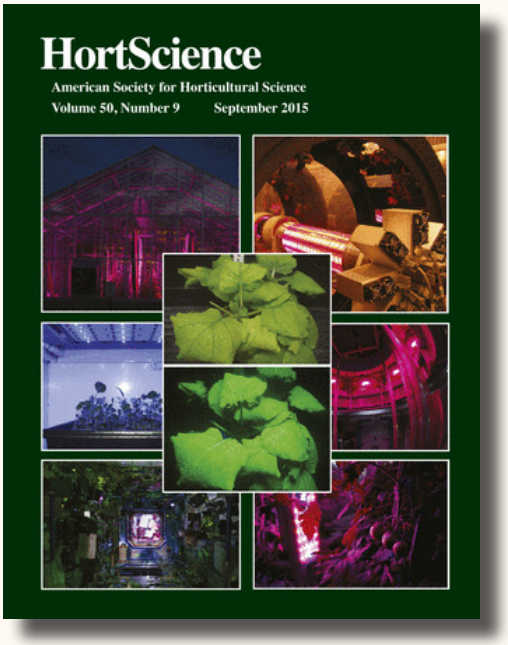
Supplement to *HortScience* Volume 50(9) September 2015



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

5–7 January 2015, Newark, Delaware.....S1

Southern Region Annual Meeting

30 January–1 February 2015, Atlanta, Georgia S17

Annual Conference

4–7 August, 2015, New Orleans, Louisiana S61

American Society for Horticultural Science
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Abstracts of Presentations

from the

Annual Meeting

of the

American Society for Horticultural Science—Northeast Region

5–7 January 2015

Newark, Delaware

Supplement to *HortScience*

Volume 50(9) September 2015

Contains abstracts of oral and poster presentations from the 2015 Annual Meeting of the Northeast Region of the American Society for Horticultural Science

Author index begins on p. S15

For citation purposes, abstracts should be cited as follows:

(*Example*)

Jeranyama, P. and J Sack. 2015. Temperature and photosynthetically active radiation effect on carbon assimilation in cranberry cultivars. HortScience 50(9):S13. (Abstr.)

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Abstracts of Presentations

Horticultural Research at the University of Delaware

Livable Delaware Programming to Protect the Environment

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A series of publications have been written and distributed that are contribute to a theme of suburban landscaping to protect environmental integrity. The first publication, "Plants for a Livable Delaware," presents 10 plants from the Delaware invasive species list that are still bought and sold in the nursery trade and provides approximately 10 alternative plants. The second publication, "Controlling Backyard Invaders," focuses on plants that were introduced either intentionally or unintentionally but are no longer in the trade. The publication outlines control strategies to reduce the pressure of these plants invading natural areas. A third publication organizes "Livable Delaware Plants," by landscape use and guides homeowners with plant suggestions for specific landscape sites such as "woodland edge," "sunny slope," and "small areas." A fourth publication entitled "Livable Ecosystems," provides recommendations for creating meadows, rain gardens and reforestation areas in the home landscape. The fifth publication entitled "Livable Lawns," discusses using a lawn where it performs a function and proper environmentally sound methods of managing lawns. This talk will focus on how these publications have been used to promote sustainable landscaping in Delaware. The publications are available at http://extension.udel.edu/lawngarden/commercial-horticulture/landscape/.

The University of Delaware Botanic Gardens—Maximizing Efficiency to Generate the Greatest Impact

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The University of Delaware Botanic Gardens (UDBG) is a 45-acre garden containing about 15 acres of developed, maintained garden areas and a 30-acre woodland used primarily for ecological education. The primary goal is to support education within the College of Agriculture and Natural Resources as well as across the university by providing students with an outdoor and hands-on learning experience. To that end, the garden contains plant collections, designed gardens, and ecological gardens to enhance the curriculum in plant science, soils, ecology, wildlife, and natural resource management. Plant sales, donations, membership and the college support the UDBG. In turn, the UDBG funds multiple student summer internships and limited educational experiences throughout the year. The interns are a major source of labor for maintenance and project implementation. In addition to its role in traditional university education, the gardens provide programing for anyone interested in plants via lectures, walks, demonstrations, and short courses. It also collaborates with the green industry through conferences and field days.

Agriculture and Extension in Delaware's Urban Communities

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There is an increasing need to raise agricultural awareness and to address food access and security issues in Delaware's urban communities. There is also an increasing need to teach communities to grow, prepare, and eat and demand fresh and nutritious, locally grown food. The University of Delaware Cooperative Extension has responded to these needs in multiple ways, including our partnership with the Delaware Center for Horticulture to facilitate the work of the Delaware Urban Farm and Food Coalition. This Coalition, a committed partnership of growers, state, county and local agencies, advocates, non-profits, health care organizations, and business and industry, supports community-oriented urban agricultural projects to expand healthy food access in northern Delaware and bring together resources and technical assistance through a collaborative approach to urban farming. Together we seek to create healthier, sustainable, and vibrant communities by expanding the growing of fruits and vegetables in and near urban areas of northern Delaware, improve access to healthy foods, and provide information on healthy eating.

A View from Above: A Multi-Faceted Approach to Keeping Lima Beans Healthy

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Abstract not available.

Watermelon Research at the University of Delaware

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Successful fruit set and development in triploid watermelons consists of eight phases: 1) flowering of triploids and diploid pollinizers; 2) pollen production by diploid pollinizers; 3) pollen

*Presenting author.

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. From 2010–14 applied watermelon research at the University of Delaware has been conducted by the Extension Fruit and Vegetable program to better understand this system. A two-year survey of grower's watermelon fields in 2010 and 2011 yielded valuable information on growing methods, pollination, early fruit set, and crop stress. Pollinizers were evaluated in 2010, 2011, and 2014 for their effect on watermelon yield and quality. In 2010 research was initiated to investigate hollow heart disorder in triploid watermelon. Over the next four years, this research has yielded valuable insight into the causal factors for this disorder, pointing to limited pollen as a key. The theory that pollination, hormone activity, and cell division in early watermelon fruit development determine hollow heart incidence and severity is being pursued. Growth regulator and stress mitigation research in the same period has shown the potential for improving fruit set and reducing plant stress. Other research has included rootstock evaluations, potassium nutrition, irrigation, degradable plastic mulch, and biannual triploid variety trials.

The University of Delaware Lima Bean Breeding Program

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Abstract not available.

Poster Presentations

Use of a Natural Biocontrol Agent *Bacillus subtilis* UD1022 to Increase Crop Yield and Reduce Contamination by *Listeria* monocytogenes on Cantaloupes

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Cantaloupes serve as one of the major crops in the state of Delaware accounting for approximately $850,000 in estimated annual sales. However, a recent turning point for the cantaloupe industry occurred this past year when the Jensen brothers received criminal charges for growing produce that was contaminated with *Listeria monocytogenes* and was associated with an outbreak resulting in the deaths of 34 individuals. The purpose of this project is to evaluate the use of a plant growth promoting rhizobacteria, *Bacillus subtilis* UD1022, to reduce the contamination of cantaloupes by *Listeria monocytogenes* in the preharvest environment as well as in the packinghouse environment. Preliminary data has shown the ability of UD1022 to help increase crop yield through complex plant-microbe interactions that increase plant defenses toward plant pathogens. Preliminary data has also shown that UD1022 can inhibit growth of *Listeria monocytogenes*, in culture as well as on leaves of Romaine lettuce plants when UD1022 is inoculated onto the roots of plants. In this study, pieces of cantaloupe rind were treated with UD1022 supernatant or sterile water immediately following inoculation with *L. monocytogenes* or after eight hours of incubation. Cantaloupe rind pieces were incubated at either 37 °C, 22 °C or 4 °C. In this study, we show that UD1022 supernatant has the ability to inhibit the growth of *L. monocytogenes* on cantaloupe rind during temperature abuse. At all temperatures *L. monocytogenes* growth was lowest when cantaloupe pieces were treated with UD1022 supernatant compared to controls. This inhibition was significant at room temperature (22 °C) ($P = 0.0024$). These results indicate that UD1022 may be used as a natural biocontrol agent to reduce the risk of contamination by *L. monocytogenes* on cantaloupe rind during times of temperature abuse in the packinghouse, during storage or transport.

Evaluating Anaerobically Digested Dairy Fiber as a Substitute for Peat in Soilless Potting Media

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Sphagnum peat has been a primary component of soilless potting media (SPM) for decades, but concerns over the sustainability of harvesting peat have led to a search for renewable media components. Anaerobically digested dairy fiber (ADDF) shows promise as a locally sourced alternative to peat. Garden chrysanthemums, cyclamen, poinsettias, and various bedding plants were grown in different formulations of ADDF-containing media. Investigation of media physical properties showed that 50% of peat could be replaced with ADDF without significant changes to water holding capacity or porosity. For almost all species, plants grown in ADDF-peat-perlite media were of equal or greater size and quality compared to those grown in media without ADDF. The ADDF was shown to provide a significant amount of available phosphate as indicated by P accumulation in plants. ADDF contributed some Mn and Na but a negligible amount of nitrogen. Although ADDF is alkaline in reaction, blending with peat effectively neutralized it. However, in one trial the pH of an ADDF-peat blend inexplicably dropped to less than five.

Pruning of Newly Planted Highbush Blueberry Bushes, *Vaccinium corymbosum* L.

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There is a difference of published opinion on how newly planted highbush blueberry bushes should be pruned. The objective of this study was to try different degrees of pruning of newly planted bare-root plants and see and measure the resulting growth effects. Twenty 3-year-old, 12–18 inch bare-root Collins blueberry plants were planted on 13 July 2012, in a 50–50 mix of sand and peat moss in one-gallon pots. Four plants each were then treated with the following degrees of pruning: 1) cut each 1-year stem 1/3, remove lower branches; 2) cut each 1-year stem 1/2, remove lower branches; 3) cut each 1-year stem 2/3, remove lower branches; 4) cut each trunk (1/2 of plant height) in half, remove lower branches; and 5) control. Total new stem length (first plus second growth flushes) and total number of new stems was measured on Dec. 9, 2012. Average total number of new stems per bush was progressively fewer for increasing severity of pruning, the largest number being for the control (unpruned) bushes. Average new stem number per bush were as follows for each treatment: control: 111; cut stems 1/3:91; cut stems 1/2:82; cut stems 2/3:60; and cut trunk 1/2:41. Total average new stem length (inches) per bush was progressively shorter for the more severe pruning treatments, with the control having the greatest total new stem length. Total average total new stem length per bush was as follows for each treatment: control: 124.56 (316.38 cm), cut stems 1/3: 115.86 (294.28 cm), cut stems 1/2: 116.13 (294.97 cm), cut stems 2/3: 101.28 (257.25 cm), cut trunk 1/2: 70.88 (180.04 cm). Average new stem length (inches) per bush was progressively longer for the more severe pruning treatments, the shortest stem length being for the control. Average new stem length per bush were as follows for each treatment: control: 18.15 (46.10 cm), cut stems 1/3: 20.92 (53.14 cm), cut stems 1/2: 22.81 (57.94 cm), cut stems 2/3: 28.58 (72.59 cm), cut trunk 1/2: 28.07 (71.30 cm). The total number of new flower buds per plant was counted on 20 April 2013. Flower bud number per plant was successively less for increasing severity of pruning, the largest number being for the control (unpruned) bushes. Average flower bud numbers per plant were as follows for each treatment: control: 97.8, cut stems 1/3: 68.5, cut stems 1/2: 59, cut stems 2/3: 44.5, cut trunk 1/2: 29.5. No pruning of newly planted bare-root blueberry bushes is recommended based on the results of this study. No pruning resulted in the greatest average total number of new stems per bush, the greatest average total new stem length per bush, the shortest average new stem length per bush, and the greatest average number of new flower buds per bush as compared to the pruning treatments.

Developing Methods for Improved Field Assessment through Sampling Techniques and Detection Methods in Lima Beans in the Mid-Atlantic Region

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Current identification for root-knot nematode (RKN), *Meloidogyne incognita*, is by examination of roots for the presence of galls or by extraction of juveniles (J2 Stage) for counting. Eight at risk fields to be planted with lima beans were chosen for extensive sampling to determine RKN levels at four selected times throughout the year. Field and laboratory assays were performed, including bioassays, root sampling, and soil processing for J2's. At harvest, lima bean yield samples were taken to determine yield loss, if any, from RKN damage in two fields. There was a correlation between RKN damage ratings and yield reduction. This information will be used to determine a threshold at which RKN causes significant yield loss and where control measures are warranted.

Examination of Various Control Measures for Root-knot Nematodes in Lima Beans

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Root-knot nematodes (*Meloidogyne incognita*) are among the most destructive nematodes, with significant crop damage capabilities. With an extensive host range and evolutionary traits allowing for persistence in the soil, even in non-ideal conditions, control for root-knot nematodes (RKN) cannot be limited to crop rotation or fallowing of fields. In recent years, the most effective chemical controls such as methyl bromide, and organophosphates have been found to be harmful to the environment and other, non-target soil biota, spurring new research in controlling RKN. New products that are in the final stages of development such as fluensulfone, compounds that are already being utilized for other agrochemical applications such as fluopyram, and completely novel chemicals are all examined in this study for efficacy against RKN in lima beans. Cultural approaches have been found to reduce RKN populations and in this study, organic matter additions via composts and manure were examined. Another approach to reduce RKN populations being studied involves the use of biofumigant cover crops such as mustards and sorghums which can reduce RKN levels by releasing naturally produced compounds that act as fumigants in the soil. Once studies are completed examining the efficacy of each of the approaches; chemical, biological, and cultural, recommendations will be developed to form the basis of a comprehensive Integrated Pest Management (IPM) approach to reduce RKN levels in lima bean fields.

Plant Growth Regulators and Their Effects as Foliar and Ovary Applications on Watermelon (*Citrullus lanatus*) Fruit Set

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Four plant growth regulators (PGR's): 6-benzyladenine delivered as the product Maxcel; N-(2-chloro-4-pyridyl)-N'-phenylurea (CPPU) delivered as the product Prestige; and 6-benzyladenine in combination with gibberellic acid 4, and gibberellic acid 7

delivered as the product Promalin were applied as foliar sprays or ovary applications to triploid watermelon plants (*Citrullus lanatus*) in a field trial at the University of Delaware Carvel Research Center in Georgetown, DE, to test their effectiveness at improving fruit set and yield in a pollen limited scenario. Prestige was applied directly to developing ovaries in order to help prevent foliar damage that had been observed in other trials when PGRs were applied over the top. Even though disease pressure took its toll on the health of the plants, an observable difference in yield was measured between PGR applications, with all three products increasing fruit set compared to the control and Promalin providing the highest overall fruit set and fruit weights. This experiment will be repeated in 2015 in order to validate these findings.

Botanical Nomenclature in the Garden: Two Hybrid Dogwoods Get Their Own Scientific Names

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The circumboreal genus *Cornus* L. (Cornaceae, Cornales) contains about 60 species divided into ten subgenera. Several Cornus species have large, showy petaloid bracts located under tight head-like, multi-flowered inflorescences. The most commonly known big-bracted species are *C. florida* (flowering dogwood), *C. nuttallii* (Pacific dogwood) and *C. kousa* (kousa dogwood). In 1965, Elwin Orton began a big-bracted dogwood breeding program at Rutgers University with the goal of developing attractive, unique, disease-resistant cultivars for the ornamentals market. He soon began to experiment with interspecific hybridization to achieve this goal. Orton's efforts were eventually successful. He is credited with being one of the first to develop hybrid dogwoods and has released 11 cultivars (eight *C. kousa* × *C. florida* and three *C. kousa* × *C. nuttallii*) since the early 1990s. A number of these are widely planted today. Artificially created hybrids can be given their own scientific names if it aids classification and improves scientific understanding. None of the dogwood hybrids have been previously described with formal scientific names, but despite this, one unpublished name has been consistently used in literature and the nursery trade: *Cornus rutgersensis*. To provide a formal scientific name for these relatively common hybrids, we followed the official rules outlined in the International Code for Naming of Algae, Fungi, and Plants. This includes the documentation of a complete morphological description, including detailed illustrations, photos, and the designation of type material (pressed herbarium samples of original hybrid trees) made available in a public herbarium. It also includes the proposal of new unique names for the hybrids. In a recently submitted manuscript, we proposed the names *Cornus* ×*rutgersensis* for *C. kousa* × *C. florida* hybrids and *Cornus* ×*elwinortoni* for the *C. kousa* × *C. nuttallii* hybrids. These names honor the institution where they were developed and their developer, respectively. After the new scientific names are officially published, they will be entered into the International Plant Name Index (www.ipni.org) and can be used in all databases, floras, books, and on garden labels.

Implementation of Real-Time PCR to Track the Proliferation of *Anisogramma anomala* (Eastern Filbert Bight) in Juvenile Hazelnut Seedlings

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Eastern filbert blight (EFB) is a serious disease of hazelnut (*Corylus* spp.) caused by the fungus *Anisogramma anomala*. Management of the disease using fungicides and pruning is expensive and labor intensive. The use of resistant cultivars is considered to be the most sustainable management approach. Breeding for resistance is challenging, however, due to the pathogen's 16-month latent period where no symptoms or signs of the fungus are present. A rapid early-detection method using real-time PCR (qPCR) has recently been developed for *A. anomala*. It allows detection of the fungus in hazelnut plants within a few months from infection. It can also be used as a tool to gain insight into the infection process and proliferation of the fungus, of which little is known today. In this study, the qPCR assay is used to track the progression and growth rate of *A. anomala* along the stems of young hazelnut trees at different dates following inoculation. Efforts to optimize the qPCR reaction, including tissue sampling techniques and qPCR primer validation, and preliminary results of *A. anomala* expression levels in 5- to 15-week-old seedlings postinoculation will be presented.

Biological Soil Survey Results from Agricultural Fields Incorporating the SOLVITA® CO_2 Respiration Test

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Fertilizer recommendations are typically based upon a chemical laboratory analysis and estimated crop needs over the growing season. What is not typically measured is the ability of farmland soils to produce their own nutrients such as nitrogen through microbial populations. This biological contribution to fertility from the soil itself or from compost amendments was measured by the Solvita CO respiration test. Results of this two year pilot study in a diversity of agricultural systems show consistent results over time. This low-cost, high-tech soil test has shown promise to provide a simple and quantitative means in surveying the current status of soil health or measure impacts over time from management practices such as cover cropping,

tillage systems, compost amendments, chemical fertilizers, and organic soil amendments. With this new assessment method, producers and advisers may add another evaluative parameter to their recommendations.

Using the Garden to Teach about Life in the 1700s; Historic Gardens at Red Bank Battlefield Park

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The James & Ann Whitall House is an 18th century historic house, located at the Red Bank Battlefield Park, on the Delaware River, in Gloucester County, New Jersey. In addition to the home, there was a kitchen/herb garden located near the kitchen door with herbs previously grown and cared for by a talented group of Rutgers Master Gardener volunteers. The 44-plus acres park provides a passive recreational area, riverside walking paths, playground equipment, and picnic pavilions. This is the historic site of Fort Mercer, one of the twin military installations which guarded the Philadelphia harbor and all communities north of Philadelphia along the Delaware River during the American Revolution. The gardens were constructed to replicate what would have been part of a homestead in the 1700s. Research was conducted to find plants that were typically part of the homestead during this time period. During the seventeen hundreds near each farm was a kitchen garden. These gardens included an abundant amount of onions. The French farmers eat their dinners of onions on bread, on Fridays and Saturdays or fasting days. Pumpkins are also abundant due to their many uses. The most common way was to cut them in half and roast them. Carrots, salad, French beans, cucumber, and currant shrubs were also included in these kitchen gardens. Signage and information sheets were developed to educate school groups and the general public on the types or plants and their uses. The vegetables grown were used in the hearth cooking demonstrations held by the Whitall House volunteers. Four herb beds were constructed to replicate what would be growing at a 1700s homestead. The beds contained herbs used for medicinal, household, culinary, and dyeing purposes. The herb demonstration gardens included: lamb's ear, borage, calendula, fennel, foxglove, rosemary, parsley, sage, lemon balm, flax, horsetail, lavender, marigold, ladies bedstraw, basil, bay, horehound, wormwood, chamomile, soapwort, and yarrow. During spring and summer months over 1000 school children and 5000 visitors tour the gardens.

Evaluation of Cold Hardiness Changes during Acclimation in Cranberry Cultivars Grown in Southeastern Massachusetts

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Freezing injury is a major abiotic stress affecting cranberry (*Vaccinium macrocarpon* Ait.). The acquisition of freezing resistance is a gradual process that enables plants to survive low temperatures until they reach maximum hardiness. An experiment was designed to assess the progression of cold hardiness of six cranberry cultivars including 'Stevens', 'Howes', 'Mullica Queen', 'Crimson Queen', 'Demoranville', and 'Early Black'. Cranberry uprights with buds (length = 6 cm) were cut from actively growing plants once per week starting from mid-September and continuing until mid-December 2014. Uprights were immediately brought to the laboratory to undergo freeze tests. Samples were placed inside a programmable freezer overnight and subjected to a step-wise lowering of temperature the following morning, at a rate of 2 °C per hour from –2 °C to –8 °C, –12 °C, –15 °C, –18 °C, –24 °C, –30 °C until the temperature of –36 °C had been reached. Samples were held for one hour at each test temperature; then, they were removed and transferred to 4 °C for gradual thawing and later placed in a plastic bag at room temperature for about 24 hours until evaluation. In October, all cultivars could tolerate temperatures lower than –8 °C and step-wise temperature decreases to –15 °C indicated that 'Early Black' had less damage (1.8 ± 0.5) than 'Crimson Queen' (3.0 ± 0.1) and the rest of the cultivars. November-collected buds subjected to step-wise temperature decrease to –30 °C indicated that 'Crimson Queen' (1.8 ± 0.5) and 'Early Black' (1.5 ± 0.6) had less damage than 'Mullica Queen' and 'Howes' (similar damage of 3.3 ± 0.5) or 'Demoranville' (3.0 ± 0.1). Results seem to suggest a timely progression (mid-September to mid-December) of cold hardiness between cranberry cultivars. Future analysis using the Gompertz function will help estimate the lowest survival temperature (LST) and the LT50.

Resistance to Eastern Filbert Blight in Progenies from New Hazelnut Germplasm Collected in Russia and Ukraine

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The disease eastern filbert blight (EFB), caused by *Anisogramma anomala*, severely restricts production of European hazelnuts (*Corylus avellana*) in North America. Developing EFB-resistant cultivars is considered to be the most effective management strategy for this disease. In 2003, a seed-based germplasm collection was made in Russia and Crimea (Ukraine) to search for new sources of resistance. Over 2,000 trees were field planted in 2004 from which about 30 resistant trees were later identified. In this study, 14 different resistant selections originating from multiple locations in Russia and Crimea and divided into four distinct genetic groups (Black Sea 1, Black Sea 2, Wild *C. avellana*, and Moscow) by a previous study using molecular markers, were crossed with susceptible male parents to examine the response of their progeny to EFB. The seedlings

were field planted in 2010 and 2011, exposed to high disease pressure, and evaluated in 2014 on a scale of 0–5 (0 = no EFB, 5 = all branches contain cankers). Results showed that all of the resistant parents transmitted EFB resistance to a useful number of their progeny; however, the patterns of inheritance differed amongst the progenies and within the genetic groups. Several parents in "Black Sea Group 1" showed a clear 1:1 resistant to susceptible ratio of their progeny, indicative of control by a single dominant gene in the heterozygous state. Another one of the parents showed a 1:3 ratio of resistant to susceptible, and two others did not fit a model for simple Mendelian inheritance. "Black Sea Group 2" was also mixed, with one parent showing 1:1 and one showing 1:3 ratios, while two others did not fit a simple gene model. The two parents from the "Wild *C. avellana* Group" and the single parent from the "Moscow Group" all showed clear 1:1 ratios. The large percentage of 1:1 ratios suggest one or more single dominant resistant genes at work in these groups, while other indications of possible control by a two-gene system (1 resistant : 3 susceptible) with both genes in the heterozygous state appear as well.

Relationship of Quinic and Benzoic Acid Levels with Fruit Rot Resistance in American Cranberry

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Fruit rot is a major problem in the production of cranberries (*Vaccinium macrocarpon* Aiton.), particularly in New Jersey and Massachusetts. Without the use of fungicides, up to 100% of a crop can be lost. Global climate change has also exacerbated the problem in other cranberry growing regions, such as Wisconsin. To combat this growing challenge, breeding for fruit rot resistance has become a major goal of the Rutgers cranberry breeding program. Resistant germplasm has been used in crosses and resistance found to be heritable. Cranberry fruit rot is caused by a fungal complex, with infection occurring during flowering or early in fruit development and remaining latent until the fruit matures. In vitro quinic (QA) and benzoic (BA) acids have been shown to suppress secretion of 'reactive-oxygen species' (ROS) by these pathogenic fungi and reduce fungal growth. To assess the possible role these acids play in field fruit rot resistance, we measured levels of QA and BA in cranberries through their development, from fruit set to mature fruit. Quinic acid levels were highest at fruit set and dropped during fruit development. Benzoic acid began to accumulate about halfway through fruit development and levels rose at fruit maturity. In our two most fruit rot resistant varieties, the quinic acid levels declined at a slower rate than in our susceptible varieties. Benzoic acid levels in resistant varieties increased at a faster rate than in susceptible varieties, resulting in higher levels in fully ripe berries. Cranberry breeding populations which are segregating for fruit rot resistance will be evaluated for QA and BA levels. This study lays out the groundwork for identifying molecular markers for organic acids and fruit rot resistance in cranberry.

ORAL PRESENTATIONS

Overwintering of the Impatiens Downy Mildew Pathogen

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Impatiens downy mildew, caused by the oomycete Plasmopara obducens, was confirmed in Delaware on garden balsam (*Impatiens balsamina*) in June 2012, and subsequently confirmed on *Impatiens walleriana* in Delaware in August 2012. The symptoms on infected *I. walleriana* include chlorosis and downward curling of leaves, leaf drop, and overall decline of plants. Symptoms on *I. balsamina* include leaf chlorosis with abundant production of sporangia on the under-surface, without leaf drop. *Plasmopara obducens* infects *I. walleriana*, cultivars and *I. balsamina*. Jewel weed, *I. capensis*, does not show obvious symptoms, but is a reported host for the pathogen and could be a potential reservoir. Sporangia are spread by air currents, water splash, and movement of infected plant material. Thick-walled oospores may form in infected plant parts, and be capable of overwintering in landscapes. In a Newark, DE, landscape bed known to have impatiens downy mildew on volunteer balsam in 2012–13, untreated *I. walleriana* plants were set in place early in June 2014. Volunteer balsam that emerged in the bed and the young impatiens were monitored for infection. Following first signs of infection in late June 2014, leaf tissue samples were submitted to two separate labs for genetic typing of the pathogen. Total genomic DNA was extracted and PCR amplification and sequencing of ribosomal intergenic and 5.8S regions (ITS) indicated that infected plants at the site in 2014 were infected with the same genetic group of *P. obducens* detected at this site in June 2013. Due to limited distribution in North America of the observed genotype, it is theorized the pathogen over-wintered in this Newark, DE, location. Seeds were recovered from the balsam and will be tested for the presence of, and/or transmission of the *Plasmopara obducens* pathogen. Root tissue was examined for oospores. Investigations have shown possible ways in which the pathogen may overwinter.

Cucumber Cultivar Evaluation for Downy Mildew Resistance

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Downy mildew (*Pseudoperonospora cubensis*) is one of the most important foliar diseases of cucumber in the Mid-Atlantic Region. It does not overwinter in the region, but enters from the southern United States. The objective of this study was to evaluate cultivars for their tolerance or resistance to downy mildew which had acceptable fruit quality and yield. Eleven cultivars were direct seeded (two seeds/hole) 21 July and reseeded as needed on 29

July. Seed were planted into raised white plastic covered beds with one drip line in single rows 12 inches between plants and five feet between beds in a randomized complete-block design with four replications. Foliage was rated by replication weekly (eight times) on a scale of 0 to 100 (0 = no downy mildew and 100 = leaves infected. Arcsine-transformed area under the disease progress curve (AUDPC) values were calculated for all treatments. Fruits were hand harvested eleven times and graded by size then weighed. Fruit were classified into: 1) Fancy (Super Select)—2- to 2 3/8-inch diameter, length 6 to 8 inches, straight and blemish free; 2) No. 1 (Select)—2- to 2 3/8-inch diameter, length 6 to 8 inches, fairly well formed and blemish free; 3) Large—2 3/8-inch diameter or larger, length longer than 8 inches; and 4) Small—1.5 to 2.0 inches, fairly well formed and blemish free and culls. At the tenth harvest ten fruit were randomly selected from each replication in the Fancy and No. 1 classes to determine length and width. There were significant differences among the cultivars for both yield and fruit number. 'Dasher II', 'Mongoose', 'Python', 'Speedway', and 'Thunder' had significantly higher fruit number than Seminis 4220, 'Tasty Green' or 'Marketmore 76'. 'Python' had a higher marketable yield than 'Marketmore 76', Seminis 4220, Seminis 8592, or 'Tasty Green'. Seminis 4220, 'Tasty Green', and 'Intimidator' had the highest percentage of fruit for the first harvest. There was little difference for length or width with the exception that 'Tasty Green' had a significantly longer fruit than the other cultivars. Two cultivars, Marketmore 76 and Mongoose, had significantly higher values under the disease progress curve which indicates the disease was more severe for those cultivars compared to the others.

Fungicide Study on Quince Rust of *Aronia melanocarpa*

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In 2014, a research study on fungicide treatments for quince rust (*Gymnosporangium* spp.) was conducted. Five-year-old bushes at Jalma Farms, a commercial operation, were used. The experiment consisted of a randomized complete-block design wherein treatments were replicated four times with two bushes per plot. Treatments included: 1) non-treated control; 2) Rally 40WSP—Early Season; 3) Rally 40WSP—Mid Season; 4) Rally 40WSP—Late Season; 5) Rally 40WSP—Full Season; 6) Serenade Optimum; and 7) BSP Lime-Sulfur Solution. Fungicide applications were made via a hand-held pressurized tank sprayer at 54 gal/A (16 fl oz/bush @ 435 bushes/A). Treatments included different application timings of the conventional fungicide Rally 40WSP applied on: 9 Apr. (D, dormant); 17 Apr. (G, green tip); 1 May (P, pink); 19 May (PF, petal fall); and 1 June, 16 June, 30 June, 10 July (1C–4C, first to fourth cover). The full bloom (B) spray was not applied due to weather conditions. The non-treated control bushes were monitored weekly from 2 May to 21 July to measure disease progression on leaves and fruit. On 1 Aug. and 11–12 Aug., respectively, final fruit and foliar disease assessments were performed on all treatments. In 2014, infection levels were low. The final assessment revealed that only 4.4% of leaves were infected (average 0.05 lesions/leaf). The Rally mid-season treatment significantly reduced foliar disease levels. The most effective treatment was the Rally full season. The full season Serenade Optimum treatment failed to provide effective control. The full season lime-sulfur treatment was partially effective, but phytotoxicity was observed on those plants. No differences were observed among treatment means for fruit due to very low disease levels.

Incorporating the SOLVITA® Soil Test in Surveys of Horticultural Cropping Systems

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Soil fertility assessments involve field sampling with soil probes and laboratory analysis of macro- and micronutrients. Chemical and organic fertilizer recommendations are then based upon crop needs. The ability of a farmland soil to biologically produce its own nutrients such as nitrogen over the growing season is not typically assessed. A "healthy" soil can produce considerable nitrogen and other nutrients through an abundant microbial population. This contribution from the soil itself or from compost amendments was measured seasonally by the Solvita CO respiration test. After staff training, this method was incorporated into a county extension program investigating a diversity of cropping systems. Consistent and accurate results from this two-year study show that farmers, gardeners, advisors, extension agents, and agricultural specialists can add a new assessment method into their technical tool box. This low-cost, high-tech soil test provided a simple and quantitative means of surveying the current status of soil health or may measure impacts over time from management practices such as cover cropping, tillage systems, compost amendments, chemical fertilizers, and organic soil amendments.

Exploring the Relationship between Trees and Human Stress in the Urban Environment

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The research literature describes a positive relationship between seeing plants and human well-being. More rapid recovery from surgery, reduced incidence of neighborhood crime, increased baby birth weight, and increased trust of neighborhood merchants are some of the outcomes attributed to exposure to trees and shrubs. In this project we attempted to find a common explanation for these outcomes. We examined the connection between urban trees and community stress.

Each of the above outcomes can be attributed, in part, to stress reduction. The health literature indicates that stress reduction is one of the consequences of exposure to plants in controlled settings. We wanted to see if exposure to city trees would have the same impact on residents. Stress levels were measured at the block level in Wilmington, Delaware, by means of a survey mailed to 1982 residents. Physical conditions were catalogued using an on-site inventory. The survey and inventory demonstrated that the total number of trees on a block has a strong negative relationship with community stress and a positive relationship with self-reported health. The results suggest that moderation of stress is one of the factors that underlies the beneficial consequences of exposure to green vegetation on inner city blocks. With this information we come one step closer to quantifying the psychological impact of city trees on human behavior.

An "Extension" Perspective: Production in High Tunnels in Delaware

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One of the major undertakings of a Capacity Building Grant by the United States Department of Agriculture (USDA) to help increase horticulture based extension to Delaware growers involved working with high tunnel growers. Although in many ways comparable to growing in the open fields, growing in high tunnels calls for different plant management skills, tools, and provisions (good ventilation, proper soil drainage, spacing, crop rotation, disease management, nutrient management, cultivar preferences). Challenges faced include the fact that high tunnels trap warm air and hence the need for heat management; high tunnels are closed and so any chemicals used should be labelled for greenhouse use, irrigation has to be incorporated; night temperatures monitored during cold spells etc. Survey shows that tomato is the number one high tunnel crop by Delaware growers. Other commonly grown crops are spinach, cucumber, mesclun salad mixes, kale, and collard greens with most growers practicing mixed cropping. Tomato production trials carried out for three consecutive years at Smyrna Outreach Center in 30 ft x 48 ft high tunnels show that high tunnel yields can be higher if tomato plants are started early (mid to late March) and protected from any events of frost using row covers. Yields can be up to 12 pounds. of tomatoes per plant during the high tunnel growing season. Most high tunnel growers select varieties based on size, taste, and growth habit and disease resistance as recommended by extension agents or from their own production experiences. The number one cultivar grown in Delaware high tunnels in 2014 was 'Rutgers'. A few growers are showing interest in using grafted tomato plants using selected disease resistant root stocks, and use of beneficial insects. Other high tunnel trials show the prospects of starting potato slips, and all year round kale production. Sharing the high tunnel production experience serves as feedback to the research community to help answer questions from the growers.

Plasticulture Compared to Strip Tillage with and without Row Covers in Conventional Muskmelon and Summer Squash Production

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The production of most cucurbit crops in the northeastern United States uses polyethylene mulch on raised beds with drip irrigation, or a plasticulture system. While the use of plasticulture systems decreases weed pressure, and increases soil temperatures, typically resulting in increased yields, disadvantages include plastic disposal issues and costs, and the intensive tillage required for installation. Strip tillage systems have been shown to decrease soil erosion, increase soil moisture retention and increase soil microbial communities. The use of spunbonded polyethylene row cover shows potential to replace the use of neonicotinoids, the common early season control method for insect pests of cucurbits, resulting in similar control of early season striped cucumber beetle (*Acalymma vittatum*) populations, therefore decreasing the incidence of bacterial wilt (*Erwinia tracheiphila*). Plasticulture and strip tillage systems were compared with and without row covers at The Pennsylvania State University's Russell E. Larson Research and Education Center in Rock Springs, PA, during the 2013–14 growing seasons. Two separate experiments were conducted, one being on conventionally managed summer squash (*Cucurbita pepo* 'Lioness'), the other on muskmelon (*Cucumis melo* 'Athena'). Yields, soil moisture level, cucumber beetle populations, and incidence of bacterial wilt were measured. Plants grown in the strip tillage system generally had lower yields than in the plasticulture system in both years. The strip tillage system showed higher soil moisture levels during the 2013 season but no trend was shown in 2014. Row covers resulted in larger plants; however, they generally resulted in equal yields when compared to not using row covers within both systems. Row cover timing of removal may have negatively affected yields in the plasticulture system. The use of row covers allowed for the elimination of neonicotinoid application with no increase in pest pressure or incidence of bacterial wilt, although there was low incidence of bacterial wilt in both years of the experiments. Lower yields in the strip tillage system observed in the muskmelon experiment and in the first year of the summer squash experiment were beyond acceptable levels. This research found that decreased soil temperatures, high weed pressure, and dramatically lower yields in the strip tillage system limit the successful use of this system for these crops and that row covers are a viable alternative to the use of neonicotinoids.

Advancing Horticultural Literacy: Measuring and Promoting the Educational Relevance of University Plant Collections

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University gardens commonly tout their vital roles as "living laboratories" and "outdoor classrooms," but how can we be sure their inherent benefits are being delivered as effectively as possible and prime users, students of ornamental horticulture and landscape design, derive the maximum value? As with any other educational materials, academic plant collections should be assessed periodically to judge their fitness for purpose based on predetermined, mission-centric standards and objectives. One key objective, horticultural literacy, is supported by access to well-curated collections that sustainably exhibit a region's ornamentally and functionally useful plants. The University of Delaware Botanic Gardens' (UDBG) holly (*Ilex*) collection was used as a test case for developing the evaluation criteria needed to produce a quantitative indication of its current relevance as a teaching resource. An initial requirement was a practical method for determining which holly taxa are most valuable to this educational function. This was accomplished via the documentation of prevalent taxa in the Mid-Atlantic and Southeastern nursery trade and a survey of plant materials instructors in USDA Hardiness Zones 6–8. The results reveal both agreement and variation in which taxa could be considered pertinent to undergraduate instruction. These findings will be useful in determining any curatorial steps (e.g. additions, removals, or maintenance) required to improve the educational effectiveness of this portion of the UDBG. Ultimately, this evaluation process could be applied to additional genera or related plant groups within the UDBG or other academic plant collections.

Plasticulture Compared to Strip Tillage with and without Row Covers in Organic Muskmelon and Summer Squash Production

Jason Lilley* and Elsa Sánchez

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Plasticulture systems, the use of polyethylene mulch on raised beds with drip irrigation, are commonly used for the production of many cucurbit crops. While the use of plasticulture systems have many benefits, disadvantages include plastic disposal issues and costs and the intensive tillage required for installation. Strip tillage systems have been shown to decrease soil erosion, increase soil moisture retention and increase soil microbial communities. Spunbonded polyethylene row cover use has shown to decrease early season cucumber beetle (*Acalymma vittatum*) populations and the incidence of bacterial wilt (*Erwinia tracheiphila*) while increasing yields. Plasticulture and strip tillage systems were compared with and without row covers at The Pennsylvania State University's Russell E. Larson Research and Education Center in Rock Springs, PA, during the 2013–14 growing seasons. Two separate experiments were conducted, one being on organically managed summer squash (*Cucurbita pepo* 'Lioness'), the other on muskmelon (*Cucumis melo* 'Athena'). Yields, soil nitrate levels, soil and air temperatures, cucumber beetle populations, and incidence of bacterial wilt were measured. Plants grown in the strip tillage system generally had lower yields than in the plasticulture system in both years. Row covers resulted in larger plants; however, they generally resulted in equal yields when compared to not using row covers within the strip tillage and plasticulture systems. Lower yields in the strip tillage system observed in the muskmelon experiment and in the first year of the summer squash experiment were beyond acceptable levels. The need for specialized tillage equipment, a late planting date, and high weed pressure are all obstacles to the successful use of strip tillage for these crops. There was low incidence of bacterial wilt in both years of the experiments. No differences were seen in yields as a result of row covers; however, row cover timing of removal was a factor.

Comparison of Controlled Release and Soluble Granular Fertilizers: Effect on Cranberry Growth and Concentrations of N and P in Soil Water

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As a result of environmental pressures, cranberry growers in Massachusetts are looking for ways to reduce off-site movement of nitrogen (N) and phosphorus (P). One suggested approach is to use controlled-release fertilizers (CRF) so that N and P are "metered-out" to the plants over the season, thus being taken up more effectively with less likelihood of leaching below the root zone or moving laterally into surface or sub-surface drainage. Some growers implementing CRF have observed good outcomes in terms of crop but evaluation of how this implementation might improve water quality was lacking. In the first year of this study, we compared four CRF (A-D) with varied N–P–K ratios to a common grower-practice soluble granular fertilizer protocol on a recently planted (second year) bog with installed tile drainage. To examine N and P in the soil water, lysimeters were placed in the bog soil with the collection cup at 20-cm depth to be within and just below the cranberry root zone. In addition to sampling the lysimeters, tile drain output was analyzed to determine potential for N and P lateral transport. Plant growth was surveyed at the end of the season, there was no crop on this two-year bed. Growth was similar among all treatments with the exception of CRF-D where runner growth was excessive. The rate of nutrient release into the soil water differed for the five treatments and differed between P and N. For both TP and PO_4, only CRF-B had increased TP and PO_4 in the soil water, and that followed a large rain event in June. All treatments except CRF-A resulted in a substantial increase in soil water N. Nitrogen levels in the grower practice actually declined immediately after the rain event: N may have moved well below the root zone. For the remainder of the season, as the grower added fertilizer (three applications occurred after that rain), soil N increased in that treatment. Tile drainage P species only increased in CRF-D, while tile drainage N was differentially elevated in all treatments. CRF-D

had the highest tile drainage N, CRF-A the lowest. These data indicate that CRF-A can support adequate growth in a new planting with less vertical and lateral movement of nutrients in the soil than that in the standard grower practice or any of the other CRF studied.

Evaluating Generic *Escherichia coli* Levels in Recirculated Hydroponic Irrigation Water

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Several New Jersey hydroponic vegetable operations are expected to comply with the USDA Good Agricultural Practices third party audit, as requested by their buyers. Audit compliance requires irrigation water sample results conforming to current recreational water use standards. New Jersey hydroponic operations requested the testing of irrigation water to better understand compliance with the USDA Harmonized Audit and the impending Food Safety Modernization Act produce rule. An initial review of literature on this subject shows that there has been little research into human pathogens in recirculated hydroponic water, existing research on pathogen levels in hydroponic irrigation waters has focused on plant disease organisms. Hydroponic systems often recirculate irrigation water and the recirculation of this water can pose a human health risk hazard should the water become contaminated. An increasing number of hydroponic operations are selling "living" herbs where the entire plant, including the root system, is sold. Potential for cross contamination, should the water harbor a human pathogen, is increased in these "living" plant harvests. Examples of potential routes of contamination in a hydroponic operation would be ill workers, rodents, and run-off into water storage tanks. Water samples were collected once a week for a period of 10 weeks from the main water holding tank. Irrigation water is stored in a 7000-gallon tank and circulated throughout the greenhouse several times daily. On average 1400 gallons of fresh water are added to the irrigation water tank to replace water that evaporated or was taken up by the crop. One hundred (100) milliters of water was collected from the irrigation tank several hours after the tank circulation pump was turned on. Generic *Escherichia coli* was found in the irrigation water during the first six weeks of sampling. Generic *E. coli* levels varied during this time period but all samples were below the accepted levels under the recreational water standards. During the final four weeks of sampling generic *E. coli* was absent. Production practices were not changed during this time and generic *E. coli* levels did not fluctuate based on average daily temperatures. Additional sampling may help to better understand generic *E. coli* fluctuations.

Breeding and Introduction of Hardy Perennials and Shrubs at Star Roses and Plants

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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.

Creating Native Meadow Habitat in Stormwater Detention Basins to Provide an Urban Pollinator Refuge

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This program examines habitat use by pollinator species between a mowed turf and a unmowed naturalized area within a dry stormwater detention basin. Stormwater detention basins are primarily designed for flood control and typically vegetated and maintained with turf type vegetation. Threatened by habitat loss, disease and pesticide use the numbers of native pollinators and commercial bee populations have been in decline. Naturalizing basins using native herbaceous wildflower vegetation can provide an increase in pollinator habitat while also incorporating storm water quality benefits. Allowing the native vegetation to grow and flower enables pollinators to utilize this small scale urban/suburban pollinator "urban refuge," for feeding, habitat, and for some species, reproduction. In this study we compared two 600-square-foot plots within a one-acre mowed detention basin, laid out at opposite ends. One plot is planted with native herbaceous meadow vegetation, mowed once in the fall, while the other plot is fescue turf grass, mowed down to 1.5 inches every two weeks during the growing season. Pollinator samples were collected every two weeks using pan traps and sweep nets on alternate days. Pollinators were identified to genus or species level, and enumerated; plot type usage was compared and typical forage distance estimated by genus. Results after two years show foraging in our basin by the honey bee and 4 genera of native bees. The naturalized area vegetation was preferred (90%, n=194), vs. mowed turf (10%, n=22). Foraging distance was calculated using intertegular distance, ranging from 7.8 m to 9766 m for all genera combined.

Temperature and Photosynthetically Active Radiation Effect on Carbon Assimilation in Cranberry Cultivars

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Carbohydrate supply is thought to limit fruit set in cranberry (*Vaccinium macrocarpon* Ait.). The extent to which photosynthetically active radiation (PAR) and temperature affects carbon assimilation in newer cranberry cultivars is relatively unknown. They seem to be anecdotal evidence that new cultivars of cranberry minimize photorespiration but it is not clear whether the newly introduced hybrid cranberry cultivars have a bigger photosynthetic capacity to support higher fruit yields compared to the older cultivars. This project evaluated the effect of PAR and temperature on net CO_2 assimilation and stomatal conductance of three new and three old cultivars. The light response curves for the six cultivars differed, particularly at the lower light intensities. 'Stevens' reached the asymptote a lot more quickly than the newer cultivars, but did not necessarily reach a similar maximum. The fact that both 'Crimson Queen' and 'Mullica Queen' reached a higher asymptote compared to Stevens indicates that these cultivars have a higher quantum yield and therefore can capitalize on existing light microclimates in the field. In a crowded canopy these differences could be significant with respect to net CO_2 assimilation. In our study, light saturation for Stevens was reached at about 400 $\mu mol \cdot m^{-2} \cdot s^{-1}$. Two of the newer cultivars tended to have lower dark respiration rates. A high dark respiration rate indicates the need for high maintenance and growth cost. The newer cultivars tended to have better carbon assimilation rates and higher light saturation points at lower temperatures.

Hazelnuts from the Republic of Georgia: The Search for Eastern Filbert Blight Resistance Continues

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The fungal disease eastern filbert blight (EFB), caused by *Anisogramma anomala*, is a major impediment to European hazelnut (*Corylus avellana*) production in North America. The use of resistant cultivars is considered to be the most effective means to manage this disease. While resistance is rare in the European species, over the past decade germplasm collection efforts from across Europe and the Caucasus region have yielded a wide variety of resistant accessions for use in breeding. In 2009, hazelnut germplasm was collected across the Republic of Georgia. It included open-pollinated seeds collected from local cultivars, grower selections, and wild plants representing a wide spectrum of the genetic diversity present in the region. From this collection, 1374 seedling comprising 50 different seed lots were grown at Rutgers University. They were field planted in 2010, exposed to high disease pressure, and evaluated for EFB in 2014 on a scale of 0–5 (0 = no EFB, 5 = all branches contain cankers). Results showed that a vast majority of the plants were highly susceptible or died prior to rating, likely from EFB (712 trees rated 4 or 5 and 520 died prior to 2014). However, 79 resistant (rating 0) and 63 tolerant (rating 1, 2, or 3) trees were identified, although a proportion of these exhibited weak growth habits and/or dieback not associated with EFB (26 "resistant" trees were weak and 6 "tolerant" trees). The 53 adapted, resistant trees spanned 23 of 50 seed lots, although several seed lots stood out by holding significant proportions of the resistant plants. This clustering is a strong indication of the presence of dominant resistance genes. Plants in these seed lots will be the first chosen for the study of inheritance of EFB resistance in progeny and for use in breeding. Nut and kernel traits will also be examined.

Plant Exploration in the Mountains of Northern Vietnam

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When visiting Longwood Gardens, guests are often impressed by the unique collection of plants. Plants are added to the collection through various means. One of the most exciting ways this happens is through plant exploration. Since 1956, Longwood Gardens has been involved in over 60 plant exploration trips that have reached every continent excluding Antarctica. During the most recent exploration trip, nearly 500 specimens were collected in remote terrain of four different mountain ranges in Northern Vietnam (Fan Si Pan, Tay Con Linh, Bát Đại Sơn and Tam Đảo). The trip was in collaboration with Royal Botanic Garden Edinburgh, Royal Botanic Garden Kew, University of British Columbia Botanic Garden, and The Vietnamese Institute of Ecology and Biological Resources. Partnerships with host-country botanist are critical with these types of trips to ensure proper permitting, access to remote locations, dealing with foreign languages and assistance with plant identification. A total of three weeks were spent in Vietnam and eleven of these days were used for collecting. The remainder of the time was spent traveling, arranging collecting permits, processing seeds and record keeping. When collecting plants, which were primarily in the form of seed, geographic coordinates were recorded, herbariums specimens were collected and a description of the plant was recorded. At the end of the trip, all specimens were transferred to quarantine sites at Royal Botanic Garden Edinburgh and Kew. Currently, a portion of the seeds are being processed and prepared for shipment to a USDA–APHIS inspection station. Following inspection, seeds will be sent to Longwood Gardens where they will be grown and evaluated for display, research, breeding or conservation potential.

Eradication versus Management—A Tale of Two Invasive Borers in New Jersey

Nicholas Polanin

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The Asian Longhorned beetle (ALB), *Anoplophora glabripennis*, was first reported in Jersey City, Hudson County, NJ, on 11 October 2002, following almost five years of annual state and federal surveys and monitoring. An initial New Jersey Department of Agriculture (NJDA) quarantine following USDA protocols affected approximately 100 trees in a nine-acre site, and the surrounding area within a one and one-half mile radius of the infestation was inspected regularly to prevent the beetle's spread. However, it was not until 14 March 2013, nearly 11 years later, that eradication efforts of ALB in New Jersey were successful. Communities within the quarantine areas suffered deforestation with the loss of 21,981 trees throughout Union, Middlesex, and Hudson counties—maples, sycamores, poplars, birches, willows, and horse chestnuts. During this time, state forestry officials were also monitoring for the next invading borer. Despite no positive sightings in the hundreds of purple colored traps along the borders of New York and Pennsylvania, the Emerald Ash Borer (EAB), *Agrilus planipennis*, was found on 21 May 2014, in Bridgewater, Somerset County, and again in Burlington County later that same summer. Considering the rigorous quarantine rules and regulations for ALB, commercial arborists, shade tree commissions, park and public property managers, and even homeowners expected similarly mandated and widespread loss of true ash (*Fraxinus*) throughout the state. What they found instead were educational websites, a renewed "Don't Move Firewood" promotional campaign, and a "new" product (ArborMectin, a 4% emamectin benzoate tree injected insecticide) and EAB services that could now legally be offered throughout the state by licensed commercial tree care providers. New Jersey is the twenty-third state within the EAB quarantine area, and considering how these two invasive borers differ along with failed eradication efforts attempted elsewhere, EAB is more akin to a "modern day gypsy moth"—a new reality in forest and landscape ash tree management.

