratio of Red to Far–Red Light-emitting Diodes Affects Growth and Cell Cycle of Lettuce Plants ................................................................. S274
Marketing and Economics.......................... S274
(044) Are Consumers Willing to Pay Price Premiums for
Newly Developed East Coast Broccoli Varieties?........ S274
(045) Does Local Label Bias Consumer Taste Bud and
Choice Behavior: Evidence of a Strawberry Sensory
Experiment .............................................. S275
(046) Cost Estimation of Establishing a Cider Apple
Orchard in Western Washington.......................... S275
(047) An Interactive Decision Support Tool to Estimate the
Economic Feasibility of Organic Apple Production..... S276
(048) Berry Production: Using Interactive Budgeting Tools
to Assess Costs, Revenues and Risks .................... S276
(049) Economic Considerations of Producing Organic
Strawberries Under Two Different Production
Systems .................................................. S276
Organic Horticulture 1................................. S277
(058) Response of Blackberry Cultivars to Fertilizer Source
in an Organic Fresh Market Production System ........ S277
(059) Performance of Eight Strawberry Cultivars in
Organically Managed High Tunnels for Fall and Spring
Production in North Carolina ............................ S278
(060) Yield of Organically Grown Mango As Affected by
Soil Applications of a Biostimulant Alga Extract ....... S278
(061) The Production of Organic Vegetables in the
Southeastern United States in Reference to Sod-based
Rotation and Strip versus Conventional Tillage ....... S278
(062) Tomato Yield, Plant and Soil Nitrogen as Affected
by High Tunnel and Field Production Systems Under
Conventional or Organic Fertility Treatments ......... S279
(063) Organic Heirloom Tomato Response to Surface-
Applied High Poultry Compost Level .................. S279
(064) Yield of Tomato Cultivars Grown in the Organic
Management in the U.S. Virgin Islands ................. S279
(065) Effect of Organic Amendments and Inorganic
Fertilizers on Agronomic Traits and Yield of Corn ..... S280
Propagation 1.......................................... S280
(159) Pretreatment Effects on Seed Germination: An
Interspecific Comparison of Two Nyssa Species ........ S280
(160) Micropropagation of a Selected Clone of
Amelanchier alnifolia .................................... S281
(161) Rooting of Adult Stem Cuttings of Cupressus
sempervirens L. ‘Stricta’ .................................. S281
(162) Hormones Improved Rooting of Zelkova serrata
Softwood Stem Cuttings ................................ S281
(163) Cutting Type and Hormone Affect Vegetative
Propagation of Phlox pulchra ............................ S282
(164) Plant Regeneration through Protocorm-like Bodies
Induced from Leaf and Petiole Explants of Pinellia ternata,
an Important Medicinal Plant ................................ S282
(165) Seed Provenance and Substrate as Significant Factors
on Picea abies (L.) Karst. Production ..................... S283
Teaching Methods 1................................. S283
(070) Increasing IPM Awareness through Customized
Educational Workshops .................................. S283
(071) A Comparison of the Effectiveness of Eight Types
of Learning Activities When Teaching “Organic Farming
Systems” to Horticulture and Non-horticulture
Majors ...................................................... S283
(072) How To: Best Methods to Present Research
Information to a Public Audience ....................... S284
(073) Adapting Extension Agritourism Training for
Undergraduate Education ................................ S284
(074) Using Innovative Technologies to Create A Custom
Learning Environment ................................. S285
(075) Establishing a New Graduate Program in a
Multidisciplinary Campus ................................ S285
(076) Challenges and Opportunities in Plant Identification
Laboratories .............................................. S286
Vegetable Crops Management 1.................. S286
(367) The DSS GeScoN for Managing Irrigation and N
Fertilization in Vegetable Crops: Application in Processing
Tomato Crop in Southern Italy ............................ S286
(368) Eggplant (Solanum melongena L.) Plant Growth and
Fruit Yield as Affected by Drip Irrigation Rate ........ S286
(369) Evaluation of Selected Black Seeded Bean (Phaseolus
vulgaris L.) for Flavonol and Triterpens Content in Nuevo
León, Mexico ............................................. S286
(370) On-farm Evaluation of Fresh Market Tomato
Cultivars for Summer Field Production .................. S287
(371) Grafted Vegetable Transplants for Earliness and
Productivity during Northern Field Seasons .......... S287
(372) Bioclimatic Modeling of Crisphead Lettuce
Phenology As a Tool for Planning Seeding and
Harvest .................................................... S288
(373) Grafting with Hybrid Rootstocks to Increase Tomato
Productivity in the Great Plains ......................... S288
Undergraduate Student Poster Competition
(Session 1) ............................................. S289
(134) Influence of Seaweed Extract and Vesicular–
Arbuscular Mycorrhizae on Growth and Development of
Bell Pepper .............................................. S289
(135) Growth and Morphology of Greenhouse Bell Pepper
Transplants Grown Under Supplemental LEDs and HPS
Lighting .................................................... S289

Appendix: Presentations Listed by Title
(136) Effect of Cultivar on Growth and Strobile Production in Hops (Humulus lupulus) in Central Florida ..........S290
(137) Nutritional Quality Parameters in Kale Cultivars Are Higher Under Narrow-band LED Light than Under Fluorescent/Incandescent Light ..............................................S290
(138) Viability and Colonization of Vesicular Arbuscular Mycorrhiza on Tomato and Cowpea Roots ..........S290
(139) Nutritive and Quality Traits of Colored Sweet Mini-peppers ..........................................................S291

Environmental Stress Physiology ..........S291
(190) Electrical Potentials in ‘W. Murcott’ Tangor Trees in Response to Salinity Stress ..................................S291
(191) Comparative Responses of Glaucium Species to Salinity Stress ..........................................................S292
(192) Screening Glaucium Species for Drought Resistance with Emphasis on the Contributing Physiological Characters and Overall Performance .................................................S292
(193) The Effect of Flooding Duration and Portion of the Roots Submerged on the Physiology, Growth, and Survival of Papaya (Carica papaya L.) ..................................................S293
(194) Enhancing Drought Tolerance in Common Bean, the Most Widely Consumed Legume ........................S293
(195) Auxin and Indol Acetic Acid Oxidase Activity during Sweetpotato Storage Root Initiation ..............S293
(196) Switchgrass Germination and Growth as Affected by Soil Salinity .........................................................S294
(197) Temperature Effect on Seed Germination in Spinach (Spinacia oleracea L.) .........................................S294
(198) Initial Evaluation of Spinach Collections for Drought Tolerance .........................................................S295
(199) Abscisic Acid Impacts Tomato Fruit Quality by Increasing Carotenoids and Soluble Sugars and Decreasing Organic Acids .................................................................S295
(200) Exogenous Foliar and Root Applied Abscisic Acid Increases the Influx of Calcium into Tomato Fruit Tissue and Decreases the Incidence of Blossom-end Rot ..........S296

Genetics and Germplasm 2 .................S296
(208) Analysis of Floral Transcriptomes of Lonicera macranthoides ‘Jincuilei’ and Its Wild Type .................S296
(209) Developing Molecular Marker Resources for Pecan ................................................................S297
(210) Determining the Genotypes for and Genetic Distances between Two Loci Controlling Caladium Leaf Spotting and Main Vein Colors .................................................................S297
(211) Possible Ancestor of Japanese Persimmon (D. kaki Thunb.) Existing in Yunnan Province and Northern Vietnam .................................................................S297

(212) Toward Understanding Genotype x Environment Interactions in Black Raspberry (Rubus occidentalis L.) ...... S298
(213) Genetic Study of Serpentine Leafminer Resistance in Valmaine Romaine Lettuce ................................S298
(214) Resistance to Phytophthora rubi in Wild North American Red Raspberry Germplasm .....................S299
(215) Evaluation of Red Cabbage Genotypes for Anthocyanin Content and Quality ................................S299
(216) Exploring Diversity in Brassica Crops for Glucosinolates and Cancer Chemopreventive Bioactivity ..................S299

Ornamentals/Landscape and Turf 1 ..........S300
(118) Ornamental Annuals and Perennials Differ as Insect Attractors .........................................................S300
(119) Initial Landscape Evaluation of Daylily Cultivars for Rust Resistance ..................................................S300
(120) River Birch (Betula nigra) Growth and Root Extension from Three Production Systems during Landscape Establishment ..........................................................S301
(121) Soil Water Content Affects Decomposition of Plantable Biocontainers for Landscape Use ..............S301
(122) Establishment of Roses in High Soil Moisture Conditions ...............................................................S301
(123) Comparisons of Species Diversity of Intensive Green Roofs between Honolulu, Hawaii, and Guangzhou, China ..................................................................................S302
(124) What Does the Consumer Say? South Florida Survey on Ornamental Grasses .................................S302
(125) National Ornamental Grass Trials 2014 ..........S302

Plant Nutrient Management 2 .................S303
(290) Struvite as a P Fertilizer Source for Irrigated Vegetables on Calcareous Soils ..................................S303
(291) Low-molecular-weight Organic Acids As a Phosphorus Fertilizer Alternative for Vegetable Production in Calcareous Soil Regions ..................................................S303
(292) Influence of Leaching Fractions of Fertigation on Soil Chemical Properties and Plant Growth during Hot Pepper Plug Seedling Production ........................................S303
(293) The Effects of a Soar Peach Micronutrient and Biostimulant Program on Peach Yield in South Georgia ..................................................S303
(294) Effects of Fertilizer Rate and Media Formulation on Vertical Growth and Basal Shoot Production of Transplanted Tissue-cultured Plugs of Dracaena ‘Ruth Luka’ ...........................................S304
Appendix: Presentations Listed by Title

(295) Using Heat Unit Models to Predict N Release from Controlled Release Fertilizers for Vegetable Production .......................................................... S304
(296) Controlled Release Fertilizers Affect Croton Production .......................................................... S304