Varietal Evaluation of Sweetpotato as an Alternative Agriculture Enterprise in Delaware for Underserved Clienteles

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Sweetpotato (*Ipomoea batatas*) has been a potential crop as an alternative agriculture enterprise for small farmers' particularly underserved clientele who has limited resources. Moreover, it is a cheap and rich sources of carbohydrates and vitamins, particularly vitamin A. Also, it is a short duration and drought tolerant crop to lessen the draught effect for those who are unable to buy crop insurance policy. However, there has not been reported any research that study varietal adaption in Delaware climate without using chemicals. Therefore, College of Agriculture and Related Sciences at Delaware State University initiated to evaluate four varieties of sweet potato in growing season of 2012, 2013, and 2014 at Smyrna Outreach and Research Center of DSU. The specific objectives were: 1) to evaluate adaptability of four variety in Delaware's climate to provide an opportunity for underserved clientele to mitigate the drought effect on minimum cost and 2) to reach out clients with this research outcome through fact sheets, field days, and extension-wide networking. We conducted field research in the randomized complete-block design with four varieties replicated three times on clay loam soil pH with 6.8. Birmingham (V2) showed the highest yield (34833 $kg \cdot ha^{-1}$) followed by TUI-001 (V6) (31,847 $kg \cdot ha^{-1}$), A-193-217 (V1) (28,935 $kg \cdot ha^{-1}$), and TI-6008 (V4) (26481 $kg \cdot ha^{-1}$), respectively. Without using any chemicals, average storage root yield of all cultivars observed higher than U.S. average yield of sweet potato (26,223 $kg \cdot ha^{-1}$ in 2012 and 27,478 $kg \cdot ha^{-1}$ in 2013) (NASS, 2013). Results imply that these varieties are well adapted to local climate of Delaware although sweet potato yield is significantly different in response to the different years. We are encouraged by these research results, and we are trying to disseminate the message to the clientele through fact sheets, field days, demonstration, one on one visits, and social media.

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from the

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Abstracts of Presentations

J.B. Edmond Undergraduate Student Paper Competition

Attributes of Fresh-Market Blackberries Identified by a Trained Descriptive Panel

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Blackberries (*Rubus* subgenus *Rubus*) are grown worldwide for fresh and processed markets. Since the University of Arkansas has one of the largest blackberry breeding programs, identifying the sensory attributes of new developments would be beneficial. Descriptive sensory attributes of 11 Arkansas-developed fresh-market blackberry genotypes (seven selections and four cultivars) were evaluated at shiny-black stage of maturity. Nine trained descriptive panelists identified groups of attributes for appearance (n=8), basic tastes (n=3), feeling factors (n=2), aromatics (n=9) and texture (n=7) in fresh blackberries. Among these, the attributes of sweetness, sourness, overall aromatics (taste), firmness and glossiness are considered of greatest importance. The panelists found sweetness of blackberries was similar across the group of genotypes, while sourness was more easily differentiated. However, the genotypes all had acceptable soluble solids levels (9% to 11%) while titratable acidity ranged from 0.7 to 1.4 g/L, and this contributed to the sensory results. Overall aromatic impact values were significantly different, but had a small range of 7.6–8.2 on the 15-point scale. Panelists were able to differentiate firmness and glossiness easily, with the selection A-2453 the most firm and glossy. Further evaluation of fresh-market blackberries using a descriptive sensory panel is needed to confirm and expand knowledge about important attributes of potential commercial blackberry genotypes.

Maintaining a Way of Life: Trials and Tribulations of Farmers Market Families

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Never before in our nation's history has there been so many ways for consumers to purchase food. From grocery stores, to super centers such as Wal-Mart and Costco, convenience stores, online purchases, community supported agriculture (CSA), and farmers markets, Americans have a multitude of venues to choose from. Although many Americans currently purchase their foods from grocery stores, a growing number of them are buying locally at their farmers' markets and from CSAs. As the sustainability movement takes a greater foothold in the American household, local products and local foods are becoming ever more important and prevalent. Yet with all of the statistics surrounding local agriculture, the human element is often lost. A majority of small farmers and their spouses, often the ones who sell at a local level, have to work full time both on and off farm to support their families and farms. This case study examines the professional lives of five local farm families who choose to sell their products at the Fayetteville, AK, farmers market. It seeks to understand farmers' reasons for farming and selling locally, as well as their biggest challenges and rewards. In addition, it seeks to fill gaps in literature, begin to develop an understanding of this phenomenon, and shed light on why these farmers choose to sell at a local level.

Evaluation of White Skin Mericlone Selections of 'Bonita' Sweetpotato [*Ipomoea batatas* (L.) Lam.] and Other Selections

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Viruses and mutations can accumulate through vegetative propagation of sweetpotato resulting in reduced yield and quality. It is recommended that growers purchase foundation seed roots so that production fields are no older than three to four generations. Foundation seed production begins with using virus-tested (VT) plant stock maintained in vitro. A VT plant is derived from meristem tip culture and the resulting plant is tested on a virus susceptible indictor plant. If no symptoms are found after several rounds of testing, it can be declared VT. Many meristem tip cultures are done for a given variety with expectations that some still possess demonstrable viruses. The process of removing viruses from plants via meristem tip culture may introduce changes in phenotype due to mutations or somaclonal variation. The objective of this research is compare in field trial yield, shape, and trueness to type for a number of mericlones for several varieties. Results showed most mericlones were not variants and thus redundancy was reduced in the tissue culture collection by eliminating some mericlones. Several mericlones did appear less robust and off-type and not suitable for using as a parental source for foundation seed.

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Effect of Production Environment and Fertilization on Growth of Juvenile *Sarracenia leucophylla*

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Sarracenia is a genus of carnivorous plants that absorb nutrients from prey through their funnel-shaped leaves. Fertilization has been reported as a way to supply extra nutrition to *Sarracenia* in cases of limited prey (e.g. greenhouse). In this experiment, 15-month-old seedlings of *Sarracenia leucophylla* Raf. (white topped pitcher plant) were divided into small and large size groups based on number of pitchers taller than 10 cm. Large and small plants were placed either outside in a sunny location or in a greenhouse. Beginning 16 June 2014, leaves of plants were sprayed with a solution of 0 ppm N (water), 25 ppm N (1/8 dilution), or 50 ppm N (1/4 dilution) prepared from a 20–20–20 water soluble fertilizer with micronutrients. The 0 and 25 ppm N fertilizer were applied every two weeks, while the 50 ppm N fertilizer was applied every four weeks followed by water two weeks later. The last date of fertilizer application was 14 Aug. 2014. Plant size was measured in May, July, and September. Data collected for each plant included the height and width of the three tallest pitchers and the numbers of pitchers taller than 10 cm. The main effect of fertilizer and the interaction between fertilizer and measurement date or plant size were not significant. For the large plants, height and width increased over time. The large plants also had a significant interaction between measurement date and environment for numbers of pitchers taller than 10 cm in which number of pitchers was highest outside at the final measurement date. For small plants, interaction between measurement date and environment were significant for height, width, and number of pitchers taller than 10 cm in which all were greater outside at the final measurement date. Ultimately, this research shows that these methods of fertilization were not effective for juvenile *Sarracenia leucophylla* under cultural practices employed during this experiment. There does seem to be an advantage to producing these plants outdoors in full sun and with access to prey.

Norman F. Childers MS Graduate Student Paper Competition

The Effective Pollination Period of New AU Kiwifruit Cultivars (*Actinidia chinensis* and *Actinidia deliciosa*)

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The aim of this study was to determine the effective pollination period (EPP) for two of the new Auburn University (AU) kiwifruit cultivars, *Actinidia chinensis* 'AU Golden Sunshine' and *Actinidia deliciosa* 'AU Fitzgerald'. In the first year, approximately 30 previously isolated female flowers (n = 30) from each cultivar were hand pollinated by direct contact with male flowers each day. The flowers for 'AU Golden Sunshine' were pollinated 1, 2, 3, 4, and 5 days after anthesis (DAA) and 1–6 DAA for 'AU Fitzgerald'. Anthesis was defined as the day the flower opened. The flowers were bagged with wax paper bags to prevent open pollination, and then tagged for the corresponding day. For 'AU Fitzgerald' fruit set, weight and size declined for the flowers pollinated 5 DAA, suggesting that the EPP is 4 DAA. For 'AU Golden Sunshine' fruit set, weight, and size remained fairly consistent over the five-day period. The study was repeated the following year for 'AU Golden Sunshine' with an extended pollination period. In the second year, approximately 32 previously isolated female flowers (n=32) from 'AU Golden Sunshine' were hand pollinated each day with harvested male pollen that was applied with a camel hair brush. The flowers were pollinated 1, 2, 3, 4, 5, 6, and 7 DAA. The same procedures were followed from the previous year. Fruit set, weight and size declined for the flowers pollinated 6 DAA, suggesting that the EPP is 5 DAA.

Effect of Winter Cover Crops on Growth and Performance of Successional Vegetable Crops

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High tunnel vegetable production can be input-intensive, lead to buildup of soil-borne pathogens, and result in the loss of soil quality from intensive cultivation. This project investigated short-season winter cover crops to address these issues by improving soil quality and reducing the need for fertilizer inputs in organic high tunnel production. Research has shown the benefits of cover crops in field production, but the use of cover crops in high tunnel production has not been thoroughly investigated in the South. This project evaluated five winter cover crop treatments, including a nontreated control, Austrian winter peas (*Pisum arvense*), bell beans (*Vicia faba*), mustard (*Brassica juncea* cv. Kodiak), and Daikon radish (*Raphanus sativus* var. *longipinnatus*), for their effect on soil quality and ability to supplement fertilizer requirement when included in a vegetable crop rotation in a high tunnel system. After incorporation, the cover crops were followed by a succession of vegetable crops, including tomato (*Lycopersicon lycopersicum*, cv. Plum Dandy) and broccoli (*Brassica oleracea* var. *italica*, cv. Bay Meadows), which were fertilized at a 0.5× rate (56 kg·ha^{-1} of N) to determine the ability of the cover crop treatments to supplement fertilizer inputs. Yield and performance of the vegetable crops were measured to determine the effects of the cover crop treatments compared to a nontreated control. Austrian winter peas yielded significantly greater biomass and greater biomass nitrogen content than the other treatments. This led to a significantly lower soil C/N ratio 30 days after incorporation. Tomato leaf chlorophyll measurements were highest following winter pea, though yield results were not significantly different. Broccoli early-season leaf chlorophyll was also increased by the winter pea treatment and plant biomass

was significantly greater, but harvest data was not significantly different. The experiment will be replicated for a second year in attempt to achieve significant vegetable yield response to cover crop treatment.

Post-transplant Establishment and Economic Value of Three Tree Species from Five Container Sizes

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With container grown trees offered to the public in an increasing array of sizes, it is important to determine the effects of transplant shock on different size container stock. Transplant shock is a condition of physiological stress from injuries, depletion of nutrients, and impaired functions, which are a normal consequence of handling, moving, and transplanting plants into conditions less favorable than those in the nursery. Beginning June 2013, six clonal replicates of *Vitex agnus-castus* L., *Acer rubrum* L. var. *drummondii* (Hook. & Arn. *ex* Nutt.) Sarg., and *Taxodium distichum* (L.) Rich. were transplanted from each of five container sizes #1, 3, 7, 25, or 45 (3.5, 11.7, 23.3 97.8, or 175.0 L, 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 xylem water potentials and photosynthetic gas exchange rates. Changes in shoot growth of each tree were calculated along with root number and extension beyond the transplanted root ball for two growing seasons. Utilizing industry standards, the initial costs of materials and labor were then compared with the size of trees two years post-transplant to determine return on investment. Across all taxa, #3 and #7 container size trees responded more vigorously and recovered from transplant quicker than those from larger container sizes. Similar responses were observed in *A. rubrum* and *V. agnus-castus*, as growth increased exponentially in #3 and #7 container grown trees. *Taxodium distichum* recovered at much slower rates, with less rapid although still vigorous growth in #3 and #7 container grown 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 rate than trees grown in other containers. The reduced stress levels and increased growth rates correlated with greater percent change found in root lengths of smaller container grown trees. Economic analysis after two growing seasons indicated a greater increase in value for #3 and #7 container grown trees vs. losses in value for some #45 container grown trees. In comparison with trees from larger containers, trees from smaller size containers exhibited reduced transplant shock, decreased establishment time and increased growth rates, thus generating a quicker return on investment.

Nitrogen Fertilizer Management of 'Strawberry Festival' Grown Under High Tunnels

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Demand for fresh strawberries has increased dramatically in recent years. However, total strawberry production in Arkansas and surrounding region has decreased in the last 50 years and today's production is less than 224 hectares (200 acres). The growing season for strawberries in Arkansas is short, extending from April to May. There is a market potential to produce berries during the offseason using season extension technologies such as high tunnels. Most of the research information on strawberry nutrient management available to producers is based on field research. Strawberry production under high tunnel systems can extend the growing season. However, fertilizer inputs may need to be adjusted since the plant is actively growing for a longer amount of time. The objective of this experiment was to determine the effect of four nitrogen fertilizer treatments on yield components, and on plant tissue (foliar and petiole) nutrient levels in order to develop a nitrogen fertigation management program to optimize strawberry production while increasing the sustainability of high tunnel plasticulture systems. The cultivar Strawberry Festival was planted in a randomized complete block design under a high tunnel. The whole experimental area received 67.3 kg N/ha before planting, which follows current recommendations for open-field production of strawberries in the mid-south. During the growing season, plants received nitrogen through fertigation in the form of ammonium nitrate (34–0–0). Fertigation treatments were: 0 kg N/ha/day, 1.12 kg N/ha/day, 1.68 kg N/ha/day, and 2.24 kg N/ha/day. Strawberries were harvested from April 1 to May 13 and were separated into marketable or unmarketable berries. There was no significant difference in marketable yield between nitrogen treatments, nor was there a significant difference in unmarketable yield using LSD test ($P < 0.10$). There were no differences in foliar N, K. S, B, or petiole NO_3-N. This result indicates that 'Strawberry Festival' can be grown with limited or no nitrogen fertigation, which would improve economic returns and reduce environmental impacts.

Flooding Tolerance of Two Landscape Shrubs (*Illicium floridanum* and *Morella cerifera*) for Use in Rain Gardens

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Two evergreen shrubs, *Illicuium floridanum* (Florida anise) and *Morella cerifera* (wax myrtle), were exposed to 9 weeks of short-term cyclic flooding to determine flooding effects on size index (SI), leaf area (LA), shoot dry weight (DW), leaf chlorophyll content (LCC), and stomatal conductance (SC). The

experiment was conducted outdoors, under a waterproof shade structure, at Auburn University in Auburn, AL. Plants were exposed to either flooded or non-flooded treatments beginning in June 2014 and ending in August 2014 (summer). The experiment was repeated August 2014 through October 2014 (fall). For the flooded treatment, plants were flooded to the substrate surface for 48 hours followed by five days of draining with no additional watering. Non-flooded plants were watered daily. Initial and final SI was measure for each plant. Weeks 8 and 9 of the experiment, LCC and SC were measured from newly matured leaves at the beginning and end of the flooding cycles. After 9 weeks, final SI and DW were measured. In addition, 3 plants per treatment per species were defoliated for LA. Results indicated that SI, LA and DW of *I. floridanum* was not affected by flooding. Although DW and LA were not affected by flooding of *M. cerifera,* SI was lower when flooded in the summer. The LCC of *M. cerifera* was higher when flooded in the fall unlike *I. floridanum*, which was lower when flooded in the fall. Summer LCC was unaffected by treatments in both plants. In both the summer and fall, SC was lower for the flooded plants of each species. Despite small differences in LCC and SC, both plant species tolerated repeated short-term cyclic flooding and would be suitable for use in rain gardens.

Clonal Structure, Genetic Diversity, and In Vitro Propagation of River Cane (*Arundinaria gigantea*), A Candidate for Use in Wetlands Reclamation

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Arundinaria is a genus of temperate woody bamboos native only to North America. It typically grows along waterways, forming stands called canebrakes. These canebrakes have a dense system of rhizomes, which acts as a vegetative buffer and prevents erosion of river and stream banks. Since European settlement of North America, canebrakes have suffered an estimated 98% habitat loss. Seed-based and vegetative propagation of *Arundinaria* is biologically and technically problematic, but in vitro micropropagation has many advantages. After many varied disinfestation experiments, nodal segments and isolated embryos of *Arundinaria* were successfully established on MS media with 3 mg/L and 1.98 mg/L BA, respectively. Average fold multiplication was higher with nodal segments, but isolated embryos were occasionally much more prolific. As a guide to restoration efforts, universally labeled microsatellite markers from other Poaceae were tested in *Arundinaria*. These markers show decreasing success with increasing evolutionary distance, but will allow assessments of population genetic diversity and clonal structure in the near future.

Plant Science Instructors' Perceptions of Learning Experiences in Online and Face-to-face Courses

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As higher education works to continuously meet the needs of students, more and more universities are offering online courses in order to increase educational accessibility for adult learners, nontraditional students, and those raised in a technology-filled society. Regardless of the method of delivery, instructors must ensure their classes are taught in an effective manner. Following the educational theory of experiential learning (Kolb, 1984), this study sought to describe perceptions and preferences of introductory plant science instructors regarding face-to-face and online lecture and lab courses. A 50-item survey was developed and evaluated for face and content validity and stability. Reliability was calculated to be 0.805. The survey was emailed to all Introductory Plant Science instructors at land grant institutions (N = 111). After double dipping for nonrespondents, which resulted in no significant differences between respondents and nonrespondents, the final response rate was 22.52% (n =25). A majority of respondents (83%) indicated that they taught via face-to-face lecture. Sixty-seven percent indicated teaching through a face-to-face lab. A majority of instructors preferred face-to-face settings for both lectures and labs. Instructors believed that students need both the lecture and lab to learn effectively. While experiential learning theory recommends learners engage in a concrete experience before receiving new information, instructors perceived that engaging students in a lecture before a lab yielded the greatest learning impact. Plant science instructors are encouraged to examine the needs of their student body in order to determine whether an online lecture or lab would be beneficial, and if so, to engage in distance education training in order to reduce barriers and apprehension associated with teaching online courses. Researchers recommend that instructors try engaging students in a lab-lecture-lab format in order to align their instructional procedures with sound educational theory.

Growth Response of Three Containerized Ornamental Taxa to Varying Low Pore–Water Concentrations of Phosphorus

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Phosphorus (P) is an essential plant mineral nutrient that also can degrade water quality when an excessive amount is introduced to an aquatic ecosystem. Less than fifty-percent of applied P is

utilized by ornamental crops. Therefore, reducing P in container nursery crop production would improve fertilizer cost effectiveness and may assist with compliance of nutrient load regulations. Based on research to date, the recommended P concentration needed for production of ornamental containerized crops is 5–15 mg·L^{-1}; however, few studies have investigated crop response applied below this recommended threshold range. This study was conducted to identify the minimum P concentration in pore-water that will produce maximal growth of popular woody ornamental taxa in containerized crop production. *Rhododendron* L. 'Karen' (azalea), *Ilex crenata* Thunb. 'Helleri' (holly) and *Hydrangea paniculata* Sieb. 'Limelight' (hydrangea) were fertilized with 80 mg·L^{-1} nitrogen, 50 mg·L^{-1} potassium and 0.5, 1.0, 2.0, 4.0, or 6.0 mg·L^{-1} P for 84 days. Maximal shoot dry weight was achieved at 1.0 mg·L^{-1} P for 'Helleri' holly, and 4.0 mg·L^{-1} P for both 'Karen' azalea and 'Limelight' hydrangea. For all three taxa, plants fertilized with 4.0 mg·L^{-1} P exhibited the highest foliar P concentration. Increasing pore-water P concentration increased hydrangea root dry weight but had no effect on holly root dry weight. Leaf tip necrosis and interveinal chlorosis were apparent in mature leaves of azalea and hydrangea, respectively, when fertilized with less than 2.0 mg·L^{-1} P. Thus, growth response to P fertilizer appears to be taxa-specific; however, 4.0 mg·L^{-1} pore-water P is adequate to maintain maximal growth for the three taxa used in this study. Future research is needed to determine if the low rate of P can effectively be delivered via controlled release fertilizer to ensure growth is not limited.

Investigation of T-budding as a Method for Propagation of Pecan (*Carya illinoinensis*)

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Pecan is a commercially important tree grown throughout much of the southeastern United States for its edible fruit. Recent pecan exports to China have increased demand, which has caused a surge in the number of new orchards being established. Pecans are commonly propagated in the nursery by patch budding. This requires seedlings to be at least 1–2 cm in diameter, which takes two to three years in the nursery to achieve. T-budding is a grafting method performed with great success on citrus and peach trees but is not commonly used on pecan. This method typically can be performed on smaller trees, ranging from 0.5 to 1 cm in diameter, that typically require less than two years in the nursery from growth to selling. A factorial experiment was conducted in spring 2013 to test the effects on T-budding in pecan trees using three different wrapping materials, two bud sizes, two types of incisions (inverted and upright T) and presence or absence of foil covering the graft. Graft success rate was very low, and results indicated there were no differences among any of the treatment combinations. Longitudinal sections of two successful and two failed budded trees were fixated, softened and embedded in paraffin for microscope analysis. Inspection of the images indicates that failed treatments are likely a result of a lack of contact between the bud and rootstock tissues. Overall success rate of the experiment combined with analysis of microscope images suggests that T-budding may not be a suitable method for young pecan propagation.

Benefits of Soil Moisture Sensor Based Automated Irrigation in Commercial Greenhouse and Nursery Production

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Freshwater scarcity, caused by the effects of climate change, a growing population, and increased environmental regulation will continue to put pressure on specialty crop producers to effectively manage water resources. Recently developed soil moisture sensor technology has been shown in previous studies to enhance water use efficiency and increase economic competitiveness of specialty crop production. A soil moisture sensor based, automated irrigation system was trialed at two commercial specialty crop producers to determine the benefit(s) of this system for a greenhouse and a woody plant producer. In both studies, side by side comparisons were conducted of plants produced with the sensor based automated irrigation, to those produced utilizing conventional grower controlled irrigation methods. Crops were examined for overall growth, plant quality, water use, as well as labor inputs into each system. Results from the studies showed that across five different species, at the two operations, equivalent size and quality plants were produced by the automated system compared to conventional irrigation methods. Of note, sensor-based automated irrigation resulted in a 41% reduction in labor hours associated with irrigation management of a poinsettia crop grown on drip tape for the 2014 holiday season. Use of the automated system also resulted in a 48% reduction of irrigation water applied to four different woody ornamental crops grown on an open pad irrigated with impact sprinklers. These studies will be repeated for the 2015 growing season to verify results.

Evaluating the Salinity Tolerance of Bermudagrass Cultivars

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Bermudagrass is a highly productive, warm-season, perennial grass, that has been grown in the United States for turfgrass use, forage, pasture, rangeland, and roadsides. Many production and reclamation sites across the United States are affected by soil salinity issues. Identification of bermudagrasses with improved

salinity tolerance is important for the successful implementation of bermudagrass production and reclamation of salt affected sites and/or with use of saline irrigation water. In this project, the relative salinity tolerance of seven vegetative bermudagrasses and ten seeded bermudagrasses, including industry standards and Oklahoma State University (OSU) experimental lines, were determined. The experiment was conducted under the controlled environment with six replications of each treatment. Four salinity levels (0, 15, 30, 45 $dS \cdot m^{-1}$) were used to test the 17 bermudagrass entries and the relative salinity tolerance among cultivars were determined by NDVI, digital image analysis (DIA), leaf firing (LF) and turf quality (TQ), shoot dry weight (SW), vertical growth (VG) and dark green color index (DGCI). Results indicate that there were variable responses to salinity stress amongst the cultivars studied. As irrigation water salinity levels increased, turf quality decreased and leaf firing increased. At the highest irrigation water salinity level (EC = 45 $dS \cdot m^{-1}$), the canopy green leaf area as measured using DIA ranged from 3.07% to 24.72% and 4.97% to 16.11% in the vegetative and seeded trial, respectively. Overall, 'Princess 77' and experimental entry OKC-1302 performed the top in the seeded and vegetative trials, respectively, at the 30 $dS \cdot m^{-1}$ salinity levels. The LF, TQ, NDVI, DGCI, SDW, VG, and DIA parameters were highly correlated with one another, indicating their usefulness as relative salinity tolerance measurements.

Warren S. Barham PhD Graduate Student Paper Competition

Variation in Growth Habit and Propensity to Flower of *Oenothera drummondii* Hook. from Three Texas Coastal Regions

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In an effort to evaluate *Oenothera drummondii* Hook. as a new species for the landscape trade and to document phenotypic variation present in the species, sixteen accessions of *O. drummondii* were collected along the coast of Texas from Brownsville, TX to Port Arthur, TX. Accessions represented three larger regional populations of the southern coast, central coast and northern coast. The southern region consisted of Brownsville and surrounding areas, the central region of Corpus Christi, and the northern coast of areas surrounding Galveston, TX. Accessions were grown in field and container conditions to evaluate growth habit, leaf morphology, flower number, and size, as well as overall ornamental appeal. Data were analyzed as individual accessions as well as by regional collection area. Differences were found among clones and regional groups for all growth measures except for internode length. In cluster analysis two large groups formed one with all southern accessions except for one and another that included the central and northern accessions. This suggests within the material collected there are two major groups of *O. drummondii* one found near Brownsville and another that extends from Corpus Christi to the Louisiana and Texas state border. In general the southern forms have a more upright and less spreading habit and blue foliage, whereas the plants from the central and northern areas have a shorter more spreading groundcover growth form. Accessions from the northern and central coast had a greater tendency to be free flowering. The results of this study will allow future researchers to target collection trips for *O. drummondii* to regions of the Texas coast based on specific traits of interest.

Evaluating Conventional Soilless Substrates by Measuring and Modeling Water Dynamics

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Water and solute dynamics within soilless substrates have not been thoroughly investigated, resulting in a lack of understanding about how water moves through the substrate profile and interacts with substrate particles within a container. In an effort to bridge this knowledge gap, computer models can be implemented to predict water dynamics within the containerized substrate. This study was conducted to assess the feasibility of a soil water model, HYDRUS-1D, to accurately predict water movement through two conventional soilless substrates (a peat based and pine bark based mix) under both transient (i.e. during irrigation) and steady state (i.e. between irrigations) conditions. The model requires container geometry (height), hydraulic properties of the substrate, and defined initial and boundary conditions. Each substrate was assumed to start at container capacity with a short (10-second) pulse of water at a rate of 15 ml/sec being applied to the surface of the system. Initial modeling efforts have been successful, with the HYDRUS-1D model producing physically realistic outcomes, including uniform movement in peat mix and rapid downward movement (channeling) in the pine bark mix. With further validation, these models may lead to more efficient irrigation practices, as well as the ability to manipulate existing soilless substrates to have optimal hydraulic properties.

Essential Oils As a Chlorine Alternative for Produce Safety: Effects on Postharvest Quality of Cherry Tomatoes

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Americans currently consume 25% more fresh and 3% less processed produce compared to consumption patterns in 1976. This change in consumption has also increased the risk of microbial contamination and food-borne illness from fresh produce. Chlorine-based products at 100-200 ppm free chlorine are widely used as inexpensive and effective sanitizers in postharvest produce washing. However, changes in regulations of chlorine, salt content of water discharge, and difficulties in regulating free chlorine in the presence of high organic matter and fluctuating pH has pushed the industry to look for alternative sanitation agents. Essential oils (EOs) which are natural volatile compounds derived from plants have demonstrated good antimicrobial effects on a wide range of bacteria and fungus, but potential for practical application in postharvest washing has not been well documented. In this study, we evaluated the postharvest quality of tomatoes in response to EO applications. Cherry tomatoes ('Mountain Magic' and 'Mountain Belle') harvested at the turning stage were dipped in a whey protein emulsion containing 0.5% of cinnamon oil, thyme oil and clove bud oil, with deionized water and 200 ppm chlorine controls. After treatment application, fruit were stored at room temperature (RT, 20 ºC) for 10 days or at 4 °C for 7 days followed by 20 ºC for 3 days (stress treatment). Weight loss, firmness, surface color, overall appearance, together with chemical properties/compounds on pH, total soluble solids, lycopene and total vitamin C were recorded/analyzed throughout the 10-day storage period. Comparing with controls, use of cinnamon oil resulted in higher weight loss while clove oil stimulated higher amounts of total vitamin C regardless of tomato variety and storage of temperature. 'Mountain Belle' tomatoes treated with cinnamon and clove oils had lower chroma value (a less intense red color) regardless of storage temperature; and these oils also caused irregular color development, scald and pitting for some harvests when 'Mountain Belle' fruits were stored at 4 °C. Results of this study indicated that application of EOs through postharvest washing is a possibility, and thyme oil appears to offer best potential for a chlorine alternative for tomatoes.

Effect of Fertilization and Irrigation on Nursery Production of Hydrangea Using Alternative Container

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Container production of nursery plants using biodegradable containers has been studied in recent years as a sustainable alternative to traditional plastic containers. Plant growth and photosynthetic performance of *Hydrangea macrophylla* 'Merritt's Supreme' were investigated in this study when they were grown in two types of containers (a conventional black plastic container and a paper biocontainer) under 5 nitrogen (N) rates (0, 5, 10, 15, and 20 mM N from ammonium nitrate) and 2 irrigation frequency (once or twice per day with the same total amount of water) treatments. Results showed that plant growth index (PGI), plant dry weights, and leaf area generally increased with increasing N rate with no difference between those grown in plastic or paper containers. Irrigation frequency didn't have significant influence on PGI, SPAD, plant dry weight, leaf area, root surface area, total root length, or stomatal conductance. Plants under 20 mM N treatment had the highest SPAD readings. When grown in biocontainer and fertilized with higher N rates, hydrangea plants tend to use more water during a day. There was no difference in photosynthetic rates among plants fertilized with 5 to 15 mM N in either plastic or paper container. Plants grown in plastic containers had higher stomatal conductance than those in biocontainers.

Interactions of Sustainable Soil Management Practices and Fumigation Strategy on Southeastern Strawberry Production

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The use of soil health promoting management practices like compost, cover crops and beneficial soil inoculants have generally been limited to organic production systems and specifically little knowledge exists concerning their incorporation into fumigated plasticulture strawberry production in the Southeast (SE). Thus our study is focused on evaluating the incorporation of a summer cover crop mix (Cowpea var. 'Iron Clay' (*Vigna unguiculata*) and Pearl Millet (*Pennisetum glaucum*genus)), compost applied in the early summer, beneficial soil inoculants (arbuscular mycorrhizal fungi (AMF) and vermicompost) added to the strawberry plug and multiple combinations of these practices as applied to both fumigated and non-fumigated plasticulture strawberry production. The study began in June 2013 with the establishment of plots in Goldsboro, North Carolina arranged in a split-plot RCBD with fumigation as the split. Results from the first harvest season in 2014 indicate significant interactions between soil management practice and fumigation strategy on per plant strawberry yield. Significant increases in marketable yields were observed for the cover crop and cover crop + compost treatments in the fumigated system as compared to the non-fumigated system, while significant increases in marketable yields of the plug inoculation treatment in the non-fumigated over the fumigated system were observed. Linear contrasts revealed a trend (P = 0.0745) toward increased plant tissue nitrate-nitrogen in plots receiving cover crops in the fumigated treatment as compared to the non-fumigated system. These results

may explain observed increases in yield for the cover crop and cover crop + compost plots in the fumigated system as nitrate-nitrogen has been shown to be highly positively correlated to yield. Alternatively, a lack of survival of the plug-inoculated AMF in the fumigated system ($P < 0.0001$) likely contributed to lower marketable yield for that treatment in the fumigated system. Due to inverse yield trends of the cover crop and plug inoculation treatments within the fumigation treatment there were no significant yield effects when these soil management practices were applied simultaneously.

Integrating Phenotypic and Genotypic Data for Flesh Texture and Marker-assisted Breeding in Peach

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Marker-assisted breeding (MAB) is a molecular technology which, if utilized correctly, allows breeders to increase efficiency of the breeding cycle and potentially decrease breeding program costs. Fruit breeding programs especially could take advantage of this technology due to the long juvenile periods of seedlings required before fruit is produced. The peach breeding program of the University of Arkansas, as a part of the SCRI RosBREED project, has begun to apply MAB and it should become a routine activity within the program. Traits important to breeders, growers, shippers, and consumers of peaches were included in RosBREED, and molecular markers identified in the project that were associated with several traits are being validated. One of these traits is flesh type, a trait that most often is classified as melting (MF) or non melting (NMF). These two flesh types are the most frequently found types in breeding programs around the world. However, other flesh types have been found within the Arkansas program, and contribute toward higher postharvest storage potential. These include non-softening (NSF) and slow-melting flesh (SMF). The endopolygalacturonase (endoPG) enzyme is involved with pectin depolymerization in peach flesh, and depending on the allelic combination of the candidate gene, this enzyme determines if a peach will be MF, NMF, or NSF when ripe. Currently, a DNA test is available to apply MAB on these three flesh types. The SMF has a crispy texture and a slower melting rate compared to MF, and only softens or melts when fully ripe. This different melting rate was theorized to be due to lower ethylene production and not due to differences in endoPG activity. During the 2013 and 2014 seasons, fruit ethylene production and softening rates were measured (phentoyped) on peach populations segregating for MF and SMF, with the objective of finding a molecular marker associated with SMF. This would then provide an additional DNA test to differentiate these four flesh types. Season 2013 results indicated that a relevant SNP associated with ethylene production rate was located on chromosome 4 of the peach genome. From this result, six simple sequence repeat (SSR) markers were designed and tested. One of these was polymorphic and differentiated SMF and other flesh types when also screened with the endoPG marker. The 2014 season results continue in analysis to further validate this new DNA test.

Economics of Insect Pest Management in Small Scale Tomato Production

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According to the 2012 Census of Agriculture, tomatoes were produced on 444 acres in Mississippi. Interest in locally grown produce has increased the importance of small scale vegetable production. Significant losses in yield and crop quality may result from insect pests and disease. Evaluation and improvement of management techniques is important to increase the viability of small scale vegetable production. Three management strategies, including calendar spray schedule, use of integrated pest management (IPM) and organic pest control, were evaluated in terms of their effect on yield and economic return for tomatoes in Southern Mississippi. This study was conducted using two varieties of tomato, Celebrity (72 day, Determinate) and Early Girl Bush (52 day, Determinate), to consider the effect of phenology on pest management. In Spring and Fall 2014, significantly greater mean yields were obtained from the IPM management system for both tomato varieties studied. Overall yields from 'Celebrity' tomatoes were not significantly different than those from 'Early Girl Bush'. Significantly greater economic return was obtained from 'Early Girl Bush' IPM than for other 'Early Girl Bush' treatments in both seasons. Total return from the 'Celebrity' IPM treatment was greater than that for the 'Celebrity' calendar treatment but not the 'Celebrity' organic treatment in both seasons. When considered across both varieties, the IPM management treatment resulted in significantly greater yields in both Spring and Fall seasons (31.549 lbs. and 29.9 lbs., respectively). Total return for IPM treatments in spring ($56.99) was significantly greater than for other treatments. In fall, total return for IPM treatments ($34.21) was significantly greater than for calendar treatments, but not than organic treatments.

Evaluation of Actinovate for Fire Blight Management

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The biological product Actinovate® (Novozymes, Inc.) was evaluated for effectiveness in controlling fire blight through a two part study. The first study was a field trial, performed at two Arkansas apple orchard sites in April 2014. Treatments were

an untreated control, an Agrimycin® (Nufarm, Ltd.) control, a Serenade® (AgraQuest, Inc., Bayer Crop Sciences, Inc.) treatment, two Actinovate treatments: an early treatment and a late treatment, and a split Actinovate + Agromycin treatment. Disease symptoms were found following all treatments and evaluated based on the USDA fireblight scoring system. Significantly less severe disease was observed following the Agrimycin treatment than the untreated control, with mean total disease ratings of 1.1% and 6.0% respectively. The split treatment also led to less severe disease occurrence than the untreated control with a mean total disease rating of 2.1%. A second study was performed using detached blackberry flowers to examine suppression of bacterial floral colonization following treatment with these same products. The suppression of colonization following treatment with Actinovate was compared to Agrimycin and Serenade, as well as an untreated control. Prime-Ark 45® blackberry flowers were oversprayed with each product and incubated at room temperature for 24 hours. Following incubation with control products, flowers were inoculated with a field-collected isolate of *Erwinia amylovora*. After a 24-hour colonization period, *E. amylovora* cells were recovered from all floral treatments and enumerated via serial dilution. All treatments were shown to significantly reduce floral colonization compared to an untreated control, with the Agrimycin treatment showing the greatest reduction. However, even following the Agrimycin treatment, the bacterial populations were greater than 10^8 CFU/flower. This suggests that the systemic effects of the Agrimycin play a more important role in disease control than the surface bactericidal effects of the antibiotic. As a result of these studies, we conclude that Agrimycin is the best means of controlling the severity of fireblight occurrence in the mid-south growing region, while the effectiveness of the combination of Actinovate + Agrimycin should be investigated further.

Education Section

Furthering the Reach of Plant Science Education through a Virtual Lab Course: A Pilot Study

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An online plant science laboratory course was created to increase the knowledge of plant science students. Laboratory courses fulfill the need for experiential learning, and reinforce abstract concepts taught in lecture classes. Online lab courses have successfully been implemented in the disciplines of chemistry, biology, soil science, and physics, but no examples of a virtual introductory plant sciences lab were found. The online introductory plant science lab course consisted of a mix of virtual simulations and hands-on activities that the student could complete at home, in their own time. The virtual simulations were all available for free public access online. Content, including weekly introductory videos and assignment grading rubrics, was added to the Blackboard course delivery platform for students to access. Content knowledge was evaluated via a researcher-developed knowledge exam. Validity was established through the use of cognitive interviews and review by a panel of plant science experts. Internal consistency was established via a pilot test with 15 undergraduate agriculture students, yielding a KR-20 of 0.68, which was deemed to be acceptable. The average pretest score was 26.11 out of 33, and scores ranged from 14 to 31. The average posttest score was 30.42 out of 33, and scores ranged from 28 to 32. All 19 students' scores increased, with an average gain of 4.32 points. Researchers concluded that the online virtual plant science lab was successful in increasing students' knowledge of plant science. Recommendations were made to be flexible in the arrangement of the weekly lesson topics and to create clear and concise directions for the students to follow.

Extension Section

Nursery and Landscape Industry Open Houses, Field Days, Education and Outreach at the LSU AgCenter

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The LSU AgCenter (Louisiana Agricultural Experiment Station and Louisiana Cooperative Extension Service) has greatly expanded nursery crop production and commercial landscape contracting outreach, education, workshops and field days over the past seven years. This coincides with the effort to develop, and continue to expand, the newly formed Landscape Horticulture Research and Extension Center at the Hammond Research Station, Hammond, LA. Efforts have include expanded field days and industry open houses, e-mail newsletters, weekly landscape horticulture news articles highlighting station research and plant evaluations, expansion of commercial ornamental and turfgrass pesticide application continuing education programs, development of the Louisiana Super Plant program, and more. Two field days are held annually at the station for nursery and landscape professionals—the Margie Jenkins Azalea Garden Horticulture Lecture Series and Spring Industry Day (in May) and the Landscape Horticulture Field Day (in October). Pesticide applicator continuing education now includes five annual meetings (up from three in 2009) with an increased emphasis on new plant material, sustainable landscaping and best management practices. E-mail newsletters are currently sent 2–3 times monthly to 1200 clientele in a five state area. A monthly calendar of events is sent to the same list. A landscape horticulture news article is written weekly and distributed statewide by the LSU AgCenter Office of Communications. The Louisiana Super Plant program was initiated in 2010 and has been well received by independent retail garden centers. The program now includes 34 plants selected by an internal LSU AgCenter committee and an industry advisory committee. Other activities adding in outreach efforts has included an annual Ball Horti-

culture University held cooperatively with representatives from Ball Seed Company, the resurrection of the dormant Louisiana Plant Materials Conference, plant release distributions with the Louisiana Society for Horticultural Research, relocating the Southeast Louisiana Nursery Association Trade Show to the same day at the October field day, participation in the National Plant Trials Database and more.

Establishing the Value of an Online Blog Post

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Blogs are an important tool for scientists, especially those in Extension, to reach and engage audiences. However, assessing the impact of online blog posts is difficult and thus it is not rewarded accordingly with its value as a vital Extension tool. Using economic models such as estimated time allocation (investment) or opportunity cost could help assign a monetary value to each page view. In this example, data were gathered for the most popular blog post from the Mississippi Fruit and Nut Blog (msfruitextension.wordpress.com) with metrics supplied by Wordpress. Average household net-adjusted disposable income data was obtained from OECD.org to calculate the opportunity cost. It was assumed that the hours a reader worked were flexible, allowing for use of hourly wage as a model input. Leisure time, valued at 1/4 of work time, was also used as a comparison. This data resulted in values being derived for the most popular post. The top post ("Holes in Tree Bark") had an opportunity cost of between $359 (leisure) and $1,435 (work). Establishing the value of online content allows authors of blogs and other platforms to quantify and justify their work.

Extension Education on New Technologies in Grape Production for the Southeast

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Grape growing has increased significantly on a national and state scale in the last decade; however, current information and education on growing bunch grapes in Alabama is lacking. Alabama has factors in place that make the expansion of the existing bunch grape industry feasible, including the recent introduction and on-going research on Pierce's Disease (PD) resistant *Vitis vinifera* grapes that is showing very promising results. Recently, two commercial Alabama vineyards were granted a license to cultivate PD-resistant *V. vinifera* selections, which makes Alabama a pioneer in cultivating an alternative grape crop and provides our vineyards a cutting edge technology to overcome the deadly Pierce's Disease. Implementation of grape growing techniques such as vertical shoot positioning training system, crop load adjustment through shoot and leaf thinning not previously practiced in muscadine or hybrid bunch grape production in the region were needed for sustainable production, but existing information on successful *V. vinifera* and hybrid bunch grape production in Alabama is very limited. Thus, there is a significant need to educate grape growers in our state on implementation of the innovative technologies for sustainable production for the local markets. Our project goal is to conduct in-depth workshops and develop new publications to promote the implementation and facilitate the adoption of the currently available innovative grape production technologies.

The National Strawberry Sustainability Initiative 'Texas Strawberry Project': Participation and Responses

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Strawberry production in Texas is low (about 150 acres). Evaluations were conducted in 2013–14 at five Texas A&M AgriLife Research & Extension Centers as well as on sixteen grower's fields located across differing climates as part of the *National Strawberry Sustainability Initiative*, directed by the University of Arkansas and funded by the Walmart Foundation. The objective of the Texas project was to revitalize the industry and expand sustainable production to typically non-producing regions of the state. Eight varieties were evaluated for production method (plastic covers vs. open field), yield and quality, insect and disease pests, fertility, irrigation, mulch type and salinity tolerance. When averaged across varieties, yields ranged from 0.3 to 1.45 lbs/plant depending on grower and location. Yields increased when produced in high tunnels and when grown on plastic mulch. Averaged across locations, 'Radiance' produced the highest yields while 'Albion' produced the lowest. However, 'Albion', 'Camarosa', and 'San Andreas' were the most tolerant to high salinity levels. Strawberries grown in alkaline soils showed severe chlorosis at some locations; however, incorporating sulfur prior to planting acidified soil pH and improved yield in some varieties. Economically-damaging pests included lepidopterous spp., aphids, spider mites and *Botrytis* gray mold. A grower survey indicated that knowledge of strawberry production increased from 'fair to poor' (69%) at initiation of the project to 'good to excellent' (92%) at completion. Additionally, 54% of growers indicated they will increase strawberry production as a result of their experience. Results of this project illustrate the susceptibility of strawberries to the various regional climates of Texas; however, modifying the growing environments with high tunnels and/or plastic mulch will improve sustainable strawberry production even in traditionally non-producing regions.

Floriculture, Ornamentals, and Turf Section

Highlights of New Bedding Plant Trials—2014

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New bedding plant cultivars (warm season annuals, cool season annuals, herbaceous perennials) are evaluated in landscape plantings each year at the Landscape Horticulture Research and Extension Center at the LSU AgCenter's Hammond Research Station, Hammond, LA (USDA Hardiness Zone 8B). Raised bed, irrigated, pine straw mulched plantings are located in full sun and partial sun/partial shade areas. Warm season trials are normally evaluated late April through early October. Data for some bedding plant trials is now being coordinated with 35 additional sites (24 university related) in the North America via the National Plant Trials Database (www.planttrials.org). Plants are given a "horticultural rating" (5 = excellent, 4 = above average, 3 = average, 2 = below average, 1 = poor, 0 = dead or nearly dead) with the following traits being considered: uniformity of habit and flowering, flower numbers relative to others ("floriferousness"), insect resistance, disease resistance, and uniqueness. Ratings are required to be taken a minimum of three times during the season. The top ten performers in warm season annuals and perennials in 2014 were 'Arrabonna Red' Celosia (PanAmerican Seed), Bounce series Impatiens (Selecta), Rio Grande series Purslane (Ball FloraPlant), Mayan series *Ruellia* (IFAS/HMA Plants), 'Sombraro Adobe Orange' *Echinacea* (Darwin Perennials), 'Lime Sizzler' *Hamelia patens* (Greenleaf Nursery), Cannova series Canna (Ball Ingenuity), 'Titan Romance Mix' Vinca (PanAmerican Seed), 'Embers Wish' Salvia (Plant Development Services/Southern Living Plant Collection), and 'Marquee Blonde Bombshell' Coleus (Burpee Home Garden). Some additional above average landscape performers included 'Love and Wishes' Salvia (Plant Development Services/Southern Living Plant Collection), 'Flash Mob Magentacaular' Petunia (Burpee Home Gardens), 'Flash Mob Pinkceptional' Petunia (Burpee Home Gardens), Vintage series *Achillea* (Darwin Perennials), 'Bondi White' and 'Bondi Blue' *Scaevola* (Ball FloraPlant), Big Bounce series Impatiens (Selecta), and Starcluster series 'Pentas' (Syngenta Flowers).

Every Landscape Business Starts with a License: What Can We Learn From There?

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Turfgrass production, ornamental horticulture, and sandscape services directly contributes $4.0 billion in output, and indirectly another $3.8 billion for a total of $7.8 billion Georgia's over $700 billion economy. This survey was undertaken to gauge the industry's recovery after the economic downturn in 2009. More specifically, the objective was to identify active green industry service businesses and generate a database (contact person, address, phone number, e-mail), and more long-term, to connect professional organizations (Georgia Urban Agriculture Council, Georgia Green Industry Association) and the University of Georgia Cooperative Extension with these businesses. Gwinnett county was selected as a representative of the Metro Atlanta urban and suburban area, and the local county licensing and revenue office served as source of information. Businesses were identified using the North American Industry Classification System number (NAICS). Three hundred and ninety two landscaping service businesses (NAICS #561730) were in the database, while 290 were established since the Great Recession. Tree removal service businesses (NAICS #561730) were represented with 35 records, 15 of which were established after 2009. There were 13 landscape architectural service businesses (NAICS #541320), of which 3 were established since 2009. There were two irrigation service businesses (NAICS #237120: Oil and Gas Pipeline and Related Structures Construction) and both were established before 2009. Approximately 90% of the businesses were small operations (1–3 employees) but with reasonable longevity (7+ years). Approximately 90% were home-based. Sixty one percent of Gwinnett county businesses were established after the Great Recession. Future work will continue in order to compile information on all Metro Atlanta counties (covering 28 counties and population of 6.6 million). The goals are to establish status of businesses (active or not), and develop a unified database with main contact person, mailing address, phone, and, e-mail.

Clean WateR^3—Reduce, Remediate, Recycle: A Specialty Crops Research Initiative Project Focused on Management of Recycled Water for Ornamental Crop Production

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Researchers received funding for the Specialty Crops Research Initiative (SCRI) Coordinated Agricultural Project "Clean WateR[3]—Reduce, Remediate, Recycle—Enhancing Alternative Water Resources Availability and Use to Increase Profitability in Specialty Crops" in September 2014. This project stemmed from a coordinated effort by scientists through a multistate research group (NC1186 Water Management and Quality for Ornamental Crop Production and Health) that resulted in a 2011 SCRI planning grant titled "Containment, Remediation, and Recycling of Irrigation Water for Sustainable Ornamental Crop Production". Planning grant dollars were used to bring scientists and stakeholders together, conduct a national survey, and discuss and identify water management strategies employed by progressive growers throughout the U.S. Funds were also used to recruit additional scientists, bringing together a multi-institutional research team, who prioritized research areas, refined project goals, and developed project objectives over an 18-month period. The team has expertise in socioeconomics, engineering, horticultural systems, plant pathology, environmental toxicology, and extension. Grant preparation was an iterative process that entailed three writing workshops prior to proposal submission. Overarching project goals are to encourage recycling and reuse of remediated irrigation runoff by developing an online decision support model available for grower use, and to research and select runoff treatment (remediation) technologies (TTs) suited for implementation at the individual site level. To support these goals, scientists will evaluate treatment technologies to remove agrichemicals and pathogens from operational water. These data will help to inform and test models that are being developed. This project will help growers treat and reuse operational water to save valuable water resources, and reduce the environmental impact of runoff water. Funding for this work was provided in part by the Hatch program of the National Institute of Food and Agriculture, U.S. Department of Agriculture, USDA–NIFA–SCRI # 2011-51181-30633 and USDA–NIFA–SCRI # 2014-51181-22372.

Recovery of *Phytophthora* spp. from the Roots of Wetland Plants Growing in Water Conveyance Structures at an Ornamental Plant Nursery

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Vegetated buffers and constructed wetlands currently are used to remediate nutrient and pesticide contaminants from production runoff at ornamental plant nurseries, but they also may help remove propagules of plant pathogens. As we began to evaluate the potential of these systems for pathogen remediation, it was important to determine if species of *Phytophthora* were present naturally within wetland plant populations currently established in runoff channels and constructed wetlands systems that receive runoff from irrigated production areas. Plant samples were collected over a period of two years from various locations in vegetated channels and constructed wetland systems at an ornamental plant nursery in southern Georgia. Samples were collected at various times throughout the year to determine if season influenced isolation frequency or the species of *Phytophthora* recovered. To isolate *Phytophthora* spp., roots were washed under running tap water and then root pieces (1–2 cm long) were embedded in PARPH-V8 selective medium. More than 350 wetland plant samples were collected, but only 22 isolates of *Phytophthora* spp. were recovered. Species of *Phytophthora* were most frequently associated with roots of plants that received runoff directly from production beds. Species of *Phytophthora* were not detected on roots of plants collected near the end of the constructed wetland system, where effluent leaves the nursery. No seasonal trends were observed in plant infestation or species of *Phytophthora* recovered. *Phytophthora* spp. were recovered very infrequently from the wetland plants in runoff channels at this nursery—only 6.3% of the 350 plants sampled were infested. The plant species that were least and most likely to be associated with species of *Phytophthora* will be discussed along with potential management issues and recommended plant species.

Can Adding Value to Native Genotypes Help Them Compete with Market-established Exotics?

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Increasing awareness of the impacts landscape plant selection imposes on our built and natural environments have resulted in an opportunity to market improved cultivars of native genotypes as alternatives to traditional exotic taxa. However, exotic plant taxa are well entrenched with producers and have established niches in the marketplace, thus posing challenges to adoption of new native plant selections. To facilitate adoption of new native plant selections the breeders must eliminate barriers to production that would place the new cultivars at a disadvantage relative to established products in the market and then provide compelling arguments for adoption of the new taxa in favor of those already entrenched in the marketplace. Specific examples from our breeding and selection efforts with Texas native plants will be used to illustrate these challenges and opportunities. Production concerns will address propagation, substrate and fertility considerations, and canopy manipulation. Examples of value-added opportunities will be discussed including superior appearance, novelty, quantifying attributes associated with enhanced adaptation to environmental stresses, reduction of liabilities associated with invasiveness, suitability to new or alternative uses, and the need for recognition and quantification of ecosystem services.