Postharvest 2 .............................................. S305

(012) Soluble Solids Content and Firmness Determination In Intact Peach Fruit cv. ‘Aurora 1’ Using Near-infrared Spectroscopy (NIR) ...................................................... S305
(013) Peach Fruit Ripening and Quality Changes as Affected by High Carbon Dioxide Treatment before Cold Storage .......................................................... S305
(014) Proteases Associated with Programmed Cell Death and Watersoaking in Ethylene-treated Immature Cucumber Fruit .......................................................... S305
(015) Sample Handling Affects Accuracy of HS-SPME GC for the Study of Volatile Aroma Compounds in Apple Tissue .......................................................... S306
(016) Volatiles Production from Isoleucine in Fresh-cut Apple, Using Alginate Coatings As the Holding Matrix .......................................................... S307
(017) Effect of Alginate Edible Coatings Formulated with Linoleic Acid on the Aroma and Quality of Fresh-cut Golden Delicious Apple Wedges ...................................................... S307
(018) Biochemical and Molecular Processes during Ripening and Over-ripening of Banana (Musa AAA Cavendish Subgroup) Fruit Exhibit Characteristics of Programmed Cell Death .......................................................... S308
(019) Acute Suppression of Ripening and Negation of a Respiratory Climacteric In Midclimacteric Tomato Following Short-Term Application of 1-Mcp Under Hypobaric Hypoxia ...................................................... S308
(020) Preliminary Physicochemical Characterization of Genomically Diverse Georgia Grown Bananas during Postharvest Ripening .......................................................... S309
(021) Glucosinolates Are Enhanced by Controlled Application of Abiotic Stresses in Broccoli (Brassica oleracea var. Italica) during Postharvest Storage .......................................................... S309

Viticulture and Small Fruits 1 .......................... S310

(327) Improved Productivity of Chambourcin Grape Grafted to Seven Rootstocks .......................................................... S310
(328) Deficit Irrigation Strategies and Wine Grape Cold Hardiness .......................................................... S310
(329) Frontenac Response to Training System and Leaf Removal Treatments .......................................................... S311
(330) Delay of Bud Break on ‘Edelweiss’ Grapevines with Multiple Applications of Amigo Oil and NAA .......................................................... S311
(331) The Use of Different Plant Growth Regulators in ‘Scarlet Royal’ Table Grape Production to Determine Postharvest Quality .......................................................... S312
(332) Early Primocane Yield Data of Advanced Thorny and Thornless Primocane-fruiting Blackberry Selections at Kentucky State University .......................................................... S312

Floriculture 1 ............................................. S315

(094) Color Expression, Pigment Composition, and Related Gene Transcription in Double Coloring Petals of Cut Roses .......................................................... S315
(095) Optimum Substrate Moisture Content Improves Quality of Impatiens and Coleus .......................................................... S315
(096) Growth and Development of Canna Lily ‘Erimine’ Liners Treated with Flurprimidol or Paclobutrazol .......................................................... S315
(097) Co-effectiveness of Supplemental Lighting and Irrigation in Conjunction with Compensation for Midday Depression of Photosynthesis of Cut Roses .......................................................... S315
(098) Response of Chrysanthemums to Various Day–Night Air Temperature Differences/Drops and Root Zone Temperatures at the Same Daily Integrated Temperature .......................................................... S316
(099) Nutrient Status of Cosmos (Cosmos bipinnatus) in Response to Mycorrhizal Treatment .......................................................... S316
(100) Petunia Mutagenesis and Identification of a Self-fertile Mutant for Tilling .......................................................... S317
(101) Productivity of Direct-seeded versus Transplanted and Season-long versus Successional Plantings of Zinnia Cut Flower Field Crops .......................................................... S317

Local Food Systems ........................................ S317

(031) Survival Analysis and Detection of Human Pathogens for Organic Strawberry Production in Tennessee .......................................................... S317
Appendix: Presentations Listed by Title

(033) What’s Hop’pening in Northwest New Mexico? Hops (Humulus lupulus) Trials Summary 2009 to 2014 ........................................... S318
(034) Hoophouses for Health: Building the Good Food Infrastructure ................................................................. S319
(035) Resources Required By Different Types of Food Hubs .................................................................................... S319
(036) Local Fertility: Municipal and Industrial Waste as a Source of Organic Matter and Nitrogen, and Its Effect on Vegetable Yields .............................................................. S320
(037) Evaluating Baby-leaf Salad Greens for Spring and Fall Production in Northwest Washington ................. S320
(038) Growing Growers in the Kansas City Metropolitan Area .................................................................................. S321

Propagation 2 .............................................................................. S321

(166) Development of a Pre-screening Method for Storage of Grafted Cucurbitaceae Seedlings ................... S321
(167) Effects of Grafting Methods and Re-rooting on the Growth Characteristics of Grafted Muskemelon Plants . S322
(168) Shoot Forcing and Rooting of Stem Cuttings of Morus (Mulberry) Species .................................................. S322
(169) Clonal Propagation of Guayule through Cuttings S322
(170) Development of a Liquid Micropropagation System for Asparagus officinalis L. ........................................ S323
(171) Growth of Christ Thorn (Euphorbia milli var. Splendens) Slips in Different Substrates .......................... S323
(172) Yield Performance and Bean Quality Traits of Cacao Propagated by Somatic Embryogenesis and Grafting ........................................................................................................... S324
(173) Propagation and Growth Parameters of Preselected Pomegranate (Punica granatum) Cuttings from the USDA–ARS National Clonal Germplasm Repository . S324
(174) In Vitro Culture of Immature Peach Embryos ... S324
(175) Effects of Indole-3-butyric Acid, Silver Nitrate, and Management on the Rooting and Stimulation of Active Growth of Hybrid Hazelnuts (Corylus americana x C. avellana) Stem Cuttings ................................................................................. S325