Preventative and Curative Measures in Commercial Liriope Production with Crown and Leaf Rot Incidence

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Major nursery plant losses in 'Big Blue' liriope (*Liriope muscari* 'Big Blue') crops have been documented throughout the Gulf Coast. The objective of these studies was to determine the benefit of pre-plant and curative measures for crown and leaf rot control in a nursery setting. Pre-plant incorporation of control (untreated), metalaxyl, Micora and metalaxyl+Micora treatments into a 5/8" pine bark mixtures were established. The media were fertilized with a complete 12-month release CR fertilizer filled 4 inch, and 1- to 3-gallon nursery containers. Containers were arranged in a RCBD with 4 treatments and 5 blocks, 10 plants/block over a 6 month period. Disease incidence was measured every two months indicating disease occurrence (%). At the end of six months the number of healthy bibs were harvested and counted. *Phytophthora palmivora* and *Fusarium oxysporum* were isolated on control plants. Preplant treatments were similar to the control for both disease occurrence and bib number after six months. Posttreatment applications to selected infected plants with Adorn, Aliette, Adorn+Aliette and oil and soap and an untreated control plots were established to either pruned and unpruned symptomatic liriope plants. At the end of six months the plant disease incidence (%) and number of healthy bibs were harvested and counted. There were no differences between treatments; however the overall disease incidence after six months decreased from 100% at the start of the experiment to as low as 10%. This can be explained by either the death of the infected bib/or bibs and new growth of adjacent bibs within the infected pot staying healthy. Bib count was similar over all treatments. There was phytotoxicity noted eight weeks after the oil and soap treatment. Using best management practices seems to be the most effective strategy to reduce crown and leaf rot disease in nurseries. Proper sanitation and using uninfected bibs is essential. Applying chemicals indiscriminately will only reduce plant quality, increase cost, and reduce plant vigor.

Container Trial of 47 *Hydrangea macrophylla* and *H. serrata* Cultivars at the Center for Applied Nursery Research

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A container-based plant trial of 47 *Hydrangea macrophylla* and *H. serrata* cultivars was conducted during the 2014 growing season at the Center for Applied Nursery Research, located in Dearing, GA (USDA Zone 8b). The purpose of this trial was to determine growth and flowering characteristics of commercially available hydrangea cultivars under commercial growing conditions, and pass that data along to growers and Extension personnel to afford these individuals to make more informed decisions on cultivar selection. The trial was initiated the first week of April, with first flowering data collected weekly, growth index [(H x W x W/3) – in cm] collected monthly, foliage quality (1–5 scale) collected monthly and mortality collected monthly. Plants were obtained as liners, sheared to 5 cm, bumped up into #3 containers filled with 5/16" aged pine bark, 2 lb lime/yard^3, 1 lb gypsum/yard^3, talstar (12 mo. Rate), 1 lb/yd^3 micromax, and high rate Harrell's Custom 18-6-8 NPK+ minors fertilizer. One cultivar, ' Goliath' had 100% mortality. First flowering date ranged from 29 April ('Eva Lyon Holmes') to 29 August (Junihitoe'), with 13 cultivars not flowering in the 2014 growing season. Final (September) growth index ranged from 17.0 ('Nightingale') to 86.1 ('Zorro'). Full tabular results of this project can be viewed at www.canr.org and the study will carry through the 2015 growing season, with results updated in Fall 2015.

Influence of Three Pruning Strategies on Growth and Form of Three *Taxodium* Clones

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Three *Taxodium distichum*, baldcypress clones, T405, T406, and T407, were planted in January, 2012. The trees were pruned each winter into three forms: 1) control (no pruning except for lower trunk shoots), 2) modest (cutting back of major branches to create a Christmas tree form), and 3) hard (cutting back all branches to their juncture with the central leader). Growth measurements collected in 2013, 2014, and 2015 included tree height, trunk diameter, crown width, and number of lateral branches. A block design was utilized with four replications, 1 tree per replication. After three growing seasons, tree height averaged 3.9 m across all clones and pruning treatments with no significant tree height differences between the three pruning strategies. Control trees did have greater trunk diameter and tree width and lower number of major lateral branches emanating from the central leader. Best tree form resulted from the modest pruning method while control trees tended to multi-leader and were more round headed.

2014 Crapemyrtle Bark Scale Crawler Counts on Natchez Crapemyrtle in Little Rock, AR

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Non-colored sticky traps were used to monitor for 'immatures' (crawlers and early nymphs) of *Eriococcus lagerstroemia* (crapemyrtle bark scale: CMBS) on a single infested 'Natchez crapemyrtle (*Lagerstroemia* x 'Natchez') starting on March 12, 2014 in Little Rock, AR (USDA Plant Hardiness Zone 7b). Five, 1.9-cm wide strips of sticky tape were attached around the circumference of five separate branches approximately 180 cm above the ground. Traps were collected nearly weekly

throughout 2014 and immediately viewed under a binocular dissecting microscope to count the number of 'immatures'. At least 3 generations were observed with peaks on 8 April, 20 June, and 15 August; mean maximum number of immatures/sticky trap were 39,496, and 5,725 for the first, second, and third generation, respectively. An additional generation may occur in late September or early October in Zone 7b.

Engineering and Construction Advances in Horticultural Substrate Research

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Cultural practices for growing greenhouse and nursery crops continue to be modified and improved due to new technologies, research data, and an increasing interest and demand for more environmentally sustainable and economic growing practices. With the development and use of new fertilizers, irrigation management strategies, production containers, plant growth regulators, pesticides, and other products/practices in the past decade, there remains a need for the substrates used to grow horticultural crops to also evolve and improve. Efforts are being made to evaluate and in some many cases re-evaluate the way many of our traditional and new alternative substrates are engineered and constructed. Advances in organic material processing (chipping, shredding, milling, grinding, separating, and constructing) are revealing new data about how to better make and manage horticultural soilless substrates. Research has been conducted on various aspects of processing organic materials including pine bark, pine wood, hardwood, coconut coir, and grasses (switch grass, giant reed, etc.) among others. Initial results provide evidence that the most influential variables relating to the processing of these materials (and the consistency and reproducibility of the end substrate components) are: 1) size of feedstock being processed; 2) moisture content at the time of processing; and 3) screen size and hammer wear of hammermills used to grind the feedstock. Bark (pine or Douglas fir) remains the most commonly used substrate for the production of container—grown nursery crops and recent trends of using bark in professional greenhouse mixes and retail bagged products continues to increase. The consistency, quality, and reproducibility of bark substrates also remain a concern for our industry (processors, manufactures, and growers). Improved methods of processing bark (and other materials) and careful management of the materials is something that is being addressed and can lead to more efficient, reliable, and economical crop production in the future as the science of growing plants continues to improve and be more profitable.

Effect of Container-Grown Plant Canopy Shape on Plant Count Accuracy Using Remote Sensing Imagery

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In general, the nursery industry lacks an automated inventory control system. Remote sensing images combined with image processing software have been used to count citrus trees, olive trees and corn plants. This technology has the potential for use in counting plants in nurseries. An experiment was conducted to evaluate the effect of plant canopy shape on counting accuracy of container-grown plants. Images were taken at 12 m above the ground. Plants were placed on a black fabric in staggered rows separated 5 cm between canopy edges. Two species of juniper (*Juniperus chinensis* L. 'Sea Green' and *Juniperus horizontalis* 'Plumosa Compacta') were selected to evaluate plant shape. Count algorithms were trained using Feature Analyst (FA) and MATLAB. Total count error, false positives and unidentified plants were recorded from output images when using FA. When FA was used there was no difference between all variables measured when an algorithm trained with an image displaying regular or irregular plant canopy shape was applied to images displaying both plant canopy shapes even though the canopy shape of 'Sea Green' is less compact than 'Plumosa Compacta'. When the algorithm trained in MATLAB was applied, there was no significant difference in total count errors when plant canopy shape was evaluated. FA and MATLAB algorithms appear to be fairly robust when used to count juniper container-grown plants from remote sensing images taken at 12 m.

Response of Selected Ozark Region Flowering Perennials to Acute Ozone Exposure

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Twenty-seven flowering perennial plant species representing 11 genera native to the Ozark Physiographic Region were exposed to a peak level of 2.0 $mg \cdot L^{-1}$ ozone gas (O_3) or ambient air for 30 minutes. Ozone source was a corona-discharge generator with the O_3 being introduced into 3 gas-tight chambers constructed of polyacrylic sheets. Ambient air showed only trace amounts of O_3. After exposure, plants were allowed to stand for seven days in a greenhouse at which time plants were evaluated for visual foliar damage. Data collected included damage severity factor, percentage of leaves affected, percentage of plants affected, and a severity index. Out of the 27 species tested, 15 species in the genera *Coreopsis*, *Echinacea*, *Liatris*, *Penstemon*, *Rubeckia*, *Solidago*, and *Tradescantia* were asymptomatic after 7 days. Ten species (*Coreopsis tripteris*, C. *palmata, Penstemon cobea*, P. *pallius*, *Solidago nemoralis*, *Silphium integrifolium*, *Olioneuron rigidum*, *Rubeckia missouriensis*, and *Solidago speciosa*) showed symptoms typical of O_3 damage ranging from bronzing and flecking of foliage to bifacial necrosis. Foliar symptoms varied in severity between plants within a species with visual manifestations differing between various the species. Within genera, individual species varied from asymptomatic to severe damage, which suggests species within desired genera should be screened for O_3 tolerance before being used in areas with degraded air quality.

Fruit Section

Assessment of Fire Blight Tolerant Asian Pear Cultivars in Alabama

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Asian pear trees are quite precocious and productive. Nine Asian pear cultivars namely 'Hosui', 'Isilwase', 'Kosui', 'Olympic', 'Shinko', 'Ya Li', 'Yoinashi', 'Atago', '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. By the end of the third season, 'Bartlett' cultivar had lost all five trees planted, and only 60% of 'Golden Russett' trees survived. All of the 'Hosui' trees were dead by the end of the fourth season. Cultivars 'Ya Li', 'Isiiwase', 'Kosui', 'Olympic', 'Shinko', and 'Yonashi' were vigorously growing. Blooming of 'Ya Li' occurred early in the season, about two weeks before 'Isiiwase' trees blossomed. This indicates the importance of planting 'Ya Li' with a companion early blooming pollinizer cultivar such as 'Ya Tse'. 'Yonashi' and 'Shinsui' were the most productive cultivars in 2014 based on their yield efficiency. 'Yonashi' produced the largest mean fruit size of 268.4 g. Our preliminary results indicate that selected Asian pear cultivars could be grown successfully on a small scale for local markets.

Progress in Breeding Primocane-fruiting Blackberries: Fruit Quality and Thornlessness

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Primocane-fruiting blackberry breeding has progressed at the University of Arkansas in recent years, with four commercial cultivars released expressing this trait between 2004 and 2013. The most successful of these has been Prime-Ark® 45 released in 2009. It has been widely planted due to its high quality fruits which have good postharvest storage potential for shipping, along with high yields. It is thorny, however, and thornlessness is desired by growers in newer developments. Both thornlessness and primocane fruiting are recessive characters, creating a greater challenge to combine these characters along with fruit quality and high yields. Prime-Ark® Freedom was released in 2013, the first commercial, thornless, primocane-fruiting blackberry. It was recommended for home garden and local-market production, as fruit postharvest storage potential was limited. Breeding has continued and increased fruit quality, including postharvest storage potential, has been a high priority in crossing and selection. In late 2014, Prime-Ark® Traveler was released. It has thornless canes along with good postharvest fruit storage potential for the commercial shipping market. This new cultivar should contribute to expanded production of primocane-fruiting blackberries particularly for the late summer and fall production season.

Foliar Uptake of Calcium in Rabbiteye Blueberry (*V. virgatum* Aiton)

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Calcium (Ca) is a xylem mobile nutrient supplied to the plant through transpiration as water passes from the root to the shoots. In addition, Ca is closely associated with cell wall stability and a positive correlation exists between the cation exchange capacity of plant cells and the Ca concentration in plant tissues. Foliar applications of Ca are utilized by growers to increase fruit cell wall stability 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 Signature SST 8% Ca (Agrian®, Loveland Products, Inc. Loveland, CO), KeyPlex® Calcium Plus (chelated calcium form calcium glucoheptonate) of KeyPlex, Winter Park, FL., and Albion Metalosate® 6% Ca (Albion Laboratories, Inc., Clearfield, UT). All treated plants had three applications: 50% bloom, petal fall and 2 weeks prior to harvest at 2 pt/A (2336 ml/ha) at 20 gals of water per acre. The Signature SST included LI 700® deposition aid at 16 oz/100 gal (473 ml/378.5 L). These applications were compared to untreated fruit harvested at the same timing as the treated material. Fruit were harvested at 40% ripe and again 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. At harvest, there were no treatment differences in leaf Ca concentration for either cultivar. However, Signature SST increased 'Alapaha' fruit Ca concentration by 59% when compared to untreated fruit. The other treatments did not increase fruit Ca concentration for either cultivar. Foliar Ca applications did not improve fruit firmness or weight, indicating no significant effect on fruit quality.

Unlocking Genetic Potential of the Peach Collection at the National Clonal Germplasm Repository in Davis, CA

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Genotyping by sequencing (GBS), a low-cost, high-throughput

sequencing technology, has been used to genotype 510 *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* (85%), with 8% of them being wild relatives (*P. mira, P. davidiana, P. kansuensis and P. ferganensis*) and 7% categorized as hybrids between peach and other related species and *Prunus spp*. The method produced on average 1.2 million sequence reads per accession, with majority of the accessions having more than 500,000 reads. We identified 23,402 single-nucleotide polymorphism (SNP) markers, with allele frequency > 0.05, present in at least ≥ 90% of all analyzed accessions distributed across the entire genome. Population structure revealed 5 groups. *Prunus persica* population was structured in three groups and remaining two groups constituted of *P. davidiana* and *P. mira* individuals, respectively. Interspecific hybrids were in between the groups (unstructured) and individuals classified as *Prunus spp*. were assigned to the related group. 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 for water use efficiency and data available through Germplasm Resources Information Network (GRIN), will be discussed.

Integrating Flesh Firmness Measurements as a Part of the Blackberry Postharvest Protocol at the University of Arkansas: First Results

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Postharvest and shelf-life characterization of fruit is critical for successful commercialization of new blackberry breeding cultivars intended for long-distance shipping. The blackberry breeding program of the University of Arkansas has released several cultivars with the aim to provide high-quality fruit to the fresh-market, shipping industry. In 2008 a protocol was designed and implemented to measure the postharvest potential of 30–40 selections each season. Six traits are evaluated after cold storage at ~5 °C for 7 d. These traits include weight loss, leakiness, mold, color reversion, firmness, flavor, and shininess, each rated subjectively. Firmness retention potential after harvest cannot be predicted based on field observations, but rather after storage. It is desirable to better quantify firmness and hopefully predict storage potential. The use of objective measurements of fruit component firmness were introduced into the program in 2013 and 2014. Fruit compression and drupelet skin and receptacle penetration firmness were evaluated using a texture analyzer in these years. Initial results indicated that compression measurements better predicted postharvest potential of blackberry selections and has potential to allow for earlier and more precise postharvest potential decisions for selection parent use or evaluation in advanced trials. Skin and receptacle penetration measurements were much more variable among selections and years, and do not show as much promise as compression in postharvest potential prediction.

Gas Exchange Response to Leaf Excision for Five *Vitis* Cultivars

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Gathering field leaf gas exchange data is essential for many research projects, and with current gas exchange systems 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 are able to collect. To help increase the number of samples collected, our research objective was to determine if gas exchange of field grown excised grape (*Vitis vinifera*) leaves was different when compared to gas exchange of grape leaves remaining on the vine. In 2006 five cultivars ('Cabernet Franc', 'Chardonnay', 'Cabernet Sauvignon', 'Tempranillo', and 'Grenache') were field planted in a randomized complete block design. All trees were drip irrigated as needed. On three occasions in 2013 and two occasions in 2014, auto program mode was used on two Li-6400 machines to simultaneously measure gas exchange on leaves from the same vine (measurements were recorded every 30 seconds). After 120 seconds, one leaf was excised and auto program continued an additional 8 minutes. Gas exchange means (n=16) for excised and non-excised leaves were graphed over time. In addition, gas exchange means at 60, 90, 120, 150, and 180 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 un-excised leaves of all varieties remained stable during the measurement period. In contrast, gas exchange parameters (stomatal conductance, leaf to air vapor pressure deficit, and photosynthetic rate) for excised leaves of each cultivar 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. Using the leaf excision technique it was possible to measure 60 leaves each hour with a single Li-6400. Therefore, it appears leaf excision might be one means researchers have to increase sample size for gas exchange data collected in the field.

New Rabbiteye Blueberry (*Vaccinium ashei*) Cultivars for Alabama

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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' with 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', 'T-965', and 'Vernon', each represented by 5 plants. Our second year results suggest selection '03-06' had the highest total yield of 7.6 kg/plant, followed by 'Titan', 'T-743', and 'Vernon'. 'Titan' and selections 'T-965' had the largest fruit size in both study years. Berries of 'T-965' and 'T-743' matured very early in the season. During the initial years of establishment cultivars 'Alapaha', 'Brightwell', 'Titan', 'Vernon', and selections '03-06', 'T-743', and 'T-611' were highly productive.

Aminoethoxyvinylglycine (AVG) Delays Maturity and Decreases Preharvest Drop in a Late Season Peach

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Late season peach cultivars in the southeastern United States have a tendency to drop their fruit prematurely before harvest leading to significant losses in yields. Additionally, late summer heat can reduce fruit firmness and negatively impact fruit quality within the distribution network to the consumer. Aminoethoxyvinylglycine (AVG) or Retain® in combination with ProGibb® was evaluated as a harvest aide to maintain or increase fruit firmness and reduce preharvest drop on drop prone, late season, peach cultivars. Retain® (333g pouch) plus 591 mL of 4% ProGibb® in 378.5 L water with an organosilicone surfactant (0.05% v/v) was applied at 935 l/ha 14 days before harvest on 'September Sun' orchards in 2013 and 2104 in Ridge Spring and Monetta, South Carolina. Premature fruit drop with Retain® was reduced by 7% and 5% in 2013 and 2014, respectively in Ridge Spring, and 11% in 2014 in Monetta. Packout yields per tree in 2013 and 2014 at Titan Farms for Retain® treated trees (73 kg, 77 kg) were similar to the control trees (70 kg, 88 kg). Packout of number one fruit for both years were similar between treated (72%, 75%) and the control (70%, 77%) treatments at Titan Farms. No effect on marketable fruit size in the Titan packouts was noted for both years as > 97% fruit exceeded 7 cm. Fruit from treated trees in the Monetta orchard had better overall size based on grower correspondence. Fruit firmness was not increased in fruit sampled from Monetta in 2014. Peak harvest maturity was delayed 2–3 days each year. Cost/benefit of the Retain® + ProGibb® combination must be considered before adoption by growers.

Interactions of Sustainable Soil Management Practices and Fumigation Strategy on SE Strawberry Production

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The use of soil health promoting management practices like compost, cover crops and beneficial soil inoculants have generally been limited to organic production systems and specifically little knowledge exists concerning their incorporation into fumigated plasticulture strawberry production in the Southeast (SE). Thus our study is focused on evaluating the incorporation of a summer cover crop mix (Cowpea var. 'Iron Clay' (*Vigna unguiculata*) and Pearl Millet (*Pennisetum glaucum*genus)), compost applied in the early summer, beneficial soil inoculants (arbuscular mycorrhizal fungi (AMF) and vermicompost) added to the strawberry plug and multiple combinations of these practices as applied to both fumigated and non-fumigated plasticulture strawberry production. The study began in June 2013 with the establishment of plots in Goldsboro, North Carolina arranged in a split-plot RCBD with fumigation as the split. Results from the first harvest season in 2014 indicate significant interactions between soil management practice and fumigation strategy on per plant strawberry yield. Significant increases in marketable yields were observed for the cover crop and cover crop + compost treatments in the fumigated system as compared to the non-fumigated system, while significant increases in marketable yields of the plug inoculation treatment in the non-fumigated over the fumigated system were observed. Linear contrasts revealed a trend (P = 0.0745) toward increased plant tissue nitrate-nitrogen in plots receiving cover crops in the fumigated treatment as compared to the non-fumigated system. These results may explain observed increases in yield for the cover crop and cover crop + compost plots in the fumigated system as nitrate-nitrogen has been shown to be highly positively correlated to yield. Alternatively, a lack of survival of the plug-inoculated AMF in the fumigated system (P < 0.0001) likely contributed to lower marketable yield for that treatment in the fumigated system. Due to inverse yield trends of the cover crop and plug inoculation treatments within the fumigation treatment there were no significant yield effects when these soil management practices were applied simultaneously.

Evaluation of Actinovate for Fire Blight Management

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The biological product Actinovate® (Novozymes, Inc.) was evaluated for effectiveness in controlling fire blight through a two part study. The first study was a field trial, performed at two Arkansas apple orchard sites in April 2014. Treatments were an untreated control, an Agrimycin® (Nufarm, Ltd.) control, a Serenade® (AgraQuest, Inc., Bayer Crop Sciences, Inc.) treatment, two Actinovate treatments: an early treatment and a late treatment, and a split Actinovate + Agromycin treatment. Disease symptoms were found following all treatments and evaluated based on the USDA fireblight scoring system. Significantly less severe disease was observed following the Agrimycin treatment than the untreated control, with mean total disease ratings of 1.1% and 6.0% respectively. The split treatment also led to less severe disease occurrence than the untreated control with a mean total disease rating of 2.1%. A second study was performed using detached blackberry flowers to examine suppression of bacterial floral colonization following treatment with these same products. The suppression of colonization following treatment with Actinovate was compared to Agrimycin and Serenade, as well as an untreated control. Prime-Ark 45® blackberry flowers were oversprayed with each product and incubated at room temperature for 24 hours. Following incubation with control products, flowers were inoculated with a field-collected isolate of *Erwinia amylovora*. After a 24-hour colonization period, *E. amylovora* cells were recovered from all floral treatments and enumerated via serial dilution. All treatments were shown to significantly reduce floral colonization compared to an untreated control, with the Agrimycin treatment showing the greatest reduction. However, even following the Agrimycin treatment, the bacterial populations were greater than 10^8 CFU/flower. This suggests that the systemic effects of the Agrimycin play a more important role in disease control than the surface bactericidal effects of the antibiotic. As a result of these studies, we conclude that Agrimycin is the best means of controlling the severity of fireblight occurrence in the mid-south growing region, while the effectiveness of the combination of Actinovate + Agrimycin should be investigated further.

The Effects of Selected Cover Crops on Growth Parameters of *Musa* (AAB Group) 'Mysore' Banana Plants

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Recently, studies were initiated in coastal Alabama to determine if production of non-Cavendish bananas to supply a potential niche market is feasible. Non-Cavendish bananas are exported to places like the US where they command a higher price than the market standard Cavendish. Cover crop usage is a common sustainable technology utilized in agricultural systems and has been encouraged in banana production. The present study was conducted to determine the effects of hairy vetch (*Vicia villosa*) and crimson clover (*Trifolium incarnatum*) as cover crops on growth parameters of 'Mysore' (AAB) banana plants. During the first season, cover crop treatments did not significantly affect growth of 'Mysore' bananas. However, when compared to the control treatment growth parameter values of cover crop treatments were consistently higher numerically. Banana plants were 18% and 16% taller in crimson clover and hairy vetch treatments respectively than those of the control treatment. Leaf area of bananas grown in crimson clover and hairy vetch were 18% and 9% greater than leaf area of bananas of the control treatment. Banana total leaf number (TLN) was only 2% higher in the crimson clover treatment compared to the control treatment whereas (TLN) in the hairy vetch treatment provided no increase over the control. Leaf emergence rate (LER) in the hairy vetch treatment was 2% higher than the control while LER in the crimson clover treatment was only 1% higher. Small difference in LER may indicate that cover crop treatments have a greater influence on overall plant size rather than on growth rate. Cover crop usage is a long-term commitment and requires more time to change the chemical and physical characteristics of the soil. Multiple-season data is needed to determine the usefulness of these two cover crops in banana fruit production.

Nutraceutical Changes in Muscadine Grape and Grape Segments During Storage

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Fresh-market muscadine (*Vitis rotundifolia* Michx.) cultivars, such as 'Supreme', have reportedly improved postharvest storability. Muscadine nutraceutical stability during storage is widely unstudied. Nutraceutical compounds in 'Supreme' muscadine whole berries and berry segments (flesh [skin and pulp] and seeds) were measured during postharvest storage for 6 weeks at 2 °C in 2012. Total anthocyanins, ellagitannins, and flavonols in whole berries and flesh were higher than seeds, while total phenolics and Oxygen Radical Absorbance Capacity (ORAC) were higher in whole berries than the flesh and seeds. Anthocyanins were present in the whole berries and the flesh, but not in the seeds. Generally, postharvest storage did not dramatically impact nutraceutical components in the whole berries or the berry segments. However, total ellagitannins in the seed slightly decreased, while resveratrol in the whole berries slightly increased during storage. Both the discovery that postharvest storage of muscadine grapes did not dramatically impact nutraceutical components in the whole berries or the segments and the identification and quantification of nutraceutical components in berry tissues provides additional information on nutraceuticals in this underutilized fruit.

Postharvest & Biotechnology Section

Composition of Butternut Squash among Cultivars and with Storage

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Butternut squash (*Cucurbita moschata*) is a popular fall and winter vegetable due to its long storage life and sweet nutty flavor. Postharvest attributes of fruit from thirty squash cultivars harvested from plantings in Laurel Springs and Waynesville, NC, were determined after 1 to 12 weeks storage at 20 °C to 24 °C and 40% to 60% relative humidity. Soluble solids content (SSC) increased from an average of 10% to 14% over 5 weeks of storage then remained constant while pH increased only slightly from 5.9 to 6.3. Neck breakdown and excessive weight loss (10-20%) occurred in some fruit after 9 or 12 weeks storage, due largely to the high storage temperature. Total carotenoid content of non saponified samples, determined by HPLC, increased between 1 and 5 weeks storage by 2- to 5-fold, depending on cultivar (2.3 to 9.9 mg/100 g fwt), with largest gains in alpha and beta carotene. Some cultivars doubled again in total carotenoids at 9 weeks. At 12 weeks, all cultivars lost 15% of total carotenoids present at 9 weeks, but amounts were still higher than at 1 week storage. Degradation of starch to sugars most likely kept the SSC constant and provided a carbohydrate source for continued synthesis of carotenoids. The relative gain in provitamin A from 1 to 9 weeks of storage averaged 3 fold (from 40 to 600 μg RAE) and indicates that butternut squash can provide a rich source of provitamin A during late fall and winter.

Chemical Changes in Sweetpotato Periderm in Response to Preharvest Conditioning to Reduce Skinning at Harvest

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Skinning or surface abrasion in sweetpotato (*Ipomoea batatas*) storage roots at harvest causes substantial losses of marketable products in postharvest. Greenhouse studies were conducted in 2011 and 2013 to determine the influence of preharvest conditioning on sweetpotato skin lignification/suberization and skinning resistance. 'Beauregard' (B-14) sweetpotato was grown in 12-L pots filled with soilless media for four months. Five days prior to harvest, plants were randomly selected and treated by: 1) cutting the main stem and removing the above ground vegetation (defoliation/devining); 2) spraying the foliage with ethephon at 32.6 g·L^{-1}; and 3) left untreated (control). Skinning resistance was measured in 2011 by the force required to scrape the skin off with a force gauge. In 2013, the skinning resistance was measured by the torque necessary to snap a skin circle off the root with a Halderson shear tester. Lignin/suberin content (aromatic domain) was determined by the thioglycolic acid method and total phenolics content was determined by the Folin-Denis method. Results showed that preharvest conditioning increased skinning resistance and skin lignin/suberin content. Skin phenolics content was the same or reduced in storage roots from devined or ethephon treated plants, respectively. Cortex phenolics increased with ethephon in 2011 but not in 2013. A relative skinning resistance index was estimated to compare both methods and to associate it with skin/lignin content. Skinning resistance was well correlated (r^2=0.64) with skin lignin/suberin content. These results indicate that preharvest conditioning induce changes in the plant that result in increased skin lignin/suberin content which was associated with resistance to skin fracture.

Changes in Key Enzymatic Activities in the Lignin/Suberin Synthesis Pathway in Response to Preharvest Conditioning in Sweetpotato Periderm

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Greenhouse studies were conducted in 2011 and 2013 to determine changes in the phenylpropanoid pathway conducive to skin lignification and/or suberization to preharvest conditioning in sweetpotato. 'Beauregard' (B-14) sweetpotato was grown in 12-L pots filled with soilless media for four months. Five days prior to harvest, plants were randomly selected and treated by: 1) cutting the main stem and removing the above ground vegetation (defoliation/devining); 2) spraying the foliage with ethephon at 32.6 g·L^{-1}; and 3) left untreated (control). Skinning resistance was measured by the force required to scrape the skin off (2011) and by the torque necessary to snap a skin off (2013). Lignin/suberin content (aromatic domain) was determined by the thioglycolic acid method. Skin and cortex phenylalanine ammonia lyase (PAL), peroxidase (POD) and polyphenol oxidase (PPO) activities were determined. Results showed that 5 days after treatment skin and cortex PAL activities were the same as the control. In contrast, skin POD increased with preharvest conditioning in 2013. Cortex

POD, however, increased with the ethephon treatment only, both years. Similarly, both skin and cortex PPO activities increased mainly with ethephon treatment both years. When pooling the data for both years, the relative skinning resistance and skin lignin/suberin content were associated with POD and PPO activities in the skin and cortex. In contrast, PAL activity was not associated with skin lignin content and skinning resistance. These results indicate that preharvest conditioning influences the last step of the lignin/suberin biosynthesis pathway (POD and PPO), but five days after treatment, changes in PAL activity (the initial step in the phenylpropanoid pathway) were not detected.

Vegetable Crops Section

Evaluation of Cowpea (*Vigna unguiculata*) Lines for Cover Crop Application

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Cover crops provide a wide range of benefits for cropping systems and additional ecosystem services. Cowpeas (*Vigna unguiculata*) have been used for as a leguminous cover crop to restore soil fertility and quality through biological nitrogen fixation, the addition of organic matter and by improving soil structure. Cowpeas are especially useful in warm southern production regions. The cultivar 'Iron and Clay' is commonly grown as a summer cover crop, but other cultivars and genotypes offer potential to fix a greater amount of nitrogen and produce more biomass. The University of Arkansas cowpea breeding program has historically focused on breeding for a processing food crop, however, the traits that make a good cover crop are entirely different. This study analyzed physical and physiological characteristics of five cowpea genotypes including two Arkansas lines ('California Blackeye', 'White Acre', 'Iron and Clay', AR 07-303, and AR 95-348), to determine which factors could be used when selecting a cultivar for use as a cover crop. If predictive models of growth, biomass, and nitrogen accumulation can be created, then time, energy and money can be saved when collaborating with a breeding program. The five genotypes varied in size and growth characteristics. It was found that chlorophyll measurements are loosely associated with plant nitrogen content and photosynthesis measurements. 'California Blackeye' measurements were significantly greater than all other genotype treatments for height and plant dry weight biomass 80 days after planting. 'California Blackeye' also measured similar in plant nitrogen content (%) to the highest-ranked genotypes, which led to 'California Blackeye' producing the greatest amount of biomass N (g). Although 'Iron and Clay' is the common genotype used for cover application, this study showed that 'California Blackeye' has more desirable cover crop characteristics.

Sweet Corn Plant Growth and Yield as Influenced by Colored Plastic Mulches

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Plastic mulches are widely used for production of solanaceous and cucurbit crops, resulting in significant increments in earliness, and fruit yield and quality. Plastic mulches also provide excellent weed control which may be useful particularly in organic production. Transparent mulch has been used to enhance seed germination and reduce earliness in sweet corn. Little is still known, however, about production of sweet corn on other plastic film mulches. Objective was to determine the effect of colored mulches on sweet corn (*Zea mays* L.) yield. Study was conducted in Tifton, GA, during Fall 2011, in a Tifton Sandy Loam. Plastic film mulches (low density PE) evaluated were black, blue, gray (gray-on-black), red, silver (silver-on-black), and white (white-on-black). Sweet corn 'Merit' was direct-seeded manually in two rows per bed (36 cm apart) with a distance of 30 cm between seed within the row. Root zone temperature (RZT) was measured by determining soil temperature midway between plants at 10 cm below the mulched soil surface. Plastic film mulches differed in their soil-warming ability, with midday RZTs being highest in black and blue mulches and lowest in silver and white mulches. Plant height was higher on silver and white mulch and bare soil and lower on black mulch. Marketable and total yields and ear weight were among the highest on silver and white mulches and among the lowest on black, blue, and red mulches. Both, plant height and marketable yield showed no change below 26 °C midday RZT and decreased with increasing midday RZTs above 26 °C. Reduced plant height and sweet corn yields in black, blue and red mulches were probably due to increased RZTs that resulted in increased plant heat stress conditions. In conclusion, colored plastic film mulches influenced root zone temperature and plant growth and yield in sweet corn.

Genetic Diversity and Population Structure of Collard Landraces

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A common vegetable grown in the southeastern United States is the leafy green cole crop known as collard (*Brassica oleracea* L. covar. *Acephala* var. *viridis*). Predominantly a fall and winter crop, collard is one of the few vegetables found in the garden during cool seasons in the Southeast. Historically, the traditional collard patch and even commercial fields were planted with unique varieties perpetuated by seed savers, and collectively, the regional diversity for this crop was probably significant through the first half of the twentieth century. Genetic erosion of this collard germplasm pool has occurred in recent decades as commercial hybrids have been adopted by both large-scale

producers and home gardeners. An unknown number of collard landraces are still being perpetuated to date; however, existing landraces are in the hands of aging seed savers. From 2003 to 2007, we explored the Carolinas and other southeastern states in search of collard gardens containing traditional landraces. We obtained about 90 samples from individual seed savers during the course of the exploration. We conducted studies of the collected landraces to evaluate the phenotypic and genotypic diversity of this pool and to determine their potential collective value for use in improving collard as well as other *B. oleracea* crops. Genotyping studies show that the landraces extend collard genetic diversity beyond that present in current cultivars. Collard is most genetically similar to common heading cabbages, Portuguese tronchuda cabbage and Brussels sprouts. On the contrary, the kale crop, thought to be most closely related to collard, is actually more distantly related than most other cole crops. The preserved collection has also shown to express significant variability for economically important characters and should prove to be an important new source of genes for trait enhancement.

Effect of Winter Cover Crops on Growth and Performance of Successional Vegetable Crops

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High tunnel vegetable production can be input-intensive, lead to buildup of soil-borne pathogens, and result in the loss of soil quality from intensive cultivation. This project investigated short-season winter cover crops to address these issues by improving soil quality and reducing the need for fertilizer inputs in organic high tunnel production. Research has shown the benefits of cover crops in field production, but the use of cover crops in high tunnel production has not been thoroughly investigated in the South. This project evaluated five winter cover crop treatments, including a nontreated control, Austrian winter peas (*Pisum arvense*), bell beans (*Vicia faba*), mustard (*Brassica juncea* cv. Kodiak), and Daikon radish (*Raphanus sativus* var. longipinnatus), for their effect on soil quality and ability to supplement fertilizer requirement when included in a vegetable crop rotation in a high tunnel system. After incorporation, the cover crops were followed by a succession of vegetable crops, including tomato (*Lycopersicon lycopersicum*, cv. 'Plum Dandy') and broccoli (*Brassica oleracea var. italica*, cv. 'Bay Meadows'), which were fertilized at a 0.5x rate (56 kg·ha^{-1} N) to determine the ability of the cover crop treatments to supplement fertilizer inputs. Yield and performance of the vegetable crops were measured to determine the effects of the cover crop treatments compared to a nontreated control. Austrian winter peas yielded significantly greater biomass and greater biomass nitrogen content than the other treatments. This led to a significantly lower soil C/N ratio 30 days after incorporation. Tomato leaf chlorophyll measurements were highest following winter pea, though yield results were not significantly different. Broccoli early-season leaf chlorophyll was also increased by the winter pea treatment and plant biomass was significantly greater, but harvest data was not significantly different. The experiment will be replicated for a second year in attempt to achieve significant vegetable yield response to cover crop treatment.

s-Metolachlor plus Handweeding Effects on Weed Control, Yield and Costs in High Density Processing Spinach

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Handweeding spinach (*Spinacia oleracea*) is expensive and the recent shift to high density production has increased its difficulty and reduced its effectiveness, largely due to the lack of cultivation. There is potential for weeds to be found in harvested spinach which must either be removed by hand in the field just prior to the first cutting, or they must be removed on the cannery production line. Growers are penalized for weeds, and profitability is reduced and there is zero tolerance for weeds in the spinach product. This research evaluated s-metolachlor applied PRE at 1X or PRE + EPOST (0.5X each) when combined with either zero, one, two, or three handweeding events (HWE) on spinach injury, fumitory (*Fumaria officinalis*) populations, yield and weed management costs in high density processing spinach. As expected, fumitory populations decreased as the number of HWE increased; however, there was no difference in fumitory numbers at harvest when either two or three HWE occurred. s-Metolachlor applications resulted in excellent control of fumitory regardless of application type, but escaped weeds still needed handweeding. Handweeding costs were 2.5 times higher as the number of HWE increased in from one to three in untreated plots. However, where s-metolachlor was applied average costs were three times less, even when three HWE occurred. When averaged across HWE, yields were not significantly different within herbicide treatments, but the number of weeds found in harvested spinach was 27 times higher in untreated compared to s-metolachlor treated spinach. Results indicate that fumitory populations decreased significantly with either application type for s-metolachlor and costs were lowest in herbicide-treated spinach. Adding a third HWE did not decrease the number of weeds found at harvest and thus dropping a third HWE from weed management strategies may help defray grower production costs.

Organic Broccoli (*Brassica oleracea* L. var. *italica*) Cultivar and Conventionally Comparative Plant Density Evaluations

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Broccoli (*Brassica oleracea* L. var. *italica*) cultivar and separate plant density trials were conducted under certified organic conditions at Clemson Coastal Research and Education Center in Charleston SC, in 2014 to examine yield and quality of hybrid cultivars 'Lieutenant', 'Emerald Crown', 'Belstar', 'Legacy', 'Isabel', 'Green Magic' 'Bay Meadows', 'Everest', 'Tahoe',

and 'Castle Dome'. A separate plant density trial was performed on a single hybrid cultivar 'Emerald Crown', examining yield and quality with the primary focus on within-row plant spacing of 4, 6, and 8 inches. Imbedded within these trials was an untreated control and a greenhouse and field treatment of a recently OMRI certified soil inoculant, Inocucor Garden Solution. With regard to the cultivar trial, greatest marketable yields were observed with untreated 'Belstar' at 13,141 kg/ha, followed by treated 'Isabel' at 12,872 kg/ha, treated 'Emerald Crown' at 12,402 kg/ha, and untreated 'Lieutenant' at 10,688 kg/Ha. "Castle Dome' was most preferred by the processing industry for its processing characteristics. Overall, the Inocucor treated plants produced greater yields in 4 out of 10 cultivars. Higher plant population produced greatest overall yields with little effect on head quality. There was a slight increase in yields with the Inocucor treatments for the 4-inch spacing producing 15,730 kg/ha vs. untreated 4-inch spacing producing 15,125 kg/ha. A similar trend was seen with the 6-inch spacing with 14,520 kg/ha and 13,613 kg/ha for the treated and untreated, respectively. Further research is needed to better understand the mechanism behind the stimulatory response observed with the Inocucor treatments especially during greenhouse production.

Ginger Production in the Virgin Islands and Postharvest Studies

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Ginger is widely utilized in the Virgin Islands but seldom grown. The objective was to determine the production potential, in-row plant spacing, length of postharvest storage and develop value added product of these spicy rhizomes. Ginger was planted at 8 and 12 inches in-row spacing in February. The high pH calcareous soils caused chlorosis which was controlled through the use of supplemental iron (Fe-EDDHA). Harvest was over a three month period starting in December by mechanical means. No significant difference was obtained in the production between in-row spacing for either total yield or marketable yield. Harvested ginger was stored at 40 °F, 60 °F, or 80 °F over 75 days. Ginger at 40 °F exhibited chilling injury after two weeks of storage. The ambient temperature, 80 °F, resulted in desiccation and sprouting of the ginger within 40 days. Refrigeration at 60 °F provided the best storage for ginger after 75 days. Ginger was also processed by slicing at 2 or 4 mm, dried and ground into powder. The 2 mm dried ginger resulted in a finer powder. Ginger was found to successfully grow in the Virgin Islands at 8-inch or 1-ft in-row spacing and best stored postharvest at 60 °F. This project was developed through grant funding by the USDA-NIFA-Insular Tropical Grant funds and USDA Specialty Crops Block Grant administered by the VI Dept. of Agric.

Vegetable Crops Section—Watermelon

Evaluation of Triploid Watermelon (*Citrullus lanatus*) Varieties in Kentucky, 2014

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In Kentucky, watermelon (*Citrullus lanatus* L.) production area is the second largest of all fresh market vegetables. Watermelons are grown on over 1,100 acres accounting for 16% of the total fresh market vegetable acreage. Watermelons are grown in various areas across the state including Casey, Lincoln, Hart, Allen, and Daviess counties. In 2014, ten triploid watermelon varieties were evaluated for yield and internal quality. The trial was established on 27 May 2014, when watermelon varieties were planted in the designated plots based on a randomized complete block design. Accomplice was utilized as the non-harvestable pollenizer for this trial. There were ten plants per plot in addition to five pollenizers per plot. Pollenizers were interplanted between every pair of triploid watermelon plants within the row. Prior to transplanting, the field was prepared by tillage and bed formation using a plasticulture system. Experimental plots were 40 ft in length. Rows were spaced on 8 ft centers with 4 ft in-row spacing. Pre-plant fertilizer application consisted of 130 lbs of urea and 100 lbs of sulfate of potash per acre. Fertigation applications at 10 lbs N per acre were made alternating calcium nitrate and potassium nitrate weekly from 4 June to 14 August. Yields in 2014 were higher compared to the previous season, ranging from 43,271–85,240 lbs/acre. Average fruit weight ranged from 15.3–20.1 lbs amongst the varieties. ORS12166 had higher total yield (627 lbs/plot) compared to nine of the ten other varieties. The exception was Exclamation (564 lbs/plot). However ORS12166 had lower soluble solids (10.2% Brix) relative to the majority of the other varieties. Harvest Moon had significantly higher soluble solids (12.2% Brix) than all other varieties and total yield was only less than one other variety in the trial (514 lbs/plot). Maxima, Captivation, Unbridled, and Premont also had reasonably good combination of yield and soluble solids.

Five Years of Fusarium Wilt: What Did We Learn?

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Fusarium wilt of watermelon, caused by *Fusarium oxysporum* f. sp. *niveum* (*Fon*), is a devastating soil-borne disease limiting watermelon production across the world. Accurate phenotyping for fusarium resistance can be tedious, especially for the large populations needed for quantitative trait locus (QTL) mapping. We used a high throughput tray dipping phenotyping method to map QTL associated with resistance to *Fon* races 1

and 2. A major QTL (R^2 = ~44%) associated with resistance to *Fon 1* on chromosome 1 was confirmed in an $F_{2:3}$ population (n = 89) developed from a cross between Calhoun Gray (resistant) and Sugar Baby (susceptible). The *Fon 1* resistance locus was consistently identified using phenotypic data collected across different time points and independent greenhouse screens. A SNP marker, NW0250430, close to the *Fon 1* QTL is potentially useful for marker assisted selection (MAS) for *Fon 1* resistance from Calhoun Gray. *Fon 2* resistance is thought to be controlled by many genes with small effect, which makes consistent phenotyping difficult. An $F_{2:3}$ population (n = 178) developed from a cross between UGA147 (resistant selection from PI 169233) and Charleston Gray (susceptible) was used to identify a QTL (R^2 = 17%) associated with *Fon 2* resistance on chromosome 11. These loci associated with resistance to *Fon* races 1 and 2 are likely targets for MAS in watermelon breeding programs.

Georgia Watermelon Trial Results from 2014

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Watermelons were the number one ranked vegetable in Georgia in terms of acreage and value in 2013. Due to the size of this industry, annual variety trials are necessary to make informed recommendations to growers. In Spring 2014, 25 varieties of seedless watermelons were trialed in Tifton, GA. Seedlings were transplanted into black plastic mulch with drip irrigation on 31 March 2014. Plants were grown using standard production practices and harvested on 24 June and 2 and 9 July. Individual fruit were weighed and counted. A subset of four fruit per replicate were evaluated for firmness, soluble solids content, length, width, hollow heart, and hard seed. The five greatest yielding varieties were 9651 HQ, SV8298WA, Wolverine, ACX6177, and Declaration. The two lowest yielding varieties were Secretariat and Bold Ruler. The variety with the greatest percentage of 36-count fruit was Crunchy Red, while the variety with the greatest percentage of 45-count fruit was Secretariat. 'Melody' was the earliest maturing variety evaluated with 67% of fruit harvested on 24 June. The variety 7387 HQ was the latest maturing variety tested with more than 30% of fruit harvested on 9 July. In general, average fruit weight declined on the third harvest. Average fruit weight ranged from 6.4 kg for 'Troubadour' to 8.7 kg for 'SV8298 WA'. Soluble solids ranged from 10.8% in 'Fascination' to 12.0% in 'Wolverine'. Firmness, measured using an 11 mm probe, ranged from 2.14 kg in 'Crunchy Red' to 1.45 kg in 'Melody'. There were no significant differences in hard seed. Continued annual evaluation of seedless watermelons will occur in Georgia in order to make informed recommendations for growers.

Pollenizer Effectiveness for Triploid Watermelon Production in Delaware

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Pollen viability and pollenizer effects on fruit quality are important components to successful triploid watermelon production. During Summer 2014 at the Carvel Research Center in Georgetown, Delaware, twenty-four pollenizer varieties were tested for pollen viability and four varieties of triploid watermelons commonly planted on the Delmarva Peninsula were examined to optimize varietal plantings for Delaware and increase Delaware seedless watermelon yield and quality. Pollen viability from the twenty-four pollenizer varieties was observed on a daily basis for two weeks over the course of a spring and summer planting. The four triploid varieties were used to compare possible differences in weight, soluble solid, and hollow heart ratings when pollinated by the same twenty-four varieties used in the pollen viability study. Results showed a slight, but significant, decline in pollen viability over the course of the spring planting. The pollenizer varieties Boost, 4290, Accomplice and 4370 pollinated the most seedless watermelons across all seedless varieties, while Edom, Red Delicious, Jadestar, and Adir pollinated the fewest. While statistically significant, there was only a 1 °Brix difference between the highest (Boost, Stargazer, 4370, Polimax, Sangria) and lowest pollenizer averages (Sidekick, Adir, Faerie), which is unlikely to be noticed by consumers. Furthermore, SF 800, Boost, and Adir produced the lowest incidence of hollow heart, while Ace, SP-6 and Faerie produced the highest.

Progressive Pollenizer Spacing for Studying Hollow Heart in Triploid Watermelon

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Research from 2010–13 in Delaware showed that hollow heart disorder in triploid seedless watermelon was more severe in pollen limiting environments, incidence with higher with increasing distance from a pollen source, and that varieties differed in susceptibility to hollow heart with higher flesh density varieties having less hollow heart. The theory that pollination, hormone activity, and cell division in early watermelon fruit development determines hollow heart incidence and severity is being pursued. In 2014 a study was designed with the diploid pollinizer variety 'Stargazer' planted between plants of a higher flesh density triploid watermelon '9651HQ' and a lower density flesh watermelon 'Liberty' in 1:1, 1:2, 1:3, 1:4, 1:5, 1:6, 1:7, and 1:8 pollenizer to seedless ratios progressively in the row. There was a linear decrease in triploid flesh density ($P = 0.0107$, $r^2 = 0.135$) from 1:1 to 1:8 ratios of 19% and 9651HQ was consistently 5% more dense than Liberty. There was a curvilinear relationship between hollow heart severity ratings and pollinizer ratio ($P < 0.0001$). In 9651HQ hollow heart was not found until a 1:4 ratio, was found at low severity in 1:5,1:6 ratios,

increased significantly at the 1:7 ratio, and then increased greatly at a 1:8 ratio. The triploid Liberty showed a similar relationship but did have some hollow heart at all ratios. This study further confirms that limiting pollen increases the incidence and severity of hollow heart. It also shows that limiting pollen decreases watermelon flesh density.

Response of Grafted Watermelon to Nitrogen

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Herbaceous grafting is an effective tool for managing numerous soil-borne diseases such as Fusarium wilt in watermelon. Some researchers have indicated an increase in plant vigor associated with grafting. Field studies were conducted at the Sandhills Research Station in Jackson Springs, NC. The objectives of these studies were; 1) determine if more vigorous rootstocks maintain similar yields and fruit quality at nitrogen levels that are less than typically used by the commercial watermelon industry; 2) determine if grafted watermelon more efficiently utilize nitrogen at higher fertility rates than non-grafted watermelon; and 3) determine rootstock effects on fruit quality at various nitrogen rates. Non-grafted plants significantly out-yielded all grafted varieties in both years. Yields from non-grafted treatments ranged from 30% to 70% more than grafted varieties, and 80%to 100% more than grafted varieties in 2013 and 2014, respectively. There was no significant interaction between rootstock and nitrogen treatment for any yield or fruit quality measure. Flesh firmness was significantly higher in fruit from plants grafted on 'Strongtosa' and 'Carnivor' rootstocks, with non-grafted fruit producing the least firm fruit flesh. The bottle gourd rootstock 'Macis' tended to produce fruit with lower soluble solids content compared to both non-grafted and interspecific squash hybrid rootstock-grafted plants. Under conditions lacking severe soil-borne disease pressure there does not appear to be any benefit to the use of grafted watermelon.

The Impact of Growth Habit, Planting Density and Weeding Regime on Watermelon Yield in an Organic System

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Organic watermelon production represents just one percent of the total watermelon production in the United States and organic production in the southeastern U.S., where watermelon is a major horticultural crop, is severely limited. Weed control in organic production is a serious challenge because conventional herbicides are not permitted. Weeds compete with the crop for resources and therefore impact yield. A field experiment evaluating the impact of in-row spacing and weeding duration on organic watermelon yield in both vine and compact cultivar types was conducted during the 2014 season. The three-way factorial design included treatments of a standard 3 ft or denser 1.5 ft in-row spacing; weeding once weekly for 0, 4, or 8 weeks after transplant (WAT); and vine-type 'AU Producer' or compact-type 'Companion' cultivars. The number of fruit per plant was higher in the denser in-row spaced plots as compared to the standard in-row spacing but yield (pounds per acre) did not significantly differ. No weeding after transplant resulted in severe yield loss however weeding weekly for just 4 WAT yielded the same as weeding for 8 WAT. The treatment effects were identical in plots of both vine and compact-type plants but a cost-analysis revealed that plots of compact-type plants required less man-hours to weed than plots of vine-type plants. Plots that were weeded for 8 WAT required 3 times more man-hours than those that were weeded 4 WAT; when considering that no improvement in yield was gained by this whole-season weeding treatment, weeding during only the first half of the season is recommended as the more efficient weeding regime.

Tolerance to Powdery Mildew Conferred in Susceptible Watermelon Scion by Grafting on Resistant Rootstocks

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Cucurbit powdery mildew (PM) caused by *Podosphaera xanthii*, can impact seedling growth and cause serious losses in greenhouse and open field production. We have developed several watermelon and bottle gourd germplasm lines with high levels of resistance to PM. A PM-susceptible cultivar, Mickylee, was grafted on these PM-resistant germplasm that were used as rootstocks. USVL677-PMS, a watermelon line and USVL848-PMS a bottle gourd line were used as susceptible rootstock controls. Each grafted rootstock was replicated 8 times with 4 plants per replication. Grafted plants were inoculated by spraying with a PM melon race 1 conidial suspension (2×10^4 conidia/mL) in sterile water (0.02% Tween 20). Grafted plants were rated for PM severity on a 0–10 scale when severe PM was observed on susceptible checks, generally 10–14 days after inoculation. Severe powdery mildew was observed on cotyledons of USVL677-PMS and USVL848-PMS. Significantly less to no PM was observed on cotyledons of PM resistant rootstocks. Severe PM was observed on cotyledon and leaves of the scion ('Mickylee') cotyledon grafted on susceptible rootstocks. Significantly ($P \leq 0.001$) less PM was observed on the second, third and upper true leaves of 'Mickylee' plants grafted on some PM-resistant watermelon rootstocks compared to susceptible rootstocks. Powdery mildew on true leaves was significantly less on 'Mickylee' grafted on two PM-resistant bottle gourd rootstocks (USVL351-PMR and USVL482-PMR) and a bottle gourd hybrid rootstock (USVL482351-PMR-F1). Not all PM-resistant watermelon germplasm lines conferred resistance to true leaves of 'Mickylee'.

Watermelon Cultivar Yield and Quality Trial Results, North Carolina, 2014

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Thirty standard size triploid cultivars obtained from ten seed companies were evaluated in 2014 at the Central Crops Research Station, Clayton, North Carolina for yield and quality. A randomized complete design was utilized using four replications per treatment. Seeding was 15 April, while transplanting in the field was 19 May 2014. 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 three 'SP-6' pollenizer plants were equidistantly established per plot. Four harvests were made 24 and 30 July, and 13 and 20 August. Each fruit was harvested and weighed. Fruits were considered marketable when they were at least 9 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, flesh firmness, and hard core in the flesh. Growing conditions were favorable as average fruit set ranged from 2.4 to 3.3 fruits per plant over four harvests across all cultivars. Hard core was 25% or higher in the first two harvests in 'Affirmed', 'SV 2757', 'SV 8298', and 'Sweet Polly'. All other cultivars had 10% or less hard core. The cultivars that produced the largest fruit (14.0 + lb) were SV 8298, SV 0051, Maxima, Crunchy Red, Tri-X-313, Talca, 7197, Exclamation, Fascination, and ACX 6177. No more than 10% of fruit in a given cultivar were not marketable due to hollow heart. SV 0051 had the firmest flesh with 5.3 lb force, while other firm flesh cultivars included Premont, 13-13077, Crunchy Red, ACX 6177, Exclamation, Maxima, Secretariat, SV 0241, SV 2757, 7197, SV 7018, SV 8298, and Troubadour (3.3 to 3.7 lb force). More fruit were harvested in the initial harvest from the cultivars Secretariat, Charismatic, UG 711, Melody, Affirmed, and Bold Ruler than the other cultivars included in this study. The top ten marketable yielding cultivars over all four harvests based on fruit number were Melody, Premont, Charismatic, SV 7018, Talca, 7197, Captivation, Exclamation, SV 0241, and Liberty. The top ten marketable yielding cultivars over all four harvests based on weight were Premont, Maxima, Talca, Melody, 7197, Charismatic, SV 7018, Crunchy Red, Exclamation, and SV 8298. Yields were generally high ranging from 55,000 to 70,000 pounds per acre across all cultivars evaluated.

Poster Section

Efficacy of Glyphosate and Halosulfuron for Control of Purple and Yellow Nutsedge in Elevated CO_2 Environments

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Carbon dioxide (CO_2) concentrations in the earth's atmosphere have continually increased each year since the beginning of the Industrial revolution and are expected to continue rising in the future, which could have a dramatic impact on agricultural production. Previous research has shown that elevated CO_2 levels increase the growth and yield of most plant species. Although many crops will likely benefit from increasing levels of CO_2 in terms of growth and yield, this benefit could be negated due to increased growth of weed species and the occurrence of herbicide resistant weed biotypes. Currently, scientists are concerned that global climate change could reduce the effectiveness of herbicides at current label rates. In Summer 2012, an experiment was conducted to determine if labeled rates of glyphosate (RoundUp Pro®) and halosulfuron (SedgeHammer®) would provide effective control of purple nutsedge (*Cyperus rotundus* L.) and yellow nutsedge (*Cyperus esculentus* L.) in an elevated CO_2 environment. Yellow and purple nutsedge tubers were grown in 3.0-L containers in either ambient or elevated (ambient + 200 μmol·mol^{-1}) CO_2 in open-top chambers and treated with 0.5×, 1.0× or 1.5× the labeled rate of each herbicide and a tank mix of each herbicide at the specified rates. At the time of treatment, purple and yellow nutsedge were approximately 10 and 20 cm tall, respectively. Results showed a positive growth response for both nutsedge species when they were grown in elevated CO_2 chambers as purple nutsedge increased shoot and root dry weights and tuber counts by 27%, 25%, and 25%, respectively, in comparison to plants grown at ambient levels. Yellow nutsedge had a greater response to elevated CO_2, increasing shoot, root, and tuber dry weights by 40%, 51%, and 100%, respectively, and tuber counts increased by 128%. Few differences were observed among herbicide treatments or rates, and all provided over 90% control in both elevated and ambient CO_2 environments. Based on the results of this study, it appears that although elevated CO_2 levels will increase the growth of both weed species, predicted future CO_2 levels will likely not impact the efficacy of halosulfuron or glyphosate for control yellow and purple nutsedge at growth stages described here. Both herbicides provided acceptable control of both nutsedge species when applied prior to the flowering stage at currently labeled rates. It is unclear if the efficacy of these active ingredients or rates would have been affected by delaying applications until either species reached maturity. It is important to note that although this study focused on a single treatment scenario, repeated herbicide applications or a combination of herbicide applications and cultural practices will likely be needed for long-term control of perennial nutsedges in a field setting.

Maintaining a Way of Life: Trials and Tribulations of Farmers Market Families

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Never before in our nation's history has there been so many ways for consumers to purchase food. From grocery stores, to super centers such as Wal-Mart and Costco, convenience stores, online purchases, community supported agriculture (CSA), and farmers markets, Americans have a multitude of venues to choose from. Although many Americans currently purchase their foods from grocery stores, a growing number of them are buying locally at their farmers' markets and from CSAs. As the sustainability movement takes a greater foothold in the American household, local products and local foods are becoming ever more important and prevalent. Yet with all of the statistics surrounding local agriculture, the human element is often lost. A majority of small farmers and their spouses, often the ones who sell at a local level, have to work full time both on and off farm to support their families and farms. This case study examines the professional lives of five local farm families who choose to sell their products at the Fayetteville, AR, farmers market. It seeks to understand farmers' reasons for farming and selling locally, as well as their biggest challenges and rewards. In addition, it seeks to fill gaps in literature, begin to develop an understanding of this phenomenon, and shed light on why these farmers choose to sell at a local level.

Introducing Agriculture to Eighth Graders in Six Coastal Counties

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Pathways2Possibilities (P2P) is an interactive career expo designed for all eighth 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. Each Pathway was led by a Pathfinder who coordinated the Pathway members to design and implement hands-on activities intended to inspire the students to further explore that Pathway. The Agriculture, Food, and Natural Resources Pathway included activities involved with forestry, farm safety, animal and dairy sciences, poultry, landscape architecture, native plants, human sciences, veterinary sciences, and environmental conservation. Partners included Mississippi State University (MSU) departments (Animal and Dairy Sciences, Landscape Architecture, and Poultry), MSU School of Human Sciences, MSU College of Agriculture and Life Sciences, Georgia Pacific, Farm Bureau, USDA Natural Resources and Conservation Service, Crosby Arboretum, and Bienville Animal Medical Center. Approximately 6300 students, more than 600 adults, and nearly 250 Jobs Corps/workforce development participants benefitted from the program.

Field Establishment for Forest Farming with Black Cohosh and Goldenseal

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One way of forest farming is to grow shade-loving medicinal plants such as goldenseal and black cohosh in forestry land including marginal woodlands. Properly implemented forest farming practice can enhance and diversify income opportunities for small scale farmers and woodland owners. Cultivation of such highly market-demanded medicinal plants instead of collecting them from the wild is an attractive and alternative way to meet the market demand and to conserve natural resources. On the farm of North Carolina A&T State University, a research field in a wooded area was established for forest farming with goldenseal and black cohosh. The overall project objective was to help small scale farms to find alternate ways to increase their productivity and profitability by developing an efficient propagation protocol for medicinal plants and using forest farming on marginal woodland. Land was slightly tilled after cleaning up of weeds and bushes in areas where raised beds were made later with added composts. Drip irrigation was established on the raised beds, with beds without drip lines served as controls. Hardwood mulch was added on top of and between the raised beds after planting to hold moisture. Each species (i.e., goldenseal and black cohosh) was planted in the raised beds using a split plot, randomized complete-block design (RCBD) with six treatments of irrigation and spacing. The irrigation treatment (with- and without drip irrigation) was applied in main plots, while spacing (three levels) was applied in split plots. The bed size was 4 ft x 76 ft and the split plot size was 4 ft x 24 ft.

Collecting and Evaluation New Lagerstroemia Cultivars in Louisiana and Texas

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The rapid influx of new *Lagerstroemia* (crape myrtle) releases resulted in a desire to establish a landscape experimental planting of these cultivars in 2013 at the LSU AgCenter's Hammond Research Station, Hammond, LA, and the Stephen F. Austin State University Gardens, Nacogdoches, TX, for the purpose of evaluating performance over a 4–5 year period. The initial idea was to concentrate on burgundy and black foliaged cultivars but most of the new cultivars are now being included, when available. Replicated plantings are located in full sun. Plants receive supplemental irrigation as needed and are mulched with wood chips and pine bark. Plants are fertilized each spring with a slow-release fertilizer. Data being collected (and to be collected) includes overall visual plant quality, date of first flower, duration of bloom season, plant height, cold hardiness (winter dieback), susceptibility to powdery mildew and susceptibility to leaf spot (*Cercospora* and bacterial). Series in the trial include Early Bird (Plant Development Services/Southern Living Plant Collection), Ebony (USDA–ARS; also sold as Black Diamond series by

J Berry Nursery), Delta (Plant Development Services/Southern Living Plant Collection), Enduring Summer (Ball Ornamentals), Magic (Bailey Nurseries/First Edition), and Princess (Greenleaf Nursery). A few other miscellaneous cultivars are also included in the plantings—Bayou View, Freedom Red, New Lavender, and First Lavender. In 2015, three new additions to the Magic series, four new additions to the Black Diamond series, and two new additions to the Delta series will be added. In addition, three new cultivars from USDA–ARS in Poplarville, MS, and five new cultivars from Mississippi State University are being added. Preliminary results confirm the early flowering of the Early Bird series cultivars. *Cercospora* leaf spot was higher in the Early Bird series and was less observed in black foliaged cultivars. Quality ratings in 2013 were highest for the Delta and Black Diamond series, followed by cultivars in the Enduring Summer series. The cold winter of 2013–14 saw major dieback in the majority of Enduring Summer cultivars and some dieback in the Black Diamond and Magic cultivars. Data collection and observations on these plantings will continue through 2016. These two plantings are the largest side by side evaluation currently on-going of over 40 of the newest *Lagerstroemia* cultivars.

Evaluation and Use of the Virtual Nursery Field Trip (VNFT) by Horticulture Instructors

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Teaching nursery production requires not only classroom lectures but also viewing actual production systems and operations. Funding, logistics, and geography often limit the scope of field trips available to students in nursery production courses. The Virtual Nursery Field Trip (VNFT) was developed with funding from USDA NIFA Higher Education Challenge Grant to supplement in-class and field trip portions of a nursery production course. Digital HD video footage was captured at 42 nursery locations in 22 states. Videos were arranged by topic for a total of nine "chapters." Video segments within each chapter or topic range from a few seconds to several minutes. Videos were compiled onto a single USB drive containing 444 individual videos (total time about 10.75 hours) and 28 company profiles for a finished project size of 29 GB. USB drives containing videos and company profiles were provided free of charge in Spring 2013 to instructors of horticulture at land grant institutions (1862, 1890, and 1994) who submitted a request form. Educators receiving the videos were surveyed in Spring 2014 to determine the effectiveness of VNFT. Of those completing the survey (55) 34 indicated they used the VNFT in nursery production or other courses. Of those using the VNFT, 82% indicated that the VNFT objective of supplementing in-class and field trip portions of nursery production course was achieved. Approximately 220 students had viewed videos by the completion of the survey. Of those who use the VNFT, 56% indicated that the videos were much better than other horticulture educational videos. Almost all instructors who used the VNFT (97%) indicated they plan to use VNFT in the future. When asked to evaluate quality, organization, thoroughness, and ease of use, 80% to 90% of users rated the VNFT videos highly. If videos were made available online, instructors indicated they would be "very likely" (61%) or "somewhat likely" (24%) to access them online. Videos are now available to educators online at http://vnft.ag.auburn.edu.

Stem Cutting Propagation and Subsequent Growth of Alabama Phlox (*Phlox pulchra* W.)

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Phlox pulchra Wherry (Alabama phlox) is an herbaceous perennial endemic to Alabama and naturally occurring in only five counties: Autauga, Bibb, Butler, Shelby, and Tuscaloosa. This study examined the effect of cutting type and hormone on rooting of stem cuttings. In September 2013, terminal or medial stem sections were treated with a 1000 mg·L^{-1} IBA (indole-3-butyric acid) and 500 mg·L^{-1} NAA (1-napthaleneacetic acid) solution, 1000 mg·kg^{-1} IBA talc, or untreated (control). Cuttings were stuck in 1:1 peat:perlite substrate in a shaded greenhouse under intermittent mist. After 6 weeks, rooting percentage, number of roots greater than or equal to 5 mm, lengths of the three longest roots, and subjective root rating (0–6) were recorded. Overall, 97% of terminal cuttings rooted, while only 47% of medial cuttings rooted. Terminal cuttings had greater number of roots, length of three longest roots, and root rating. For terminal cuttings, untreated cuttings and those treated with IBA/NAA solution had greater values for root number, length of second and third longest roots, and root rating. Rooted cuttings were transplanted to trade gallon pots 29 October 2013, and overwintered in a shade structure. Select plants were cut back by half their height in Apr. 2014. Height, average width, and number of flowers were recorded through Summer 2014. Uncut plants were significantly taller, wider, and with more flowers than cut plants in April. In July, the average heights of plants left untreated or receiving IBA/NAA solution were greater than plants treated with IBA talc. No other differences were significant. In September 2014, terminal stem cuttings were stuck after being treated with the same hormones as 2013. Values for rooting percentage, root number, length of three longest roots, and root rating were greater for IBA talc than control and IBA/NAA solution. Overall, 69% of cuttings rooted in 2014. Based on rooting results both years and the similar growth of all stock plants, terminal cuttings receiving no exogenous hormone application may be the most cost-effective method of stem cutting propagation of *P. pulchra*.

Impact of Hormone, Cutting Length, and Magnetized Water on Rooting of *Camellia sasanqua* Thunb.

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Camellia sasanqua Thunb. (Christmas camellia) offers more aesthetic growth habit, finer texture, glossy green foliage, and loaded fragrant pink flowers. To better regenerate this beautiful plant for market demand, hardwood stem cuttings were collected in April 2014 and treated with rooting hormones and magnetized water. Hardwood stem cuttings of *C. sasanqua* rooted well and hormones significantly affected on rooting percentage and quality. With hormone concentrations went up, rooting rate and root volume increased both in K-IBA quick dip and Hormondin powder (talc). For 8,000 mg·L^{-1} treatments, liquid (K-IBA) resulted in significantly better rooting rate of 100.0% and root volume of 41.8 cm^3 than that of double dips (5000 mg·L^{-1} K-IBA + 3000 mg·L^{-1} talc; 93.8%, 26.5 cm^3) and talc (87.5%, 21.8 cm^3). Cuttings treated with magnetized water and K-IBA 3000 mg·L^{-1} showed greatest root volume (43.2 cm^3) and higher rooting rates (93.8%). Without magnetized water, cuttings treated with 8000 mg·L^{-1} K-IBA had the highest rooting rate of 100%, but root volume was lower (30.8 cm^3). Magnetized water did promote the growth of roots, but not root initiation. Cuttings at 10 cm long did not only root better (100.0%) than that of 20cm ones (89.0%) under the double dips, but also root within two months instead of four months. Hardwood cuttings of *C. sasanqua* should be collected in April at 10 cm long, treated by liquid K-IBA at 3000 or 8000 mg·L^{-1} for enhancing root initiation. Magnetized water is highly recommended for irrigating rooted cuttings.

Rooting and Overwinter of *Magnolia zenii* 'Pink Parchment' Stem Cuttings

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Magnolia zenii 'Pink Parchment' is a new deciduous cultivar for its large, showy, fragrant flowers, uniform growth habit, and heat tolerance. It is a great garden plant with very limited supplies because of its propagation and overwinter survival difficulty. Softwood cuttings were treated with both liquid and talc hormones at 1000, 3000, and 8000 mg·L^{-1} and rooted cuttings were overwintered in heated and unheated greenhouses. Rooting hormones significantly improved rooting of *Magnolia zenii* 'Pink Parchment' stem cuttings and the highest rooting percentage of 75% was under the treatment of K-IBA at 8000 mg·L^{-1}. The highest total root length, 44.04, was under treatment of double dips (liquid 5000 mg·L^{-1} + talc 3000 mg·L^{-1}). The effectiveness of hormone concentration depended on the application methods and liquid, talc, and double dip at 8000 mg·L^{-1} yielded 75%, 37.5%, and 62.5% of rooting, respectively. Rooted cuttings had 77.8% of survival in the heated greenhouse and only 41.7% in the unheated greenhouse. Growers could root the softwood stem cuttings with liquid or double dip hormones at 8000 mg·L^{-1} or higher and rooted cuttings should be overwintered in a heated greenhouse.

Substrate Components and Drench-applied Bonzi (paclobutrazol) Affects Growth and Flowering of Greenhouse-grown Annual Plants

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Studies were conducted to evaluate substrate components effects on growth response of Belgian mums and fall annuals to paclobutrazol applied as a drench. Rooted cuttings of Belgian mum (*Dendranthema ×grandiflora* Tzvelv. 'Olawa Red') and 200 cell plugs of dianthus (*Dianthus chinensis* L. 'Ideal Select Salmon') and snapdragons (*Antirrhinum majus* L. 'Sunset') were potted into 1.5 L (15 cm) azalea pots (12 Aug. 2014 for mums and 20 Aug. 2014 for dianthus and snapdragons). The three substrate treatments were a peat:perlite mix (75:25, by vol.; PL), a pine bark:peat mix (50:50, by vol.; PB), and a WholeTree:peat mix (50:50, by vol.; WT). WholeTree was loblolly pine (*Pinus taeda* L.) trees (all above ground potions) that were chipped and reduced in a hammer mill to pass a 1.27-cm screen. Pine bark was an industry standard aged southern pine bark screened to pass a 1.91-cm screen. Paclobutrazol (PGR) treatments were 0 (control), 1, 2, or 3 ppm applied once roots were visible at the bottom of the containers. PGR was applied as a substrate drench (118 ml per pot) applied on 3 Sept. 2014 for mums and 11 Sept. 2014 for dianthus and snapdragons. Data collected was plant height (PH), growth index (GI) [(height + widest width + width perpendicular to widest) / 3], flower number (FN) (open flowers and buds showing color), and shoot dry weight (SDW). There was a significant substrate × PGR interaction on PH, GI, and SDW for mums. Mum PH and GI decreased linearly as PGR increased among all substrates. Mums grown in PL had a greater GI than other substrates for the 0 and 1 ppm PGR treatments while there was no substrate effect for the 2 and 3 ppm PGR treatments. There was no substrate × PGR interaction for dianthus or snapdragons. Snapdragon PH and GI was not effected by PGR while PH and GI were greatest for PL and WT substrates. Dianthus PH and GI decreased 21% and 12%, respectively, with PGR (average of all rates) compared with the control. There was no difference in dianthus GI or SDW among substrates. The results of this study indicate there is some concern that substrate components play a role in the efficacy of PGR as indicated by the substrate × PGR interaction in growth of Belgian mums.

"Moving the Needle": An E-book of the Achievements, Accomplishments, and Impacts of the National Strawberry Sustainability Initiative

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The University of Arkansas Division of Agriculture Center for Agricultural and Rural Sustainability launched the National Strawberry Sustainability Initiative (NSSI) in February 2013, with a grant from the Walmart Foundation. In May 2013, Phase I of the NSSI awarded 20 grants to land-grant and public universities around the country totaling $2.64M. The projects worked to increase the sustainability of the strawberry industry with the following priorities: 1) increase local strawberry production, supply and availability within the United States; 2) reduce chemical and energy inputs; 3) conserve and preserve water resources; 4) improve soil quality and health; 5) reduce food safety risk of fresh berries; 6) reduce crop losses and spoilage; 7) improve yield and economic return to producers; and 8) develop appropriate metrics for strawberry production sustainability. The goal was to move research from labs to field demonstration. NSSI Phase I ended June 2014, with significant outputs and impacts to project areas highlighted in the e-book "Moving the Needle: Accomplishments of the National Strawberry Sustainability Initiative 2013–2014." Accomplishments included creating an e-learning tool, an online diagnostic tool, and an interactive budget tool, patenting two Rutgers developed cultivars, the expansion of strawberry production areas and season extension in Texas, Kansas, Arkansas, and Nebraska, and over 60 project and production videos on the NSSI YouTube channel. The e-book contains profiles of NSSI projects with links to project outputs and imbedded videos. In total, the publication contains over 70 links to videos, interactive tools, and publications on strawberry production. NSSI Phase II began July 2014, with the goal of moving from demonstration to practice with on-farm projects to increase the capacity for sustainable strawberry production. Complete NSSI information including the free, downloadable e-book can be found at http://strawberry.uark.edu.

Relating Acidity and Sweetness in Peach Progeny with the Maturity Date DNA Marker G4Mat

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The University of Arkansas (UA) peach [*Prunus persica* (L.) Batsch; 2n=2x=16] breeding program has been ongoing since 1964. Initially the program focused on developing non-melting cultivars for the baby food industry. Since the mid 1990s the focus has shifted to the development of cultivars for fresh-market use, particularly white peaches and nectarines. Sweetness and acidity are two important flavor components that impact consumer acceptance of peaches. As a part of the RosBREED SCRI project, UA has collected genotypic and phenotypic data on various traits in segregating populations and parents with the aim of incorporating marker-assisted breeding (MAB) in the peach breeding program. Phenotypic data, including soluble solids content (SSC) and titratable acidity (TA; expressed as malic acid) were taken during 2011, 2012, and 2013. Fruit maturity date was also recorded. Haplotype analysis on maturity date was performed using genotypic information obtained from the Peach 9k-SNP array. Haplotype analysis results indicated four single nucleotide polymorphisms (SNP) associated with maturity date on chromosome 4 of peach (G4Mat) and four different haplotypes (alleles) were differentiated within the UA program. These haplotypes confirmed seven allelic combinations (diplotypes). The haplotypes found within the UA breeding program range from very early (VE) to very late (VL) alleles. Individuals homozygous for the VE allele matured on average 29 June (day 181) and usually expressed lower SSC. Individuals carrying a VL allele expressed higher SSC values in some years. Diplotypes showed similar TA values in all years. Currently, additional genotyping of seedlings and parents is being done to further validate these initial findings. These results can be used in the breeding program to better differentiate maturity dates genotypically, particularly in parent selection for crossing to achieve specific maturity date objectives.

'Bluesfest' Rabbiteye Blueberry

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Rabbiteye blueberries, (*Vaccinium ashei*, Reade = *V. virgatum,* Aiton) are native to the southeastern United States, and due to their broad adaptation, vigor and high yield potential rabbiteye blueberry cultivars are grown widely throughout the region by both producers and homeowners. Commercial blueberry producers in the Gulf Coast region have capitalized on the lucrative early U.S. fresh berry market by growing early to mid- season ripening rabbiteye blueberry cultivars that ripen earlier than highbush type blueberries that are native to and are widely grown in more northern regions. Production of rabbiteye blueberries is also expanding into the Pacific Northwest where they may be grown to capitalize on late season fresh berry markets. The mid-season ripening rabbiteye blueberry 'Powderblue' is among more popular rabbiteye blueberries mostly due to its exceptionally light blue fruit that results from a relatively thick natural waxy coating on berry skins. However, the relatively small berries of 'Powderblue' may at times sell for less than larger berries of other cultivars. 'Bluesfest' is a productive new rabbiteye blueberry developed and released by the United States Department of Agriculture, Agricultural Research Service. Important attributes of 'Bluesfest' include its mid-to-late season ripening period, exceptionally light blue color, and berry size exceeding that of fruit of 'Powderblue', an industry standard.

Characterization of Anthocyanins in 'Southern Home', a Complex Hybrid Grape

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The black-skinned cultivar Southern Home is noteworthy due to its extreme disease resistance, attractive leaves, and unique fruit shape. 'Southern Home' is a complex hybrid of several *Vitis* species including *V. rotundifolia* (Michx.), *V. popenoei* (Fen.), *V. munsoniana* (Sims.), and *V. vinifera* (L.). The first three species are all from the Muscadinia (Planch.) subgenus, while *V. vinifera* is in Euvits (Planch.). Unique to muscadine berry chemistry is the presence of 3,5-diglucoside anthocyanins of delphinidin, cyanidin, petunidin, peonidin, and malvidin, and these compounds are some of the most abundant flavonoids present. Conversely, *V. vinifera* contains anthocyanins as a complex mixture of monoglucosides, monoglucoside-acetate, and monoglucoside-p-coumarate. The anthocyanins of *V. popenoei* and *V. munsoniana* are widely unstudied. Anthocyanin 3,5-diglucosides are less stable to oxidation and heat, compared to corresponding monoglucosides, which may result in rapid color loss during wine or juice storage. High-performance liquid chromatography analysis indicated that 'Southern Home' had the same profile as full *V. rotundafolia* with four large peaks representing diglucosides of delphinidin, cyanidin, petunidin, peonidin, and malvidin, confirmed by high-performance liquid chromatography/mass spectrometry. 'Southern Home' is six generations removed from *V. vinifera*, and is more muscadine than *V. vinifera* in other phenotypic traits.

Effect of Nitrogen Fertilization on Antioxidant Capacity, Vitamin C and Carotenoid Content in Satsuma Mandarin *Citrus unshiu*

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The objective of the present study was to determine the effects of nitrogen rate and application frequency on Satsuma mandarin (*Citrus unshiu* Marc., cv. Owari) antioxidant capacity and total carotenoid content. The experiment was initiated in 2014, at the Auburn University Gulf Coast Region, Wiregrass Research and Extension Center, Headland, Henry County, AL. Fertilization treatments consisted of a granular ammonium nitrate fertilizer (N) at three rates including control (0 kg), medium (0.17 kg) and high (0.34 kg N/tree/year) applied in three (mid-March, mid-May, mid-July) or six applications (March–August). Satsuma mandarin fruit were harvested at 10:1 soluble solids to titratable acidity ratio and extractable juice samples were characterized for antioxidant capacity based on ferric reducing antioxidant power (FRAP), reduced vitamin C (antioxidant content) and total carotenoid content. Based on the results, *Satsuma mandarin* cv. Owari fruit juice antioxidant capacity was enhanced by the medium rate of N application. Similarly, vitamin C content was enhanced by high N rate. The frequency of N application did not modify or affect antioxidant capacity and vitamin C content. However, optimal fruit juice total carotenoid content was achieved with six applications of N fertilizer. In addition, there was no difference among treatments in regard to rates of N application with respect to total carotenoid content. Results of this study illustrate that N fertilization is essential to achieving optimal fruit nutrition.

Vitamin C Content in Underutilized Selected *Musa* Species from Southeastern United States

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Given the increasing interest and demand for cold-hardy short-season banana hybrids of *Musa* sp., adaptable to southeastern United States, the present study determined the effect of artificial ripening, quality and nutrition of three banana cultivars. Three underutilized banana cultivars differing in genotype 'Kandarian' (Musa ABB), 'Ele Ele' (Musa AAB) and 'Brazilian' (Musa ABB) were grown at The University of Georgia Bamboo Farm and Coastal Gardens Savannah, Georgia (latitude 32.133' N, 81.2'W, elevation 14 meters). Mature green banana fruit at the full three quarter stage of maturity were either treated with aqueous solution of Ethephon (500 ppm immersion for five minutes) or control (water immersion for five minutes) and stored for nine days at 20 °C and 95% RH. Banana quality and nutrition were determined based on peel color, ripening color index (RCI) and vitamin C (reduced, oxidized and total) content. Among the three genotypes, 'Kandarian' fruit were more sensitive to postharvest Ethephon treatment when compared to 'Ele Ele' and 'Brazilian' fruit respectively. Overall, peel coloration (RCI) was more pronounced and uniform in 'Kandarian' fruit when compared to 'Brazilian' and 'Ele Ele' respectively. Throughout storage, in 'Kandarian' fruit tissues the concentrations of total, reduced and oxidized vitamin C progressively and significantly declined and were higher when compared to 'Ele Ele' in response to Ethephon treatment. In contrast, 'Brazilian' fruit tissue concentrations of total, reduced and oxidized vitamin C remained relatively unchanged throughout storage. Overall, results indicate both peel coloration (RCI) and vitamin C (reduced, oxidized and total) content are reliable indicators of fruit ripening in banana hybrids of *Musa* sp. adaptable to the southeastern United States. 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.

Growing Pierce's Disease Tolerant Hybrid Bunch Grapes in Alabama

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Pierce's Disease (PD) is a serious threat to the cultivation of

grapes in the United States, especially in the warmer southern regions. Presently, there is no known cure for PD, which is caused by the bacterium *Xylella fastidiosa*. Usually vine death occurs within two to three years of infection. French–American and American hybrid bunch grapes that are tolerant to PD also can produce substantial crop for the fresh market and for processing which can add value to the grape production. Currently, the commercial bunch grape production in the Southeast is very limited, and sustainable production systems have not been determined. An experimental vineyard was established at the Sand Mountain Research and Extension Center (SMREC), Crossville, AL, in 2008 to compare the performance and determine the best suited Pierce's Disease (PD) tolerant American and French-American hybrid bunch grape cultivars. We used a RCBD with 4 replications and 4 vines/replication. Vines were trained to a single wire bilateral cordon. Our six-year data indicate 'Stover' is the most vigorously growing PD tolerant cultivar in our plot based on the trunk cross sectional area measurements, while 'Champanel' had the largest pruning weight of 13.8 lbs/vine. PD tolerant hybrid bunch grape cultivars differ in cumulative yield/vine with 'Villard Blanc' producing the highest cumulative yield of 61 kg/vine for the six years of study. We have also established that 'Villard Blanc' had the largest cluster size of 287 g, while 'Conquistador' had the smallest. Based on their overall performance, vigorous and productive vines with a good fruit quality we consider 'Villard Blanc', 'Black Spanish', and 'Cynthiana' as well adapted PD tolerant cultivars for North Alabama conditions.

New Technology for Sustainable *Vitis vinifera* Production Tested in the Southeast

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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. Our results suggest selection '501-12' had the lowest pruning weight, while '502-01' had the highest. Selection '502-10' matured early in the season, and was harvested on 15 August, while '501-12' ripened late and was harvested on 25 September. The selections differed in total yield per vine with the late maturing '501-12' producing 1.8 kg/vine and the mid-season selection'502-01' yielding 3.6 kg/vine. The yield of the late season selection was affected by powdery mildew. Early-season selection '502-10' had the largest cluster weight of 184 g. The preliminary results of our study are 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.

Peach Rootstock Evaluation in Alabama

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Eighteen *Prunus* rootstocks budded with 'Redhaven' peach were planted at 16 locations in North America in 2009. Fourteen of the rootstocks were planted at the Chilton Research and Extension Center near Clanton, AL. The results after the sixth growing season in Alabama show significant differences among rootstocks for their survival rate, number of root suckers, vegetative growth, fruit maturity date, fruit size, cumulative yield, and yield efficiency. All of the trees grafted on 'Mirobac' and 'Krymsk®1'were dead in 2014. The largest trees were measured on 'Lovell', 'Guardian', 'Viking', 'KV010-123', while the trees on 'Controller 5' had the smallest TCSAs. Fruit size was largest (207 g) for trees grafted on 'Bright's Hybrid #5' and 'Penta' (202 g). Trees grafted on 'Guardian' also had large fruit size (186 g). 'HBOK-32' and 'KV010-127' produced the smallest fruit of 163 g. Total yield per tree (93.3 kg) was highest for trees grafted on 'Guardian' and lowest (26.3 kg) for trees grafted on 'Controller 5'.

Sensory Comparison of an Extremely Firm Fresh-market Blackberry Selection to Industry Cultivars

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The University of Arkansas has one of the largest blackberry breeding programs worldwide where unique traits are incorporated into breeding selections and cultivars. One new trait in the program is an extreme firmness of blackberries, which is of potential value for improved postharvest handling. Berries with this firmness attribute seem "crispy" when ripe. However, it was undetermined if these berries would be considered too firm by consumers and not as a positive attribute. Our study compared the breeding selection A-2453, which exhibits the extremely firm attribute, to four commercial cultivars (Natchez, Ouachita, Osage, and Prime-Ark® 45) using a trained sensory descriptive panel (n=9), a consumer panel (n=74), as well as fruit composition. The descriptive panel identified A-2453 as the firmest blackberry, but not different from 'Osage' or 'Ouachita', two firm cultivars but not considered as "crispy". The consumer panelists liked the firmness of A-2453 the same as the other genotypes, all having high liking ratings (6.9–7.3) on a 9-point scale. There were no differences among genotypes for consumer overall impression (how the consumers rated the liking of all the factors of the blackberry). This indicated that A-2453 was liked as much as the other genotypes, even though it was substantially firmer. Consumers identified 'Nat-

chez' as the largest berry as compared to the others, paralleling compositional measurements. Soluble solids values of the genotypes were within an acceptable commercial range (8.9% to 10.6%) and descriptive ratings for sweetness were similar indicating the panelists could not differentiate among the small differences in soluble solids values among these genotypes. Descriptive ratings for sourness, a reflection of tartness, were not different. Our results show that A-2453 has positive acceptability from consumers, furthering its usefulness in the program and the pursuit of developing a firmer fresh-market blackberry.

Postharvest Evaluation of Southern Highbush and Rabbiteye Blueberry Genotypes Grown in Georgia

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In Georgia and in the southeastern United States, two main types of blueberries are commercially grown: southern highbush (species complex between *Vaccinium corymbosum* L. and *V. darrowii* Camp) and rabbiteye (*V. virgatum* Aiton). Often southern highbush fruit are perceived to have higher fruit quality characteristics as compared to rabbiteye fruit; however, evidence for this is inconclusive at best. The main objective of this study was to examine the postharvest fruit quality attributes of fresh southern highbush and rabbiteye cultivars commonly grown in Georgia. During the 2014 harvest season, fruit was harvested from the University of Georgia Blueberry Research Farm near Alapaha, GA from seven highbush cultivars: 'Rebel', 'Star', 'Emerald', 'Farthing', 'Meadowlark', 'Legacy', and 'Camellia'; two advanced highbush selections: TH-1111 and TH11-25; and seven rabbiteye cultivars: 'Vernon', 'Alapaha', 'Brightwell', 'Powderblue', 'Tifblue', 'Ochlockonee', and 'Premier'. Fruit was collected from a commercial packer in Alma, GA from seven rabbiteye cultivars: 'Brightwell', 'Austin', 'Premier', 'Alapaha', 'Ochlockonee', 'Powderblue', and 'Tifblue'. Genotypes represent an array of fruit ripening times throughout the season. An Instron universal testing machine was used to run puncture (skin strength) and Kramer shear press (fruit firmness) tests. Within each location and test, genotypes were significantly different ($P < 0.0001$) for max load value (N) across southern highbush and rabbiteye genotypes. Blueberry type was not significantly different for skin strength ($P = 0.874$) ranging from 1.242N (TH-1111) to 0.795 N ('Rebel'), and was significantly different for fruit firmness ($P < 0.0001$) ranging from 722.18N ('Powderblue') to 285.34N ('Rebel'). Rabbiteye cultivar values for skin strength and fruit firmness ranked similarly from Alapaha to Alma, yet there tended to be lower values for each test for the fruit from the commercial packing facility when compared to the fruit hand harvested from the research farm. The results from this study will be used as a as a baseline for future work with frozen fruit treatments. Increased knowledge of the potential differences and similarities of highbush and rabbiteye cultivar fruit quality, as well as information about the potential improvements offered by new germplasm, will be beneficial for both the blueberry growers and the industry as a whole.

Estimation of Heritability and Genetic Correlations for Economically Important Traits in Passion Fruit

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Brazil is the largest producer and consumer of passion fruit (*Passiflora edulis* Sims.) in the world. Due to the economic and social importance of this crop, breeding programs must accelerate the development of new cultivars. Genetic parameter estimation is an important tool for planning long-term breeding strategies and expected genetic gains. Despite the importance of the crop, this information is still not available to passion fruit breeders. The objective of this research was to estimate genetic parameters (heritabilities and genetic correlations) for economically important traits in passion fruit. The study was conducted between 2011–13 at the State University of North Fluminense Darcy Ribeiro (UENF), Rio de Janeiro State, Brazil. Data from the evaluation of 81 full-sib progenies derived from the third cycle of recurrent selection at UENF were evaluated. The experiment was arranged in a randomized complete-block design with two blocks and five plants per plot. The full-sib progenies were distributed based on a rectangular grid of 19 rows and 15 columns. The traits assessed were: number of fruits, yield, fruit weight, fruit length, fruit width, pulp percentage, thickness of the skin, and soluble solids content. All analyses were carried out in the software ASReml v3.0. Heritability coefficients for all characteristics suggest there is enough genetic variability to respond to selection. Among the estimates of heritability the soluble solids content (°Brix) showed the highest value (0.53), while pulp percentage presented the lowest estimate (0.18). There was a high correlation between yield and number of fruits (0.97) suggesting that only one of these traits needs to be measure in practice. As number of fruits is easier to measure and with higher heritability (0.41) than yield, thus yield will be indirectly selected when higher number of fruits is selected in future generations. The genetic correlation between pulp percentage and thickness of the skin was the highest among the combinations of traits (–0.98), indicating again that only one of them needs to be evaluated for future selections. Both genetic parameter estimations provide useful information, which can be incorporated in the breeding program for more efficient development of improved cultivars with higher yield and better quality.

Alternative Cropping Systems for Sugarcane

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Planting cover crops during the fallow period prior to planting sugarcane has the potential to influence not only the following sugarcane crop, but the economics of the production system as a whole. Research was conducted at the USDA–ARS Sugarcane Research Unit at Houma, LA, to determine the impact of cover crops on sugarcane production. The experiment included seven treatments; two cover crops, kenaf (*Hibiscus cannabinus* L.) and cowpeas (*Vigna unguiculata* L. Walp.), three cover-crop harvest treatments for each cover crop, and a control. The experiment had four replications. The kenaf and cowpeas were planted on 8 May 2013. The three cover crop harvest treatments included the removal of the cover crop at 50 days after planting (DAP), the removal of the harvested cover crop at 100 DAP, and lastly, cutting the cover crop at 100 DAP and incorporating the plant material into the soil prior to sugarcane planting. The control treatment did not have a cover crop. Sugarcane variety HoCP 96-540 was planted on 26 August 2013, 110 days after planting the cover crops. The plant cane was harvested on 17 November 2015. Although the sugarcane total recoverable sugar (TRS) (kg/mt) was greater with the kenaf cover-crop treatment 50 DAP (120 kg/mt) compared to the cowpea treatment 50 DAP (111 kg/mt) and the cowpea 100 DAP with the residue incorporated (112 kg/ha), none of the cover crop treatments were significantly better or worse than the control (no cover crop). The average values for the sugarcane production factors across all treatments were 95,700 plants/ha (plant population), 112 mt/ha (sugarcane yield), 114 kg/mt (sugar yield per metric ton of sugarcane), and 12,841 kg/ha (sugar yield per hectare). The results demonstrate the potential use of these alternative cover crops during the fallow period prior to planting sugarcane without adversely affecting the plant cane yields.

Going Natural: Effective Weed Control in Squash with Pelargonic Acid

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Pelargonic acid, a natural, but not certified organic herbicide, has been shown to be phytotoxic, acting as a contact herbicide, injuring and killing plants through cell membrane disruption. Pelargonic acid, a fatty acid also known as nonanoic acid, is a nine-carbon chained organic compound found in many plants, animals, and foods. Two years of field research in southeast Oklahoma determined that pelargonic acid was an effective weed control method for smooth crabgrass [*Digitaria ischaemum* (Schreb.) Schreb. ex Muhl.], cutleaf groundcherry (*Physalis angulata* L.), and spiny amaranth (*Amaranthus spinosus* L.) in squash (*Cucurbita pepo* L.). Pelargonic acid [Scythe® (57% pelargonic acid)] was post-directed applied at three rates (3%, 6%, and 9% v/v Scythe®) in sequential applications 8 days apart. Ninety-eight percent of smooth crabgrass and 94% of broadleaf weeds were controlled with the 9% Scythe® rate after the sequential application. The 9% rate of Scythe® was less effective in controlling yellow nutsedge (*Cyperus esculentus* L.), with only 41% control 1 day after the sequential application. Unfortunately, increasing the rate of Scythe® also increased the crop injury, resulting in 4.4%, 8.0%, and 12.5% injury for Scythe® at the 3%, 6%, and 9% rates, respectively. As the result of crop injury, the 6% Scythe® treatment produced the highest squash yields (kg/ha) and fruit number (fruit/ha). The 6% Scythe® applied in a timely sequential application has the potential to provide adequate weed control with minimal crop injury that results in yields equivalent to weed free conditions.

Impact of Kenaf Extracts on Germination of Green Bean, Tomato, Cucumber, and Italian Ryegrass

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The chemical interaction between plants, referred to as allelopathy, may result in the inhibition of plant growth and development. The objective of this research was to determine the impact of kenaf (*Hibiscus cannabinus* L.) plant extracts on the seed germination of five plant species. Four concentrations (0, 16.7, 33.3 and 66.7 g/L) of kenaf leaf, bark, and core extracts were applied to the germination medium of redroot pigweed (*Amaranthus retroflexus* L.), green bean (*Phaseolus vulgaris* L.), tomato (*Solanum lycopersicum* Mill.), cucumber (*Cucumis sativus* L.), and Italian ryegrass (*Lolium multiflorum* Lam.) seeds. The treated seeds were placed in a non-illuminated incubator at 27 °C. Germination was recorded after seven days in the incubator. Seed germination decreased with increasing extract concentration for all the plant species tested, except for green bean. Tomato, cucumber, Italian ryegrass, and redroot pigweed followed similar trends in their responses to the extract source (kenaf bark, core, and leaves) and the impact of extract concentration. The research demonstrated an allelopathic response to kenaf leaf extracts resulting in reduced seed germination for tomato, cucumber, Italian ryegrass and redroot

pigweed. Sensitivity to the allelopathic impact of the kenaf leaf extracts from highest to lowest was Italian ryegrass > tomato > redroot pigweed > cucumber > green bean, with reductions in percentage germination of 79% (Italian ryegrass), 78% (tomato), 53% (redroot pigweed), 40% (cucumber), and 0% (green bean). Future research should focus on assessing the impact of kenaf extracts on post-germination growth, and isolating the active allelopathic ingredients in the kenaf leaf extracts. The resulting information could be used to pursue cultural practices that utilize these natural allelopathic materials to benefit crop production and limit weed competition.

Pelargonic Acid as a Herbicide in Sweet Bell Peppers

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Pelargonic acid, although not certified as organic, is naturally occurring in many plants, animals, and foods. It is also phytotoxic to plants as a contact herbicide, injuring and killing plants by destroying the cell membrane. Vegetable producers would benefit from additional herbicide options that are safe to the crop and provide effective weed control. Research was conducted in southeastern Oklahoma to determine the impact of pelargonic acid on weed control efficacy, crop injury, and pepper (*Capsicum annuum*) yields. Experimental treatments included pelargonic acid applied unshielded post-directed at 5.6, 11.2, and 16.8 kg/ha, plus an untreated weedy control and an untreated weed-free check. 'Jupiter', a tobacco mosaic virus resistant sweet bell pepper with a 70-day maturity, was transplanted into single rows on raised 91-cm centered beds with 46 cm between plants (23,900 plants/ha) on 28 May and 27 May, 2010 and 2011, respectively. Pelargonic acid was post-directed applied each year in mid-June and then reapplied eight days later. Weeds included smooth crabgrass (*Digitaria ischaemum*), cutleaf groundcherry (*Physalis angulata*), spiny amaranth (*Amaranthus spinosus*), and yellow nutsedge (*Cyperus esculentus*). The 16.8 kg/ha pelargonic acid treatment resulted in the maximum smooth crabgrass control (56%) and broadleaf weed control (66%) at 1 day after the initial spray treatment (DAIT), and 33% yellow nutsedge control at 3 DAIT. Pelargonic acid was less effective at controlling yellow nutsedge than smooth crabgrass and broadleaf weeds. As the rate of pelargonic acid increased from 5.6 to 16.8 kg/ha, yellow nutsedge control also increased significantly for all observation dates. Only the 16.8 kg/ha pelargonic acid application produced greater fruit per hectare (4784 fruit/ha) and yields (58.65 kg/ha) than the weedy control (1196 fruit/ha and 19.59 kg/ha). It was determined that post-directed applications of pelargonic acid significantly controlled weeds compared to the weedy-control, and resulted in four times the fruit production (fruit/ha) and three times the yield (kg/ha) than no weed control.

Impacts of Biofumigation and Anaerobic Soil Disinfestation in Strawberry Production

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Due to the phase-out of methyl bromide, there is a need for alternative, non-chemical fumigation treatments in strawberry production. Anaerobic soil disinfestation and biofumigation are two alternative fumigation methods that have shown success as non-chemical based alternatives. Biofumigation treatments with *Brassica* seed meals have been found to increase fruit yield in strawberry production compared to other alternative fumigation methods, such as green manure application. Anaerobic treatment yields have been found to be equivalent to those of Pic-Chlor 60 under certain anaerobic soil disinfestation conditions. Combining both methods may lead to an increase in yield while increasing fumigation benefits. A trial was conducted with 11 pre-plant soil-incorporated treatments arranged in a randomized complete-block design with six rows (blocks).The biofumigation treatments consisted of deactivated mustard meal, deoiled mustard meal, mustard pellets, and Biofence mustard seed meal. Other treatments included dried molasses as a carbon source for an anaerobic treatment, and a Basamid® chemical treatment. Additional combination treatments of deactivated mustard meal and molasses, deoiled mustard meal and molasses, molasses and soybean meal (to lower amendment C:N ratio), were also applied as well as a control with no treatment. Harvested fruit were counted, weighed, and graded into marketable and non-marketable categories. Total, marketable, and non-marketable yields for each treatment were then compared using mixed model analysis of variance (Glimmix procedure, SAS Institute, Cary, NC) and least squares means were compared with ten orthogonal contrasts of scientific interest. Plants treated with Basamid® had an average yield of 228 g/plant but were not different statistically from those treated with the combination of the biofumigation treatment with deoiled mustard meal and anaerobic soil disinfestation with molasses (184 g/plant; $P > 0.05$). Plants in the control plot in which no treatment was added produced the lowest overall yield (134 g/plant). Plants treated with Basamid® had the overall largest yield of non-marketable fruit (85 g/plant). Plants treated with Basamid® (143 g/plant) and those in the combination treatment of deoiled meal and molasses (110 g/plant) were not different statistically in marketable commercial yield ($P > 0.05$). The plants treated with the biofumigation treatment of mustard pellets provided the largest overall marketable yield among the single source alternative methods (113 g/plant) tested. However, the Basamid® treated plants had a larger marketable yield by contrast than all other single source biofumigation treatment plots combined for contrast ($P < 0.05$). The combination treatment

of the biofumigation treatment of deoiled mustard meal and the anaerobic soil disinfestation treatment with molasses can provide a comparable marketable yield as the chemical treatment Basamid®. Future work will evaluate pathogen and soil nutrient dynamics affecting productivity in these alternative soil disinfestation treatments.

Evaluation of Cowpea (*Vigna unguiculata*) Lines for Cover Crop Application

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Cover crops provide a wide range of benefits for cropping systems and additional ecosystem services. Cowpeas (*Vigna unguiculata*) have been used for as a leguminous cover crop to restore soil fertility and quality through biological nitrogen fixation, the addition of organic matter and by improving soil structure. Cowpeas are especially useful in warm southern production regions. The cultivar 'Iron and Clay' is commonly grown as a summer cover crop, but other cultivars and genotypes offer potential to fix a greater amount of nitrogen and produce more biomass. The University of Arkansas cowpea breeding program has historically focused on breeding for a processing food crop, however, the traits that make a good cover crop are entirely different. This study analyzed physical and physiological characteristics of five cowpea genotypes including two Arkansas lines ('California Blackeye', 'White Acre', 'Iron and Clay', AR 07-303, and AR 95-348), to determine which factors could be used when selecting a cultivar for use as a cover crop. If predictive models of growth, biomass, and nitrogen accumulation can be created, then time, energy and money can be saved when collaborating with a breeding program. The five genotypes varied in size and growth characteristics. It was found that chlorophyll measurements are loosely associated with plant nitrogen content and photosynthesis measurements. 'California Blackeye' measurements were significantly greater than all other genotype treatments for height and plant dry weight biomass 80 days after planting. 'California Blackeye' also measured similar in plant nitrogen content (%) to the highest-ranked genotypes, which led to 'California Blackeye' producing the greatest amount of biomass N (g). Although 'Iron and Clay' is the common genotype used for cover application, this study showed that 'California Blackeye' has more desirable cover crop characteristics.

Response of 'San Andreas' Strawberry Grown on Color Mulch Film Under High Tunnel Production Systems

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Strawberries benefit from environmental modifications provided by protected agriculture technologies. Adapting plasticulture, fertigation, and other technologies to high tunnel crop production systems allows refinement of practices to maximize crop production. Since the 1950s, plasticulture (plastic mulch and drip irrigation) has been used extensively in commercial strawberry production. Black, white, and clear are plastic mulch colors most commonly used for modifying soil temperatures. Other film colors including red, green, and brown can modify the light environment near plants via reflectance and absorption of specific light wavelengths. While high tunnel production and ambient production of plasticulture strawberries require similar cultural practices and materials, the protected environment of a high tunnel differs from the ambient environment in regard to light transmission, temperature, moisture, and incidence of pests. The objective of this study was to determine the effect of plastic colored film mulches on strawberry production under high tunnel. A Haygrove Super Solo (TM) high tunnel (25 ft x 200 ft) located the University of Arkansas Research and Extension Center in Fayetteville, AR, was used for this experiment. The experimental design was a completely randomized block design (six blocks). Each block consisted of plastic mulch of a different color: Brown, silver, black on red, blue, green, and black. Each block was replicated four times. Plugs of the strawberry cultivar San Andreas were planted on 17 September 2014. Variables measured included: total yield (marketable and unmarketable), soluble solids, plant and root mass, and crown numbers. This study showed no significant differences in any of the plant variables measured (total yield, soluble solids, plant and root mass, crown numbers). Overall, the brown and green colored films had the highest total yield, marketable fruit weight, and yield per ha. However, these films also had a higher number of unmarketable fruit. When the cost of colored film is figured into the cost of production, brown, silver, and blue films are the most expensive and cost twice as much as the black colored film most producers are currently using. Based on our results, the use of colored films to grown San Andreas strawberries in a high tunnel system is not recommended.