Teaching Methods 2 ......................................................... S325

(077) Smart Devices and Apps Help Support Research, Extension, and Teaching .................................................. S325
(078) Promoting Horticulture in the United States—A National Study and Action Plan ................................................. S326
(079) Assessing Student Learning from an Experiential Hydroponics Production Module in a Greenhouse Management Course ........................................................................................................ S326
(080) A Pilot Study of College Students’ Experiences with an Educational Game to Learn Difficult Plant Science Concepts ........................................................................................................ S326
(081) A Proactive Model for Recruiting Students into Agriculture Disciplines ......................................................... S327

Tropical Horticultural Crops ......................... S327

(315) Genetic Diversity of Papaya Ring Spot Virus in Puerto Rico ................................................................. S327
(316) Assessing Avocado for Laurel Wilt Resistance, Fruit Quality, and Horticultural Traits for Production in East Central Florida ................................................................. S327
(317) Development and Biochemistry of Timbiriche (Bromelia hemisphaerica Lam.) Fruits .......................... S328
(319) Banana Fruit Production in More Temperate Climates: Making a Case for Banana Fruit Production in Coastal Alabama ........................................................................................................ S328
(320) Lessons Learned in Conservation Tillage Vegetable Systems in the Sub-tropics and Tropics .................. S329
(321) The Guam Plant Extinction Prevention (GPEP) Program for Saving Rare Plants in Guam .................. S329
(393) Propagation of the Fruit Crop Artocarpus altilis by Root Cuttings of Various Lengths and Diameters ...... S330

Vegetable Crops Management 2 ............... S330

(374) Nutritively Important Pigments in Baby Chinese Kale Are Higher Under Narrow Band LED Light than Under Fluorescent/Incandescent Lighting in Controlled Environments ................................................................. S330
(375) Compost for High Tunnel Tomato Production ... S330
(376) Effect of Compost Application Rates on High Tunnel Tomato Yield ........................................................ S331
(377) Antioxidant Content of Pepper Grown in Recycled Waste ........................................................................ S331
(378) Biostimulants Effects on Bell Pepper (Capsicum annuum) Plant Growth, Fruit Yield, and Incidence of Fruit Disorders ................................................................. S331
(379) Sucker Control of Tomato Seedlings by Fatty Alcohol Application .......................................................... S332
(380) An Investigation of Weed Suppression Using Various Pre-emergent Herbicide Treatments on a Direct-seeded, Field Grown Leaf Lettuce ‘Green Salad Bowl’ Crop ..S332

Undergraduate Student Poster Competition 2 ......................................................... S333

(140) The Effects of Control Release Fertilizer Packets on Nutrient Leaching ................................................................. S333
(141) Teaching Elementary Age Students about Sustainable Food Production through a Successful Local School–University Student Club Partnership ........................................... S333
(142) Iowa State University Heritage Tree Program: Preserving the Genetic Heritage of Iowa State’s Award-winning Campus ................................................................. S334
Appendix: Presentations Listed by Title

(143) Evaluation of (Synsepalum dulcificum) Growth and Productivity in Response to Media Formulation .............S334
(144) Interaction of e-Brassinoïdole and Unicanzole on the Salt Stress in Two Cultivars of Sweetpotato ..............S334
(145) Effects of Nutrient Salt Formulations and 6-Benzylaminopurine on Micropropagation of ‘Blue Moon’ Wisteria .................................................................S335
(146) Preliminary Identification of Molecular Markers Associated with Precocity in Mangaba Tree .....................S335

Genetics and Germplasm 3 ...................... S335
(217) Breeding for Improved Germination Under Water Stress in the Russian Dandelion ...........................................S335
(218) QTL Analysis for the Identification of Loci Controlling Antioxidant Capacity in Brassica oleracea L. var. italicar ..........................................................S336
(219) Collard Landraces are Novel Sources of Glucoraphanin and other Aliphatic Glucosinolates ..........S336
(220) Integrating Genetics and Weed Management ....S336
(221) Cryopreservation Protocols Using Aluminium Plates, V Cryo-plate and D Cryo-plate Method .................S337
(222) Cryopreservation of Blueberry Dormant Shoot Tips Using V Cryo-plate Method ................................S337
(223) Effect of Time in Cryoprotectant Solution and Dehydration in Shoot Apex Regeneration of Genipap for Cryopreservation ............................................S338
(224) Effect of Different Procedures and Time Storage on the Contamination of Zygotic Embryos for the Purpose of Exchange of Coconut Germplasm ............S338
(225) Mid-term In Vitro Preservation in Minimum Growth Condition of Wild Chayote (Sechium compositum Donn.Sm.) .................................................................S339
(226) Mid-winter Cold Hardiness of Corylus fargesii Germplasm As Determined in Laboratory Freezing Tests ........................................................................................................S339