Simulated Seawater Flooding Reduces the Growth of Ten Vegetables at Seedling Stage

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Excessive salinity in soil and irrigation water in combination with waterlogging in coastal regions can significantly reduce the productivity of many agricultural crops. Seedlings of ten vegetables (broccoli, chinese cabbage, chinese greens, cucumber, eggplant, kale, radish, red crunchy radish, spinach, and tomato) were flooded with simulated seawater (SSW) at electrical conductivity (EC) of 44.0 ± 1.3 $dS \cdot m^{-1}$ or tap water at EC of 0.8 ± 0.1 $dS \cdot m^{-1}$ for 24 h and grown subsequently for two weeks in a greenhouse. Chinese greens and cucumber plants died shortly after flooding with SSW, while other vegetables exhibited various degrees of visible salt damage. Chinese cabbage suffered the strongest reduction, while spinach, tomato, and eggplant exhibited the least decrease in dry weight due to SSW flooding in comparison with their perspective control. Two weeks after

flooding treatment with SSW, net photosynthetic rate of broccoli, kale, spinach, and tomato was reduced by 43–67%, transpiration rate by 35–66%, and stomatal conductance by 51–82%. In summary, spinach, eggplant, and tomato were the most tolerant, while chinese cabbage, chinese greens, and cucumber were the least tolerant to SSW flooding.

Introduction of Aquaponics System for Vegetable Production in Myanmar under Farmer-to-Farmer Program

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Aquaponic techniques are very new in Myanmar. In a dry season, there is insufficient amount of water and level land in Myanmar for vegetable production due to hot weather. This affects the nutrition of the people of Myanmar due to unavailability of vegetables, as vegetables are essential for balanced diet. The aquaponic system represents the suitable technology that can be applied under suitable field conditions or in controlled environmental conditions. Aquaponics is a combination of fish and plant culture in a system. Plants absorb the nutrients that are generated by the fish, either by excretion or by microbial breakdown of organic waste. This system reuses and conserves the water. The purpose of the project was to provide hands on training to farmers to acquaint them to the aquaponic system. The system built was consisted of four plant growing beds, each of which was supported on four columns of blocks and the fish tank was buried partially in the ground at the head of a row between the tanks. Seventeen participants of the host organization (CSSDD) received two weeks of training. Recommendations were made on new fish stocking, quarantine, water quality, pH, and other maintenance on fish production as well as vegetables transplants and production. The future impacts of the project are, the people of Myanmar who can start their own aquaponic system, they can reduce their cost of chemical fertilizers. In Myanmar, Aquaponics could contribute to food production if appropriate system will design that is economically feasible to manage for farmers.

Evaluation of Low Pressure Irrigation System for Leafy Greens Production on St Croix

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Leafy greens are high value crops for the vegetable growers in the U.S. Virgin Islands (USVI). Lettuce and Kale are two nutritious and profitable greens in the local farmers market and supermarkets. High cost of irrigation, off-island freight, labor and management are the major constraints for vegetable growers in the USVI. Drip irrigation has been used successfully in recent years in growing crops, though, cost of electricity, water and labor are added challenges. The University of the Virgin Islands Agriculture Experiment Station conducted an experimental trial using a low pressure microirrigation system for growing leafy greens. The method employed a gravity based system included treadle pump, rainwater catchment, and overhead water tank (250 gallon). The wooden sticks at the base pushed repeatedly by the foot to provide drive for pump to refill the water tank. Twelve varieties of lettuce and five varieties of Kale direct seeded in the field in September 2013 in a randomized block with three replications. In-row spacing between plants was kept 1 ft and 2 ft between rows. Crop was drip irrigated by gravity fed low pressure system. All lettuce varieties were grown successfully and quality heads (over 1 lb each) harvested in 4 weeks of planting. Two varieties 'Black Cabbage' and 'tz9332' of Kale yielded well and harvested four times in growing season. Initial results obtained suggest adoption of low cost irrigation technology and assist farmers to expand their income by improving production of quality vegetables and saving costs in irrigation water.

National Cowpea Improvement Association

New Findings on Postharvest Protection of Cowpea with Edible Vegetable Oils—A Report on Progress

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Cowpea, *Vigna unguiculata* ([L.] Walp.), is an edible legume high in protein. The bruchid, *Callosobruchus maculatus* (F.) has long been associated with damage in stored legumes. Synthetic pesticides are frequently used to protect stored grains often leading to pest resistance and food safety concerns. Alternative measures are highly desirable. We evaluated eight vegetable oils (canola, coconut, garlic, peanut, olive, soybean, sunflower, and truffle) in the laboratory *against C. maculatus* for toxicity as pre- (preventive) and post- (therapeutic) oviposition grain treatments. These were tested on four cowpea cultivars: Early Scarlet (ES), Mississippi Purple (MP), Mississippi Silver (MS) and California Blackeye #5 (CBE). For post-oviposition assessment seeds containing one day old eggs were treated while for pre-oviposition seeds without eggs were treated before infesting with 5 pairs of adult weevils. For each variety 4 g of seed were treated with 4, 8, 12, 16 and 20 μL oil (equivalent to 2, 3, 4, 5, and 6 mL/kg) and untreated seeds as control. Experiments were set up in a completely randomized design and replicated five times. In the pre- and post-oviposition evaluation adult emergence was delayed by 5 days on treated seeds. Percent cumulative emergence varied among oil treatments and seed varieties indicating a variety by oil interaction. Number of emerged adults decreased with increased oil rate on all varieties. Post-oviposition adult emergence on MS was 10% for seeds treated with 2–4 mL/kg and 5% for 5–6 mL/kg. MP and ES seeds treated with 2 mL/kg had 30% emergence. On CBE emergence was < 60% on seeds treated with 2 mL/kg and < 30% on 6 mL/

kg; various controls had > 70%. Number of eggs varied with oil treatment; soybean, peanut, canola had fewer eggs than garlic, sunflower, olive and truffle oil. Adult emergence on MS was 20%, 10%, and 5% for seeds treated with 2 and 3 and 4–6 mL/kg, respectively, and 25% for MP seeds treated with 2 mL/kg. On ES adult emergence was 15%, 10%, and 5% for seeds treated with 2, 3, and 4–6 mL/kg, respectively. CBE had emergence < 10% on all treatments. Overall, 2 mL/kg of canola, coconut, garlic, peanut, and olive oil were most effective in preventing adult emergence. These oils could potentially protect cowpea against the cowpea weevil. Future studies will address issues related to the bioactive components oils.

Cowpea Research on a Comeback in North Carolina: Challenges and Metrics for Successful Production and Use in Sustainable Integrated Systems

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Cowpea [*Vigna unguiculata* (L.) Walp.] is an important legume crop in southeastern United States. Pest damage and other biological constraints present challenge to sustained cowpea production. To improve cowpea yield and quality as well as expand its use several approaches including the use of pesticides, crop rotation, adjusting planting dates, intercropping and biological control have been used. Nevertheless, none of these strategies is effective when used in isolation. Integrated Pest and crop Management is an approach with great promise. Screening and using existing and commonly grown cultivars with desirable agronomic traits is often recommended. This study was conducted in 2014, at two locations, Greensboro (the Piedmont) and Goldsboro (Coastal Plains) in North Carolina. Forty-eight cowpea varieties, which represent the most common as well as recently released varieties, were obtained from local stores and other sources and evaluated for resistance to pests and valuable agronomic traits (cover crop and forage potential). The experimental design was a randomized complete-block design with four replications at each location. Analysis of the data revealed significant differences among the 48 varieties for cowpea bacterial blight (*Xanthomonas campestris* pv. *vignicola*) and pod rot (*Choanephora cucurbitarum*) infection, foliage retention, ground cover equivalence (GCE), and the number of nodules per plant. 'Mixed Iron & Clay', 'Big Red Ripper', 'Tohono O'odham', 'Mayo Clima', 'Lady', 'Vietnamese Black', 'Whipporwill Steele's Black', 'Red Bisbee', 'Whipporwill', and 'Carrapichio' were selected as cover crops with the highest GCE. Eighteen varieties showed high level of resistance to bacterial blight with disease severity rating < 1.0 on a 0–5 scale. 'Dixie Lee', 'Chinese Red', 'Pinkeye Purple Hull bur', and 'Texas Cream 8' showed high incidence of pod rot. 'Mixed Iron & Clay', 'Big Red Ripper', 'Mayo Clima', 'Tohono O'odham', 'Penny Rile Cowpea', 'Lady', 'Vietnamese Black', and 'Bisbee Cowpea' were rated good to excellent for forage use with foliage retention scores ≥ 3.0 on a 1–5 scale. 'Mixed Iron & Clay', 'Black Crowder', and 'Whipperwill' had the highest number of nodules per plant. The selected varieties for all variables will be further evaluated in 2015 season to confirm their ranking for the various traits.

Preparing for the Brown Marmorated Stink Bug: Lessons from the Invasion of 2014 in the North Carolina Piedmont

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Cowpea (*syn*. Southern pea), *Vigna unguiculata* ([L.] Walp.), is typically attacked by many insect pests including a suite of pod suckers [green stink bug, leaf-footed bug, tarnished plant bug, and the brown marmorated stink bug (BMSB), etc.] that render cowpea pods and grain unusable, caterpillars such as the tomato fruitworm, foliage and flower feeders such as thrips and various beetles. These insects can substantially reduce pod and grain yield of cowpea. This has made some farmers reluctant to grow cowpea. Fortunately, technology exists to make cowpea production sustainable and profitable. We evaluated 48 commonly available cowpea varieties at two locations in different ecological zones in North Carolina, Greensboro (Piedmont) and Goldsboro (Coastal Plains). The varieties included Blackeye, Purple hull and Crowder types. The goal of the study was to compare several traits (especially response to pest incidence, composition and severity) to serve as a basis for developing location-specific management approaches. No pesticides were applied. Using 2-row plots of 4 m replicated four times we observed a clear disparity between locations in pest composition, incidence and intensity. The BMSBs were the major insect pest observed in Greensboro where high populations (5.5 bugs/plant) were enumerated on pods; in Goldsboro the highest BMSB count was only 0.13 bugs/plant. Twenty-four varieties in Greensboro had less than 1.0 bugs/plant, the recommended threshold for pesticide application. Damage to pods and seeds was remarkable; fresh pods 34 varieties > 51%; fresh seeds 31 varieties > 50%. These population levels and associated damage observed in Greensboro were unprecedented on cowpea. This is significant because most growers produce cowpea for fresh market direct consumption or freezing. Although cowpea did not suffer significant damage from BMSBs in Goldsboro, another important insect pest, the cowpea curculio (*Chalcodermus aeneus* Boh.), caused severe damage (16% to 62% seed damage) at that location with relatively low (0.93% to 21%) seed damage occurring in Greensboro. Future work will determine the underlying factors responsible for this dichotomy. This knowledge will guide us in developing appropriate management tactics tailored to each location keeping in mind current and potential uses for cowpea.

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Abstracts of Presentations

from the

Annual Conference

of the

American Society for Horticultural Science

4–7 August 2015, New Orleans, Louisiana

Supplement to *HortScience*

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Contains abstracts of colloquia and workshops, plus oral and poster presentations from the 2015 ASHS Annual Conference.

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For citation purposes, abstracts should be cited as follows:

(Example)

Touchell, D. and T. Ranney. 2015. Breeding Cold-hardy Energy Grasses. HortScience 50(9)S.87. (Abstr.)

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

Symposium, Colloquia, and Workshops

Presented at the Annual Conference of the American Society for Horticultural Science
4–7 August 2015 New Orleans, Louisiana

Symposium

Monday, 3 August 2015

From Wild Germplasm to Molecular Tools for Applied Breeding: Black Raspberry as a Case Study

Sponsor: Fruit Breeding (FRBR) Working Group

Moderator: Nahla Bassil

USDA–ARS Corvallis, Corvallis, OR; bassiln@hort.oregonstate.edu

Objective: Engage breeders and others interested in germplasm evaluation, molecular marker development and their use in an interactive symposium.Provide access and financial support to students. Come learn about our experience with black raspberry from collecting and evaluating wild germplasm, to developing molecular tools, to applied breeding.

Abstract: We will describe using phenotypic and genotypic methods to evaluate wild germplasm for genetic diversity, population structure, and to compare wild to cultivated germplasm to select the most interesting plants. Participate in an interactive session on using genotype information for genetic mapping using JoinMap software, and learn how the genetic linkage map can be used for quantitative trait analysis. Finally, we will provide examples on how to design, develop, and use DNA tests for genetic analysis, and what is needed to use these tools in applied breeding. The afternoon will be dedicated to answering questions and for practicing what was presented in the morning session.

9:00–9:15 AM

Introduction

Nahla Bassil*
USDA–ARS, NCGR, Corvallis, OR; nahla.bassil@ars.usda.gov

9:15–10:30 AM

From Wild Germplasm to Molecular Tools for Applied Breeding: Black Raspberry as a Case Study

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

10:30–12:00 PM

From Wild Germplasm to Molecular Tools for Applied Breeding: Black Raspberry as a Case Study

Jill Bushakra*
USDA–ARS, NCGR, Corvallis, OR; jill.bushakra@ars.usda.gov

12:00–1:15 PM

From Wild Germplasm to Molecular Tools for Applied Breeding: Black Raspberry as a Case Study

Paul Sandefur*
Washington State University, Pullman; paul.sandefur@email.wsu.edu

1:15–2:15 PM

Lunch Break

2:15–4:45 PM

Discussion

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

Tuesday, 4 August 2015

*CEU Approved

Alternative Specialty Crops: Opportunities and Challenges

Sponsors: Working Group of Asian Horticulture (WGAH), Tropical Horticulture Working Group (TROP), and the Pomology Working Group (POM)

Coordinators: Hye-Ji Kim and Shengrui Yao

Objective: This colloquium will bring together researchers and specialists to address the importance of alternative specialty crops, introduce various types of alternative specialty crops and their consumption as fresh and/or processed fruits, share their cultural practices and marketing strategies, and discuss how to mitigate potential problems associated with the introduction of alternative specialty crops.

2:00–2:05 PM

Introduction to the Colloquium

Hye-Ji Kim*
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Current global agriculture has promoted the most intensive agricultural production systems, which has led to the loss of biodiversity by limiting the number of crops and restricting the range of food and nutritional constituents of foods available to the community. The introduction of alternative specialty crops to agricultural production systems provides comparative advantages including promotion of biodiversity, improvement of regional food diversity and human health, and sustainable utilization of plant genetic resources. It can also benefit farmers by providing new marketing opportunities through multiple-facets: diversifying crop production systems with value-added crops, increasing yields with less water and fertilizer inputs, improving resilience to climate variability, boosting crop resistance to pests and diseases, and therefore ultimately increasing farm incomes. Alternative specialty crops can help farmers to gain access to regional, domestic and global markets with new products. There is an urgent need to identify alternative crops and varieties that can be profitably grown in the region. Meanwhile, there are challenges associated with the introduction of new crops: lack of information on alternative crop varieties, cultural practices, marketing and invasive potential. Farmers may face risk from poor economic returns if proper management and marketing information is not provided. When introducing new crops, invasiveness assessment and control methods also should be taken into account. Particularly, alternative fruit crops have been introduced many decades ago and grown in many regions throughout U.S. They are gaining attention in recent years due to their inherited advantages such as adaptation under a multitude of environments, higher nutritional value and improved fruit qualities.

2:05–2:30 PM

An Overview of a Long-term Research with Alternative Fruits in the Intermountain West Region of the United States

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The competitive nature of global market mandates production of fruit which are not common to a given region, and taking advantage of a niche market with higher profitability. Alternative fruit have become extremely popular in the recent years, mainly because of their health benefits. During the past 20 years, the University of Idaho Pomology Program has experimented with several new alternative fruit crops in the Intermountain West region. As part of this effort, several varieties and selections of table grapes, quince, Asian pears, persimmons, walnuts, almonds, berries, and mulberries have been studied for adaptability and fruit quality. Among the successful or promising types and varieties of fruit were: '*Aromatnaya'*, 'Rich', and 'Smyrna' quince; 'Kikusui' and '21st Century' Asian pears; 'Alborz', 'Persian Gulf', 'Jupiter', and 'Emerald' table grapes; and "Non pareil' and '*Montreal'* almonds. A number of other grapes such as 'Fresno', 'Mars', 'Red Globe', NY36095, and 'Challenger' are also suitable for small-scale markets. Seven varieties of Haskap berries (native to Japan) have also been studied under high pH conditions of southwest Idaho and have shown promising results and sustained production. 'Fuyu' and 'Masumoto' persimmons showed satisfactory performance as long as the extreme sub-freezing temperature did not exist. Mature trees of these varieties were much more tolerant to sub-freezing temperatures than the young ones. A large number of newer generations of alternative fruits such as black berries, pecan, walnuts, and gooseberries are being studied at the present time.

2:30–2:55 PM

Asian Pear: A Potential Alternative Fruit Crop for Growers in the Mid-Atlantic Region

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Production of European pears (*Pyrus communis* L.) in the Eastern United States is limited by a number of physiological and pathological problems. In an attempt to expand sustainable pear production in that region, a series of long-term field trials of Asian pear [*Pyrus pyrifolia* (Burm. F) Nak. (syn. *P. serotina* L.)] were established at two sites in Maryland. To compare precocity, productivity, and survival, nine Asian pear cultivars and three European cultivars were planted in 2010 at the Wye Research and Education Center. Asian pears were precocious and productive and many trees flowered and fruited in the second leaf. After the fourth leaf, survival of 'Isi'iwasi', 'Shinsui', 'Kosui' and 'Olympic' was good. Many 'Hosui' and 'Ya Li' (Asian pear) trees as well as 'Bartlett' and 'Golden Russett' (European pear) trees had died at that point, following bloom infections of fire blight (*Erwinia amylovora*). Eighteen pear cultivars in two established plantings were evaluated for their field-tolerance to fire blight following a severe hailstorm at Keedysville. The cultivars 'Shin Li', 'Daisu Li', 'Shinsui', and 'Olympic' fared as well as 'Magness', a fire blight-tolerant European pear that served as a benchmark in that evaluation. On the other hand, 'Hosui', 'Choju', 'Kosui', 'Seigyoku', 'Ya Li' and 'Ts'e Li' were severely damaged. Using fruit from the replicated trial at Wye, consumer tastings were also conducted. In these tastings, 'Yoinashi', 'Atago', 'Shinko', and 'Olympic' were well-received by consumers. After tasting Asian pears, most people reported that they would be interested in purchasing the fruit and asked for the names of local producers, even those less familiar with the crop. Based on our long-term research results, there appears to be a good opportunity for locally produced Asian pear fruit. With the correct cultivar selection for fire blight management, local growers should be able to produce this alternative crop sustainably and market their fruit profitably.

2:55–3:20 PM

Jujube, an Alternative Crop for the Southern and Southwestern United States

Shengrui Yao*
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Jujube cultivars were first imported into the United States in 1908. Now, the commercial production is limited but jujube is distributed widely, growing and producing well in the United States, especially in the Southwest. Jujubes leaf out late in season and can avoid late frosts in most years in late frost devastated areas like New Mexico. Even when the early growth is frost-killed, they can regenerate themselves and still set fruit, as occurred in 2014. From 2010 to 2014, we had less than two apple crops but a reliable jujube crop every year. Jujube adapts well to wide range of soil and climate conditions. This drought tolerant crop has fewer pest and disease problems than apples or peaches. Jujube produces high quality fruit in the semiarid Southwest. In rainy/humid areas, especially with frequent rains around harvest time, fruit cracking and disease can ruin the crop. Jujube fruit is nutritious with vitamin C content of 200–600 mg/100g fresh weight. Mature jujube fruit has soluble solid content of 25% to 35% or higher. Now, as people are more concerned about healthy diet, consumers are interested in jujubes for its nutritional value and health benefits. Growers from different states are interested in growing jujubes, but commercially available cultivars and research and extension support are limited. The New Mexico State University Alcalde Center has imported/collected over 50 cultivars since 2011 and observes their growing habits, flowering and fruiting habits and evaluates their fruit. We also conducted basic fruit cold storage and fruit processing study. Several promising cultivars have been identified for fresh eating, drying and ornamentals. Jujube is not only a good alternative crop for commercial production but also good edible landscape plants. 'Li', 'Li-2', and 'Redland' were self-fruitful while 'Lang' was not. Sun dried fruit kept less than 10% of the fresh fruit vitamin C content but processed products from fresh fruit kept fruit vitamin C well. Jujubes steamed or boiled for 20 minutes retained over 80% of their original vitamin C content while pie retained 50% of its original vitamin C. After tasting jujubes in our jujube fruit tasting workshops each year, customers were impressed with its fruit quality and interested in planting and consuming jujubes.

3:20–3:45 PM

The Commercial Date Industry in the United States

Glenn Wright*
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The commercial date industry in the United States is located primarily in the Sonora Desert of southeast California and southwest Arizona. The industry comprises about 13,500 acres, of which 75% is found in California and the rest in Arizona. The Spaniards introduced date palms to the United States. Small quantities were imported for experimental purposes by the USDA beginning in the late 1800s, and commercial quantities were imported in the early 1900s. During this period, most imported offshoots originated in Algeria, Egypt, Tunisia, and Iraq. Important varieties that were imported include 'Deglet Noor', 'Khadrawi', 'Zahidi', 'Hayany', and 'Halawy'. Of these, 'Deglet Noor' is the most important. Recently, the 'Medjool' from Morocco was introduced. This variety is becoming increasingly popular because of its large size and high sugar content. Date palm operations are moving from areas that are under pressure from urbanization to more remote locales. Low volume drip and microjet irrigation is beginning to replace the tradition flood and basin irrigation methods. Some dates are produced using organic methods because of consumer demand. Pollination and harvesting operations are becoming increasingly mechanized. Farm operations begin in January when the trees are dethorned.

Operations that occur later in the year include pollination, training the fruit arms, strand thinning, fruit thinning, supporting the arms, spreading the strands, and bagging the developing fruit. Harvest begins in August for 'Medjool' and October for 'Deglet Noor'. Some individual growers have formed cooperatives to pack the fruit at a centrally located packinghouse. At the house, fruit are graded, then packed, and placed in storage until shipment. Dates from the region are marketed by individual growers, and by the grower cooperatives, and sold to customers around the world. Palm trees are also sold for landscape purposes to customers across the United States.

3:45–4:10 PM

Potential of Greater *Castanea* Production in the United States

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Chestnut trees (*Castanea* spp.) are highly valued in orchards, nurseries, and landscapes for their edible nuts, lumber, and shade tree applications. However, chestnut blight (*Cryphonectria parasitica*) and other biotic and abiotic challenges have limited chestnut species/hybrids that are appropriate to grow. Asian germplasm, however, continues to show promise in offering resistance to diseases that have discouraged U.S. growers in further cultivating this genus. An overview of *Castanea* species/hybrids that indicate merit for the orchard, nursery, and landscape will be presented. In addition to careful germplasm selection, pest control, hypovirulence, crop isolation, and other practices could further bolster chestnut production in the United States.

4:10–4:35 PM

Woody Ornamental Plants with Edible Attributes

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The diversity of plant species significantly increased the dynamics of our landscapes and daily gardens. To better promote our common woody ornamental plants, their edible traits and nutrients are summarized. People should better understand the functions of woody plants around us and select plants that are both beautiful ornamentals and food sources for our tables and wildlife. Also, existing fruit plants have great potential for ornamental applications and the success of marketing examples such as blueberry are discussed. The detailed breeding and selections of *Diospyros* and *Acca sellowiana* are updated. Some exotic woody plants with edible parts as new sprout of *Toona sinensis* are described. *Ginkgo biloba* was introduced to European landscapes in 1784 and later to the United States. While many selections were released for their ornamental attributes, its seeds are a great nutritious food source. Future breeding work should be focused on both ornamental and edible characteristics, especially on extracting the seed from its smelly aril. Ornamental plant hunters should place both ornamental and edible functions on the priority list and bring better edible woody ornamental plants to our markets! Together, we should be able to better promote woody ornamental plants with edible attributes to the public and increase the interest of woody landscape plants.

4:35–5:00 PM

Asian Vegetable Crops: Production, Nutrition and Consumer Preference

William Sciarappa*
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The rapid expansion of Asian populations in the United States presents significant opportunities for the produce sector to take advantage of their close proximity to densely populated areas. Asian populations grew 69.5% between 1990–99 and 77.5% from 2000–09. To focus horticultural producers, an ethnic crops survey was conducted by Rutgers University to examine fruit and vegetable expenditures among Chinese and Asian Indians. Expenditures were determined for specific Asian produce types and total produce costs. Data was extrapolated to east coast populations (90% confidence interval error margin 5.6%) to assess market segments. Chinese consumer values ranged from $245 to $296 M per annum and Asian Indians ranged from $190-$230 M per annum. The average annual fresh fruit and vegetable expenditures by both Asian groups was 2 to 3 times respective national averages. Chinese, Korean, and Asian Indian crops were grown for three years (2011–13) in New Jersey, Massachusetts, and Florida. Small plot, replicated trials were used and evaluated for various parameters of morphological features, plant growth, yield and nutritional value. Chinese crops were Shanghai bok choy (*Brassica rapa* var. *chinensis*), pak choi/mizuna (*Brassica rapa* var. *chinensis* and var. *japonica*), Chinese broccoli (*Brassica oleracea*), Chinese mustard (*Brassica juncea*), sugar pea (*Pisum sativum*), chives (*Alium shoenoprasum*), garland chrysanthemum (*Chrysanthemum coronarium*), and shepard's purse (*Capsella bursa-pastoris*). East Indian crops were fenugreek (*Trigonella foenium*), Indian Sorrel (*Rumex acetosa*), tri-color radish (*Raphanus sativas*), Fenugreek (*Trigonella foenium-graecum*), amaranth (*Amaranthus tricolor*), roselle (*Hibiscus sabdariffa*), lemon balm (*Melissa officinalis*), swiss chard (*Beta vulgaris* subsp. *cycla*) and malabar spinach (*Basella alba* cv. 'Rubra'). Nutritional values were analyzed for the percentage of nitrogen, phosphorus, potassium, calcium, manganese, iron, zinc, and sulfur for some leading crop candidates as amaranth species, nightshade, and spinach. This science-based data helps support claims for nutrition and health benefits that drive market consumer interest and demand, which, in turn, directs horticultural production opportunities. From these results, local

farmers can benefit from premium pricing and catering to the special culinary needs of this sizable ethnic market, which is quickly penetrating established mainstream institutions. Also, today's healthy choice for food calls for increased nutritional value from eating more horticultural crops where consumers may find expanded even better choices of vegetable and herb cultivars. (Research team: Jim Simon, Ramu Govindasamy, Kathleen Kelley, Frank Mangan, Shouan Zhang, Surendran Arumugam, Peter Nitzsche, Richard Van Vranken, Stephen Komar, Albert Ayeni, Gene McAvoy, Ed Dager, Chung Park, Qingli Su, Brian Schilling.)

5:00–5:25 PM

Growing and Analyzing International and Alternative Vegetables for Production, Marketing, and Medicinal Properties in Tennessee

Arvazena Clardy*
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Tennessee has a growing number of international citizens from various Asian, Indian, African, Middle Eastern, and Hispanic countries now residing in the Nashville area and surrounding counties. These new Tennessee residents desire their traditional vegetables, which are not grown in Tennessee. Nashville and surrounding counties have several International grocery stores, these stores ship in vegetable produce from out of the county and some of these stores will keep this produce for sales past the recommended shelf life. The local groceries and farmers markets do not carry these desired fruits and vegetables, therefore creating a market for these vegetables. In the Tennessee region, there are many small and limited resource producers who are struggling to remaining viable and need to create and identify new markets to increasing their incomes. At Tennessee State University, we have been researching and working with small and limited producers statewide with growing and marketing international and alternative vegetables. We are presently are producing twelve (12) different varieties of peppers, Bottle Gourd, Bitter Melon, White Eggplant, Tinda, Chinese Okra, and Tomatillos as alternative vegetables for the local residents and new international residents now living in Tennessee. For the past four years we have grown twelve varieties of peppers, herbs and tomatillos for the Italian and Hispanic markets; in the past three years Bottle Gourd, Bitter Melon, Chinese Okra, White Eggplant; and in the past two years for Tinda. We evaluated the feasibility of growing these vegetables in the Tennessee region and marketing strategies. Bitter Melon and Bottle Gourd have been identified to contain medicinal properties for assisting with reducing inflammation, reduction of blood pressure, provide anti-anxiety effects, and diabetes prevention in some individuals who consume these vegetables. These vegetables are also highly nutritional, tasty, and low in calories, which could assist in fighting obesity in Tennessee. We have assisted with production training, and educating small producers with alternative marketing strategies (direct sales with hotels, restaurants, individuals, and farmers markets). Dr. Wu, Assistant Professor of Food Science, is presently analyzing the fruits and leaves of the Bottle Gourd and Bitter Melon for their medicinal and nutritional benefits. There was collaboration with Rita Fleming (a Health Education Specialist) and Leslie Speller-Henderson (a Nutrition Education Specialist) on the introduction of these vegetables to local residents to assist in the fight of obesity and as an alternative nutritional vegetable for consumption in Tennessee.

5:25–5:55 PM

Panel Discussion

Wednesday, 5 August 2015

*CEU Approved

Climate Change—Realities, Controversies, and Responses

Sponsor: Fruits and Vegetables Working Group

Coordinators: Dennis T. Ray, Carl E. Sams, and William Vance Baird

Objective: Present and evaluate the scientific evidence for global climate change, assess its quality and interpret implications to plants and plant production in horticulture, and investigate existing/potential adaptations (natural and engineered).

Abstract: By understanding recent trends in climate, we can gain insight into the challenges that climate change is likely to bring to horticultural production over the next several decades. Horticultural crop value is derived from both the quantity and the quality of the harvested plant material, and both quantity and quality are affected by climate. Because of this there are increasing concerns about how climate change will impact the sustainability of our horticultural production systems. This colloquium will look at trends in climate that are most likely to continue or intensify, and the use of models to predict how near-term changes in climate might impact the physiology of temperate to tropical crops. Perennial crops (apple, grape, citrus, coffee, banana/plantain, and cacao) and one annual crop (lettuce) will be discussed. In all cases, unanticipated stresses may occur, and new breeding techniques and genetic resources may need to be adopted or developed to accelerate the breeding of new cultivars. All of this will lead toward a discussion of climate smart agriculture, which is the alignment of food security, sustainable production, climate resiliency, and greenhouse gas mitigation.

2:00–2:15 PM

Introductory Remarks

2:15–3:00 PM

Past as Prologue: What Do Recent Climate Trends Tell Us about Tomorrow?

Robert Henson*
Weather Underground, Boulder, CO

Barring a volcanic cataclysm, it is virtually certain that global temperatures will rise over the 21st century. There remains a good deal of uncertainty over how much of a rise to expect by 2100, mainly because it is still unclear how quickly or slowly the world's economies will act to restrict carbon emissions. It has also become increasingly clear that the rise in global temperature will not be linear: the last few decades reveal a "two steps forward, one step back" pattern, largely driven by multidecadal patterns of ocean circulation. A good deal of uncertainty also remains in how climate change will play out on the local and regional scale, with the projected trends in some locations more confidently identified than in other locations. Despite these unresolved questions, many aspects of future climate change projected by models are extensions of phenomena already being observed, such as the exacerbation of drought impacts by rising temperatures and the tendency in much of the world for precipitation to be increasingly concentrated in heavier bursts. By understanding which recent trends in climate are likely to continue or intensify, we can gain more insight on the challenges that near-term climate change is likely to bring to horticultural and agricultural operations over the next several decades.

3:00–3:30 PM

Near-term Climate Predictions and Their Impacts on the Physiology of Temperate Crops

Anthony King*
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Syeda Mariya Absar
Oak Ridge National Laboratory, Oak Ridge, TN

Sujithkumar Surendran Nair
Oak Ridge National Laboratory, Oak Ridge, TN

Benjamin L. Preston
Oak Ridge National Laboratory, Oak Ridge, TN

Prediction of climate change over the next decade or two presents challenges both shared with and distinct from climate predictions for mid-century and later. We review general aspects of predicting future climate change, including distinctions between forecasts and projections, and the specific challenges of near-term predictions. From the perspective of impacts, adaptation and vulnerability in the agricultural sector, we discuss approaches that might be most appropriate to climate predictions for the next two decades, and how these approaches compare with widely discussed projections of climate change such as those found in the Intergovernmental Program on Climate Change (IPCC) assessment reports. The uncertainties in future climate change associated with uncertainty in the future use of fossil fuels and the implementation of strategies to mitigate those emissions are, for example, of little concern over the next decade or two because alternative future energy scenarios diverge very little in the near term. Differences in the simulated response of the climate system to these small scenario differences are even smaller, or at least well within the uncertainties and internal variability of the climate models. With this understanding of near-term climate prediction, we then consider how near-term changes in climate might impact the physiology of temperate-latitude crops as represented by process-based, biophysical crop growth models such as the Decision Support System for Agrotechnology Transfer cropping system model (DSSAT), the Environmental Policy Integrated Climate crop growth model (EPIC), and the crop module of the land-surface scheme (CLM-Crop) of the Community Earth System Model (CESM). With a brief review of the treatment, or more nearly non-treatment, of horticultural crops in these widely utilized types of agricultural models, we present results for cotton (*Gossypium hirsutum*) in the Blackland Prairie region of Texas from simulations with DSSAT and EPIC. We illustrate how model results vary with the source of climate change prediction, and conclude with discussions of the modeled response of plants to elevated future atmospheric CO_2 concentrations (CO_2 fertilization) and physiological acclimation to higher temperatures and other changes in the environment.

3:30–4:00 PM

Past and Future Climate Patterns Affecting Temperate, Sub-tropical and Tropical Horticultural Crop Production

David Glenn*
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Perennial horticultural crop production will be impacted by climate change—effects on temperature, water availability, solar radiation, air pollution, and CO_2. Horticultural crop value is derived from both the quantity and the quality of the harvested product; both of which are affected by the climate. Perennial crop production is not easily re-located as the regional climatic characteristics change due to many socio-economic factors including long re-establishment periods, nearness to processing plants, availability of labor, and accessible markets. The literature suggests that the CO_2 fertilization effect may positively contribute to yield and persist longer for perennial horticultural crops if nutrients and water availability are not limited and proper management options (e.g., spacing, pruning, thinning) are implemented to take advantage of the CO_2 effects. On the contrary, the positive CO_2 effect may be negated by the detrimental effects of extreme temperatures on phenology, carbon sinks, reproductive physiology and changes in the disease/pest complex in the agroecosystem that has not relocated to a more optimal climatic region. Case studies of two deciduous temperate fruit crops (apple and grape), two evergreen subtropical crops (citrus and coffee), and two tropical crops (banana/plantain, and cacao) are presented based on literature research to examine past changes and forecasts of the future. Future climate change

scenarios are presented to illustrate the potential impact on the existing centers of horticultural production. We conclude that there is a lack of information on the yield and quality responses of perennial horticultural crops to elevated CO_2 and the interaction with warming temperatures in order to address the trade-offs of future relocation versus adaptation and mitigation for these intensive and complex cropping systems.

4:00–4:30 PM

Sustainable Lettuce: Adaptability to Uncertain Production Conditions

Ryan Hayes*
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Lettuce is a popular and widely consumed leafy vegetable. California and Arizona annually produce more than 250,000 acres of iceberg, romaine, leaf, and specialty types of lettuce, supplying more than 95% of the U.S. market as well as exports to Canada and other countries. These states have dominated lettuce production in the United States since the 1920s. Lettuce is best suited for production in temperatures that range from 18 °C to 25 °C, and production rotates with the seasons to production districts in California and Arizona where this temperature range predominates. Cultivars that are adapted to different soil conditions, photoperiods, and plant stresses are needed to insure a year round supply of lettuce. There are increasing concerns that climate change may impact the sustainability of this production system. Unexpected periods of higher than ideal temperatures may increase the occurrence of premature bolting and thermoinhibition, as well as the physiological defects tipburn and rib necrosis. Nearly all the water needed to grow lettuce in the western U.S. is provided through irrigation, and there are concerns about the future availability of water for crop production. The geographical range of plant pathogens and pests may change, leading to the regular occurrence of biotic stresses currently considered rare or exotic. The effect of climate change on pest and pathogen severity, and the resulting amount of economic loss, will depend upon the specific interactions between the host, the pest or disease, and the production environment. Lettuce is a diploid, autogamous crop with extensive genetic variation within the crop and in its wild relatives for resistances to biotic and abiotic stresses. Breeding approaches suitable for inbred crops have been used successfully to develop improved cultivars, and can be applied to develop cultivars adapted to the stresses anticipated to occur in the future. Other unanticipated stresses may nonetheless occur, and new breeding techniques and genetic resources may need to be adopted or developed in lettuce to accelerate the breeding of new cultivars. This will shorten the time between identification of new production constraints and release of improved cultivars.

4:30–5:00 PM

The Other CSA: Climate Smart Agriculture

Joanne Logan*
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According to the National Climate Assessment, U.S. average temperature has increased almost 2 °F since 1895, and most of this increase has occurred since 1970. The most recent decade was the nation's and the world's hottest on record, and 2012 was the hottest year on record in the continental United States. Temperatures are projected to rise another 2 °F to 4 °F in most areas of the United States over the next few decades. In addition, most areas of the United States have observed an increase in very heavy precipitation, ranging from 5% in the Southwest to 71% in the Northeast, and this trend is expected to continue as the atmosphere warms. Agriculture significantly contributes to greenhouse gas emissions and yet is especially vulnerable to consequences of climate change. Globally, agriculture contributes 30% to 40% of anthropogenic greenhouse gas emissions. Climate smart agriculture is the alignment of food security, sustainable production, climate resiliency, and greenhouse gas mitigation, and should be promoted on a nationwide scale. Horticultural practitioners are in the perfect position to implement smart climate agriculture (CSA). Vegetable and fruit production is intrinsically diversified, which automatically fosters a certain level of security and sustainability. There is also a rich tradition of incorporation of genetic variability such as heritage and heirloom varieties, integrated pest management, and organic production. Although carbon dioxide enrichment has a direct benefit on plants, projected increases in temperature will have a wide range of effects on fruits and vegetables such as growing season, heat stress, chilling, disease and pest pressure and transmission, evapotranspiration, soil erosion, nutrient and pesticide availability and runoff, storage, growth and development, frost, water resources, and greenhouse management. In addition, the horticultural workforce will be greatly impacted by rising temperatures. Strategies such as improved water management, reduced tillage, efficient storage and transportation, promotion of local markets, optimal fertilizer use, better harvest efficiency, diversification, integrated pest management, and incorporation of legumes and cover crops are examples of strategies that not only increase climate resiliency, but also serve as mitigation schemes to reduce emissions either directly or indirectly.

5:00–5:30 PM

Panel Discussion

Thursday, 6 August 2015

*CEU Approved

Vertical Farming: Challenges and Opportunities

Sponsor: Controlled Environment (CE) Working Group

Coordinator: Marc van Iersel

Objective: This colloquium will explore the challenges and opportunities related to horticultural production in controlled environmental agriculture facilities. The colloquium will cover production practices, sustainability, and socio-economic aspects of controlled environmental agriculture.

Abstract: Indoor, controlled environmental agriculture, including vertical farms and plant factories, provides year-round opportunities to bring more horticulture into urban environments. Among the touted benefits are food production in cities, little need for transportation, high resource use efficiency, no pollution, and no need for arable land. On the other hand, there are questions about whether factory farms are economically viable. The initial costs are high and most "farms" depend on electrical lighting, requiring large amounts of energy.

8:00–8:05 AM

Introductory Remarks

8:05–8:45 AM

Commercializing Vertical Farming—AeroFarm Approach

Edward Harwood*

AeroFarms, Ithaca, NY; edharwood@aerofarms.com

Founded in 2004, AeroFarms® is a mission-driven company leading the way to address our global food crisis by building, owning, and operating farms that grow locally flavorful, safe, healthy food in a sustainable and socially responsible way, setting a new standard for culinary freshness and flavor. AeroFarms is fundamentally transforming agriculture and disintermediating the supply chain for baby leafy greens by enabling local indoor farming at commercial scale all year round utilizing aeroponics and LEDs. Our productivity per square foot is over 75 times greater annually versus the field farm driven by our proprietary growing algorithms. Every one of our harvests has over 10,000 data points being monitored to ensure high quality and consistency. This marriage of engineering and science and data science is redefining agriculture today. Some of these challenges and opportunities will be shared.

8:45–9:25 AM

Optimizing Production Methods for Vertical Farms

Nate Storey*

Bright Agrotech LLC, Laramie, WY; nate@brightagrotech.com

Vertical farming is booming, with dozens of vertical farms being established every year. Vertical farms are taking many forms, from warehouse systems to vertical greenhouse systems to living walls. Growing vertically introduces some unique growing variables uncommon to horizontal agriculture. These variables warrant rethinking many of the traditional layouts and forms of hydroponic growing by optimizing for volumetric production, air circulation, environmental controls and operational costs. This presentation will address these new considerations and give examples of vertical farms that are changing the way food is grown and distributed in urban and suburban environments. This topic is of importance to the academic community because there are many areas of vertical farming that are very fertile research areas, and because vertical farming, as a nascent industry, will benefit from industry-academic partnerships as the industry grows.

9:25–10:05 AM

Growing Food for Space and Earth: NASA's Contributions to Vertical Farming

Raymond Wheeler*

NASA, Kennedy Space Ctr, FL; raymond.m.wheeler@nasa.gov

Perhaps one of the first demonstrations of vertical farming was carried out by NASA with the Biomass Production Chamber at Kennedy Space Center, FL. Plants were grown on four circular shaped shelves stacked vertically in a closed chamber, with lighting provided with 96, 400-W high pressure sodium lamps. All the plants were grown using a recirculating nutrient film technique, and transpired humidity was condensed and returned to the hydroponic systems. Crops tested included wheat, soybean, potato, lettuce, tomato, rice and radish. This allowed validation of basic protocols developed by university researchers but on a larger scale, and inside a tightly closed atmosphere. The closed atmosphere allowed tracking of volatile organic compounds produced in the system, including ethylene gas, which was chemically scrubbed for some tests. Subsequent testing using standard growth chambers expanded to include LEDs as a light source, and a demonstration of a roof-top solar collection system with optical fibers delivering the light to a chamber inside the building. A series of plant growth tests was also carried out in NASA's Habitat Demonstration Unit for planetary surface missions. In this case, the plant growth system was placed on a circular shelf surrounding a lift between the lower lab module and the upper crew quarters module. This took advantage of under-utilized volume for growing food within a human living space. More recent testing has focused on testing and selection of dwarf cultivars to maximize production per unit volume for space missions. Many of these concepts and technologies being studied for space align closely with challenges for terrestrial vertical agriculture.

10:05–10:45 AM

From Photons to Food

Bruce Bugbee*

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The four most environmentally sensitive inputs to our food

production system are sunlight (photons), water, nitrogen, and phosphorous. Sunlight is the limiting input if food is grown with electric lighting. Here I review and analyze radiation capture, the quantum yield of photosynthesis, respiration efficiency, and carbon partitioning efficiency to show that a mole of photosynthetic photons can yield up to a gram of dry mass of food, regardless of the source of photons. Assuming an electric cost of $0.10/kWh and our most efficient electric lights (6.1 moles of photons/kWh), the economic value of summer sunlight is $400,000 per acre over a 100 day growing season. Winter sunlight during the darkest 60 days of the year is worth about $40,000 per acre. These values drive the comparative costs associated with indoor/outdoor food production. I also compare water, nitrogen and phosphorous recovery to show the wide variation among indoor and outdoor food production systems.

10:45–11:25 AM

Emerging Technologies and Associated Challenges for Controlled Environment Agriculture

George Kantor*
Carnegie Mellon University, Pittsburgh, PA; kantor@ri.cmu.edu

Emerging technologies provide the potential to measure, analyze, and control what happens in agricultural environments. Robotics and high-resolution sensing have been developed to provide intelligent automation capabilities in other domains, but there are many engineering challenges that must be addressed before their potential for agriculture can be fully realized. This talk will review some recent robotics research systems, discuss existing barriers to implementation, and suggest possible paths to bring these technologies into high-impact application in controlled environment agriculture systems.

11:25 AM–12:00 PM

Panel Discussion

Tuesday, 4 August 2015

*CEU Approved

Trends in Plant Biotechnology

Sponsor: Plant Biotechnology (BTCH) Working Group

Moderator: Manjul Dutt; manjul@ufl.edu

Abstract: Plant Biotechnology has evolved from an experimental science to an interdisciplinary effort aimed at increasing crop productivity. Biotech crops have been developed to improve nutritional value, increase biomass, protect against abiotic and biotic stresses and a source of therapeutic protein production among others. These crops have been cultivated commercially and adopted in a rapidly increasing number of countries over the past 20 years. Sequencing the genome of most common crops plants and development of robust genomics tools has enhanced identification of genes for key traits. This rapid identification of useful genetic information has resulted in a quick transfer of genes and genetic elements using biotechnology into susceptible plants. This workshop will discuss some of the current trends and progress made to integrate genomics and plant biotechnology tools for the rapid development of genetically modified horticultural cultivars. Future trends and prospects for biotechnological applications will also be discussed.

8:00–8:20 AM

TILLING and ecoTILLING for Variation in Genes for Ornamental Traits

Dayton Wilde*
University of Georgia, Athens; dwilde@uga.edu

Genomic resources and tools enable the discovery of variation in genes for horticultural traits. Candidate genes have been identified that play similar roles in the control of flowering, architecture, and disease-resistance in different crop species. Natural or induced variation in candidate genes can be detected by mutation screening techniques such as high-resolution melting (HRM) analysis. We have used HRM to screen for EMS-induced mutations in the *Mlo* gene of petunia. *Mlo* mutation could potentially lead to resistance to powdery mildew. The USDA blueberry germplasm collection was screened for natural variation in *TFL1*, a gene that regulates floral initiation. Novel alleles of these candidate genes can be used for trait development in ornamental plants.

8:20–8:40 AM

Grafting "Away" the Concerns on Genetically Engineered Plants?

Guo-qing Song*
Michigan State University, East Lansing; songg@msu.edu

Grafting is a well-established agricultural practice, and it now has implications for the commercialization of transgenic plants for non-transgenic products. In our recent studies, we transformed a hairpin RNA (hpRNA) vector to a major sweet cherry rootstock cv. Gisela 6 in order to silence *Prunus necrotic ringspot virus* (PNRSV), which is a major pollen-disseminated Ilarvirus. All transgenic rootstocks showed accumulation of hpRNA-derived small interfering RNAs (siRNAs) and high resistance to the PNRSV. Subsequently, we performed grafting studies to investigate whether PNRSV-resistant transgenic rootstocks developed through siRNA-mediated gene silencing can enhance virus resistance of non-transgenic scions. We found transported (rootstock-to-scion) siRNAs in a non-transgenic scion of sweet cherry grafted on a transgenic rootstock. More importantly, inoculation of non-transgenic scions with PNRSV revealed that the transferred siRNAs enhanced PNRSV resistance in the scions grafted on the transgenic rootstocks. Low amounts of transferred hpRNA siRNAs in scions, compared to those detected in PNRSV-infected but symptomless cherry plants using non-transgenic rootstocks, implied little concern of these siRNAs for food safety. These findings provide the basis for 'using transgenic rootstocks to produce non-transgenic products of scions in rootstock-scion grafted plants', while minimizing concerns about food and environmental safety.

8:40–9:00 AM

Genetic Improvement of Horticultural Plants: Transgenic or Non-Transgenic?

Yi Li*
University of Connecticut, Storrs; yi.li@uconn.edu

Although the global biotech crop hectarage continues to grow for the 19th consecutive year, the debate over the transgenic plants is getting hotter and hotter worldwide. I will discuss technologies that can be used to produce non- transgenic products from transgenic plants such as the gene deletor technology. I will also discuss technologies that are highly efficient to produce non-transgenic traits in crop plants, such as CRISPR technologies. I will further discuss pros and cons of these technologies in genetic improvement of horticultural crops.

9:00–9:20 AM

Opportunities for Modification of Tissue-specific Anthocyanin Accumulation in Solanaceous Crops

John Stommel*
USDA–ARS, Beltsville, MD; john.stommel@ars.usda.gov

Anthocyanins are secondary metabolites derived from the phenylpropanoid pathway with important physiological roles in plant tissues that also influence crop quality and nutritive value. In flowers, anthocyanins may function as attractants for pollinators and aid in the dispersal of seeds and fruit. They also function in plant tissues as antioxidants and ultraviolet and visible light protectants. This class of compounds has generated considerable interest for their presumptive health promoting effects in mitigating or preventing chronic diseases. Anthocyanin biosynthesis has been studied extensively. The enzymes in the

anthocyanin biosynthetic pathway are functionally conserved across diverse plant species and the genes that encode these enzymes share high sequence similarity across species. Tissue- or developmental-specific expression exhibited by anthocyanin structural genes is controlled by regulatory genes. A common set of proteins, comprised of MYB and bHLH MYC proteins plus WD40 repeat proteins, interact to form a regulatory complex that controls transcription of anthocyanin structural genes. The role of the MYC-MYB-WD40 regulatory protein complex is well accepted for its role in anthocyanin biosynthesis. *Myb* and *Myc* provide one of the best examples of combinatorial plant gene regulation. Together with the WD40 protein, MYB and MYC provide extensive regulatory function in plants and result in new phenotypic traits by virtue of variation in the MYC or, more commonly, the MYB component. Gene families with multiple copies of anthocyanin biosynthetic and regulatory genes and resulting variation in function of these genes, particularly for regulatory genes, is responsible for differences in pigmentation and patterns of tissue- or developmental-specific pigmentation within and between species. Opportunities for modification of anthocyanin composition and tissue-specific pigmentation in selected Solanaceous crops will be discussed.

Tuesday, 4 August 2015 Maurepas

*CEU Approved

New Technologies for Managing Breeding Data

Sponsor: Ornamental Plant Breeding (OPB) Working Group

Coordiinator: Michele Scheiber, NovaFlora, West Grove

Objective: Explore new technology available for acquisiton and management of breeding related data.

Abstract: Managing plant breeding data is a cumbersome, labor-intensive, yet essential, task for any breeding program. However, a variety of technologies and software are available to reduce labor inputs, increase efficiency and uniformity, and improve the ability to track trends. Workshop topics will include data management of pollination records, pedigrees, trial data, and multiple projects as well as the integration of technology. Several novel software programs will be discussed and demonstrated. In addition, tablets used in conjunction with Excel will be presented for capturing field data. Finally, innovative approaches for maximizing the potential of traditional spreadsheets will be presented.

1:45–2:00 PM

Field Notes: The Next Generation

Steve Todd*
USDA–ARS, Raleigh; smtodd@ncsu.edu

2:00–2:15 PM

‘Excel’ing at Breeding Data Management

Michele Scheiber*
NovaFlora, West Grove

2:15–2:30 PM

How Do I Transform More and More Data into Useful Breeding Information? Integrating Data Sources to a “Single Source of Truth” is Key for the New Generation of Breeding

Evert Keuken*
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2:30–2:45 PM

Trial Tracker Software

Scott Holmes*
Extreme Technology Corp., St. Catherines; scott@etcweb.com

Tuesday, 4 August 2015

Public Gardens and People: Overcoming Disasters

Sponsor: Public Horticulture (PUBHORT) Working Group

Coordinator: Carolyn W. Robinson

Objective: To discuss catastrophes that public gardens sometimes face, how the event affects the garden and community, and what can we learn from these experiences.

Abstract: This workshop will focus on three gardens and how they have overcome different tragedies. Paul Soniat, Director of New Orleans Botanical Garden, will tell us about their destruction and triumphant rise after Hurricane Katrina. Sabina Carr, Vice President of Marketing at Atlanta Botanical Garden, will discuss a devastating construction accident and the process of moving forward. Finally, Andrew Pulte of the University of Tennessee (UT) will describe how The UT Gardens had to evolve after losing 19 large trees during Spring 2011. There are many impacts to both the people and the gardens with disasters such as these, but they are also opportunities to learn and improve for the future.

1:45–2:30 PM

Destruction and Triumphant Rise of Public Gardens after Hurricane Katrina

Paul Soniat*
New Orleans Botanical Garden; paulsoniat@bellsouth.net

2:30–3:15 PM

How Did the University of Tennessee Gardens Evolve?