Ornamentals/Landscape and Turf 2........... S340
(126) Evaluation of a Predetermined Fungicide Rotation for Control of Impatiens Downy Mildew in a Texas Landscape .................................................................S340
(127) Evaluation of Ground Covers for Use in Guam Landscapes ..............................................................................S340
(128) Phytotoxicity of Herbicides, Fungicides, and Insecticides on Ornamental Monocot Species in Southeastern U.S. for Interregional Research Program (IR-4) ........................................................................S340
(129) Management of an Invasive Ornamental: Suppression of Ruellia simplex (Mexican Petunia) by Native Species during Initial Establishment from Seed ..........S341
(130) Effect of Glycinobetain Seed Priming on Turfgrass Germination Under Drought, Salinity, and Sub-optimal Temperatures ....................................................S341
(131) to Persistence of the Fungicides Chlorothalonil and Fludioxonil Under Snow Cover .................................S341
(132) Effects of Saline-Alkali Conditions on Turfgrass Establishment ..................................................................S342
(133) Effect of Nitrogen Rate on Turfgrass Quality among Five Cultivars of St. Augustinegrass ........................S342

Produce Quality, Safety, and Health Properties .................................................. S342
(022) Teaching Good Agricultural and Handling Practices to Mississippi Producers .............................................S342
(023) Food Safety Training Adapted for Various Size Operations ...........................................................................S343
(024) Effect of Sanitizers on the Survival of Lactobacillus plantarum and Salmonella on Surface Inoculated, Hydrocooled Strawberries ........................................S343
(025) Detection of Coliforms in Lettuce Plants (Lactuca sativa cv. Black Seeded Simpson) Grown in a Municipal Sludge Compost and Peat ........................................S344
(026) Watermelon-based Sunscreen Blocks UVA and UVB Light ..............................................................................S344
(027) Sensory and Chemical Characteristics of Citrus × Poncirus Hybrids ................................................................S344
(028) The Effect of Multi-wavelength Light-emitting Diode Lighting on the Growth Response of Leaf Lettuce at Different Stages ..................................................S345
(029) Studying on Improving the Quality Using PGA Acid in Grape of Fujiminori Grapevines ........................S345
(030) Mineral and Fatty Acid Composition in Croatian Garlic (Allium sativum L.) Ecotypes ..........................S345

Vegetable Breeding ................................ S346
(259) Variation in Chlorogenic Acid Content among Blueberry Cultivars, Breeding Selections and Populations Grown in North Carolina ............................................S346
(260) Genetic Diversity of the USDA Cabbage Collection Germplasm Using SSR Markers ..........................S347
(261) Selection for Geosmin Production in Table Beet (Beta vulgaris sp. vulgaris) .................................................S347
(262) Combining Fruit Quality and Late Blight Resistance in Tomato ...........................................................................S347
(263) Studies on Heterotic Effects of Crosses of Onions with Different Skin Colored Onion Lines ......................S347
(264) Development of SSR and SNP Markers and Association Mapping of Morphological Traits in Cowpea [Vigna unguiculata (L.) Walp.] ..................................S348
(265) Evaluation of Carrot (Daucus carota L.) for Traits
### Viticulture and Small Fruits 2

<table>
<thead>
<tr>
<th>Presentation Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>(333) Strawberry Virus Detection, Identification, Best Management Practice Recommendations and Information Dissemination</td>
<td>S351</td>
</tr>
<tr>
<td>(334) Strawberry Production in High pH Soil at High Elevation in the Southwest</td>
<td>S351</td>
</tr>
<tr>
<td>(335) Extending the Season for Strawberry Production Under High Tunnels: Lessons Learned during a Harsh Winter</td>
<td>S352</td>
</tr>
<tr>
<td>(336) Comparison of Winter Strawberry Production in a Commercial Heated High Tunnel versus a University Greenhouse</td>
<td>S352</td>
</tr>
<tr>
<td>(337) Tri-Trophic Level Interactions of T. urticae and Beneficial Inoculants in Three Strawberry (Fragariaananassa) Varieties</td>
<td>S353</td>
</tr>
<tr>
<td>(338) The National Strawberry Sustainability Initiative: From Laboratory to Field</td>
<td>S353</td>
</tr>
</tbody>
</table>

### Herbs, Spices, and Medicinal Plants

<table>
<thead>
<tr>
<th>Presentation Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>(322) Essential Oil of Caryopteris x clandonensis ‘Durio’: Chemical Composition and Repellent and Larvicidal Activity against Aedes aegypti (L.) (Diptera: Culicidae)</td>
<td>S358</td>
</tr>
<tr>
<td>(323) Phenolic Content and Antioxidant Capacity of Spicebush (Lindera benzoin L.) Teas</td>
<td>S359</td>
</tr>
<tr>
<td>(325) An Effect of Natural Yuju Oil on Moisturizing, Erythema, Melanin, and Elastic Efficacy by Essential Oil Production Methods</td>
<td>S359</td>
</tr>
<tr>
<td>(326) An Effect of Native Herbal Essential Oil of Chrysanthemum boreale Makino EEG and Autonomic Nervous System Responses</td>
<td>S360</td>
</tr>
</tbody>
</table>