Andrew Pulte*
The University of Tennessee, Knoxville; pulte@utk.edu

Tuesday, 4 August 2015 Borgne

*CEU Approved

Therapeutic Methods for Emerging Diseases in Citrus and Other Horticultural Crops

Sponsor: Citrus Crops (CITR) Working Group

Moderator: Tripti Vashisth; tripti.vashisth@gmail.com

Objective: The purpose of this workshop is to review the therapeutic methods that are being employed for different emerging diseases in citrus and other horticultural crops. This workshop will encourage and facilitate the mutual exchange of ideas and information concerning the use of therapeutic methods for diseases in horticultural crops and how these approaches can be adopted in citrus.

Abstract: The citrus industry is currently threatened by a disease called "Huanglongbing, (HLB)." Also called citrus greening, HLB is one of the most destructive diseases of citrus and one of the greatest limitations on production in every citrus producing region where it is present. The HLB-infected trees often display multiple disease and mineral deficiency symptoms, poor fruit set, high fruit drop, low fruit quality, and low overall yields. At present there is no cure for this disease and therefore poses a big threat to entire American citrus industry. It is anticipated that this workshop on use of different therapeutic approaches such as nanoparticles, RNAi, etc. will generate a discussion on how similar approaches can be employed in citrus to combat HLB and other diseases. The specific objectives of this workshop are: a) to increase our knowledge about the therapeutic methods that are being or have been used for suppressing/curing diseases in horticultural crops; b) to have a better understanding about what type of therapeutic approaches are being used for diseases like citrus greening or canker; and c) how the approaches from other horticultural crops can be adopted for citrus.

1:45–2:00 PM

An Overview of Citrus Production

Ed Stover*
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2:00–2:25 PM

In-field Thermotheraphy of HLB-infected Citrus Trees

Reza Ehsani
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Tripti Vashisth*
University of Florida, Lake Alfred; tripti.vashisth@gmail.com

2:25–2:50 PM

Therapeutic Strategies for Combating Citrus Greening Disease

Robert Shatters*
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2:50–3:15 PM

Exploration into Antibacterial Nano Compounds: Model Approaches Being Tested Against Bacterial Spot of Tomato Caused by *Xanthomonas* Species

Mathews Paret*
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Tuesday, 4 August 2015

*CEU Approved

Basic and Applied Physiology Research on Selected Biostimulants for Horticultural Crops

Sponsor: Crop Physiology (CROP) Working Group

Coordinator: J. Pablo Morales-Payan; morales.payan@upr.edu

Abstract: The workshop will focus on presenting published and new data on the effects of selected biostimulant groups (amino acids and peptides, alga extracts, humates and related substances) on the physiology and responses to abiotic and biotic stress, growth, yield, and quality of horticultural crops.

1:45–1:55 PM

Introductory Remarks

1:55–2:15 PM

Biostimulants from the Sea: Marine Plant Extracts and Their Impact on Plant Stress Resistance

Jeffrey Norrie*
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Marine plant extracts are increasingly popular inputs in modern integrated agricultural programs, be they conventional or organic. They also make up a good portion of the biostimulant market, which has recently been redefined to focus on responses to abiotic stress factors. *Ascophyllum nodosum* extracts in particular, are popular in horticultural applications and field crops. The science database supporting mode-of-action and efficacy is expanding rapidly. On a fundamental level, Acadian Seaplant's *Ascophyllum* extracts have been found to increase the manufacture of genetic transcripts leading to the production of several important antioxidant enzymes and cytokinins, as well as a down-regulation of the transcription for cytokinin-destroying compounds. Research has also shown an effect on the regulation of other hormones and protective compounds. Moreover, research has shown improved plant tolerance to abiotic osmotic stresses, specifically salinity and drought. Additional studies have shown the effects of Acadian extracts against high and low temperature. Given that many stresses in the field are compounded, this information can be invaluable to growers in designing effective management programs. Extended benefits include interaction

with soil microbia that have the potential to induce feedback effects onto the target crop, providing a newer area for potential plant benefits and plant-microbe signaling. This presentation will focus on peer-reviewed research identifying these responses as well as a discussion on possible modes-of-action. The impact of this research on several horticultural crops will be discussed.

2:15–2:35 PM

Soil Microbial Inoculants Impacts on Strawberry Plug Plant Growth and Development

Amanda McWhirt*
North Carolina State University, Raleigh; amanda.mcwhirt@gmail.com

The use of soil inoculants to promote plant growth has been widely demonstrated. Of particular interest are vermicompost and arbuscular mycorrhizal fungi (AMF) which have been shown to have stimulatory effects on plant growth due to various mechanisms including increased nutrient availability and uptake, production of plant growth promoting compounds and increased stress tolerance. The incorporation of these inoculants into plug production for strawberries may provide various benefits including increasing the rate of plant development, increasing plant growth and root development, and increasing populations of beneficial soil organisms in the field often lost through fumigation practices. These benefits to plug plants may be cumulative resulting in improved plant survival and yields, yet there are few studies that examined the individual and integrated impacts of vermicompost and AMF on strawberries. In our study we evaluated the addition of vermicompost, one native and two commercial AMF inoculants and the combination of AMF and vermicompost inoculants compared to a control on strawberry plug plant production. We additionally examined the method of incorporation of AMF inoculant into the plug (mixed with media, top dressed and dip) and two rates (recommended and high) of AMF inoculant. Plug plant rate of development, ratios of root to shoot growth, percentage of roots colonized by AMF and nutrient uptake were evaluated and results will be shared. The potential for vermicompost and mycorrhizal fungal inoculants for stimulating strawberry plug plant production will be discussed.

2:35–2:55 PM

Biostimulants Based on Amino Acids and Related Compounds

J. Pablo Morales-Payan*
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Free amino acids and peptides are the active ingredients of one of the major groups of crop biostimulants. There are numerous commercial formulations available to growers, from those with one compound to those with a blend of several compounds. Exogenous amino acids and peptides applied to horticultural crops have been associated with increased chlorophyll concentration, accelerated growth, augmented biomass accumulation, enhanced fruit set, enlarged fruits, increased soluble solid concentration, higher tolerance to abiotic stress, and in some cases more tolerance to biotic stress has been found as well. Results of basic and applied research on horticultural crops will be presented, with emphasis on tropical and subtropical crops.

2:55–3:25 PM

Demonstration of Equipment for Research on Biostimulant Responses

Eric Price*
LI-COR Biosciences, Lincoln, NE; eric.price@licor.com

*CEU Approved

Online Learning and Big Data in Horticulture: New Insights and Directions

Sponsor: Computer Applications in Horticulture (COMP) Working Group

Moderator: Zachary T. Brym; zack.brym@usu.edu

Objectives: 1. Provide an overview of new computing tools and approaches for improving data management in horticulture. 2. Share practical experiences and insights in the development of an asynchronous online extension program.

Abstract: The rise of big data in research mirrors the increase in take up of online learning. Using computers to store, analyze and present data has become the norm, not only in horticultural research but also in teaching and extension. There are several online learning tools that are available but very little attention has been paid to how well these courses actually support learners. The first part of this workshop aims to introduce valuable concepts and techniques in order to improve familiarity with advanced computing tools and increase efficiency of data management. The second part of the workshop describes the development, deployment, and evaluation of a synchronous online extension program for Tennessee nursery producers.

1:45–2:15 PM

Developing an Asynchronous Online Extension Program for Tennessee Nursery Producers

Amy Fulcher
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S. Christopher Marble*
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Asynchronous online extension programs (AOEP), in which content is made available on-demand, have the potential to

reach a larger audience, offer more scheduling flexibility, and reduce the strain of limited financial resources and time for Extension faculty. In comparison with traditional in-person Extension programming and online synchronous programming (live-webinars), asynchronous programs can require significant time and resources during the initial development stages. The University of Tennessee, with support from the TDA, USDA and TSU, recently developed an asynchronous education program, the "Tennessee Master Nursery Producer Program" (TMNP). The TMNP consists of 21 one-hour modules covering topics including container and field production, nutrition, irrigation, pest management, pruning, propagation, and economics and marketing. Prior to program development, consider the availability and expertise of key personnel, content organization, flow, and depth, delivery platform and software, and initial plus recurring costs (e.g. hosting costs) and responsibilities (e.g., updating content, fielding queries, etc.). Key roles for TMNP development included a project coordinator, curriculum developer, information technology specialist, and narrator. For the curriculum developer, initial development of each module required approximately 40 hours plus subsequent editing, revision, and formatting. Within initial development, script preparation required the most time followed by research and content development (gathering and selecting information for each module). The largest expense was personnel: the curriculum developer and project coordinator. Software costs were kept to a minimum through discount educational licenses for Microsoft Office® (Microsoft Corporation, Redmund, WA) and Articulate® Presenter (Articulate, New York, NY) (used to add multimedia to PowerPoint® slides) and utilization of open-source software including Moodle™ (Moodle Pty Ltd, Perth, Western Australia) for the online delivery system and Audacity® (audacity.sourcefoge.net) for recording narration. All members of the developmental team must have clearly defined roles and responsibilities and a completion schedule must be established at the project's onset. Finalizing the program format at the beginning of the development process, i.e., image size, font, slide layout, and graphics is critical to prevent additional formatting later. Using a trained narrator can be more expensive than an amateur, but may require significantly less editing, and ultimately reduce costs and time to completion. Curriculum previously developed for live presentations are not adequate for online delivery and will likely require significant revision. AOEP can be a pathway to expand Extension's accessibility to stakeholders. Understanding the development process, essential positions, and budgeting appropriately for personnel expertise and time is essential to successfully developing and launching an AOEP.

2:15–2:45 PM

Comparing an Asynchronous Online Extension Program and a Traditional Face-to-Face Program for Delivering Master Producer Content

Amy Fulcher*
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Adam Blalock
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Asynchronous online extension programs (AOEP), in which content is made available on-demand, have the potential to help Extension programs reach a wider audience due to scheduling flexibility and elimination of travel, while reducing the strain of limited time and financial resources of Extension professionals. However, in comparison with traditional in-person Extension programming and online synchronous programming (live webinars), asynchronous programs can require significant time and resources during the initial development stages. The University of Tennessee, with support from the TDA, USDA and TSU, recently developed a Tennessee Master Nursery Producer Program (TMNP) consisting of traditional in-person classes (simultaneously accessible as live webinars). The traditional delivery format was subsequently phased out and replaced by an asynchronous education program. The traditionally formatted TMNP consisted of 24 hours of live instruction taught over a six-week period. Nationally recognized experts (in-state and out-of-state) were scheduled to teach various components of nursery crops production, as well as pest management, economics and marketing, and estate planning. The AOEP is comprised of 21 one-hour modules, and covers container and field production, plant nutrition, irrigation management, pest management, pruning, propagation, and economics and marketing. Topical quizzes were given at the end of each day of the traditional program, while each module of the AOEP is followed by a quiz with a minimum score requirement to advance to the next module. A comprehensive final exam was administered for the live program and is currently administered within the AOEP. The advantages and disadvantages and requirements of each type of program delivery will be covered including cost to develop, implement, and administer; prerequisite computer skills of participants; development and stability of program content; graduation rates; social dynamics and instructor rapport; and ability to respond to emerging issues. While content was not identical, graduates of the AOEP estimate roughly a three-fold greater economic impact compared with graduates of the live program. The potential effect of program delivery on economic impact will be discussed as well as ways to maximize impact and user satisfaction with an AOEP. The use of AOEP for data

collection and archiving will also be covered. Programs with a traditional delivery format and AOEP can both help disseminate information to Extension clientele. Understanding the advantages and disadvantages and requirements of AOEP and traditional programs can help extension professionals make an informed decision about the program delivery that best suits their program and audience needs.

2:45–3:15 PM

An Introduction to Advanced Computing in Science

Zachary T. Brym*
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Alexander Susko
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Using computers to store and analyze data has firmly landed as the norm in science. Many advanced software tools are available to the every-day computer user that can help in achieving his or her scientific goals. Section 1 of the workshop introduces a suite of advanced computing skills that provide the foundation for becoming proficient at using generalized, broadly applicable, and freely available computing software. Generalized programming languages, like Python, SQLite, and R: can be used by any scientist to customize and streamline their data management and analyses. This workshop introduces valuable concepts, techniques, and resources to incorporate advanced computing into your work. To improve the repeatability and efficiency of your data management and analysis we present a short list of simple steps: 1) improve the documentation of your data through logs and metadata; 2) maintain an unprocessed or original form of the data; 3) use standard data file formats such as .txt and .csv; 4) use good null values; and 5) simplify your data into standard tabular structure within relational databases.

Tuesday, 4 August 2015 Bayside C

Five-minute Impact Strategies for Engaging Students—Where to Start with Service-learning and Fundraising?

Sponsor: Teaching Methods (TCHG) Working Group

Moderator: Brian Trader; btrader@longwoodgardens.org

Objective: To share and communicate ideas on student engagement inside and outside of the classroom. Highlight methods of integrating students into various communities and organizations through service learning. Explore new opportunities of student experiential learning through innovative fundraising.

Abstract: How do we engage with our students on a deeper level and connect through meaningful learning experiences? Members of the Teaching Methods Working Group will present five-minute strategies, ideas and tips on working with students inside and outside of the classroom. There will be an emphasis on student-centric learning and how service-learning projects, fundraising, club travel impacts and enforces learning outcomes. At the end of the session, others are encouraged to ask questions, discuss teaching strategies and offer their own tips for the group's benefit.

4:00–4:10 PM

1. Service-Learning with Local Schools—Incorporating Multiple Courses on the Same Project

David Kopsell*
Illinois State University, Normal, IL; dkopsel@ilstu.edu

4:10–4:20 PM

Rebuilding Historic Irish Gardens One Peat Brick at a Time

Ann VanDerZanden*
Iowa State University, Ames; vanderza@iastate.edu

4:20–4:30 PM

From Propagation to Professional Development

Brian Pearson*
University of Florida, Mid-Florida Research and Education Center, Apopka; bpearson@ufl.edu

4:30–4:40 PM

Using IFAT Quizzes to Engage Students

Susan Barton*
University of Delaware, Newark,; sbarton@udel.edu

4:40–4:50 PM

Using Flipped Classroom, BYOD, and Public Speaking to Engage Students

Kent Kobayashi*
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4:50–5:00 PM

I Do . . . I Understand

Kauahi Perez*
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5:00–5:10 PM

Fruit and Vegetable Culture Class Turned Veggie Venture

Brian Trader*
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Tuesday, 4 August 2015

*CEU Approved

The Eyes Have It: Understanding the Roles of Branding and Marketing of Consumer Horticultural Products Using New Technologies

Sponsor: Marketing and Economics (MKEC) Working Group

Moderator: Cheryl R. Boyer; crboyer@ksu.edu

Objective: This workshop will focus on new methods of consumer research featuring advances in technology on a variety of fronts.

Abstract: Eye tracking devices have enabled greater understanding of consumer choices and decision making related to horticultural products for several commodities such as ornamental plants and nano-packaged food products. Experimental auctions provide another dimension in consumer behavior research by implementing real economic consequences. Techniques to merge experimental auctions and eye-tracking analysis will be discussed. Evaluation of a statewide promotional program, *Fresh from Florida*, using eye-tracking technology to study consumer preference for plants and program awareness in order to determine participants' purchase likelihood will be featured. While research into social media marketing for garden centers and nurseries is new and ongoing, the opportunities and challenges will also be discussed.

4:00–4:15 PM

The Role of Plant Brands and Perceived Quality

Bridget Behe*
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Patricia Huddleston
Michigan State University, East Lansing; huddles2@msu.edu
Lynnell Sage
Michigan State University, East Lansing; sagel@msu.edu

4:15–4:30 PM

Eye Tracking Technology Data Collection Methods

Lynnell Sage*
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Patricia Huddleston
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4:30–4:45 PM

Eye-tracking and Experimental Auctions: An Innovative Approach

Alicia Rihn
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Chengyan Yue
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Jingjing Wang*
University of Minnesota, St. Paul; wang2797@umn.edu

4:45–5:00 PM

Consumer Willingness to Pay for Nano-Packaged Horticultural Products

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5:00–5:15 PM

State Promotional Campaign Awareness and Visual Attention

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5:15–5:30 PM

Like It, Pin It, Follow It: Opportunities and Challenges for Social Media Marketing in Garden Centers and Nurseries

Cheryl Boyer*
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Tuesday, 4 August 2015

*CEU Approved

Automation and Mechanization in Commercial Vegetable Production

Vegetable Crops Management (VCM) Working Group

Moderator: Ajay Nair; nairajay@iastate.edu

Objective: To provide new information on automation and mechanization technologies utilized in commercial vegetable production.

Abstract: One of the major challenges confronting the vegetable industry is the lack of consistent and skilled labor supply. Finding skilled labor is critical for timely completion of field activities and overall productivity of the farming enterprise. In the last two to three decades vegetable industry has made huge strides in adopting tools, equipment, and techniques that over time have reduced labor requirements for growing and harvesting produce. Although mechanization and automation advances have been more for the harvest of processing vegetable, more and more fresh market vegetables are either being harvested mechanically or there is some form of mechanization/automation utilized during their production process. This workshop will provide information on technologies that focus on automated site-specific irrigation and fertilizer application; Geographic Positioning System (GPS) based planting, cultivating, chemical application, and harvest equipment; and GPS based field mapping technology for yield prediction in vegetable crops. Workshop will also cover the topic of automated thinning technology currently being tested in lettuce producing areas in California and Arizona. The final portion of the workshop will highlight the increasing role of Unmanned-Aerial-Vehicles (UAVs) in horticultural crop production. There will be live demonstration of UAVs followed by information on post-image processing and interpretation of images for agricultural 3-D mapping. This workshop would include three presentations as well as a short discussion/demonstration period.

4:00–4:30 PM

Mechanization and Technologies in Processing Vegetables—Past, Present, and Future

Gordon Johnson*

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Over a 25-year period, mechanized harvest of pickling cucumbers and lima beans were studied by the University of Delaware to determine where improvements in crop recovery and harvest could be found. Research showed that with lima beans, variety selection, field preparation, cultivation, and harvester operation speeds all impacted crop losses. Improvements of over 25% could be obtained by addressing these factors. A breeding program in lima beans is ongoing to develop more upright varieties with higher pod set to improve recovery. Changes in pickle vine pickup and feeding mechanisms and pinch roller pickle detachment improved cucumber harvest recovery by >5% and reduced crop damage by as much as 15%. Pickle varieties were evaluated for best characteristics for harvest recovery and multiple harvest of pickling cucumbers grown on black plastic mulch by machine is being explored. Current research is being conducted on site-specific variable rate overhead irrigation adapted to processing vegetable fields as well as subsurface irrigation potential for these crops. Research with variable rate application of nitrogen in sweet corn showed equivalent production to standard application methods with 18% reduction in nitrogen applied. Current research has shown the potential for developing site-specific risk maps for southern root knot nematodes in processing vegetables for targeted controls and the use of local weather data to predict outbreaks of downy mildew in lima beans. Also demonstrated is the potential for GPS based variable rate planting, application of fertilizer, and application of chemicals such as nematicides according to application maps. GPS auto steer systems are being widely adopted for planting, cultivating, chemical application, and harvest in processing vegetable systems. The potential for GPS based yield monitoring and mapping in crops such as sweet corn, peas, shelled beans, tomatoes and snap beans has been demonstrated but has not yet been widely adopted.

4:30–5:00 PM

Automated Thinners in California Lettuce Production

Richard Smith*

University of California Cooperative Extension, Salinas; rifsmith@ucdavis.edu

Thinning crops is a labor-intensive activity and growers and researchers have sought a means of mechanizing this crop production practice. Efforts by Land Grant Universities and private companies to develop automated thinners for sugar beets extend back over 100 years. Early designs incorporated various swinging or spinning blades, but no plant detection technology. In the 1960s, the John Deere Corp. developed a beet thinner that utilized a plant detection mechanism (moisture sensitive metal plate that greatly improved the resulting stand. Computer processing of digital images crop plantings is now available and has made it possible to make precise decisions on which plants to remove and leave. In 2011, the first automated thinners with computer processing were introduced to the lettuce industry. They used a spray kill mechanism to remove unwanted lettuce plants and associated weeds. There are now four companies with commercially available machines for thinning lettuce. These machines remove unwanted lettuce plants and associated weeds in a 10 cm wide strip around the seedline and within 9 to 12 mm to either side of the keeper plants. Materials used to remove the unwanted lettuce plants include fertilizer and the herbicide carfentrazone. Evaluations in 2014 showed that automated thinners took 2.25 hours/ha (range 0.59 to 4.92 hours/ha) and hand thinning 16.21 hours/ha (range 11.56 to 22.53 hours/ha) to thin lettuce. However, the double removal/weeding operation 7–14 days following thinning took 16.23 hours/ha in the automated thinner treatment and 13.12 hours/ha in the hand thinned treatment; the increase in time for double removal and

weeding in the automated thinner area was due to the greater number of doubles in the automated thinner treatment (2530 double/ha) than hand thinning (368 doubles/ha). The total time for thinning and double removal/weeding operations was 18.48 hours/ha in the automated thinner treatment and 29.33 hours/ha in the hand thinned treatment. The desired spacing for all fields in the study was 25.4 cm. The mean plant spacing in the automated thinner treatment was 26.1 cm (range 25.4 to 27.6 cm) and 26.6 cm in the hand thinned treatment (range 24.4 to 29.5 cm). Automated thinners have some key advantages over hand thinning and this technology is expected to continue to improve and find applications to other crop production practices.

5:00–6:00 PM

Integrating UAVs into Photogrammetry Applications for Agricultural 3D Mapping

Kurt Nolte*
University of Arizona, Yuma; knolte@ag.arizona.edu

Micro-UAVs (Unmanned-Aerial-Vehicles) with a total weight below 5 kg have recently gained considerable attention as alternative image capture platforms in agriculture and other horticulture-based applications. Recent technological improvements in image acquisition, camera stabilization, miniaturized optical systems, enhanced payload capacity, complete autonomous navigation and improved the flying performance has resulted in using UAVs as a low cost alternative to the classical manned aerial systems. And when compared to large aerial survey platforms, UAVs are considered to have greater maneuverability, terrain independent and have the ability to be rapidly set up and deployed. While photogrammetry is a relatively old practice of determining the geometric properties of an object directly from a digital image, integrating photogrammetry with the use of UAVs is a relative new approach to agricultural, and in particular, vegetable crop production. Essentially, accurate depth and geometric 3D representation of an object or landscape can be generated from two or more images with overlapping perspectives. Unique crop measurements, contour lines and terrain elevations, hillshade maps, aspect and slope more data can then be extracted through analysis of information contained within the digital elevation model (DEM), digital surface model (DSM), orthomosaic and point cloud creations when generated through photogrammetry. Practical tests with two different systems at several locations revealed that both systems were capable of acquiring images in a systematic manner and were useful in 3D image rendering. The great advantage of utilizing UAV systems is the ability to quickly deliver high temporal and spatial resolution information and to allow a rapid response in a number of critical situations where immediate access to 3D geo-information is crucial. This presentation reports the state of the art of UAV for photogrammetric applications, giving an overview of different UAV platforms, applications and showing the latest developments of UAV post-image processing.

Wednesday, 5 August 2015

*CEU Approved

Germplasm Exchange and the Nagoya Protocol: What Changes Can Plant Breeders Expect?

Sponsor: Intellectual Property Rights (IPR) Working Group

Moderator: Todd P. West; todd.p.west@ndsu.edu

Objective: The objective of this workshop is to familiarize plant breeders and other intested parties on the ramifications of the Convention on Biological Diversity and the Nagoya Protocol on germplasm exchange.

Abstract: The art and science of plant breeding, responding to consumer preference and environmental challenges, requires access to diverse germplasm from around the world. However, the policy landscape governing access to and benefit sharing from the use of genetic resources is increasingly complex. The International Treaty on Plant Genetic Resources for Food and Agriculture, the Nagoya Protocol to the Convention on Biological Diversity, and intellectual property agreements on plant variety protection and patents intersect and are giving rise to new norms of access and terms for benefit sharing from the use of genetic resources. The impact of these agreements on the collection, dissemination and use of germplasm will be discussed. Royalties and non-monetary benefit sharing approaches will be considered as well as challenges for future germplasm collection and use.

8:00–8:20 AM

An Introduction to the Nagoya Protocol

Barbara Campbell*
Cochran, Freund and Young LLC, Denver, CO; barbc@patentlegal.com

8:20–8:40 AM

The Nagoya Protocol and the Plant Treaty: A Practical Perspective to Compliance and the Development of ABS Agreements

Bruce S. Manheim*
WilmerHale Law Firm, Washington, DC; bruce.manheim@wilmerhale.com

8:40–9:00 AM

Understanding the International Plant Treaty and the Nagoya Protocol: An Introduction for Plant Breeders

Jennifer Long*
United States Agency for International Development, Washington, DC; jlong@usaid.gov

International legal requirements for the collection and conservation of genetic resources have changed in recent years. Once considered the common heritage of humanity, genetic resources are now governed by international legal frameworks, which have

shifted ownership of these resources from the global commons to national jurisdiction. Many plant genetic resources for food and agriculture were held in the international collections of the international agricultural research centers (CGIAR) and these were transferred to the Multi-lateral System (MLS) to be held in-trust for the international community. The MLS allows genetic resources of individual crop species, noted in Annex 1 of the International Treaty on Plant Genetic Resources for Food and Agriculture, to be accessed and used per the terms of the Standard Material Transfer Agreement (SMTA), which is essentially a combined MTA and licensing agreement. This multilateral system model contrasts with the bilateral system implemented under the Nagoya Protocol, where terms of access, use and benefit sharing are negotiated on an accession-by-accession basis with the country from where the accession is obtained. Understanding this legal landscape and the implications for access to and use of genetic resources in breeding programs is particularly important for public sector breeders. This presentation will consider practical issues related to germplasm collection and conservation, applied research using genetic resources from outside the United States, and research collaborations with non-US based researchers. In addition, the presentation will cover information resources available to the community to learn more, and provide information on how the research community can engage in shaping the implementation of these agreements to achieve the shared goals of improved conservation and use of genetic resources, and the fair and equitable sharing of benefits from their use.

9:00–9:30 AM
Discussion

Wednesday, 5 August 2015 Nottoway

*CEU Approved

Invasive Plant Management and Restoration: Current Research and Future Challenges

Sponsor: Invasive Plants Research (INPR) Working Group

Moderator: Lyn Gettys; lgettys@ufl.edu

Objective: Objectives of this workshop are to 1) provide approaches for invasive plant management and native plant restoration as developed by researchers and government agencies; 2) present research on how global climate change may impact current management strategies; and 3) Discuss current challenges and future research needs.

Abstract: Non-native (or alien) plant species are commonly introduced into new geographical regions for food, fiber, fuel, medicinal or ornamental use, or are often inadvertently introduced. Regardless of the means of introduction, certain plant species have the ability to outcompete native vegetation and can begin to cause significant ecological damage by displacing native vegetation and wildlife, invading cropland, and impeding waterways. It is estimated that more than $25 billion is spent each year to control over 5,000 invasive plant species in the United States alone. Due to increasing urbanization, water restrictions, and global climate change, there is a growing concern regarding the negative impacts of invasive species on our environment and if current management practices will remain effective in the future. Objectives of this workshop are to present approaches to invasive plant management and how current strategies will need to be altered to meet future challenges.

8:00–8:15 AM
Introduction

Lyn Gettys*
University of Florida, Davie; lgettys@ufl.edu

8:15–8:35 AM
Invasion Pathways for Invasive Aquatic Species: Case Studies from Florida

Lyn Gettys*
University of Florida, Davie; lgettys@ufl.edu

Florida's tropical climate provides a hospitable environment to tourists and exotic species alike because air temperatures rarely dip below freezing for extended periods of time. Bodies of water in Florida are among the most highly invaded aquatic systems in the world owing to their ability to serve as incubators for a wide range of introduced aquatic species. An important issue that is rarely explored is how these invaders reach Florida in the first place. Vectors or introduction pathways for exotic aquatic species are many and diverse—although some non-native species are introduced via natural phenomena such as extreme weather events or movement of fauna, many invaders arrive as a result of anthropogenic actions. To compound the situation, isolated introductions can quickly expand to widespread invasions because the majority of waters in Florida are interconnected. I will outline the events that led to the introduction to Florida of several historically problematic aquatic species, including waterhyacinth (*Eichhornia crassipes*) and hydrilla (*Hydrilla verticillata*). I will also discuss the likely introduction pathways responsible for a number of new invaders, including feathered mosquitofern (*Azolla pinnata*), giant salvinia or kariba-weed (*Salvinia molesta*), rotala (*Rotala rotundifolia*), redroot floater (*Phyllanthus fluitans*), crested floatingheart (*Nymphoides cristata*) and tropical American watergrass (*Luziola subintegra*). A number of these exotic species are federally listed noxious weeds, which in theory should virtually eliminate their movement and introduction, at least by anthropogenic means. In practice, new invaders are routinely discovered in Florida; despite existing legislative prohibitions of their importation and distribution, their presence is often attributed to intentional or

accidental introduction by water garden, aquarium or fish pond owners. It is therefore clear that the most effective strategy to reduce the introduction and spread of invasive aquatic species is through diligent monitoring of waters and increased public awareness of the environmental damage caused by non-native aquatic invasive species.

8:35–8:55 AM

Effect of Substrate Composition and Fertility on Ramet Production in Crested Floatingheart (*Nymphoides cristata*)

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Crested floatingheart is an introduced ornamental water garden plant that has escaped cultivation and invaded waters in the southeastern United States. The species is particularly problematic in the canals of southern Florida and in the Santee Cooper reservoir in the Carolinas, where it has colonized more than 5,000 surface acres. Little is known about the reproductive potential of crested floatingheart, but it appears that most recruitment results from clusters of rhizomes that are colloquially referred to as "ramets." In this study we investigated the effects of substrate composition and fertility on ramet production in crested floatingheart. Single plants were plugged into dishpans filled with one of five substrate mixes that were amended with one of four fertilizer rates and cultured under submersed conditions for 6 months. Analyses of variance 6 months after planting revealed that substrate composition had an early but weak effect on ramet production and that there was no interaction between the main effects of substrate composition and fertility level. However, there is strong evidence that fertility level drives ramet production by crested floatingheart. Ramet production was lowest in plants cultured with 0 g/L of fertilizer and highest in plants cultured with 4 g/L fertilizer. These results suggest that aquatic systems with high levels of sediment nutrients are most likely to experience severe infestations of crested floatingheart.

8:55–9:15 AM

Growth and Control of Invasive Weeds under Elevated CO_2

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Atmospheric concentrations of CO_2 have been increasing since the onset of the industrial revolution. Regardless of the debate on the effects of this rise on climate, most plants exhibit a positive growth response to elevated CO_2 due to increased photosynthesis, resource use efficiency, and/or allocation to belowground structures and weeds are no exception. In fact, the CO_2-induced growth stimulation of several invasive weeds was greater than for any previously examined plant species and many weeds are predicted to become more problematic as CO_2 continues to rise. This raises concerns about how weed control strategies in plant production systems will change in a future, higher CO_2 world. Further complicating this situation is recent evidence suggesting that elevated CO_2 may increase herbicide tolerance in some weeds. This tolerance may be due to an herbicide dilution effect caused by increased growth. Also, changes in weed morphology (e.g., increased leaf thickness) and/or physiology (e.g., decreased stomatal conductance) can alter herbicide uptake, translocation, and overall efficacy. Weed control strategies will be further complicated by the fact that repeated application of herbicides, particularly those with the same modes of action, results in the development of weed populations resistant to herbicidal control and herbicide resistant weed populations are being identified. To date, approximately 235 different weed species have developed resistance to 22 of the 25 known herbicide sites of action and to 155 different herbicides; herbicide resistant weeds have been reported in 82 crops in 65 countries. Determining how weed species will respond to increased levels of CO_2 and the subsequent effect of increased CO_2 on herbicide efficacy on these weeds is critical to our ability to control important weeds and increase productivity and profitability as atmospheric CO_2 continues to rise.

9:15–9:35 AM

An Invasive Species Assessment System for the North Carolina Horticultural Industry

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Wednesday, 5 August 2015

*CEU Approved

The Roots of a Horticultural Revolution

Sponsor: Root Growth & Rhizosphere Dynamics (RHIZ) Working Group

Moderator (s): Astrid Volder; avolder@ucdavis.edu and Arthur Villordon; avillordon@agcenter.lsu.edu

Objectives: 1) Provide an overview of advances in the understanding of the intrinsic and environmental cues of root architecture development. 2) Highlight advances in the study of root architecture & physiology in some horticultural species. 3) Examine current challenges in the study of root development & physiology in horticultural species. 4) Stimulate research collaborations through interactions and networking among the participants.

Abstract: It is becoming increasingly evident that optimization of root architecture for resource capture is vital for enabling the next green revolution. In globally important cereals such as maize and rice, the enhanced knowledge of root architecture has already led to measurable gains in the ability to exploit soil resources with corresponding enhancements in yield attributes. Although cereals provide much needed calories, horticultural crops are essential to human health and food security on a global scale. Yet, knowledge about root architecture in horticultural species is limited and measurement of root growth and root system architecture are often overlooked in horticultural research. The overarching goal of this workshop is to highlight the hidden half of horticultural crops, the root system. One of the goals of this workshop is to provide an overview of advances in model systems, focusing on the adaptive strategies that plant root systems have developed to cope with a variety of environmental stresses. In addition, the workshop will highlight advances in the study of root architecture and physiology in some horticultural species. Understanding how plant roots respond to environmental challenges is critical in the development and testing of tools and practices for modifying plant growth, especially in regions characterized by low input agriculture. Knowledge of the intrinsic signals that mediate root development and affect resource capture will facilitate the development of crop varieties that are tolerant to a range of growing environments.

8:00–8:20 AM

Development of an Aeroponics System to Facilitate Investigations into the Development of Entire Sweetpotato Root Systems

Arthur Villordon*
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The study of plant root biology has traditionally lagged behind compared to stems, leaves, flowers or fruits. Traditional methods for measuring roots grown in soil such as washing and root tracing are destructive and time consuming. Alternative approaches like the use of observation windows and rhizotrons typically underestimate some root growth parameters. Recent advances in imaging technologies have enabled the non-destructive measurement of root development but are currently cost-prohibitive and generally inaccessible to the broader scientific community. Another method is the use of aeroponics, where plant roots are fully accessible through the growth cycle, and can be fully recovered for harvesting. In this presentation, we describe ongoing work to develop an aeroponics growth system for facilitating observations of developing sweetpotato root systems and for enabling storage root formation. One of the goals of the work is to facilitate investigations into elucidating the role of genotypes in determining root system developmental responses to the presence or absence of specific nutrients. Results from ongoing work will increase our understanding of how nutritional cues influence sweetpotato root system development and storage root formation. Such knowledge has the potential direct agricultural applications through the identification and evaluation of management practices that optimize fertilizer recommendations.

8:20–8:40 AM

Root Production, Distribution, and Turnover in Conventional and Organic Blueberry Systems

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Northern highbush blueberry is a shallow-rooted crop with very fine, fibrous roots. Recently, we installed minirhizotrons (root observation tubes) in a conventional and an organic blueberry planting in western Oregon. We wanted to know exactly when and where new roots were being produced and to determine whether different fertilizer and weed management practices were affecting root production and turnover. At both sites, root production peaked once in mid- to late May, about a month prior to harvest, and again in September, about a month before dormancy each year. Most roots were located < 30 cm deep and averaged only 20–75 μm in diameter. In general, plants produced more roots in raised beds than in flat ground, with sawdust mulch than with weed mat, with granular fertilizer than with fertigation, and with no or lower rates than with higher rates of fertilizer. Plants on raised beds and grown with no or low rates of fertilizer also produced deeper roots. The average median lifespan of the fine roots was 115–135 d, but roots survived an average of 60 d longer with fertigation than with granular fertilizer. Overall, timing of root production in blueberry appears to be highly dependent on temperature, shoot growth, and fruit development, while total root production and lifespan are mostly affected by the availability of soil water and nutrients. Practices such as raised beds, sawdust mulch, and reduced fertilizer rates can be used to increase root production, while fertigation may reduce plant carbon costs associated with root turnover.

8:40–9:00 AM

Root Distribution and Its Representation for Quantifying Plant Water Uptake: An Applied Perspective

Xuejun Dong*
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Plant roots are a central figure regulating various processes in the rhizosphere. The function of roots and its ecological consequences pervade a wide range of disciplines including forage, horticultural and crop sciences. A perennial obstacle to understanding comes from the hidden nature of plant roots. This may to some extent be alleviated by new development in root imaging technologies. But it is extremely difficult to fully validate some of the intriguing and huge information provided by today's phenotyping tools. Yet, accurate knowledge of roots and their function in the rhizosphere is central to the solution of today's leading agricultural problems, such as feeding a growing world population while minimizing pollution to soils and waters. This poses tremendous pressures for scientists to come up with approximation solutions based on incomplete information and knowledge gaps. In soil-plant water relations problems, this naturally requires integrating simulation models with experimental measurements. Despite the rapid standardization of the leading methods describing soil-plant system water follow, one aspect that has subtle and practical consequences but is still not sufficiently appreciated in applications, is the representation of root distribution and its linkage with the soil water flow mechanisms. In this paper, I will review several major forms of root functions as used widely in soil-plant water flow problems and compare the consequences of their respective uses for sensitively describing root water uptake response to local soil dryness, which is important for plant breeding and effective field testing. As a case study, four types of root distribution function (linear, exponential, asymptotic and polynomial), with and without uptake compensation, will be discussed in a native prairie (central North Dakota) and a winter wheat crop (southwest Texas). The case study will demonstrate the usefulness of different root distribution functions in varying soil types and their effectiveness in characterizing plant water use patterns for drought stress adaptation.

9:00–9:20 AM

Identification of Landscape Plant Species for Use in Rain Gardens

Amy Wright*
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As urbanization increases, so does the volume of stormwater runoff entering native waterways. This runoff often carries excess nutrients and other pollutants, and the volume may overwhelm natural waterway capacities. Rain gardens are a Low Impact Development (LID) strategy that can be used to trap and filter runoff. Proper plant selection is critical for the success of rain gardens since they absorb water and nutrients and provide aesthetic value to a functional garden. Although many recommendations for rain garden plant species exist, few have actually been critically evaluated for tolerance of the fluctuations in hydrology that occur in a rain garden. Plants in a rain garden may experience inundation for up to 48 hours followed by long periods with no additional irrigation. By exposing plants to repeated flood-drain cycles in a controlled environment, it is possibly to identify plants suitable for use in rain gardens. Previous and current research has directly identified three grasses, four evergreen shrubs, five deciduous shrubs, and two herbaceous perennials that are tolerant of expected rain garden conditions. Conversely, research identified two species that were not tolerant despite appearing on many recommended lists. Plants tolerant of rain garden conditions typically have vigorous root growth and often can adjust root system architecture to minimize effects of inundation. Additionally, plants with larger root systems at the time of planting are more likely to establish and survive in these conditions. Although plants often exhibit reduced canopy dimensions when flooded, visual quality is typically not compromised. Finally, it does not appear that exposure to flooding during production imparts any additional flooding tolerance once in the landscape.

9:20–9:40 AM

Patterns of Root Production in Tree Crops in Response to Environmental Variation

Astrid Volder*
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Fine root production and turnover data for a range of tree crops will be reviewed, as well as potential implications for water and nutrient acquisition. Seasonal patterns of fine root production varied by species and soil depth, showing that the commonly held perception that roots are predominantly produced in Spring and Fall is not a universal pattern across species. More detailed case studies will show the impacts of N fertilization rates on young pecan root growth and survival during establishment, as well the impacts of ongoing irrigation experiments on almond root traits and root production. Outcomes of these studies will be linked to potential management recommendations.

Wednesday, 5 August 2015 Maurepas

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Soil Health and Implication in Organic Nutrient Management on Vegetable Production

Sponsor: Organic Horticulture (ORGH) Working Group

Coordinator: Monica Ozores-Hampton; ozores@ufl.edu

Objective: The workshop will present information on the interactions of soil health, nutrient management and BMPs in organic vegetable production

Abstract: The organic vegetable industry is familiar with production practices aimed to improve the health and function of the soil. Soil health is defined as continued capacity of the

soil to function as a vital living ecosystem that sustains plants, animals, and humans. The definition implies the management of the soil to provide food, shelter and water for future generations. The most common indicators of soil health include soil physical, chemical and biological properties. However, with the adoption of best management practices (BMPs), improving soil health while optimizing nutrient management in order to minimize the nutrients movement out of the root zone and reduce the environmental impact can be challenging in organic production. Best management practices, including cover crops, compost, and other soil amendments are non-regulatory, incentive-based cultural practices intended to reduce or prevent nutrient loss into the watersheds while maintaining agricultural productivity and profitability. Therefore, objective of the workshop is to present information on the interactions of soil health, nutrient management and BMPs in organic vegetable production.

8:00–8:30 AM

Can Organic or Conventional Vegetables be Produced Sustainably without Cover Crops?

Eric Brennan*
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Vegetable and fruit consumption patterns in the United States show that most people need to eat far more fruits and vegetables to meet the current nutritional guidelines for a healthy diet. Recent analyses suggest that following these guidelines would require a 50% increase in the acreage devoted to these crops. But this could have serious environmental implications if unsustainable production practices are used, and this situation will likely intensify with population growth and climate change. Cover cropping is well recognized as a "best management practice" in vegetable production systems because cover crops can provide a variety of ecosystem services (nutrient cycling, pest suppression, soil improvement, erosion control, etc.). However, cover cropping is still relatively uncommon in many of the most important vegetable production regions in the United States. Are these systems without cover crops sustainable and if not, could cover crops change this? Should cover crops be required in vegetable production systems? If most vegetable growers used cover crops, how would this affect the supply and cost of vegetables, the amount of land and other resources needed to meet the demand for in major vegetable production regions? Such a radical change in major vegetable production regions of the United States could potentially have ripple effects throughout the country. This interactive presentation will draw from short and long-term research with cover crops in high-value vegetable production in Salinas, California, and on the results of recent surveys of cover cropping experts in the United States. It will highlight some major challenges and benefits with cover cropping in organic and conventional systems, and address some critically important and difficult questions that impact human and environmental health.

8:30–9:00 AM

Compost Quality Guidelines for Organic Vegetable Production

Monica Ozores-Hampton*
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The success of long-term Florida organic vegetable production and maintenance of environmental quality will dependent on soil health and quality. Compost is, primarily, a soil amending product that may improve soil quality and enhance nutrient use efficiency, thus improving the productivity of organic vegetable crops. When considering the use of compost, it is valuable to ask what is the main purpose of the compost application? Compost can be applied as soil conditioner which will increase soil organic matter, improve structure, stimulate biological activity, reduce bulk density, improve water use efficiency, etc. Compost can be applied as nutrient source and although the contribution of nutrients such as phosphorous (P), potassium (K) and micronutrients may be low, it needs to be calculated. Even when compost is not relied on as a nutrient source, its nutrient contribution should be calculated and accounted in the fertility program. Guidelines for the use of compost are still limited or non-comprehensive in addressing all the potential positive and negative effects of compost application in organic vegetable production. Therefore, objective of this presentation will be to present guidelines for the assessment of compost quality, considering physical, chemical and biological properties in order to promote the positive effects of compost on the soil-crop system and minimize any potential negative impact on organic vegetable production.

9:00–9:30 AM

Organic Fertilizers for Greenhouse Crop Production

Mary Rogers*
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Additional Authors:
Liz Perkus, Justin Carlson, Carl Rosen, Mary Rogers, Julie Grossman, Joanne Slavin, John Erwin

Organic, locally produced fruit and vegetables are in demand and greenhouse production can improve quality of produce, meet consumer needs, and increase grower profitability. This is of particular interest in northern climates with a narrow window for field production. Organic fertility amendments require some microbial breakdown before nutrients become available. There is much research on organic fertility in field production systems but less in greenhouse settings, leaving growers without recommendation and guidelines. From a production and environmental standpoint, we need to increase our understanding of microbial breakdown rates and nutrient mineralization from organic fertilizers for containerized fruit and vegetable crops in greenhouses and how this impacts plant growth and crop quality. Our research shows a crop x fertilizer response to commonly available organic fertility sources and will result in crop-specific recommendations for greenhouse producers.

9:30–10:00 AM

Effect of Long Term Compost Application in a Certified Organic System on Soil Quality and Vegetable Yields

Sven Verlinden*
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Additional Authors
Louis McDonald, William Bryan, James Kotcon, Silas Childs, Todd Childers

In 1999, West Virginia University, established an organic farming systems project with an agronomic, animal and horticulture component. The organic farm became certified organic in 2002 and has been operated under organic certification for the past 13 years. In the market garden section of the 63-acre farm, 32 plots measuring 5 meters by 15 meters were established. Sixteen of these plots were managed as high input and sixteen as low input plots. High input plots received 22 tons of composted dairy manure per hectare and a rye-vetch cover crop during each winter season since the inception of the farming systems. Fertility in low input plots was managed solely with a rye-vetch cover crop. A four-year rotation of legumes, cucurbits, solanaceous, and leafy crops was established in 1999 and has been maintained ever since. Soil organic matter in the top 15 cm of the soil profile has remained unchanged in low input plots at 5.2% in 2004 to 5.4% in 2014. Dramatic increases in soil organic matter from 6.4% in 2004 to 8.7% in 2014 were observed. Over this period yearly compost application improved yields by 22% in all crops combined, however individual crops responded quite differently. Peas only showed a yield gain of 4% in high versus low input plots, whereas pumpkin yield was increased by 57% in high input plots when compared to low input plots. The yield was 11%, 15%, 18%, 23%, and 25% higher in high input plots than for low input for tomato, peppers, zucchini, green beans, and lettuce respectively. Additional data from concurrent experiments with differing rates of compost (11 to 88 ton per hectare) showed that over-application (more than 22 tons of composted dairy manure per hectare) can lead to nutrient leaching and phosphorus build up in soils, despite incremental improvements in yield.

Wednesday, 5 August 2015

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Document the Impact of Your Research, Teaching, or Extension Activity

Sponsor: Floriculture (FLOR) Working Group

Moderator: Kimberly Moore; klock@ufl.edu

Objective: The goal of this workshop is to assist participants in writing meaningful statements describing the impact their work.

Abstract: Increasingly, impact statements are an expectation for publically funded work. While they allow us to describe our work using powerful, succinct language, many of us struggle to write impact statements. In this workshop, our presenters will provide key concepts and approaches to documenting impacts. Participants should bring draft impact statements to the workshop. They will work with the presenters and other participants to strengthen their impact statements based on workshop content. All of the participants will leave the workshop with more focused and clear statements describing the impact of their work.

8:00–8:15 AM

Getting the Most out of Your Impact Statements

John Dole*
North Carolina State University, Raleigh; john_dole@ncsu.edu

8:15–8:30 AM

Document the Value of the Public Investment in Your Research

Linda Brewer*
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8:30–8:45 AM

Kiss: Keep Impact Statements Simple

Marc van Iersel*
University of Georgia, Athens; mvanier@uga.edu

8:45–9:00 AM

Understanding Your Audience—What to Include in Impact Statements for NIFA

Megan O'Reilly*
USDA–NIFA, Washington, DC; moreilly@nifa.usda.gov

9:00–9:15 AM

Impact Statement Writing Workshop

Wednesday, 5 August 2015 Bayside C

*CEU Approved

Unique and Alternative Fruit Crops

Sponsor: Viticulture and Small Fruits (VSF) Working Group

Moderator: Lisa Wasko DeVetter; lisa.devetter@wsu.edu

Objective: The objective of this workshop is to provide information about unique/alternative fruit crops that researchers and extension personnel are being increasingly asked about.

Abstract: This workshop will introduce several unique and alternative fruit crops that are increasingly being encountered among researchers and extension personnel. The purpose of this workshop is to provide information about the production and relevant physiology of these specific fruit crops so that researchers and extension personnel are better able to address questions concerning these crops. Specific crops to be addressed include: hardy kiwi (*Actinidia arguta*), haskap (*Lonicera caerulea*), unique caneberry species (*Rubus glaucus*, *R. coreanus*, and/or

R. phoenicolasius), and continental-climate grapes (*Vitis* spp.).

8:00–8:30 AM

Cold-Climate Wine and Table Grapes

James Luby*
University of Minnesota, St Paul; lubyx001@umn.edu

8:30–9:00 AM

Unique Caneberries

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

9:00–9:30 AM

Haskap

Eric Gerbrandt*
University of Fraser Valley, Abbotsford; ericgerbrandt@hotmail.com

9:30–10:00 AM

Hardy Kiwi

Iago Hale*
University of New Hampshire, Durham; iago.hale@unh.edu

Wednesday, 5 August 2015

*CEU Approved

An Overview of the NEW eXtension, and How to Evaluate Your Online Extension Program

Sponsor: eXtension (EEXT) Working Group

Moderator: Danielle Treadwell; ddtreadw@ufl.edu

Objective: The objectives of this workshop are to learn about the new opportunities eXtension will be offering to land grant faculty, and to build a toolbox of evaluation strategies for online extension programs.

Abstract: eXtension has recently re-evaluated its role and is positioning itself to better respond to the changing needs and priorities of land-grant faculty and staff and the clientele they serve. The NEW eXtension is advancing exceptional, technology-enhanced learning environments while building on the Cooperative Extension System's content, educator, and leadership resources. Today, eXtension is an innovative place for Extension educators and strategic partners to marry content with technology that appeals to and attracts new audiences to Cooperative Extension. Online extension programming is an important strategy for many extension specialists, and is utilized to improve clientele access to important information and to provide visual and audio enhancements to the learning environment. Evaluation is important and necessary in extension programming, but program evaluation for online programs presents several challenges: spatial and temporal distance from the target audience; difficulty in confirming the program's impact on participants; and the lack of established methodologies for measuring the value of the program to the public. The objectives of this workshop are to learn about the new opportunities eXtension will be offering to land grant faculty, and to build a toolbox of evaluation strategies for your online extension program. This workshop will be particularly important for members and leaders of eXtension Communities of Practice and Learning Networks and for all faculty with Extension programs online.

10:15–10:45 AM

An Overview of the NEW eXtension, and How to Evaluate Your Online Extension Program

Terry Meisenbach*
eXtension, Rancho Mirage, CA; Terry.Meisenbach@extension.org

Sarah Baughman
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Danielle Treadwell
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eXtension has recently re-evaluated its role and is positioning itself to better respond to the changing needs and priorities of land-grant faculty and staff and the clientele they serve. The NEW eXtension is advancing exceptional, technology-enhanced learning environments while building on the Cooperative Extension System's content, educator, and leadership resources. Today, eXtension is an innovative place for Extension educators and strategic partners to marry content with technology that appeals to and attracts new audiences to Cooperative Extension. Online extension programming is an important strategy for many extension specialists, and is utilized to improve clientele access to important information and to provide visual and audio enhancements to the learning environment. Evaluation is a critical component of extension programming, but evaluating for online programs presents several challenges: spatial and temporal distance from the target audience; difficulty in confirming the program's impact on participants; and the lack of established methodologies for measuring the value of the program to the public. Based on the work of the Military Families Learning Network (MFLN) participants will explore options for evaluating online educational programming including social media. The MFLN, initially an eXtension project, provides online professional development for military service professionals.

10:45–11:15 AM

Evaluating Online Educational Programming for the Military Families Learning Network

Sarah Baughman*
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Wednesday, 5 August 2015

*CEU Approved

Reducing Postharvest Losses: Historical Perspective and Emerging Technologies

Sponsor: Postharvest (PH) Working Group

Moderator: J. Wyatt Brown; wbrown@calpoly.edu

Objective: To discuss postharvest losses in the context of historical and current practices, to present emerging technologies to reduce such losses in both developing and developed nations, and to discuss methods to facilitate the adoption of these technologies.