### Plant Biotechnology

<table>
<thead>
<tr>
<th>Presentation Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>(271) Somatic Embryogenesis and Organogenesis of Rare Woody Species in Georgia, Stewartia and Franklinia</td>
<td>S360</td>
</tr>
<tr>
<td>(272) Genetic Transformation of Micro-Tom Tomato with a Citrus Calcium Signal Modifier Gene (CSM-1)</td>
<td>S360</td>
</tr>
<tr>
<td>(273) Camelina Species Under Drought Stress</td>
<td>S361</td>
</tr>
<tr>
<td>(274) Develop Microsatellite Markers for Ginkgo biloba L. Clones</td>
<td>S361</td>
</tr>
<tr>
<td>(275) Molecular Regulatory Mechanism of Ginkgo biloba L. from Next-generation Sequencing Technology</td>
<td>S361</td>
</tr>
<tr>
<td>(276) Evaluation of Genotyping by Sequencing in Octoploid Strawberry</td>
<td>S362</td>
</tr>
<tr>
<td>(277) Rapid Assay of Tissue Specific Promoters in Vitis</td>
<td>S362</td>
</tr>
<tr>
<td>(278) Identification and Validation of Candidate Genes</td>
<td>S362</td>
</tr>
</tbody>
</table>
Appendix: Presentations Listed by Title

Affecting Volatile Compounds in Strawberry Fruits ....S363
(279) Petunia Metacaspases Are Regulated during Corolla Senescence and in Response to Abiotic Stress ............S363
(280) Transcriptomic Analysis of Cold Stress-responsive Genes in Brassica oleracea ......................................S364

Temperate Tree Nut Crops .................. S364
(349) Grafting Olive to Control Verticillium Wilt: A Study Under Controlled Conditions .................................S364
(350) Excessive Blanking in Pistacia vera cv. ‘Pete 1’ .................................................................S364
(351) Performance of Five Pecan Cultivars and Selections as Immature Trees in Southern Georgia ..................S365
(352) Nitrogen Fertilization of Young Chinese Chestnut Trees .............................................................................S365

Vegetable Crops Management 3 ............S365
(381) A Comparison of Ca and Mg Rates in Soilless Media for Optimum Vegetable Production Irrigated with Alkaline Water .............................................................S365
(382) The Impact of Nitrogen and Sulfur Fertilization on Yield, Quality, and Flavor of Field Grown Vidalia Onion ...S366
(383) Evaluating Cover Croping Systems for Beginning High Tunnel Producers in West Virginia .......................S366
(384) Sweetpotato Weevil Damage Influenced by Variety and Harvest Date .......................................................S366
(385) Strip-tillage and Row Cover Use in Organic and Conventional Cucurbit Crops ..............................................S367
(386) Studies on Occurrence and Infection Time of Downy Mildew of Onion (Allium cepa) in Korea ..................S367

Weed Control & Pest Management ..............S367
(302) Critical Period for Weed Control in Grafted versus Nongrafted Tomato ....................................................S367
(303) Effect of Increasing Spray Solution Salinity on Postemergence Herbicide Weed Control and Crop Tolerance ..............................................................................................................S368
(304) Effect of Simulated Glyphosate Drift to Four Potato Processing Cultivars ..................................................S368
(305) Risk of Herbicide Resistance for GMO Corn in Chile S369
(306) Allelopathic Effects of Horseradish Leaves ......S369
(307) Effects of Photosensitive Shadehouses on Ornamental Plant Pests ..............................................................S369
(308) Jasmonate Application to Broccoli Plants Reduce Growth and Survival of the Insect Herbivore, Trichoplusia ni ..................................................................................................................................S370
(309) Induced Systemic Acquired Resistance, after Applying Two Oxidant Based Disinfectants to Kidney Beans (Phaseolus vulgaris) Seedlings, Followed by a Bacterial Wilt Disease Inoculation ......................................S370

Crop Physiology ........................................S371
(176) Increased Fertilizer Levels Do Not Prevent ABA-Induced Chlorosis in Pansy .....................................................S371
(177) Water-deficit Priming Increases Leaf Gas Exchange of Papaya (Carica papaya L.) .............................................S371
(178) Ecophysiological Performance, Growth, and Yield of Four Pigeonpea Varieties Under Different Planting Dates and Densities in the Southeastern United States ..............S372
(179) Contrasting Responses of Corn Ecophysiological Performance and Yield to Agricultural Practices in Two Years with Different Rainfalls ................................................S372
(180) Low Temperature Conditioning Effect on Secondary Metabolism and Antioxidant Capacity of Garlic during Development ............................................................S373
(181) Characterization of Drought Response of Transgenic Tomato Plants Expressing Spermidine Synthase Under Constitutive or Fruit/Ethylene-specific Promoters ........S373
(182) Changes in Carbohydrate Synthesis during Cold Acclimation in Cranberry (Vaccinium macrocarpon) ........S374