Abstract: Postharvest losses in developing and developed nations can be significant, commonly representing a loss of 10-40% of the harvested product. Losses occur through mishandling, insufficient cooling, poor storage and temperature management, and lack of infrastructure to get products to market in a timely fashion. Decreasing postharvest losses is often a first step to increased economic returns, especially in areas with limited resources. This workshop will discuss: 1) historical postharvest methods to reduce produce losses—their benefits and shortcomings; 2) emerging technologies for both developed and developing nations, including cooling and transportation; and 3) methods to increase the adoption of new technologies and practices, including education and the linking of farmers to both local and international markets.

10:15–10:40 AM

Postharvest Losses: An Overview

J. Wyatt Brown*
California Polytechnic, San Luis Obispo; wbrown@calpoly.edu

10:40–11:05 AM

Postharvest Losses: Emerging Technologies to Mitigate

Chris Watkins*
Cornell University, Ithaca, NY; chris.watkins@cornell.edu

11:05–11:30 AM

Postharvest Losses: Appropriate Mitigation Strategies in the Developing World

Elizabeth Mitcham*
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Wednesday, 5 August 2015

*CEU Approved

Developing, Producing, and Commercializing Bioenergy Crops and Technologies

Sponsor: Bioenergy (BioE) Working Group

Moderator: Thomas Ranney; tom_ranney@ncsu.edu

Objective: The objective of the workshop are to explore progress and opportunities in developing, producing, and commercializing new crops and technologies for emerging bioenergy sectors.

Abstract: Success of emerging bioenergy industries hinge on the simultaneous development and management of an entire supply chain ranging from crops to bioprocessing, on a substantial scale. Crop improvement, production, bioprocessing, and development of novel value-added technologies all play important roles in the efficiency, feasibility and profitability of the entire endeavor. Moreover, there is considerable interdependence among all of the various components, disciplines, and constituents in the supply chain. This workshop will take a broad view to explore progress, challenges, and opportunities facing the future of bioenergy.

10:15–10:30 AM

Breeding Cold-hardy Energy Grasses

Darren Touchell*
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Thomas Ranney
North Carolina State University, Dept. of Horticultural Science, Mills River; tom_ranney@ncsu.edu

Perennial grasses have considerable potential as bioenergy crops. However, high-yielding, subtropical/tropical perennial grasses like conventional sugarcane (*Saccharum officinarum*) and energy canes (mostly *Saccharum spontaneum* hybrids), lack adequate cold hardness to be grown as dedicated energy crops throughout most of the temperate US. Miscanthus (*Miscanthus* spp.) are promising bioenergy crops that can be grown in temperate regions. However, there have been limited breeding and development efforts to improve and domesticate these crops. The original *Miscanthus* ×*giganteus* was a natural occurring, highly infertile allotriploid ($2n = 3x = 57$) hybrid between a tetraploid *M. sacchariflorus* ($2n = 4x = 76$) and a diploid *Miscanthus sinensis* ($2n = 2x = 38$). This clone has high biomass yields, but limited genetic diversity. Allohexaploids of *M.* ×*giganteus* were developed through oryzalin-mediated chromosome doubling to restore fertility. These fertile hybrids were crossed with diploid *M.* spp. to develop new fertile allotetraploid breeding lines and advanced to F_2 populations. Improved allotetraploids were then crossed with selected diploids. Embryo culture was used to produce new triploid hybrids with broader genetic diversity. These initial breeding efforts have also shown considerable improvement in biomass yield and should provide improved bioenergy feedstocks for temperate regions.

10:30–11:00 AM

High-fiber Sugarcane Breeding and Production for use as Bioenergy Feedstock

Anna Hale*
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Paul White
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11:00–11:15 AM

Survey of Fungal Diseases of Switchgrass Seed and Plants

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Progress on development of switchgrass as a dedicated biofuels crop has progressed rapidly in the past few years. Production of switchgrass in large monoculture acreages will increase the risk of plant disease, and the need for development of sustainable disease management practices. We have conducted surveys of commercial switchgrass seed from across the United States, and from field plants in Tennessee for fungal pathogens. Infection rates among seed lots ranged from less than 1% to 87%. Our studies have revealed several seedborne and soilborne fungal pathogens. These include *Alternaria alternata*, *Bipolaris oryzae*, *B. sorokiniana*, *B. spicifera*, *B. victoriae*, *Curvularia lunata* var. *aeria*, *Fusarium acuminatum*, *F. armeniacum*, *F. equiseti*, *F. graminearum*, *F. tricinctum, Phoma herbicola*, *Pithomyces chartarum*, and *Sclerotinia homoeocarpa*. Koch's postulates were completed for these pathogens to confirm pathogenicity on switchgrass. Many of these fungi are known to cause disease and economic losses in related crops, such as corn, oats, rice, sorghum, wheat, and turf grass. Although these fungi vary in their ability to reduce biomass when inoculated onto mature plants, many can cause significant losses in stand count when applied to seed.

11:15–11:45 AM

Sugar Crops for Biofuel/Bioproduct Production

Donal Day*
LSU AgCenter, St. Gabriel, LA; DDay@agcenter.lsu.edu

A USDA-funded grant to the LSU AgCenter program to develop crops that can be used for biofuel production across the Southern United States to supply significant quantities of feedstocks for the next generation biofuel/bioproduct industries also offered the opportunity to improve local farm incomes, create manufacturing jobs as well. This program, directed by the LSU AgCenter, is a multi-researcher, multi-unit program that utilizes a wide variety of talents to develop new crops that can be produced sustainably and the technologies to locally convert them to fermentable sugars and biomass. The major constraints on the chosen crops were the ability to tolerate the wide variety of climatic conditions that exist between North and South Louisiana and the need for staggered harvest schedules such that crops can be delivered continuously to processing facilities over a major portion of a year. Two crops, similar in structure and containing fermentable sugars, energycane and sweet sorghum, were chosen for development. Energycane is a variant of sugarcane, which is high in fiber and low in sugar containing juice and sweet sorghum, a relative of grain sorghum, which produces less seed and also contains a sugar juice. Energycane is a perennial crop and sweet sorghum is an annual crop. Both crops can be harvested and processed in a manner similar to sugarcane. The fermentable sugars present in these juices could support rapid development for biofuel or any fermentation based bioproduct, with lignocellulosic sugars phasing in as conversion technologies develops. The two chosen crops appear to be productive on marginal or underutilized land such that they won't impact current crops. We are now in a position to answer key questions as to the utility of these crops as biofuel feedstocks. Processing of these crops post- harvest, using standard technologies, produces sugar syrups which are storable and contain high contents of fermentable sugars and biomass. The biomass is suitable both for power generation and can be converted to fermentable sugars using technologies that have been developed for converting corn stover to fermentable sugars. The value of these syrup sugars should be competitive with the value of sugars in sugarcane molasses.

11:45 AM–12:15 PM

Engineering High Biomass C4 Grasses for Production of Polyhydroxyalkanoate Biodegradable Plastics

Stevens Brumbley*
University of North Texas, Denton; Stevens.Brumbley@unt.edu

Wednesday, 5 August 2015

National Issues Workshop: Our Responsibility As AFRI and SCRI Stakeholders

Sponsor: ASHS National Issues Committee

Coordinator: Thomas Björkman; tnb1@cornell.edu

Objective: Help sustain the critical role of AFRI and SCRI in keeping horticulture funded by providing constructive stakeholder comment on the requests for proposals through the most effecctive channels.

Abstract: Many ASHS members depend on funding from the NIFA programs AFRI and SCRI. Keeping these programs effective is critical to our discipline. One responsibility we have, but need to execute better, is to provide constructive stakeholder comment on the requests for proposals. Those comments are due shortly after the New Orleans conference, so priority issues identified in this workshop can have an immediate impact. This workshop is a structured discussion where audience input is essential in order to identify common concerns. These programs are supporting excellent horticultural research, so identifying priorities and policies that need to stay is primary. The agency has recently made policy changes in response to stakeholder input, so feedback on whether those are having the desired effect is timely. Finally, are the horticultural needs and opportunities of importance in the coming three years that should be more explicitly addressed in future requests for proposals?

10:15–10:30 AM

The Role of Stakeholder Feedback in NIFA Programs

Mary Peet*
USDA–NIFA, Washington, DC; mpeet@nifa.usda.gov

10:30–10:45 AM

How SCRI Has Used Stakeholder Feedback

Tom Bewick*
USDA–NIFA, Washington, DC; tbewick@nifa.usda.gov

10:45–11:00 AM

Effect of Funding Policies on Academic Horticultural Research Capacity

Richard Marini*
The Pennsylvania State University, University Park; rpm12@psu.edu

11:00 AM–12:15 PM

Our Role Helping AFRI and SCRI Keep Horticultural Research Vibrant

Thomas Björkman*
Cornell University, Geneva, NY; tnb1@cornell.edu

Wednesday, 5 August 2015

*CEU Approved

Horticultural Demonstration Initiatives: Lessons Learned from Successful Partnerships

Sponsor: Tropical Horticultural Crops (TROP) Working Group

Moderators: Rammohan Uckoo; rammohanuckoo@yahoo.com and Shad Nelson; shad.nelson@tamuk.edu

Objective: This workshop will discuss and showcase: a) some of the case studies of successful partnerships of university and industry to effectively integrate and work toward expanding the mission of land grant system; and b) bhe challenges and opportunities of establishing such.

Abstract: Promoting innovations and educating horticulture at the grass roots through an integrated industry and land grant university system has existed for several decades. However, developing viable partnerships is the need of the hour. The collaborations help address specific problems, exchange innovative ideas and provide rapid means of dissemination of discovered sciences. These strategic partnerships also provide an excellent opportunity to the academicians, scientists, producers, industry personnel and students to nurture both their scientific as well as leadership skills.

2:00–2:30 PM

Improving Orchards Irrigation Management Practices at the On-farm Level: A Ten-year Case Study of Collaboration between Scientists and Citrus Producers

Shad Nelson*
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Catherine Simpson
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Juan Carlos Melgar
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Mamoudou Setamou
Texas A&M University, Kingsville Citrus Center, Weslaco; Mamoudou.Setamou@tamuk.edu

The Lower Rio Grande Valley (LRGV) of South Texas is the citrus producing region of the state and is known for its high value, deep red colored grapefruit crop varieties. The majority of citrus groves are irrigated using traditional flood irrigation practices stemming from water supplies along the Rio Grande River that border the United States and Mexico. During peri-

ods of extensive drought, the reservoirs along the Rio Grande become depleted to the point that water restrictions are placed on all growers. This is an extreme challenge for citrus producers in general, because deciding not to irrigate citrus trees is not an option to sustain such a perennial crop and keep trees in good health. Over 90% of citrus in the LRGV is irrigated using large-pan flood (TFd) irrigation practices, with little incentive for growers to change to a more conservative irrigation practices due to low water pricing. The Texas Water Development Board invested funds for a 10-year (2004–14) study for the purpose of evaluating on-farm irrigation practices with hopes of finding potential irrigation alternatives that can be employed by growers that are cost effective and allow citrus producers to be prepared for future drought years. The outcome of this 10-year collaborative effort between scientists and citrus growers show water savings for alternative irrigation methods such as drip, micro-jet sprinkers, and border flood (BFd) irrigation that channels water faster down the tree row. It was found that BFd irrigation use had similar water savings to that of drip and micro-jet sprinklers. Besides saving 36% of water using BFd when compared to TFd, the BFd irrigation method produced the highest percentage of fresh-market fruit in the larger grapefruit size class resulting in the highest economic benefit to the growers.

2:30–3:00 PM

Gulf Coast Landscape Horticulture Research Gardens—A New LSU AgCenter Industry/ University Partnership

Allen D. Owings*
Louisiana State University, Hammond; aowings@agcenter.lsu.edu

Land grant university research gardens for landscape horticulture plant trials are not a new concept. Over the past 10 years in the southeastern United States, there has been renewed interest in expanding these plant trials, however, beyond what is traditional done with seasonal bedding plants. A Landscape Horticulture Research and Extension Center, housed at the LSU AgCenter's Hammond Research Station, Hammond, LA, was initiated in 2004 under the leadership of then recently appointed station superintendent and research horticulturist Regina Bracy. Prior to this change in the station mission, efforts at Hammond since horticulture programming inception in 1922 had been primarily fruit and vegetable work with secondary work in ornamentals and other specialty crops. Gardens at the station include a sun garden, shade garden, care and maintenance area, azalea garden, piney woods garden, low care rose garden, crape myrtle garden, field production and evaluation garden, urban forest area and camellia garden. Most gardens have raised beds with irrigation and pine straw mulch. Plant trials conducted include warm season annuals, cool season annuals, herbaceous perennials, ornamental grasses, tropical/sub-tropicals, new flowering shrubs, new trees, an extensive collection of new crape myrtles and more. Data from some bedding plant trials at the Louisiana State University (LSU) AgCenter is now being coordinated with 35 additional sites (24 university related) in the North America via the National Plant Trials Database (www.planttrials.org). Cooperative effort is on-going with many national nursery companies such as Greenleaf Nursery, Bailey Nursery, Ball Horticulture, Conard-Pyle / Star Roses, Plant Development Services, Inc. We also have close partnership with similar university efforts in neighboring and nearby states Mississippi State University, University of Florida/IFAS Quincy and Stephen F. Austin State University Gardens, Nacogdoches, TX. In-state nurseries are also involved in cooperative efforts with plant trials at the station. Consumer, master gardener and industry people's choice (plant favorites) are voted on at meetings and field days. In the future, plants of distinction will be introduced at the LSU AgCenter's annual landscape industry day in the spring. Funding for efforts comes from the specialty crop competiveness block grant program, Louisiana Nursery and Landscape Foundation for Scholarship and Research, nursery financial and in-kind contributions, master gardener society donations, urban forestry funds, urban/wildland interface grants, and firewise landscaping grants. Industry events at the station include a spring industry day and lecture series, landscape pest management workshops, a fall landscape industry field day, Ball Horticulture University, Louisiana Plant Materials Conference, and more.

3:00–3:30 PM

Application of Appropriate Postharvest Technologies to Benefit the Sweetpotato Industry

David Picha*
Lousiana State University Agricultural Center, Baton Rouge; dpicha@agcenter.lsu.edu

The application of appropriate postharvest technologies is required to provide consistent supplies of high quality fresh market and processed sweetpotato products to meet increasing domestic and international market demand. Strong year-round interest in a diversity of fresh and value-added sweetpotato products requires a better understanding of the postharvest physiology of the roots, coupled with the utilization of proper temperature and storage atmosphere management. Long-term storage is necessary for sweetpotato producers to maintain their domestic market position over extended periods of time. The export market is also an expanding segment of the U.S. sweetpotato industry, with Canada and the United Kingdom being the leading international market destinations. Strong partnerships between universities and the private sector have been established to strengthen the growth of the U.S. sweetpotato industry. An increasingly diverse market for processed and value-added sweetpotato products may require different postharvest technology strategies for different products. Regulation of the storage temperature and atmospheric composition allows for manipulation of sweetpotato carbohydrate metabolism, product flavor, and quality. Individual sugar concentrations in sweetpotato roots can be significantly altered by temperature and atmospheric oxygen concentration during curing and storage. Significant increases in sucrose content, the principal sugar in raw roots, occur in sweetpotatoes with decreasing storage temperatures. Increases in the two main monosaccharides, fructose and glucose, also

occur with decreasing storage temperature, but to a lesser degree than sucrose. Low atmospheric oxygen concentration during curing and storage enhances sucrose synthesis, but diminishes the synthesis of fructose and glucose. The future for domestic market growth and export market expansion for U.S. sweetpotato products remains bright. Strong research and extension programs covering the entire sweetpotato supply chain, coupled with significant private sector investment in new product development and marketing has continued to advance the sweetpotato industry forward. Utilization of microwavable films to wrap individual roots is an increasingly popular packaging technology, which has been adopted to add value and preparation convenience to sweetpotato roots in the retail market sector. Advancements and adoption of appropriate postharvest technologies will allow for year-round supplies of high quality fresh market and processed product forms of sweetpotatoes that will continue to strengthen the industry.

3:30–4:00 PM

On-Farm Demonstrations of Novel Planting Strategies: Working with Growers to Optimize Soil Environments, Reduce Water Loss, and Manage Pests and Diseases

Catherine Simpson*
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Shima Chaudhary
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Mamoudou Setamou
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Citrus production in Texas is primarily located in the four southernmost counties in close proximity to the Mexican border in the Lower Rio Grande Valley (LRGV). The majority of fruit produced in this region is a variety of deep red grapefruit that is destined for the fresh market. The LRGV has a subtropical climate and calcareous soils ideal for producing sweet, red grapefruit; however, the industry is faced with many unique challenges associated with citrus production. In 2009 we were challenged to manage a devastating pest, the root weevil (*Diaprepes abbreviatus*) combined with *Phytophthora spp*. that invades damaged roots, while maintaining crop production and optimizing water use in a time of extreme drought. To address these issues we developed a promising planting strategy that interrupts the life cycle of the root weevil, effectively controlling populations and minimizing the risk of *Phytophthora* infection to roots, while providing optimal soil environmental conditions for plant growth and production. Using a plastic mulch groundcover on young citrus trees planted on raised beds resulted in reduced water lost from the soil surface and maintaining water lower in the soil profile where roots occur, elevating soil temperatures while diminishing *Diaprepes* populations. When compared to the traditional planting strategy of flatbed production without groundcover, we found that this novel strategy increased plant height, trunk diameter and canopy perimeter. We also found that there were a significantly lower number of *Phytophthora* propagules found in soil samples collected under the canopy of citrus trees in raised beds compared to those on flat soil. Working in concert with a local citrus producer, a demonstration site has been established to exhibit these strategies and promote water savings and pest management at the on-farm level.

Wednesday, 5 August 2015

Student Career Workshop: Speed-dating on Career Options, 3rd Edition

Sponsor: Industry Division

Moderator: Angela Davis; angela.davis@hmclause.com

Objective: 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.

Abstract: 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. In addition to a quick Q&A, students can take time afterward to mingle and discuss career ideas with the speakers.

4:00–4:15 PM

Presentation #1

Fred Hulme*
Everris US, fred.hulme@everris.us.com

4:15–4:30 PM

Presentation #2

Angela Davis*
Harris Moran Seed Co., Davis, CA; angela.davis@hmclause.com

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

4:30–4:45 PM

Presentation #3

Rakesh Kumar*
Syngenta; rakesh.kumar@syngenta.com

4:45–5:00 PM

Presentation #4

Tamiko Gaines*
HM.Clause; t.gaines@hmclause.com

5:00–5:15 PM

Presentation #5

Jeffrey Norrie*
Acadian Seaplants Limited, Dartmouth, NS; jnorrie@acadian.ca

5:15–5:30 PM

Presentation #6

Steven Millett*
Hort Americas

Wednesday, 5 August 2015

*CEU Approved

Fresh Produce in the City: A Workshop and Tour

Sponsor: Local Food Systems (LOCSYS) Working Group

Moderator: Carl Motsenbocker; cmots@lsu.edu

Objective: Both the workshop and the tour are designed with the underlying objective of bringing together interested ASHS members and leveraging their interest and expertise in bringing fresh produce to urban and other underserved locations now and in the future.

Abstract: One of the nation's most important movements related to horticulture is the urban farming movement and access to fresh produce in underserved and other urban environments. These movements are huge opportunities for horticulture and related sciences to simultaneously serve the sciences and the local and global society. Efforts to study, develop, and support these movements include partners from both private and public institutions, individuals, communities, industries, schools, and faith-based institutions throughout the country. Starting with an introduction to one NGO's efforts to bring fresh produce to several U.S. cities, including inner-city New Orleans, this workshop will include brief introductory presentations before becoming an open discussion of current and future efforts to bring fresh produce to underserved areas. The discussions may include audience descriptions of efforts they are involved in; perceived current and future needs; introductions and networking opportunities; current and future research; teaching and extension/service needs; integration of horticultural expertise into community projects; and current and future financial, physical and human support for these efforts. In addition to the workshop, a short, informal tour to a New Orleans center that provides fresh produce for underserved clientele is planned. The tour will complement the workshop, providing context for discussions at the workshop and in the future. Both the workshop and the tour are designed with the underlying objective of bringing together interested ASHS members and leveraging their interest and expertise in this space now and in the future.

6:00–6:15 PM

ReFresh Project: A Community Health Hub

Jeffrey Schwartz*
Broad Community Connections, New Orleans, LA; jeff@broadcommunityconnections.org

6:15–6:30 PM

It's All about the Food

Cindy Ayers-Elliot*
Foot Print Farms, Jackson, MS; cayers2010@att.net

6:30–6:45 PM

Panel Discussion

Emery Van Hook
Market Umbrella

Emily Nicoli-Doyle
Sprout NOLA

Meredith Smith
Whole Cities Foundation

Keith Stewart
Whole Cities Foundation

Lee Rouse
LSU AgCenter Orleans Parish

William Evans*
Mississippi State University, Crystal Springs; bill.evans@msstate.edu

6:45–7:00 PM

Fresh Produce in the City: A Workshop

William Evans*
Mississippi State University, Crystal Springs; bill.evans@msstate.edu

7:00–7:15 PM

Urban Food Production Around New Orleans

Carl Motsenbocker*
LSU AgCenter, Baton Rouge; cmots@lsu.edu

7:15–7:30 PM

Whole Cities Foundation: Who We Are and What We Do

Meredith Smith*
Whole Cities Foundation

7:30–7:45 PM

Whole Cities Foundation Projects in Urban Food Systems

Emery Van Hook*
Market Umbrella

7:45–8:00 PM

SPROUT NOLA: Gardens in the City

Emily Mickley-Doyle*
Sprout NOLA

Thursday, 6 August 2015

Fresh Perspectives on Citrus History

Sponsor: History of Horticultural Science (HIST) Working Group

Coordinator: David A Karp; dkarp@ucr.edu

Objective: The purpose of this workshop is to explore topics in citrus history that are of great interest and importance but have not been adequately covered in the existing historical and horticultural literature.

Abstract: The purpose of this workshop is to explore topics in citrus history that are of great interest and importance but have not been adequately covered in the existing historical and horticultural literature. It offers new historical studies of satsuma cultivation on the Unites States Gulf Coast, grapefruit cultivation in the Indian River district of Florida, and blood orange cultivation in the Mediterranean basin and around the world. It also provides a review of recent developments in citrus archeobotany in the Mediterranean region, and a synthesis of the long and fascinating history of the citron.

8:00–8:30 AM

History of Gulf Coast Citrus

James Spiers*
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Claudine Jenda
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Bridget Farrell
Auburn University, Auburn, AL; bsf0004@auburn.edu

Alabama, Louisiana, and Mississippi are not often thought of as citrus producing states. However, citrus has been grown along the coastal regions of these states since the late 19th century. The climate along the northern fringe of the Gulf of Mexico from Louisiana to northwestern Florida is suited quite well for production of satsuma mandarin (*Citrus unshui* Marc.), one of the most cold-hardy commercial citrus species. The climate is cool enough for a suitable amount of acid to remain in the fruit for optimum flavor, and for adequate peel color development. Also, satsumas typically reach optimum eating quality prior to fall freezes along the Gulf Coast. There were once thousands of acres of satsumas planted in this region. Alabama alone had over 20,000 acres in satsuma orchards in 1923. Periodic severe freezes, as well as the occasional hurricane, prevented a citrus industry of this magnitude from remaining viable. Though freeze damage remains the primary limiting factor for citrus production in this region, there is great local interest and a small industry focused on local markets has endured. Satsuma remains the primary citrus grown along the Gulf Coast region, though sweet oranges account for a large portion of citrus sales in Louisiana. Past and present production, including cultivation, freeze protection strategies, pest issues, and marketing of citrus produced along the Gulf Coast, are discussed.

8:30–9:00 AM

Archeobotany of Citrus in the Ancient Mediterranean

Dafna Langgut*
Tel Aviv University, Tel Aviv; langgut@post.tau.ac.il

Today citrus fruits are a major component of the Mediterranean landscape and one of the most important cultivated fruits in the region; however they are not native to the Mediterranean Basin. In this study the route of citrus' spread and its diversification is revealed by the use of botanical remains and historical information. *Citrus* primo-domestication area is southwestern China and northeastern India. *Citrus medica* (citron) was the first *Citrus* to spread west, apparently through Persia and the Southern Levant (remains were found in a Persian royal garden dated to the 5th to 4th centuries BCE) and then to Egypt and western Mediterranean (Early Roman period, since ca. 3rd century BCE). In the latter region seeds and pollen remains of both citron and lemon were found in gardens owned by the affluent in Pompeii and Rome. It therefore seems that lemon was the second citrus species cultivated in the Mediterranean. The contexts of the botanical remains in relation to important gardens show that citrus in antiquity were products representing high social status. The lime and the pummelo reached the Mediterranean during the Muslim conquest (starting during the 7th century AD); sour orange in the 11th century; sweet orange in the 15th century; and mandarin in the early 19th century. The archaeobotanical remains used in this study include pollen grains, seeds and molecular analysis and were taken only from secure archaeological contexts (in terms of stratigraphy and chronology). Historical information comes from ancient texts, art artifacts (such as wall paintings, mosaics and appearance on coins), and philology. The latter also suggests that the citron made its way to the Mediterranean from India via Persia.

9:00–9:30 AM

History of Citron (*Citrus medica* L.): Biological and Cultural Features

Eliezer Goldschmidt*
Hebrew Univ of Jerusalem, Rehovot; eli.goldsmit@mail.huji.ac.il

The citron *(Citrus medica* L.) is assumed to be one of the three forefathers of the *Citrus* genus and the first to have reached the Near East. For many generations citron fruits, praised for their

beauty and medicinal properties, have been the major citrus fruit known in Europe, as indicated by the large portion of Ferrari and Volkamer classical texts devoted to citrons. Its adoption by the Jews for the sacred Tabernacles worship turned the citron (=Etrog) fruit into a Jewish symbol, subject to intense legal and customary discourse. Jews apparently played a central role in the distribution of citrons within the Mediterranean and beyond. Thus, the history of the citron has in addition to its bio-evolutionary course, a unique human dimension; both aspects acted in close interaction and are reflected in the current state of citron horticulture and trade. The ancient history of the citron in its South-East Asia center of origin is still shrouded in mystery, but its contribution to the genetic makeup of the lemon tribe and other cultivars is beyond doubt. Interestingly, although citrons are mono-embryonic and mainly propagated by seed, the vast majority of emerging seedlings show close similarity to the mother plants, with hybrids only seldom encountered. This indicates, along with ecological evidence, that citrons maintain a self-fertilization mechanism, which preserves their species identity. Citron may however serve as the male parent; e.g., the Bergamot, which has been shown to be a citron-sour orange hybrid and, like the citron, has a persistent, non-abscising style. A central theme in the use of citron-Etrog for Tabernacles is the grafting problem. Citron trees are very degenerate, sensitive to *Phytophthora* root collar rot and, to a lesser degree, exocortis. Grafting has been used extensively to overcome these problems, at least since the 16th century. However, the use of 'grafted' citrons for Tabernacles was controversial, according to religious authorities, and rejected by most religious communities. This prompted a search for non-grafted or allegedly never-grafted citrons in remote places such as Yemen and Morocco. As a matter of fact, according to current scientific views, grafting is not expected to involve genetic changes in the scion, and there seems to be no scientific basis for the rejection of grafted citrons. Furthermore, a genetic comparison between Mediterranean, Yemenite and Morocco citrons showed them to be closely similar and distinctly different from lemon and other citrus species.

9:30–10:00 AM

History of Blood Oranges

Antonio Catara*
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Giovanni Continella
Università di Catania, Catania; gcontine@unict.it

Giuseppe Reforgiato Recupero
Centro di Ricerca per l'Agrumicoltura e le Colture Mediterranee, Acireale; giuseppe.reforgiato@entecra.it

In 1646, Giovanni Battista Ferrari provided the first known report of blood oranges in his Hesperides, relating that a missionary during his stay in the Philippines had observed the presence of an orange fruit characterized by red flesh ("purpurei coloris medulla") and a grape-like savor ("quae uvam sapiat"). Later, Loureiro in Flora Cochinchinensis (1790), Gallesio in Traité du Citrus (1811), Risso and Poiteau in Histoire Naturelle des Orangers (1818–22), and Inzenga (1815–87) in Agrumi Siciliani described different types of orange characterized by red color in the fruit, which was also depicted in a picture by Bartolomeo Bimbi in the 18th century. Many authors agree that blood oranges have a Mediterranean origin, from ancient 'Sanguinelli' varieties, such as 'Doppio Sanguigno'. Authoritative texts suggest a second, independent origin in Spain, from 'Doblefina', and a third from 'Shamouti Orange', referred to as 'Shamouti Blood' (Hodgson, 1967). The 'Moro' cultivar has long been the most highly pigmented commercial fruit, with deep red violet flesh, ripening from December to February. The 'Tarocco' variety, probably named for its shape like a spinning top, was discovered in the early 1900s in the area of Pedagaggi (Syracuse Province), but spread rapidly to Lentini and Francofonte (Syracuse) and south of Mount Etna, where the best conditions exist for the expression of its genetic potential. Thanks to the Citrus Experimental Station of Acireale, today called the Research Centre for Citriculture and Mediterranean Crops, and the University of Catania, 'Tarocco' has become 'the King of Oranges' in Sicily, with many clones differing in ripening season, shape (presence of a broad neck) and degree of pigmentation. More than 60 germplasm accessions exist, and more than 20 'Tarocco' clones are now cultivated, supplying high quality fruits to markets from mid-December to mid-May. The anthocyanin development in the peel and the flesh of blood oranges, largely represented by cyanidin -3-glucoside and cyanidin-3-(6"malonil) glucoside, is cold-dependent. A transcriptional regulator gene, named Ruby, not expressed at all in blonde oranges, correlates with the amount of anthocyanin, but a molecular marker (LTR) located just upstream of Ruby is responsible for the presence of anthocyanin and the activation of Ruby. Molecular investigation confirms that the blood orange varietal group has a common origin (with pummelo and mandarin as parental species), providing pummelo the Ruby allele. Subsequently (cumulative) mutations were the exclusive genetic mechanism determining the variability of the group.

Thursday, 6 August 2015

*CEU Approved

Molecular Physiology and Genetics of Fruit Growth and Development

Sponsor: Pomology (POM) Working Group

Moderator: Anish Malladi; malladi@uga.edu

Objective: Advances have been made recently in our understanding of the molecular physiology and genetics of various aspects of fruit growth and development in tree fruits. One goal of this workshop is to summarize such advances in apple, peach and other tree fruits. Another goal is to further explore avenues for integrating molecular and genetic approaches to improve our understanding of fruit growth and to apply such knowledge for improving fruit production.

Abstract: Advances have been made recently in our understanding of the molecular physiology and genetics of various aspects of fruit growth and development in tree fruits. One goal of this workshop is to summarize such advances in apple, peach and other tree fruits. Another goal is to further explore avenues for integrating molecular and genetic approaches to improve our understanding of fruit growth and to apply such knowledge for improving fruit production.

8:00–8:20 AM

Reevaluating Growth of Sweet Cherry By Functional Modelling with Reference to Anatomy, Cell Growth, and Endoreduplication

Todd Einhorn*
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David Gibeaut
Oregon State University, Hood River; david.gibeaut@oregonstate.edu

Matthew Whiting
Washington State University, Prosser; mdwhiting@wsu.edu

8:20–8:40 AM

Cell Division and Enlargement in Peach Mesocarp Cells Affected by Time of Thinning

Gregory Reighard*
Clemson University, Clemson, SC; grghrd@clemson.edu

Rafael Pio
Universidade Federal de Lavras, Lavras

Filipe Bittencourt Machado de Souza
Universidade Federal de Lavras, Lavras

Peach fruit size is affected by crop load, cultivar, and temperature during the Phase I growth stage. Fruitlets from peach cultivars, 'Carored', 'Summerprince', 'Redhaven' and 'Scarletprince', ripening sequentially from mid-May to early July were sampled every 5 days from week 2 to week 5 post-bloom. Fruitlets were collected from the outside canopy of each tree on all four quadrants and were fixed with FAA (ethanol-formaldehyde-acetic acid) before mounting for sectioning. Trees of each cultivar were either thinned one week or four weeks after petal fall with 4 replicates for each cultivar and treatment. Mesocarp cell number and size were counted and calculated from the transverse sections using an Infinity Analyze software program. Differences in cell number due to crop load were observed within days after the petal fall thinning. Early thinned trees had significantly more cells than later thinned trees 3 weeks after the first thinning date. At 4 weeks postbloom, 'Redhaven' and 'Scarletprince' had more cells than earlier ripening 'Carored' and 'Summereprince'. Differences in cell size occurred within 5 days of thinning for 'Carored'. The other cultivars did not exhibit differences in cell size until 2 weeks after the earlier thinning treatment. Three weeks after the petal fall thinning, fruit from early thinned trees had mesocarp cells 5% to 43% larger than those in the later thinned trees. At 5 weeks after bloom, 'Carored' and 'Summerprince' had larger but fewer cells than the later ripening 'Redhaven' and 'Scarletprince'. Fruit from the early thinned trees ripened earlier and were larger at harvest.

Specified Source(s) of Funding: Hatch Project SC-1700465

8:40–9:00 AM

Fruit Growth in Apple: Current Knowledge of the Molecular Players

Anish Malladi*
University of Georgia, Athens; malladi@uga.edu

9:00–9:20 AM

Apple Fruit Acidity, What Do We Know about It Now?

Kenong Xu*
Cornell University, Geneva, NY; kx27@cornell.edu

9:20–9:40 AM

Understanding the Genetic Basis of Abscission in Sweet Cherry to Enable Mechanical Harvesting

Benjamin Kilian
Washington State University, Pullman; ben.kilian@wsu.edu

Nnadozie Oraguzie
Washington State University, Pullman; noraguzie@wsu.edu

Matthew Whiting
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Amit Dhingra*
Washington State University, Pullman; adhingra@wsu.edu

Thursday, 6 August 2015

*CEU Approved

Recycling Used Agricultural Plastics

Sponsor: Plasticulture (PLAST) Working Group

Coordinator: Keith Williamson; keith.williamson@guardianag.com

Objective: Present an overview of the recycling of agricultural plastics, tips on how to participate in recycling programs, and an evaluation of non-recycling options. An extended period of discussion will be included following the presentations.

Abstract: The use of plastics in agriculture has greatly enhanced productivity and the economic livelihood of farmers and ranchers throughout the world. This is especially true of horticulturalists, as we attempt to provide food for the expanding world population. These agricultural plastics include plastic mulch films, greenhouse plastics, bale and silage wraps, nursery containers, etc. However, the success story of Plasticulture has been blemished by the failure to find and utilize means to dispose of these materials in a manner that does not harm the environment. In this workshop we will look at this problem. We will talk about

the unsustainable aspects of disposal, such as field burning and landfilling. And we will talk about avenues that exist and are being developed to give more sustainable solutions to the disposal of plastics from agriculture and tips on how to support and participate in recycling efforts.

8:00–8:30 AM

An Overview of Recycling Agricultural Plastics

Keith Williamson*
Guardian Ag Plastics, Hartsville, SC; keith.williamson@guardianag.com

Topics include: a) recycling agricultural plastics defined and contrasted with using degradable plastics; b) types of plastics and special characteristics that impact recycling; and c) the history of ag plastic recycling and current activities, including case studies.

8:30–9:00 AM

Recycling Plastic Agricultural Mulch Film

Gene Jones*
Southern Waste Information Exchange (SWIX), Tallahassee, FL; gene@swixusa.org

This presentation will provide and overview of the agricultural plastic mulch industry in the United States and detail recycling activities and opportunities that exist. The presentation will also provide information on the obstacles faced and lessons learned

9:00–9:30 AM

Tips for Growers on Recycling Used Plastic Film and Containers

Lois Levitan*
Cornell University, Ithaca, NY; lcl3@cornell.edu

Virtually all types of horticultural plastics—including mulch film, greenhouse and tunnel covers, irrigation tubing and drip tape, nursery pots and trays—can be recycled, some more easily than others. These tips are for growers, for Extension and research horticulturalists who work with them, and for industry reps who sell plastics to growers. We will cover: 1) how to prepare horticultural plastics for recycling; 2) equipment and methods to efficiently remove plastic from the fields and compact it for transport to recycling markets; 3) hoops to jump, hurdles to clear and issues that arise in collection and processing; 4) costs of recycling, and who pays; 5) viable recycling markets in different areas of the country; 6) why geography matters; 7) Engaging new and prospective markets; and 8) where to find educational and outreach materials that promote and explain how to recycle agricultural plastics.

9:30–10:00 AM

Panel Discussion

Moving the National Strategic Plan for Consumer Horticulture Research, Education, and Extension Forward: Creative Destruction and Rebuilding

Sponsor: Consumer Horticulture and Master Gardeners (CHMG) Working Group

Moderator: Ellen Bauske; ebauske@uga.edu

Objective: Continue development of a national strategic plan for consumer horticulture research, education, and extension.

Abstract: The ASHS Consumer Horticulture and Master Gardener (CHMG) Workshop will continue development of a national strategic plan for consumer horticulture research, education, and extension. The CHMG Workshop held July 31, 2014 in Orlando, Florida focused on the need for a national strategic plan for consumer horticulture research, education, and extension. The objective of the plan is to galvanize support of the diverse stakeholders, focus academic efforts, and build a strong case for research, education, and extension resources. In the past year, progress has been made. John Clark, past president of ASHS, University Professor at the University of Arkansas, and fruit breeder will begin the workshop speaking on the benefits of strategic planning and the importance of strengthening ASHS interactions with public gardens, arboreta, and the gardening public. Tom Bewick, National Program Leader of Plant Sciences at the National Institute of Food and Agriculture, will present the draft plan that was created by a small steering committee of academicians, industry representatives, and practitioners of consumer horticulture. He will lead workshop participants through the creative destruction and rebuilding of this draft, with a goal of incorporating recommendations of workshop participants. Make plans to be a part of this strategic planning process by attending the workshop and participating in this activity.

10:15–10:25 AM

Welcoming Remarks

10:25–10:40 AM

Strategic Planning, Public Gardens, Arboreta, and the Gardening Public

John Clark*
University of Arkansas, Fayetteville; jrclark@uark.edu

10:40 AM–1:10 PM

Presentation and Reconstruction of the National Strategic Plan for Consumer Horticulture Research, Education, and Extension

Tom Bewick*
USDA–NIFA, Washington, DC; tbewick@nifa.usda.gov

Jenn Tedeschi
National Gardening Association
Maree Gaetani
National Gardening Association

1:10–1:25 PM

Consumer Horticulture Strategic Plan

Ellen Bauske*
University of Georgia, Griffin; ebauske@uga.edu

Thursday, 6 August 2015

*CEU Approved

Implications of Climate Change for Pest Management for Horticultural Crops

Sponsor: Weed Control & Pest Management (WCPM) Working Group

Moderator: Carlene A. Chase; cachase@ufl.edu

Objective: The objectives of the workshop are to:1. Provide a source of information for ASHS members about the ways in which climate change is impacting pest management.2. Provide a forum for discussion of the implications of these impacts on pest management.3. Assist ASHS members in prioritizing research intended to mitigate adverse effects of pest populations that are being influenced by climate change.

Abstract: In addition to climate change affecting horticultural crop growth and yields, horticulturists should recognize that climate change will also affect pathogens, rates of disease progression, pests and their natural enemies, and weeds. Increases in atmospheric and soil temperatures may result in less effective disruption of pathogen, pest, and weed life cycles that typically occurs during winter in temperate regions. This workshop will provide an opportunity for ASHS members to receive critical information on the ways in which pathogens, pest and beneficial arthropods, and weeds are currently being affected by climate change and the prospects for the future.

1:45–2:15 PM

Effects of Climate Change on Pathogens and Diseases

Karen Garrett*
University of Florida, Gainesville, FL; kgarrett@ksu.edu

2:15–2:45 PM

Impacts of Climate Change on Weeds and Weed Management

Lewis Ziska*
USDA Agricultural Research Service, Beltsville, MD; Lewis.Ziska@ars.usda.gov

2:45–3:15 PM

Climate Change Effects on Pest Arthropods and Their Natural Enemies

James D. Harwood*
University of Kentucky, Lexington; James.Harwood@uky.edu

Thursday, 6 August 2015 Bayside A

*CEU Approved

Prospects and Opportunities in Herbs, Spices, and Medicinal Plants Research

Sponsor: Herbs, Spices, & Medicinal Plants (HSMP) Working Group

Moderator: Hideka Kobayashi; hideka.kobayashi@kysu.edu

Objective: Objectives of the workshop is to bring together leading academic scientists, and exchange and share their experiences and research results about emerging issues in herb, spice and medicinal plant research. Several focus areas had been identified and those include: drug discovery, new medicinal crops, germplasm preservation, and phytochemical analysis. The workshop also provides the premier interdisciplinary and multidisciplinary forum for researchers and educators to present and discuss the recent innovations, trends, and opportunities in the field of Herbs, Spices and Medicinal Plants.

Abstract: The year 2013 marked another period of increase in sales of herbal dietary supplements, a total of $994 million. Among the most popular were cranberry, garlic, saw palmetto, soy, and ginkgo; some of which have been used in traditional and indigenous medicines for centuries. The resurgence in popularity of botanical and herbal medicine is partly fueled by recent regulatory changes and interests among aging baby boomers who have become increasingly conscious of their health. Medicinal plants nowadays serve as a source of dietary supplements, crude drug materials, and pharmaceutical constituents that have gone through rigorous scrutiny. While many medicinal species have been domesticated and are now grown in the field or under controlled environment for harvesting, many remain wildcrafted both domestically and internationally. Excessive, non-sustainable collection of plants from the wild has resulted in loss or destruction of habitats, decrease in genetic diversity or even in some cases, extirpation, thereby possibly causing a loss of traditional usage and knowledge in medicinal plants. Many rare and endangered medicinal plants and their phytochemical constituents have not been thoroughly analyzed, screened or evaluated for their potential in health amelioration or other possible uses, creating substantial constraints and the need for germplasm preservation of medicinal plant species. The purpose of this colloquium is to bring together leading academic scientists, researchers and specialists in various disciplines, including dietary supplements, natural product chemistry, pharmaceutical science, phramacognosy, horticulture, plant germplasm preservation, and indigenous medicine to address

current issues and trends in herbs, spices and medicinal plant research. Specifically, we will discuss how to tackle issues in needed research or newly emerging areas such as medicinal plant uses in indigenous medicine, germplasm preservation, drug discovery, and quality control.

1:45–2:00 PM

Hunting and Collecting Native *Allium* in the Western United States

Barbara Hellier*
USDA–ARS, Pullman, WA; barbara.hellier@ars.usda.gov

North America is rich in native *Allium* genetic resources with approximately 87 native species described and is considered a secondary center of genetic diversity for the genus. The majority of those species (57) occur in the west. As with the old world species like garlic, *A. sativum*, onion, *A. cepa*, golden garlic, *A. moly* or *A. stipitatum*, North American native Alliums have a long history of use as food, medicine and ornamentals. Of the 87 native North American *Allium* species, bulbs, leaves, or seed of 25 are reported as being used for food, spice or as a medicinal for a wide range of conditions by native peoples. The USDA–ARS Plant Germplasm Introduction and Testing Research Unit, Pullman, WA maintains the National Plant Germplasm System wild *Allium* collection. We have worked with a number of native *Allium* species, *A. fibrillum, A. columbianum*, and *A. douglasii* in Washington, *A. schoenprasum* in Montana, but the majority of work has been with *A. acuminatum* from the Great Basin: collecting, conducting common garden studies, developing seed zones and cultural parameters for scalable seed production.

2:00–2:15 PM

Traditional Plant Medicine of the Houma People

Lanor Curole*
United Houma Nation, Golden Meadow, LA; lanor.curole@unitedhoumanation.org

The Houma people are a Native American tribe located in the state of Louisiana. In 1682, the Houma tribe was recorded by the French explorer Cavelier de La Salle as living along the Red River on the east side of Mississippi River. By 1706, the tribe moved down the Mississippi River to settle near the confluence of Bayou Lafourche after the Tunica drove them out of the site. The Houma then retreated into the coastal marshes where they remain today after the 1803 Louisiana Purchase. The United Houma Nation have been a recognized tribe since 1972 and there are about 17,000 enrolled tribal citizens residing within a six-parish service area: St. Mary, Terrebonne, Lafourche, Jefferson, Plaquemines, and St. Bernard parishes. The Houma culture has a rich tradition of using native plants for human health amelioration. Previous investigation revealed the Houma people used seventy three species native to the region, including elderberry (*Sambucus canadensis* L.) and Canada cocklebur [*Xanthium strumarium var. canadense* (P. Mill.) Torr. & Gray]. Knowledge and use of local plants still remains important, and individual Houma traiteurs (healers) use plant medicines in the community. Healing traditions are generally passed down from elders within certain families. The preservation of medicinal knowledge and tradition has been threatened by coastal erosion. Many species are quickly disappearing and no longer available due to coastal erosion, destruction of the habitat and development. Preservation of medicinal knowledge is further challenged by western medicine that is often driven by profit. Strategies to combat these obstacles include reaching out to tribal youth about traditions, plant preservation and the way of life.

2:15–2:30 PM

Screening North American Plant Species for Health Ameliorating Properties: Comparative Floristic and Cross-cultural Approaches

Hideka Kobayashi*
Kentucky State University, College of Agriculture, Food Science, and Sustainable Systems, Frankfort; hideka.kobayashi@kysu.edu

Drug discovery is a process to identify medicinal compounds that have potential for health amelioration. Many medicinal compounds or lead chemicals have been isolated from plants in the past. For instance, various plant species have been randomly screened for anti-cancer or anti-HIV properties. However, more focused and efficient approaches can be employed, including utilization of ethnomedical knowledge gained from books, databases, or direct contact with shamans and tribal people who have been passing information for generations. In the case of the North American indigenous medicines, the Native Americans have been practicing indigenous medicines for centuries, utilizing plants often endemic to the local area or region. While many tribes still practice indigenous medicines, some of the knowledge has been lost due to the Native American Diaspora. One approach to screen North American plant species is to compare them with related species in other regions for medicinal properties. Floristic similarities are often noted between North American and East Asian flora. For instance, ginseng species (*Panax ginseng* and *P. quinquefolius*) occur in both regions and have been used for treatments of various aliments for centuries. Similarly, goldenthread species, especially *Coptis japonica*, are very important medicinal plants in Traditional Chinese Medicine and Kampo, and another species has also been commercially used in Canada in the past. Thorough floristic and cross-cultural examination of North American species should be considered for screening health amelioration properties or compounds with potent biological activities.

2:30–2:45 PM

Challenges with Multiple Growers Providing Consistent Raw Materials Using *Echinacea* as an Example

Jeanine Davis*
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Lijing Zhou
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Jennifer Crumley
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John Balles
AMWAY Corp., Buena Park, CA; john.balles@nutrilite.com

Product consistency is of growing importance in the herbal/dietary supplement industry. Product consistency can be controlled to some extent through standardization based on one or more chemically active constituents, but ultimately there needs to be more consistency in the raw material supply chain. This is challenging when the raw materials are sourced from multiple growers in different locations. We recently completed a study with Amway/Nutrilite on *Echinacea purpurea* and *Echinacea angustifolia* that provides a good example of the problems that can be encountered. Seed source, growing location, growing season, and plant age at harvest all influenced not only plant yields but the profiles and concentrations of phytochemicals in leaf and root materials. To improve consistency, more efforts should be directed at breeding varieties specifically for production for herbal/dietary supplement industry. More research on environmental effects on the herbs during production, including fertilization, irrigation, soil types, disease incidence, and insect pressure, should be conducted to help develop grower guidelines to improve consistency in the raw material supply chain.

2:45–3:00 PM

Screening Native Botanicals for Bioactivity: An Interdisciplinary Approach

Elizabeth Floyd*
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William T. Cefalu
Pennington Biomedical Research Center, Louisiana State University, Baton Rouge; William.Cefalu@pbrc.edu

Plant-based therapies have been used in medicine throughout recorded history. Information about the therapeutic properties of plants can often be found in local cultures as folk medicine is communicated from one generation to the next. We are investigating native Louisiana plants that were used in Creole folk medicine to identify potential plant-based sources of therapeutic compounds for treating insulin resistance and type 2 diabetes. To screen native southwest Louisiana plants, we use an interdisciplinary approach that combines expertise in disciplines ranging from cultural anthropology and botany to biochemistry and endocrinology. Translation of accounts of Creole folk medicine has yielded a list of plants with documented use in treating a variety of conditions, including inflammation. These plants are collected, vouchered and catalogued prior to extraction of the soluble components. The extracts are analyzed for bioactivity in regulating inflammatory responses in macrophages or fatty-acid induced insulin resistance in C2C12 skeletal muscle cells. Our screen found that several extracts alter gene expression of inflammatory markers in macrophages. Multiplex analysis of kinase activation in insulin signaling pathways in skeletal muscle also identified a subset of extracts that alter insulin-stimulated AKT phosphorylation in the presence of fatty acid-induced insulin resistance. Our experience indicates that an interdisciplinary approach to screening botanical sources of therapeutic agents can be successfully applied to identify native plants as potential sources of therapeutic agents in treating insulin resistance in skeletal muscle or inflammatory processes associated with obesity-related insulin resistance.

Thursday, 6 August 2015

*CEU Approved

New Innovations in Commercial Horticultural Applications

Sponsor: Industry Division

Moderator: Angela Davis; angela.davis@hmclause.com

Objective: To introduce conference participants to new and innovative technologies available for research, teaching, and extension.

Abstract: This workshop is designed to introduce new and innovative technologies available for research, teaching and extension. Presentations will concentrate on new and/or innovative products and aspects of each company.

1:45–2:00 PM

Measuring Leaf Area Index under Any Sky Condition

Eric Price*
LI-COR Biosciences, Lincoln, NE; eric.price@licor.com

Leaf area index, also known as LAI, is the ratio of leaf surface area to ground surface area. When comparing above ground plant biomass, LAI is often an important variable. The LAI-2200C Plant Canopy Analyzer measures light transmission through a canopy to provide an accurate and non-destructive calculation

of LAI. A new development uses the position of the sun to minimize the effect of light scattering on the LAI measurement, which increases the accuracy in a variety of canopy types and sky conditions.

2:00–2:15 PM

Plant and Soil Sensors for Better Control of Plant Quality

Lauren Crawford*
Decagon Devices, Pullman, WA; lauren@decagon.com

Do you think that plant and soil sensors to manage irrigation are just for growers that want to save water? While the use of the sensors may often save water, the real benefits to growers come from better control of plant quality, disease, and maturation. Join Lauren Crawford of Decagon Devices for a discussion of the latest advances in soils and plant monitoring. Lauren will discuss recently released sensors as well as specific results that growers are seeing in practice. The GS1 soil water content sensor, a stainless steel and epoxy sensor released in 2014 is designed for growers requiring a rugged but inexpensive soil water content sensor. The Spectral Reflectance Sensors (SRS), also released in 2014, continuously monitor plant characteristics such as NDVI and PRI. Lauren will also preview Decagon's PlantPoint system, an irrigation monitoring and control system developed as part of a large SCRI grant scheduled to be released in late 2015.

2:15–2:30 PM

Accurate Measurement of Photosynthetically Active Radiation

Mark Blonquist*
Apogee Instruments, Inc., Logan, UT; mark.blonquist@apogeeinstruments.com

Apogee Instruments has released several new products in the recent past, including: leaf chlorophyll meter that outputs chlorophyll concentration in units of umol chlorophyll per m^2 of leaf surface, quantum sensor with an improved spectral response for more accurate PAR measurements, quantum sensor that uses USB to connect directly to a computer or small power supply and has internal memory for logging data, and small weatherproof spectroradiometer that interfaces with a datalogger or computer and is designed for longterm deployment. Details of these products and application to horticulture will be discussed.