Genetics and Germplasm ..........................S374
(227) Candidate Genes for Ornamental Traits in Blueberry ................................................................................S374
(228) Genetic Structure of Peach Breeding Germplasm from Embrapa, Brazil ..........................................................S374
(229) Analytical and Sensory Analysis of Pepper Fresh-cut Quality Reveals Extensive Diversity within the Capsicum Genepool for Crop Improvement ..............................................S375
(230) Traditional Plant Breeding Approach Used by Bridgestone Americas, Inc. to Develop Guayule as a Domestic Natural Rubber Source .................................................................S375
(231) Genetic Resources of the Functional Food, Teramnus labialis (L.f.) Spreng for Improving Seed Number, Flavonol Content, Oil Percentage, and Fatty Acid Compositions S376
(232) Variation of Carotenoids and Polyphenolics in Peach (Prunus persica L.) and Implications on Breeding for Modified Phytochemical Profiles ..............................................................S376
(233) Evaluation of Hop Cultivars for Commercial Production in North Carolina ..................................................S377
(234) Investigating Stevia Germplasm as Alternative Highly Profitable Crop for Farmers ........................................S377

Growth Chambers and Controlled Environments 2 ..................................................S378
(153) Physical and Chemical Characteristics of Hydroponic Media and Their Effects on Growth of Arugula Microgreens ..................................................................................................................S378
Appendix: Presentations Listed by Title

(154) Winter Season Greenhouse Production of Strawberry in Desert Southwest .......................................................... S378

(155) Effects of Shade Cloth on Specialty Crop Production in High Tunnels ................................................................. S379

(156) Temporary Low Temperature Accumulates Antioxidant Phenolic Compounds in Kale .............................................. S379

(157) Air Anion Improves Lettuce Growth in a Plant Factory ......................................................................................... S379

(158) Season Extension and Sugar Accumulation in Low Tunnel-grown Spinach ............................................................... S380

Ornamental Plant Breeding ................................................... S380

(235) Establishment of In Vitro Propagation System and Induction of Autotetraploidy in Monarda fistulosa and M. punctata (Lamiaceae) ................................................................. S380

(236) Polyploidization in Hippeastrum Hybrids and H. papilio ..................................................................................... S381

(237) Pineapple Lily (Eucomis) Tissue Culture and Somatic Embryogenesis ........................................................................ S381

(238) Daytona Heat Danica Pink, Daytona Heat Petty Blue, and Daytona Heat Dale White, New Vitex Releases ........... S381

(239) Assessment of Rosa Species Plant Architecture in the Field ..................................................................................... S381

(240) Phenotypic Variation of Advanced Dichroa x Hydrangea Hybrids .................................................................................. S382

(241) Characterization of 10 Hybrid Rose Populations for Heat Tolerance ........................................................................ S382

(242) A Need for Speed: High Throughput Phenotyping for Rhododendron pH Adaptability ................................................ S382

(243) Selection, Evaluation, and Introduction of Hardy Superior Woody Plants By the NDSU Woody Plant Improvement Program ................................................................. S383

(244) Boxwood Breeding at the United States National Arboretum ..................................................................................... S383

(245) Development of Genic Microsatellite Markers for Genetic Diversity Analysis of Boxwood Accessions to Breed for Blight-tolerant Cultivars .............................................. S384

Vegetable Crops Management 4 ...................................... S384

(387) Light Source Effects on Hydroponically Grown Miniature ‘Pom Pom’ Lettuce ................................................................. S384

(388) Soilless Media Effects on Hot Peppers (Capsicum chinense Jacq.) Growth and Development and Root Colonization by Trichoderma ........................................................................ S385

(389) Commercial Extract From the Brown Seaweed Ascophyllum nodosum (Stimplex®) Improves Yield and Quality of Hydroponically Grown Lettuce .......................................................... S385

(391) Interaction between Chemical-induced Stress and Biological Agents on the Incidence of Sweetpotato Tip Rot in Mississippi ............................................................ S385


BioEnergy............................................................... S386

(186) Evaluating Switchgrass Cultivars for Bioenergy Production in New Jersey ...................................................................... S386

(187) Oil Smoke Point Testing of Camellia oleifera .......................................................................................... S386

(188) Salt Tolerance of Six Switchgrass Varieties .......................................................................................... S387

(189) Genetic Diversity, Cytogenetics, and Biomass Yields among Arundo Species and Accessions (Arundinaceae) ...... S387

Floriculture 3 ............................................................... S388

(110) Substrates Affect Irrigation Frequency and Plant Growth of Potted Orchid ...................................................................... S388

(111) Controlling Flowering of Photoperiodic Ornamental Crops Using Light-emitting Diode Lamps: A Coordinated Grower Trial .......................................................... S388

(112) Characterization and Comparison of Lesions from Physiological Disorders on Ornamental Sweetpotato (Ipomoea batatas), Tomato (Solanum lycopersicum var. hirsutum ‘Maxifort’), and Interspecific Geranium (Pelargonium x ‘Caliente Coral’) ................................................. S388

(113) Development of Photosynthetic Response Curves and Their Integration into a Decision-support Tool for Floriculture Growers .......................................................................................... S389

(114) Potting Medium Microbial Respiration Rates and Sporidial Efficacy Responses to a Single Application of Three Chlorine Dioxide Formulations ........................................................................ S389

(115) Postharvest Chilling and Vase Life of Herbaceous Peonies ...................................................................................... S390

(116) Foliar Plant Growth Retardant Applications Suppress Height of Seed-propagated New Guinea Impatiens .......... S390

(117) Ethephon Applications Delay and Diminish Flowering of Streptocarpus ........................................................................ S391

Organic Horticulture 2................................................... S391

(051) On-farm Research Using Soil Amendments for Soil Quality and Disease Suppression in Organic Vegetable Systems ........................................................................ S391

(052) Engaging Stakeholders to Refine Research Objectives for Grant Proposals ...................................................................... S392

(053) Cover Crop Value as Perceived by Organic Vegetable Growers ............................................................................................ S392

(054) Evaluation of Organic Alternatives for Weed Management in Pulasan (Nephelium ramboutan-ake) .... S392

(055) Organic Mulch as an Alternative to Black Plastic Mulch .............................................................................................. S393

(056) Effects of Cover Crops and Vermicompost on Strawberry Production in the Southeastern United States .... S393
Appendix: Presentations Listed by Title

Pomology ................................................. S394
(357) On-farm Soil Quality Testing in Organic, Integrated, and Conventional Peach Orchard Systems ............... S394
(394) Organic Mulchings and Their Effects on Development, Fruit Yield and Quality in Watermelon . S394

Plasticulture .............................................. S394
(184) Managing Winter Injury for Annual Strawberry Plasticulture Production Systems in the Great Plains ... S395
(185) Evaluation of Season Extension Covers in Higher Elevation (6500+ ft.) Growing Areas ..................... S395
(186) Effect of Colored Plastic on Growth and Yield of Two Cultivars of Eggplant (Solanum melongena L.) in Dry Tropics .................................................. S396

Pomology .................................................. S396
(353) Precocious Flowering of Kentucky State University Pawpaw Advanced Selections and Cultivars ........ S396
(354) Developing Mechanical Harvesting for California Black Ripe Table Olives: Olea europaea cv. ‘Manzanillo’ ................................................................. S397
(355) Cactus Virus X (CVX) a New Threat to Pitahaya/ Dragon Fruit (Hylocereus Species) Production in California ................................................................. S397
(356) Floral Visitors to Chinese Date (Ziziphus jujuba) in New Mexico and Their Potential Role in Pollination ... S397
(357) Incidence of Phyllosticta Fungal Spot and Cracking Prevalence in the Fruit of Sixteen Pawpaw (Asimina triloba) Varieties ............................................. S398
(358) Identification of Blooming Type, Blooming Process, and Pollen Germination Rate of Jujube (Ziziphus jujuba Mill.) in New Mexico ........................................... S398
(359) Unique Pawpaw Germplasm Selections in the Kentucky State University Repository Collection ...... S399
(360) Does Rootstock and Fertilizer Choice Affect Apple Orchard Productivity and Soil Community Ecology? .. S399
(361) New Rootstocks for Florida Peach Production: Horticultural Evaluation of Two New Rootstocks With Potential Resistance to the Peach Root-Knot Nematode ............................................. S400
(362) Physical and Chemical Attributes of Pomegranate (Punica graminatum L.) Fruit Grown in Georgia .......... S400
(363) Tropicalized Peaches Can Be Produced in Central Mountainous Region of Puerto Rico ....................... S401
(364) Rootstock Testing of Prunus Species Hybrids for Peach in South Carolina ........................................... S401
(365) Simulation of Light Distribution in 3D Model of ‘Golden Delicious’ Apple Trees ................................. S401
(366) Surveying the Research and Extension Needs of U.S. Cider Apple Growers and Cider Makers ................. S402

Viticulture and Small Fruits 3 ..................... S402
(339) Determination of Cultivar-specific Threshold Temperatures and Heat Requirements for Prediction of Budbreak, Full Bloom, and Veraison in Wine Grape ... S402
(340) ‘Noiret’ Winegrape Bud Cold Hardiness: Effects of Temperature, Month, and Black Rot Severity .......... S403
(341) Freezing Tolerance of Vitis vinifera Cultivars New to Northeastern United States ............................. S403
(342) Managed Canopies of Norton Grape Reduced Juice Acidity and Berry Rot ....................................... S403
(343) Effects of Substrate pH on Growth of Vaccinium arboreum from Different Provenances ...................... S404
(344) Spatial Distribution of Iowa Vineyards ......................... S404
(345) Characterizing the Profiles and Relationships of Sugars and Anthocyanins in Strawberry Cultivars and Selections from the North Carolina Breeding Program S405
(346) Influence of High Tunnel and Shade on Blackberry Yield and White Drupelet Disorder ................................ S405
(347) Analysis of the Other Half: Root Morphology of a Segregating Backcross Population between Vaccinium corymbosum and V. arboreum ........................................ S405
(348) A Comparison of Blackberry Cultivars for a High-elevation Arid Climate ........................................ S406

Index of Authors and Moderators for Oral and Poster Presentations ............................ 407

S446   HortScience 49(9) Supplement—2014 ASHS Annual Conference