2:30–2:45 PM

Web-Based Data Management and Portable Blue Tooth Devices

Wendy Sayre*
Spectrum Technologies, Aurora, IL; wsayre@specmeters.com

Bluetooth device and mobile app (for use with portable TDR meter)—Our TDR BlueTooth Device and Mobile App works with new or existing FieldScout TDR soil moisture meters to enable data to be sent directly and wirelessly via Bluetooth to your smart phone or tablet instantly, eliminating the need for a computer, cables and GPS accessories. Optionally, readings may be time and date stamped and geo-referenced with smart phone GPS information and sent automatically to our web-based utility for centralized documentation, reports and mapping of soil moisture measurements. Field notes may be added to all entries in the field (individual readings, research plots, and sessions) and readings may be taken in free form (as you go) or a guided management zone pattern. **Web-based data management system—**Spectrum's enhanced SpecConnect web-based data management system auto-uploads and stores information from stationary weather stations, wireless networks along with certain portable meters to view detailed real-time data, calculations and reports/graphs for analysis and documentation. This data is accessible from a smartphone, pc / laptop or web device. Optional alerts will text or email you based on sensor threshold levels you select (i.e., soil moisture, temperature). **Wireless Mesh Network—**Collect real-time, site-specific data across multiple microclimates / research plots / greenhouses using a variety of diverse sensors and up to 15 sensor (pup) stations which all send data wirelessly back to a base (retriever) station. The Retriever station consolidates, stores data, and optionally can transmit all detailed sensor data to a web based data management system via cellular or Wi-Fi modems. Network works well in environments with obstacles and rolling terrains; self-healing/forming network.

2:45–3:00 PM

Assessment Review Tools and Methods

Steven Gylling*
Gylling Data Management Inc., Brookings, SD; steve@gdmdata.com

3:00–3:15 PM

Heliospectra—Intelligent Light for Efficient Growth

Jimmy Gustafsson*
Heliospectra, Gothenburg; jimmy.gustafsson@heliospectra.com

3:15–3:45 PM

Ellepot

David Dobos*
Ellepot, Belleville, MI; dd@blackmoreco.com

Thursday, 6 August 2015

*CEU Approved

Seed Biology and Seed Treatments

Sponsor: Seed & Stand Establishment (SSEST) Working Group

Moderator: Michael Olszewski; olszewsk@temple.edu

Objective: The objective is to present diverse research topics regarding seed treatment technology and to discuss their effects on stand establishment.

Abstract: Seed treatments include coatings, encapsulations, or other "enhancements" that typically result in increased vigor and/or in breaking dormancy. These treatments have a variety of applications as commercial seed technology and as a means of facilitating stand establishment for some plant species. Industry, governmental and university researchers will discuss practical applications of several seed treatments and their potential impact on stand establishment. Following the presentations, there will be a group discussion on the significance of seed technology and its practical applications. This workshop will highlight the importance of seed treatments in horticulture and it will show several applications of seed technology and biological responses that result in enhanced stand establishment.

1:45–2:15 PM

Influence on Non-ionic Surfactant Seed Coatings for Promoting Germination and Plant Growth under Deficit Irrigation and Non-optimal Temperatures

Matthew Madsen*
USDA–Agricultural Research Service, Burns; matthew.madsen@oregonstate.edu

2:15–2:45 PM

Embryo Rescue and Artificial Seed Encapsulation Treatments in Flowers

Amir Khoddamzadeh*
Oklahoma State University & Florida International University, Stillwater; akhoddam@fiu.edu

Bruce Dunn
Oklahoma State University, Stillwater; bruce.dunn@okstate.edu

2:45–3:15 PM

Seed Treatments and Germination Responses of Seabeach Amaranth, a Threatened Plant in the United States

Sasha Eisenman*
Temple University, Ambler, PA; eisenman@temple.edu

3:15–3:45 PM

Modifying Soil Water Status and Improving Stand Establishment in a Water Repellent Soil Using Surfactant Coated Seed. II

Mica McMillan*
Aquatrols, Paulsboro, NJ; mica.franklin@aquatrols.com

Thursday, 6 August 2015

*CEU Approved

Cornell Apple Breeding, Genetics, and Genomics: Exciting Times!

Sponsor: Pomology (POM) Working Group

Moderator: Michele Warmund; warmundm@missouri.edu

The American Pomological Society, founded in 1848, is the oldest fruit organization in North America. The mission of the Society is to "foster the science and practice of fruit production and variety development." In keeping with this mission, this year's keynote presentation will provide an overview of one of the most significant apple breeding programs in North America. Since 1895, the Cornell apple breeding program has released 65 apple varieties, with 'Cortland', 'Macoun', 'Empire', 'Jonagold' and the scab resistant 'Liberty' among the best known. 'SnapDragon' and 'RubyFrost' are the two most recently-developed cultivars. The top priority of the Cornell University program is breeding for fruit quality, but investigators are also conducting genetic research on plant architecture, resistance to flesh browning, enhancement of vitamin C and specific antioxidants in fruit. To enhance the understanding of traits important in genetic improvement, epigenetic, genetic and genomic studies with students are conducted in collaboration with many valued colleagues at USDA and Cornell in the area of germplasm use, storage research, developing and testing of cider varieties, new ornamentals and disease resistant varieties.

2:00–3:00 PM

Cornell Apple Breeding, Genetics and Genomics: Exciting Times!

Susan Brown*
Cornell Univ, Geneva, NY; skb3@cornell.edu

Friday, 7 August 2015

*CEU Approved

New Orleans USDA–ARS Projects on Crops of the South

Sponsor: Federal Partners (FP) Working Group

Coordinator: Penelope Perkins-Veazie; penelope_perkins@ncsu.edu

Objective: This working group is designed to highlight the activities and accomplishments of partners in non-university institutions, especially those in federal or government science positions.

Abstract: The Federal Partners Working Group was organized to better capture the research role of federal employees in the United States, Canada, and other countries. The goal of this workshop is to highlight work being done at the New Orleans USDA–ARS location. Research areas include allergens, afla-

toxins, rice, sugar cane, and functional foods, food processing and sensory quality.

8:00–8:15 AM

Functional Beverages and Value-added Foods: Opportunities Beyond the Juice

John Beaulieu*
USDA–ARS, New Orleans; john.beaulieu@ars.usda.gov

Steve Boue
USDA–ARS, New Orleans; Steve.Boue@ars.usda.gov

Recently, not-from-concentrate blueberry and pomegranate juices have been evaluated for qualitative changes and alterations in the volatile and anthocyanin profiles through processing to HTST pasteurization and storage. We will present data illustrating the high quality characteristics and appraisal of essential quality compounds, including press cake for future value-added use.

8:15–8:30 AM

Structure, Function and IgE Epitopes of the Peanut Panallergen Ara h 8

Barry Hurlburt*
USDA–ARS, New Orleans; Barry.Hurlburt@ars.usda.gov

Bet v 1 from birch pollen is a common sensitizing agent and Oral Allergy Syndrome (OAS) results when patients consume certain fruits, vegetables, tree nuts and peanuts. Here, we report the 3-dimensional structure of Ara h 8, the Bet v 1 homolog from peanut. The overall fold is very similar to that of Bet v 1, Api g 1 (celery), Gly m 4 (soy) and Pru av 1 (cherry). Ara h 8 binds the isoflavones quercetin and apigenin, as well as resveratrol avidly. Using micro-chip technology we have mapped the important linear epitopes for IgE binding.

8:30–8:45 AM

USDA–ARS Research on Preharvest Control of Aflatoxin Contamination in Food and Feed Crops

Jeffrey Cary*
USDA–ARS, New Orleans; Jeff.Cary@ars.usda.gov

Aspergillus flavus is a saprophytic, filamentous fungus that can invade agronomically important oil seed crops such as corn, peanut, and cottonseed, where it produces the toxic and carcinogenic family of secondary metabolites—aflatoxins. Aflatoxin B1 is the most potent natural carcinogen known and, as such, its presence in commodities is strictly regulated by the Food and Drug Administration (FDA) and European importers of American food products. The total annual loss to the U.S. corn industry alone due to aflatoxin contamination has been estimated at approximately $200 million. Aflatoxin contamination in crops such as corn can be much more serious in developing countries because the largest proportion of the crop is used for human consumption and there is limited capacity to monitor aflatoxin in the grain. Ingestion of food contaminated with high levels of aflatoxins has been implicated in acute toxicosis that often results in death while chronic, low-level exposure can lead to liver cancer, immune suppression, and stunting of growth in children among other pathological conditions. Despite the many advances made in the biochemistry, genetics, and ecology of *A. flavus* and aflatoxin production, current control strategies fail to effectively eliminate aflatoxin contamination. This presentation will provide an overview of preharvest aflatoxin control research being conducted by scientists in the Food and Feed Safety Research Unit at the USDA–ARS Southern Regional Research Center in New Orleans, LA. Multifaceted approaches being undertaken include biological control, host plant resistance strategies (breeding and genetic engineering) and -omics technologies (proteomics, transcriptomics, metabolomics) to study mechanisms controlling aflatoxin biosynthesis and fungal development. Taken together, these approaches will lead to the development of novel biotechnological control strategies, contributing to the reduction of preharvest aflatoxin contamination.

8:45–9:00 AM

Presentation

Donna Shaw*

Friday, 7 August 2015

*CEU Approved

International Horticultural Consultants Workshop

Sponsor: International Horticultural Consultants (ICON) Working Group

Moderator: Clinton C. Shock; clinton.shock@oregonstate.edu

Objective: Encourage international consulting through sharing knowledge of the benefits and challenges.

Abstract: Horticulturists can make substantial contributions through international consulting. Specific problems need to be overcome due to cross cultural communication, misunderstood local needs, lack of value placed on international efforts by the consultant's home institution, and confusion in professional research roles versus consulting. This workshop and the following discussion seek to share consulting experiences to foster future success.

10:15–10:35 AM

Bridging the Cultural Gap

Roland Ebel*
Universidad Autónoma del Estado de México, Toluca; ebelroland@hotmail.com

Working as an international consultant or for a foreign research institution is an experience that changes your professional life. For some, it is an influential temporal event. For others, it is the starting point of an international career. There are some who find a new home away from home. International work improves your technical, methodological, and personal skills. There is no universal methodology for succeeding abroad. Yet, there are ten

golden rules that international "newcomers" should consider:

1. *Learn the language!* Not only is this an act of intercultural respect, it also allows you to understand the hallway conversations, where no English is spoken.
2. *Be modest!* There is a strong tendency in developing countries to exalt foreign specialists. Newcomers face a high risk of (unconsciously) fitting into the role of "a superior creature". Resist temptation! There are smart people everywhere.
3. *Work hard!* Working responsibly and effectively is the correct way to gain respect.
4. *Field work unites!* Get involved in any possible outdoor activity, either academic or social.
5. *Observe!* Plants develop differently in other climates and soils. Not everything that works at home will be a success abroad. Instead, observe the new ecosystems and learn from local farmers!
6. *Adapt yourself to the context but do not assimilate!* Go for local food, enjoy the new culture, but do not try to imitate your colleagues.
7. *Keep your private life private!* Going abroad is a great fun, but one should always keep in mind that in moral concerns foreigners are judged more strictly than locals.
8. *Do not complain about poor infrastructure!* There is no doubt that developing countries are economically worse off than the Western world. Local people there don't need to be reminded continuously.
9. *Avoid public discussions on politics and religion!* This is none of your business.
10. *Bring in your contacts!* Everybody has different skills and expertise to share. Yet, there is one thing all international consultants have in common and which is appreciated everywhere: international contacts.

All along this workshop, these *rules* will be explained by overseas examples. Tips on fieldwork and overcoming administrative barriers will also be discussed. Is there a better place than New Orleans to talk about overcoming cultural gaps?

10:35–10:55 AM

Experiences with the Farmer-to-Farmer Volunteer Specialist Program: Projects in Guatemala and the Dominican Republic

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Perhaps one of the best ways for prospective consultants to gain international experience is the USAID-funded Farmer-to-Farmer (F2F) program. This program offers numerous opportunities for volunteer specialists to solve all sorts of problems with many different crops in many different countries. The specialist may be asked to fulfill many tasks and in some cases, make presentations, develop budgets, make recommendations and file reports: all things commonly required of paid consultants. Experiences of this type are very useful as examples of prior consulting accomplishments when one is applying for paid consultant positions. Farmer-to-Farmer programs also provide the experience of working through subcontractors—as USAID contracts with numerous agencies such as ACDI/VOCA, Winrock International, Land O'Lakes International Development, CNFA, and others to manage the numerous projects in various countries. Each project may be quite different from another. Examples of recent F2F volunteer projects in Guatemala (Partners of the Americas) and in the Dominican Republic (FAVACA/Partners) will be discussed as they relate to valuable consulting experiences gained.

10:55–11:15 AM

Benefits and Challenges of Faculty Engagement in International Agricultural Development Work

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Horticulture is often an important component of agricultural development projects and there are significant opportunities for faculty members at universities to become involved in such projects. Before embarking on such projects, however, it is important for faculty members to understand how typical activities such as research, teaching, and extension relate to international agricultural development objectives. Funding agencies are focused on specific outcomes and impacts that may not require the usual research, teaching, or extension efforts. Fundamental research is usually not considered critical to agricultural development and only applied translational research that will have clear impacts on development objectives will typically be funded. Other important activities that faculty members might engage in include providing short-term technical assistance, capacity-building activities, and consulting. Benefits of engaging in such activities include new sources of funding, publishing opportunities (but not typically a donor objective), new collaborative ties, opportunities to establish an international reputation, opportunities to make a difference, and interesting travel experiences. These benefits should be carefully weighed against the challenges of engaging in international work which include low initial return on investment, potential misconceptions at the home institution and/or state, significant periods of time away from home, and whether sufficient academic "credit" will be given for such activities.

11:15–11:30 AM

Unexpected Needs for Flexibility in International Consulting

Clinton C. Shock*
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Typically a consulting assignment is well defined. Local needs have been accessed and the consultant's abilities are chosen to meet those needs. How do you go about accessing the contribution that you can provide? What do you do when you discover that unanticipated factors are limiting success? These factors may be outside of your immediate knowledge

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Tuesday, 4 August 2015

Viticulture and Small Fruits 1

Moderator: Andrew Ristvey
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8:15– 8:30 AM

An Initial Estimation of Chill Requirement in the Dormancy Release of the Deciduous Specialty Fruit Crop Aronia

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An initial estimation of chill requirements for the cultivated variety of the black chokeberry (*Aronia mitchurinii*) have been developed using three classic temperature-based models. Aronia, as it is known in the commercial trade, is a shrub in the Family Rosaceae and in the apple subtribe of Pyrinae and is known for the high antioxidant content in the fruit. It is presently gaining interest as a specialty fruit crop in the United States. The purpose of this study was to estimate the minimal chill requirements for dormancy release of *A. mitchurinii* through the use of three chill models and develop recommendations for the southern extent of orchards in the United States. Three temperature models were used to calculate chilling hours or chilling units though measured ambient air temperatures during two dormant seasons. Chilling hours were determined by calculating the number of hours below 7 °C (H7) and by the number of hours between 7 °C and 0 °C (HB). Chilling units (CU) were calculated through the Utah model, which assigns a weighted effectiveness within a range of temperatures. Several times during both seasons, a randomly selected group of dormant plants being held outside were brought into a greenhouse environment being maintained at 23 °C with 12 hours of light (both daylight and supplemental). At that point, the accumulated chill hours/units were calculated for that group using the three models. Bud swelling and dormancy break was observed in these plant groups. It was noted, especially in the second year study, that plant groups receiving less than 800 H7 did not exhibit full terminal bud dormancy release. With all groups receiving more than 900 H7, dormancy release occurred, but axillary buds broke dormancy before terminal buds in at least half the plants. Averaging results from the two years, full dormancy release occurred only after 1100 H7, 828 HB and 626 CU. Greater chilling hour or unit accumulation increased vigor and growth rate. This information can set initial guidelines for orchard locations within the United States. With a commercial preference for organically grown fruit, many orchards would not consider growth regulators to break dormancy, limiting the plant's southern range. Further studies in successive years are needed to more accurately determine chill requirement for Aronia dormancy release, along with examining the best model for that determination.

8:30–8:45 AM

Evaluation of Strawberry Cultivars in Virginia

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On-farm studies in the southeast district of Virginia were conducted in the 2013–14 growing season, to identify strawberry cultivars that provide high yield and flavor compared to the current widely-grown cultivars, Chandler, Camarosa, and Sweet Charlie. At three grower sites, one each in the cities of Virginia Beach and Chesapeake, and one in Westmoreland County, 12 cultivars in three replicates were evaluated in a randomized complete-block design. Each replicate comprised of 12 to 30 plants, depending on cultivar and site. Sites were maintained as per commercial grower practices. Data was collected on plant stand count, season fruit yields, berry sweetness, and fruit size. 'Camino Real' and 'Benicia' can offer yield potential similar to 'Chandler' and 'Camarosa' in annual plasticulture production. 'Camino Real' produced large berries at all locations and 'Albion' produced large berries at two of the three locations. The sweetest cultivars were 'Flavorfest', 'Albion', and 'Sweet Charlie'.

Specified Source(s) of Funding: VAES, VCE, and the College of Agriculture and Life Sciences at Virginia Tech. Plants donated by North Carolina State Univ.

An asterisk (*) following a name indicates the presenting author.

8:45–9:00 AM

Survey of Turkish Strawberry Production Areas for Soil-borne Fungal Diseases

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Strawberry cultivation is increasing and is centered in the Mediterranean and Aegean Regions. The production is conducted either in open field or under cover with an annual hill culture system. Cultivars developed by the Universities of California and Florida dominate production. It is not common to apply pre-planting fumigation in production areas and usually crop rotation is applied to avoid soil-borne pathogens. However, both the incidences and the severity of soil-borne pathogens have been increasing and these diseases have become the major problem in production. We surveyed important strawberry production areas to identify common soil-borne pathogens. Plant samples were collected from provinces in Mediterranean and Aegean Regions representing the major areas of Turkish strawberry production both in Spring and Fall of 2014. In both seasons, 300 symptomatic plant samples were cultured on potato dextrose agar including penicillin or oomycete selective media to detect the pathogens. *Macrophomina*, *Fusarium*, *Verticillium*, *Rhizoctonia*, *Colletotrichum*, *Phytophthora*, *Alternaria, Pestalotiopsis* and *Botrytis* spp. were the commonly identified fungal and oomycetous organisms. In most cases, the samples were infected by more than one pathogen. There were some differences in the frequencies of pathogens for seasons and locations. The results are significant for developing management practices needed to be employed against soil borne pathogens in strawberry production areas especially where soil fumigation is not performed.

9:00–9:15 AM

Understanding the Distribution Damage of Chitosan-coated Strawberry (cv. Monterey) Packed in Corrugated Container Caused by Location on Pallet

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Strawberry is a non-climacteric fruit and highly susceptible to water loss, softening, and fungal spoilage. Strawberry firmness is a very important quality for consumers. However, strawberries soften easily during handling and transportation. Therefore, edible films and coatings are gaining popularity to meet consumer demands and prevent economic losses during transportation. One of the most commonly used edible film and coating for fresh produce is chitosan. It provides excellent film-forming properties and maintains postharvest quality of fruit and vegetables. Chitosan improves the textural quality of fruits and reduces the loss of firmness. This study was designed to compare the quality of coated and uncoated strawberry as related to the location (bottom, middle, and top) of the corrugated containers on the pallet after being subjected to International Safe Transit Association (ISTA) 3H procedure, which simulates air-ride truck vibrations on a vibration table. Strawberries (cv. Monterey) were obtained from Apio Inc. (Guadalupe, CA) at commercial ripe stage. Strawberries were coated with 1%, 2%, and 3% chitosan solutions. Briefly, 10, 20, and 30 g of chitosan was dissolved in 1000 mL of water that contained acetic acid. Fruits were then air-dried at ambient temperature and placed in corrugated box. Corrugated boxes were 21 tiers high on pallets. Boxes at tiers 1, 11, and 21 were marked as bottom, middle, and top, respectively. Corrugated containers were then subjected to the ISTA 3H procedure. Following the procedure, firmness and weight loss of 10 strawberries for each group were measured. Uncoated and coated strawberries placed on the top of tier had lower firmness values than the samples placed on middle and bottom tiers. It is possible that transmitted vibration levels were higher on the top of the tier. Therefore, strawberries on the top were more damaged compared to other fruits. In addition, chitosan coatings maintained the firmness of strawberry better than the uncoated fruits on the same location of the pallet. Similar results were obtained for weight loss of samples. The weight loss of strawberries placed on the bottom and middle tiers were lower than the samples placed on top. Chitosan coatings were effective to control the weight loss of fruits compared with the uncoated ones. [M.S. Aday thanks the Scientific and Technological Research Council of Turkey (TUBITAK) BIDEP-2219 for postdoctorate support.]

9:15–9:30 AM

Sustainable Soil Management Practices Interactions with Fumigation Strategy in Southeast Strawberry Production

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Soil health and the management practices associated with its promotion is an area of growing interest for growers of horticultural crops nationwide as a means to sustain the long-term productivity of the soil. However, little understanding exists for the incorporation of soil health promoting practices into non-organic production systems, and more specifically for their incorporation into fumigated plasticulture strawberry production in the Southeast (SE). Our two-year field study evaluated the incorporation of a summer cover crop mix [Cowpea var. Iron Clay (*Vigna unguiculata*) and Pearl Millet (*Pennisetum glaucum*genus)], compost applied in the early summer, beneficial soil inoculants [arbuscular mycorrhizal fungi (AMF) and vermicompost] added to the strawberry plug and multiple combinations of these practices as applied to both fumigated and non-fumigated plasticulture strawberry production. The study began in June of 2013 with the establishment of plots in Goldsboro, NC, arranged in a split-plot randomized complete-block design with fumigation as the split. Treatments were assessed for their impacts on strawberry growth, yield, and berry quality as well as changes to chemical, physical, and biological indicators of soil health. Results from the 2014 and 2015 harvest seasons indicated significant interactions between soil management practice and fumigation strategy on per plant strawberry yields and fruit quality measures. Explanations for these significant interactions on yields will be discussed as they relate to corresponding changes in soil health parameters. Results indicate that sustainable soil management practices have a place in SE strawberry production, but that recommendations for their use should likely be fumigation strategy dependent.

Specified Source(s) of Funding: Walmart Foundation

9:30– 9:45 AM

Improving Fumigation Efficiency by Increasing Drip-tape Number and Using Low-permeability Film in Raised-bed Production Systems

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Drip fumigation is commonly used for controlling soilborne pests in raised-bed strawberry production system in California. However, the high emission loss and poor pest control indicate that the current fumigation practice with two drip tapes and polyethylene film (PE) covering need to be improved. In September 2014, a field trial was conducted in a grower's field in Oxnard, CA, to evaluate fumigant emission, distribution, pest control and strawberry yield by doubling the drip-tape number and covering beds with low permeability film (LPF). The treatments included application of Tri-Clor EC (a mixture of 94% chloropicrin and 6% inert ingredients) at a full rate (224 lbs/acre) or a half-rate (112 lbs/acre) through either two or four drip tapes under LPF, a full rate through two drip tapes under PE, and a non-fumigated control under LPF. The LPF dramatically reduced chloropicrin emissions compared to PE covering. The peak emission flux in LPF covered beds was about 10% of that in PE covered beds, while no emissions were detected from uncovered furrows from all treatments. Fumigant concentration in the LPF beds at half-rate was still higher than that in the PE beds at full rate. The four drip-tape layout was found to further improve fumigant concentration and vertical distribution compared to the two drip-tape layout. The four drip-tape layout showed the best nutsedge control at either full or half rate. Strawberry yield during early growth season in LPF beds were higher than in the PE beds and non-fumigated control. The overall results imply that the combination of increasing drip-tape number and covering beds with LPF can further improve fumigation efficiency or use reduced rates in raised-bed production systems.

Specified Source(s) of Funding: California Department of Food and Agriculture, Specialty Crop Block Grants Program.

9:45–10:00 AM

Anaerobic Soil Disinfestation (ASD): A Biological Strategy for Control of Soil-borne Diseases in Strawberry Production

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Anaerobic soil disinfestation (ASD), a biological alternative to soil fumigation, has been shown to control a range of soil-borne pathogens and nematodes in numerous crop production systems. Current work is focusing on how to optimize ASD (in terms of carbon source used, temperature and degree of anaerobiosis attained) to control specific sets of pathogens, and to understand which mechanism(s) are responsible for disease control. Data will be presented from a series of on-going field and greenhouse trials that test the effect of soil temperature, carbon source (e.g. rice bran, grape pomace, molasses) and cumulative anaerobic

conditions (Eh in mVhr below 200mV) on suppression of *Verticillium dahliae, Macrophomina phaseolina,* and *Fusarium oxysporum*. Results indicate that microsclerotia of *V. dahliae* can be reduced by 80% to 100% providing soil temperatures are above 18 °C and a cumulative Eh of 50,000mV hours below 200mV is achieved. Shifts in soil microbial communities and associated production of organic acid and volatiles during the anaerobic phase may be associated with disease suppression. Further, microbial shifts associated with ASD using rice bran (RB) as a carbon source persist for at least 10 months, and enhanced *V. dahliae* suppression was observed two years after ASD treatment despite multiple tillage operations and planting of rotation crops. Temperature and Eh thresholds for other pathogens are being determined. When soil temperatures are high ASD with RB as a carbon source shows promise for reducing *Fusarium* and *Macrophomina*, but did not provide complete control. Trials are being repeated with refinements to see if greater pathogen control can be achieved. Additional carbon sources such as grape pomace and molasses are also being tested and impacts on nitrogen dynamics as well as production and disease incidence monitored. In 2014–15 1000ac of commercial strawberry and raspberries in CA were planted using ASD, and in one field demonstration organic strawberry yields were almost doubled using ASD relative to grower standard practices.

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Tuesday, 4 August 2015

Pomology 1

Moderator: Gregory Michael Peck
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8:30–8:45 AM

Evaluating the Pollen Tube Growth Characteristics of Different Crabapple Cultivars

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Reducing crop load improves apple (*Malus* ×*domestica* Borkh.) size and color, and increases return bloom therefore minimizing biennial bearing. Chemically thinning apple trees during bloom can be an efficient way to reduce crop load. Most bloom thinning chemicals are caustic, causing damage to floral organs, thus preventing fertilization. However, the precise timing of bloom thinning applications has been somewhat subjective. Understanding apple pollination and fertilization, specifically pollen tube growth rates, can help improve application timing, greatly improving chemical thinning efficacy and reliability. Crabapples are often used as pollinizers in commercial orchards. The crabapple 'Snowdrift' has been used to develop a Pollen Tube Growth Model for estimating application time of bloom thinning chemicals. However, other crabapple genotypes may have different pollen tube growth rates. In 2014, emasculated apple blossoms located on 'Fuji', 'Golden Delicious', and 'Pink Lady' dwarfed trees grown in root bags were hand pollinated with pollen from one of five crabapple cultivars, (Evereste, Indian Summer, Snowdrift, Selkirk, and Thunderchild) and placed into growth chambers for 24 hours at temperatures of 12 °C, 18 °C, 24 °C, or 30 °C. Pollen tube growth was ceased after 24 hours by placing the blossoms in a 5% sodium sulfite preservative solution. The styles from pollinated blossoms were stained with a water-soluble fluorescent solution containing 0.01% Aniline Blue dye in 0.067M K_2HPO_4 for pollen tube visualization using a Nikon Eclipse Ci microscope (Tokyo, Japan) and a Nikon Intensilight C-HGFI (Tokyo, Japan). Data collection included pollen germination on the stigmatic surface, number of pollen tubes penetrating through the base of the stigma, length of the longest pollen tube, style length, and the number of pollen tubes that grew to the base of the style. The General Linear Model Procedure (SAS Inst., Cary, NC) was used to perform an analysis of variance on the collected data. Preliminary results from 2014 suggest pollen from 'Selkirk' and 'Thunderchild' grew significantly further down the styles of all three maternal cultivars followed by 'Indian Summer', 'Evereste', and 'Snowdrift'. On average 'Selkirk' and 'Thunderchild' pollen tubes grew 57.2% and 53.6% of the total style length, respectively. This project is being replicated in 2015. Significant differences between the pollen tube growth rates of pollen genotypes will help improve chemical thinning application timing and therefore improve crop load management in apple orchards.

Specified Source(s) of Funding: Funding was provided by a USDA Specialty Crop Block Grant, awarded by the Virginia Department of Agriculture and Consumer Services, entitled, "Advancing Organic Apple Production in Virginia" and the Virginia Agricultural Experiment Stations and the Hatch

8:45–9:00 AM

Apple Pollen Tube Growth and Spur Leaf Injury in Response to Thermal Shock Temperature and Duration

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Blossom thinning can confer significant benefits to apple growers, including increased fruit size and annual bearing. Early thinning reduces competition among fruit, which increases cell division and fruit size potential. Blossom thinners are not used in apple

crop load management programs in the mid-Atlantic region. Disincentives for use include a lack of registered products, the potential for leaf and fruit injury, and inconsistent results. In 2014, we evaluated the use of short duration forced heated air treatments (thermal shock) as a blossom thinning strategy. In the field setting, 80 uniform 'York' spurs were selected when king blossoms were at late balloon stage. On each spur, the side blossoms were removed and each king blossom was emasculated. Spurs were isolated from pollinators with insect netting. On the following day, blossoms were hand pollinated with 'Rome' pollen. Using a variable temperature heat gun, thermal shock treatments were applied to solitary blossoms 24 hours after pollination. The effects of output temperature (five levels) and treatment duration (four levels) were evaluated in a completely randomized design with a factorial treatment structure. A data logging thermometer recorded output temperature of the heat gun, and the distance between the heat gun aperture and blossom or leaf was held constant (2 cm). Blossoms were harvested 96 h after pollination, placed in a labeled vial containing 5% sodium sulfite, and stored at 4 °C until microscopic analysis. Pollen tube growth was observed via fluorescence microscopy, and damage to spur leaves was quantified using a visual rating scale. Short duration treatments (0.5 and 1.0 s) did not reduce pollen tube length or the number of pollen tubes to reach the base of the style. At 2- and 4-s durations, temperatures greater than 56 °C arrested pollen tube growth and prevented pollen tubes from reaching the base of the style. Visible leaf injury exceeded 10% with the following treatment combinations: 2 s duration at > 70 °C and 4 s duration at > 56 °C. Pollen tube growth was reduced or arrested at temperature and duration combinations that caused minimal visible injury to spur leaves. Outcomes of this trial suggest that thermal shock may have potential as an apple blossom thinning strategy.

Specified Source(s) of Funding: The State Horticultural Association of Pennsylvania

9:00–9:15 AM

Developing a Sustainable Strategy for Pollination in Tree Fruit

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Pollination (and subsequently, fertilization) is a critical step determining fruit quality and productivity. Growers struggle perennially with many issues related to pollinators (i.e., bees) and pollinizers (i.e., trees as sources of compatible pollen). Currently, fertilization in tree fruit crops is variable and unpredictable, mediated by the western honeybee (*Apis mellifera*), a species under global decline, mainly due to the effects of colony collapse disorder. Our objective is the development of an artificial pollination system that eliminates the need for pollinators and pollenizers in commercial tree fruit production systems. Our field trials are evaluating both supplemental pollination and replacement pollination (i.e., in the absence of pollinators and pollenizers). In 2014, several field trials investigated the potential for both pollination approaches. In 'Tieton' sweet cherry (*Prunus avium* L.), a single supplemental pollen application (120 g/acre) increased fruit set significantly, by about 15%. This improvement was due apparently to increased pollen deposition as we recorded a 225% increase in pollen grains per stigma from flowers treated versus those which were untreated. Full replacement pollination was evaluated by utilizing frames wrapped with a single layer of bee exclusion netting that were deployed to limbs prior to any flowers opening. In 'Bing' sweet cherry, two pollination applications, at about 40% and 80% full bloom, were as effective as natural open pollination—whole tree yield was similar for both treatments (4.8 and 3.3 kg/tree for natural and replacement pollination, respectively). In addition, a trial with 'Gala' apple (*Malus* ×*domestica* Borkh.) revealed that artificial pollination treatment with two pollen suspension solutions improved fruit set by about 56% and 75% compared to open-pollinated control. These trials demonstrate the potential for artificial pollination systems to improve yield security and production efficiency in specialty crop production, and build resilience to pollinator decline and climate change.

Specified Source(s) of Funding: Washington Tree Fruit Research Commission

9:15–9:30 AM

Evaluation of a Media for Artificial Pollination of Tree Fruit

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There exist persistent and emerging threats to tree fruit grower abilities to consistently pollinate their crops: weather conditions during flowering are predicted to become increasingly variable, colony collapse disorder threatens bee populations, pollinators harbor diseases that limit fruit marketability, pollenizers are sources of virus diseases, and there exists much confusion over pollinizer density and distribution. Our research team's goal is to develop an artificial pollination system for tree fruit based on the electrostatic application of pollen in liquid suspension. The current research was designed to assess the role of potential pollen suspension constituents on pollen viability over time. Lab studies were conducted in 2014 and 2015 on previously collected apple (*Malus* ×*domestica* Borkh.), sweet cherry (*Prunus avium* L.) and pear (*Pyrus communis* L.) pollen. Our trials investigated pollen germination after incubation in solution, after 5-, 30-, and 60-minute intervals, with a range of concentrations of sucrose, boric acid, calcium chloride ($CaCl_2$), and commercially available

surfactants. Sucrose at 1% to 4% was ineffective for improving pollen germination at all sampling times. However, sucrose at 8% and 16% improved pollen germination by 132% and 143% compared to water alone, respectively, at 30 minutes. Similarly, at 60 minutes 8% and 16% sucrose solutions increased germination over the control by 254% and 240%, respectively. The effects of boric acid and calcium chloride upon pollen germination in liquid delivery media are less clear. Calcium chloride at 0.075% caused 21% higher germination than control after 5 minutes. After 5 and 60 minutes, 0.025% $CaCl_2$ also improved pollen germination by 11% and 10%, respectively. Boric acid had no effect on pollen germination. When compared with control at 5 and 60 minutes, the composite suspension with calcium chloride (8% sucrose, 0.05 boric acid, and 0.025% $CaCl_2$) yielded 225% and 198% germination increases as a percentage of control. The composite suspension without calcium chloride was more consistent and produced significantly higher germination than control at all three loading times: 158% at 5 minutes, 161% at 30 minutes, and 316% at 60 minutes as a percentage of control. The commercial surfactant Regulaid® and growth regulator ReTain® did not inhibit pollen germination. The results of these trials introduce a baseline for the development of pollen carrier media for application via electrostatic spray systems in tree fruit pollination.

Specified Source(s) of Funding: Washington Tree Fruit Research Commission

9:30–9:45 AM

Precision Chemical Thinning—A Useful and Practical Guide for Apple Growers

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Precision thinning is a strategy to increase the efficacy of chemical thinning. The overall concepts are to define the optimum fruit number per tree and try to thin to that specific number through the precision thinning program. The method relies on five main steps: 1) identifying the target number of fruit per tree; 2) using the Cornell Apple Carbohydrate Thinning model to predict thinning response; 3) applying the thinners; 4) using the Fruit Growth Rate model for early assessment of thinning response; and 5) re-applying the thinners if needed. Beginning in 2012 we organized a statewide New York group effort in order to manage chemical thinning of 'Gala' and 'Honeycrisp' more precisely. In practice, growers were advised to follow a sequence of thinning sprays to achieve their target crop load beginning with a spray at bloom, followed by a spray at petal fall. Then, if needed (defined by fruit growth rate model) another spray at 12 mm fruit size and if needed a final spray at 18 mm fruit size. The carbohydrate model was used to guide the rate of chemical and timing while the fruit growth model indicated the percentage of thinning achieved. In 2013 and 2014 most 'Gala' blocks did not thin enough showing a very heavy crop. In these conditions starting the thinning program with bloom sprays was a valuable tool and reduced the amount of hand thinning required. Most 'Honeycrisp' blocks did not thin enough in 2013 but some slightly overthinned in 2014. Bloom thinning sprays were quite effective in 2013 but less so in 2014. Bloom sprays of Maxcel showed great efficacy. The 10–12 mm spray was not effective in 2013 partially due to the positive carbohydrate balance, however it gave good thinning results in 2014. The sequential sprays provided excellent crop load control. The carbohydrate model can be a guide to let growers know whether or not to spray, how much to spray, what days to avoid spraying. However, the fruit growth rate model has been the best method to physically access, in a more precise way, thinning efficacy. The use of both models together in the precision thinning program is a useful tool to optimize crop load and fruit size and a great way to improve profitability.

Specified Source(s) of Funding: ARDP– Apple Res. and Dev. Program NYEVI—New York Farm Viab. Institute USDA–NIFA—Specialty Crop Block Grant

9:45–10:00 AM

Validating the Use of the MaluSim Carbohydrate Model for Apple Fruit Thinning

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In commercial apple (*Malus ×domestica* Borkh.) orchards, farmers remove part of the crop each year in order to reduce biennial bearing and increase fruit quality. This process is referred to as "thinning" and is often accomplished through the use of plant bioregulators and/or caustic chemicals. Due to within- and between-year variability in environmental conditions and the differential response apple trees have to chemical thinners based on cultivar, rootstock, and tree health and age, thinning apple fruit remains one of the most difficult management tasks in an apple orchard. To help overcome this challenging task, researchers at Cornell University have developed MaluSim, a computer-based algorithm that estimates the daily carbohydrate balance for an idealized 'Empire' apple tree using daily high and low temperatures and total daily solar radiation as inputs. In theory, knowing the carbohydrate status of the apple tree at the time of thinning application should allow apple growers to alter products and rates so as to avoid over- or under-thinning. Five years of field trails have been conducted in Winchester, VA, in an effort to validate the MaluSim model in the mid-Atlantic region. In these experiments, 6-benzyladenine (MaxCel, Valent BioSciences) and carbaryl (Sevin XLR Plus, Bayer CropScience LP) were

applied to 'Bisbee Red Delicious' and 'Crimson Gala' trees on two- to three-day intervals from petal fall to a fruitlet size of approximately 20 mm in diameter. Crop load data was used to assess the effect of thinning from each application treatment. Through the use of cross correlations and the generalized additive model, the MaluSim model provided the most significant response when a six-day running average of the model output was used. Additionally, when the MaluSim model predicted greater carbohydrate levels at the time of thinning, the crop load at harvest was significantly greater. Through these experiments, the MaluSim model was shown to be a useful tool for understanding the impacts of environmental conditions on chemical thinning efficacy.

Specified Source(s) of Funding: Funding for this work was provided in part by the Virginia Agricultural Experiment Stations and the Hatch Program of the National Institute of Food and Agriculture, U.S. Department of Agriculture.

Tuesday, 4 August 2015

Ornamentals/Landscape and Turf 1

Moderator: Elizabeth Barton
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9:00–9:15 AM

Effects of Paclobutrazol on the Physiology, Growth, and Biomass Allocation of Three *Fraxinus* Species

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Fraxinus spp. (ash) trees are widely found in urban areas across the United States where they experience varying degrees and types of stress. The arrival of emerald ash borer (*Agilus planipennis* Fairmaire) into North America in the early 1990s dramatically altered the future of urban *Fraxinus* trees in North America. To date, this invasive phloem-feeding pest has killed tens of millions of *Fraxinus* trees and is found in 24 states and two Canadian provinces. Fertilizer and paclobutrazol (PB) are marketed as a means to alter growth and enhance tree vigor. Fertilizer typically increases radial growth but may reduce root:shoot ratios. Paclobutrazol, a gibberellin inhibitor, may reduce radial and shoot growth but increase root:shoot ratios. We evaluated effects of fertilization or PB applications on two North American species, *Fraxinus americana* L. and *Fraxinus quadrangulata* Michx., and one Asian species, *Fraxinus mandshurica* Rupr., grown in a common garden location and under similar conditions. These three species are common in urban landscapes, are evolutionarily diverse and have varying levels of inherent resistance to emerald ash borer. In 2010, 63 *Fraxinus* spp. trees, (21 of each of the above species) growing in a plantation were assigned to one of three treatments: fertilization, PB application, or untreated control. Gas exchange, foliar nutrient concentration, radial growth, and biomass allocation were assessed to evaluate tree response to treatments. Throughout the two-year study, gas exchange was not affected by species or treatment. In 2010, there were no treatment effects on foliar N but differences among species were apparent and in 2011, fertilizer increased *F. quadrangulata* foliar N (2.19% ± 0.085) compared to control trees (1.72% ± 0.128). In 2010, there were no treatment effects on growth. In 2011, radial growth of fertilized trees was 20% and 40% more than control and PB trees, respectively. In October 2011, we harvested trees to assess treatment effects on biomass allocation. Root : total biomass ratios of PB trees were 9% or 10% higher compared to control or fertilized trees, respectively, when species were combined. Biomass allocation was rarely different between fertilized and control trees. Results indicate the three *Fraxinus* species differ considerably in growth, foliar nutrients, and biomass allocation and their response to PB and fertilizer.

Specified Source(s) of Funding: Michigan State University Project GREEEN

9:15–9:30 AM

A Comparison of Organic Matter Amendments for Use in Extensive Green Roof Substrates

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Organic matter is important for water retention and nutrient availability in green-roof systems. Yet few quantitative green-roof studies provide data for various sources of organic matter (OM). Coconut coir (CC), rice hulls (RH), SmartLeaf® (SL), and mushroom compost (MC) were used as green roof substrate amendments. The effects of OM on water-holding capacity, nutrient availability and plant establishment were measured. Growth of *Phedimus kamtschaticus* was greater with MC or SL compared to CC or RH. Substrate moisture and nutrient availability were significantly affected by OM source during an 8-month rooftop experiment and a 6-month growth chamber study. Coconut coir showed high moisture retention, low nutrient availability, and low aboveground biomass, indicating that nutrient availability is crucial to successful plant growth and establishment on a green roof. Composted materials such as MC and SL that have higher levels of available nutrients, promote better growth than unprocessed materials like RH and CC.

Specified Source(s) of Funding: Wallace Bailey Research Grant, University of Maryland

An asterisk (*) following a name indicates the presenting author.

9:30–9:45 AM

Irrigation Effects on Growth, Stress, Visual Quality, and Evapotranspiration of Ornamental Grasses

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Information available about standard watering procedures of ornamental grasses is fairly nonexistent, and often not research based. Finding exact water requirements of specific ornamental grass species is extremely valuable for large scale water savings. It is important to determine precise irrigation needs of ornamental grass species, and test the limits to which the grasses can survive around those needs. This research has the potential to represent a large range of ornamental grass species; serving as a platform for future studies on the subject. The results will be an understanding of these grasses both in terms of physiological stress and ornamental aesthetics. Three genera of ornamental grasses were evaluated; *Panicum virgatum* 'Rotstrahlbusch' (Rotstrahlbusch Switchgrass), *Schizachyrium scoparium* 'Blaze' (Blaze Little Bluestem), and *Calamgrostis brachytricha* (Korean Feather Reed Grass). These three genera were chosen to represent a diverse group of popular ornamental grass species. All three genera were subject to irrigation amounts of 0%, 25%, 50%, and 100% relative to bluegrass evapotranspiration. Five replications in each treatment were subject to these irrigation levels for the 2013 and 2014 growing seasons. Results showed all three species in the 25%, 50%, and 100% treatments were considered acceptable for landscape purposes. The 25% treatment contained plants which had greater height, width, and circumference. The 25% treatment resulted in grasses with the highest ornamental quality and landscape impact ratings, both measurements of aesthetic quality. Physiologically, the 25% treatment grasses were in the lowest bracket of plant stress. A second research project was initiated in 2014 evaluating one species (Blaze Little Bluestem), which was subject to irrigation amounts of 25%, 50%, and 100% relative to bluegrass evapotranspiration. Initial results indicated all plants in the study were acceptable for landscape purposes. Grasses in the 25% treatment used 50% of the water, but were about 60% more stressed than the 100% treatment. Grasses in the 50% treatment used 75% of the water, but were about 30% more stressed than the 100% treatment. Coupling these studies together, initial results indicated that ornamental grasses which receive less water will use less water and can still result in healthy, beautiful plants and large scale water savings.

Specified Source(s) of Funding: Water Resource Institute, Colorado Agricultural Research Station

9:45–10:00 AM

Graywater as an Alternative Irrigation Water Source for the Green Industries

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The use of alternative irrigation water sources has become an imperative premise to green industry activities. Their dependence on high quality and ground, surface, and potable water supplies is endangered by severe and lengthy droughts and stiff competition from other extensive human uses and allocations, and scrutiny on the environmental impact of green industry activities. Landscape irrigation is the largest user of water in urban setting with reports suggesting it accounts for ≥ 50% of the total residential potable water use. Graywater—untreated water that comes from laundry washers, showers, and bathtubs, constitutes about 50% of the total household wastewater—has the potential for becoming a significant source for landscape irrigation. While studies from our group and others suggest laundry graywater effluents can be used to satisfactorily grow ornamental plants, there is concern over the long-term effects of graywater irrigation on the chemical, physical, and biological characteristics or urban landscape soils and their surrounding built and native ecosystems. We have established long-term landscape graywater irrigation studies on replicated landscape plots to evaluate these effects, and to serve as a demonstration and educational platform to provide answers and practical solutions to the potential use and management of residential graywater irrigation.

Specified Source(s) of Funding: ARS–USDA (NFRI), HRI

Tuesday, 4 August 2015

Undergraduate Student Oral Competition

Moderator: Katherine Warpeha
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12:00–12:15 PM

Effect of Nutrient Application Rate on Plant Growth Indices and Biomass of Fennel (*Foeniculum vulgare* cv. Grosfruchtiger) Produced Within a Protected Agricultural Greenhouse System

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Fennel (*Foeniculum vulgare* cv. Grosfruchtiger), a member of the Apiaceae family, is a perennial crop cultivated for its culinary and nutraceutical use. All parts of the plant are aromatic and edible, and seeds are used for extracting essential oil, which is known to be a potent and powerful aid for digestive health. As a result, there is an increased demand for this unique crop. Traditionally, fennel has been cultivated in soil; soilless production within protected agricultural systems has been limited. This study investigated the effect of fertilizer rates on the growth of 'Grosfruchtiger' in a protected agricultural environment. Fennel seeds purchased from Johnny's Selected Seeds (Winslow, MA) were germinated in a soilless substrate in a greenhouse at the Mid-Florida Research and Education Center located in Apopka, FL. Four weeks after germination, seedlings were transplanted into 7.6-L containers filled with soilless substrate (Fafard 4 Mix, Sun Gro Horticulture, Agawam, MA) and watered through a drip irrigation system. A slow release fertilizer (Osmocote Exact Standard, Everris International, The Netherlands) was applied at a rate of 2, 4, and 4 g/L after transplanting. Plant growth indices (width1 × width2 × height) were recorded weekly. Eight weeks after transplanting, plants were destructively harvested and dried in an oven at 65 °C until a constant dry weight was obtained to quantify shoot biomass. Differences in plant growth indices and biomass among nutrient application rates will be discussed. Results from this work will assist in selection of fertilizer application rates for fennel production in a protected production environment.

12:15–12:30 PM

Analysis of Genetic and Nutritional Diversity Among Selected Accessions of Dry Beans and Nuña Beans (*Phaseolus vulgaris* L.) from the USDA–ARS National Plant Germplasm System

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Beans (*Phaseolus spp*.) are one of the most economically and nutritionally important crops worldwide, with a value of over $17 billion harvested annually. They are one of the most ancient crops of the New World, having been cultivated for thousands of years. They are an environmentally diverse crop, growing in temperate and subtropical environments from sea level to more than 3000 m above sea level, and are consumed as either fresh pods or as a dry bean, making them an ideal nutritional food legume in areas where storage without refrigeration is necessary. They are the most important legume for direct human consumption with more than 23 million metric tons produced in 2013. Of the more than 20,000 *Phaseolus* accessions held at the Western Regional Plant Introduction Station (WRPIS), the most abundant species by far is *P. vulgaris* L. with over 17,000 accessions. Of these, 177 are described as "snap" varieties, grown for harvest as fresh vegetable, while the remainder are described as "dry beans." Among these, 90 are classified as nuña beans, or the Peruvian "popping" bean. These beans have been selected and raised among the Andean natives in the high mountains for millennia and have the unique characteristic of bursting when subjected to heat, making them a high protein food in conditions where boiling would consume scarce fuel. This property also makes these beans a potential nutritious snack food, both in and of themselves, as well as in the form of an extruded product. We analyzed the molecular diversity of 35 nuña and 8 common dry bean accessions and compared a range of nutritional factors, including protein, starch, sugars, phytate, and antioxidant activity. Genetic analysis using AFLP markers showed nuñas were distinct from the common dry beans analyzed, and there were two distinct groups within the nuñas. There was a similar wide range of nutritional characteristics within both the common dry beans and the nuñas. Values for nuñas and common bean respectively were: protein (18% to 25% and 17% to 27%), extractable polyphenols (50–350 and 50–450 mg/100 g GAE), non-extractable polyphenols (50–220 and 70–175 mg/100 g GAE), phytate (0.45% to 1.2% and 0.6% to 1.0%), and total antioxidant activity (8–52 and 7–48 mg TE). There is enough genetic variation in both nuña and common dry beans to breed popping beans adapted to a temperate, long-day environment and to develop a highly nutritious snack food for America.

Specified Source(s) of Funding: NP301:2090-21000-028-00

12:30–12:45 PM

Physical and Chemical Effects of Mulch on Weed Seed Germination

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Weed seed germination and subsequent growth results in a major cost to nursery owners, landscape contractors, and homeowners. The objective of this study is to determine how physical and chemical characteristics of different mulches impact weed seed germination. A mixture of three broadleaf (pigweed, spurred anoda, and morning glory) and three grassy (signal grass, crabgrass, and johnsongrass) weeds were broadcast over a nursery container containing soiless media mulched at several different mulches and at different depths. The media was a 3:1:1 bark:sand:peat:media (v/v), amended with a Osmocote 15–9–12 fertilizer at 2 lbs N/ cubic yard and 8 lbs/cubic yard dolomitic lime. Mulch materials included pine bark mulch, pine bark chips, hardwood chips, shredded pine straw, and a control. Particle size distribution was measured using USDA sieves ranging from 1" to < #30 and chemical analysis (pH, EC, P, K, Ca, Mg, Mn, Fe, Mo Cu, Zn) were tested at the LSU

Soil Testing Lab. Three mulching depths including 0, 2, and 4 inches were evaluated in this study. Nursery containers were evaluated over an eight-week period irrigated overhead using 0.5" of water twice daily as needed. There were significant differences measured between mulch material physical and chemical characteristics. Larger sized particles and shallow depths allowed greater light penetration. Hardwood bark pH was greater than both pine bark and shredded straw. Nutrient levels were also different among mulch materials. Generally, greater depths improved weed control and reduced plant growth. Future research will expand weed species and mulch materials in production systems.

12:45–1:00 PM

Capitalizing on the Benefits of Berries as a Treatment for Cancer

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It is widely known that berries are healthy, offering many benefits to the consumer. Berries serve as antioxidant sources to help prevent the action of free radicals in the body, which can have many destructive effects, such as oxidative damage. Berries also provide essential nutrients necessary in the human diet. These benefits can be substantiated through experimentation to investigate the human molecular pathways affected by the nutrients contained in these fruits. Our lab is particularly interested in the nutraceutical effects of the plant phenolic, gallic acid, and its potential role in preventing human stomach cancer. Gallic acid is a secondary plant metabolite found in blackberries, raspberries, and strawberries. It has previously been shown to induce cell cycle arrest in various types of cancer, including lung, breast, and colon cancers. The present study leverages microarray analysis, qPCR, and flow cytometry to study the effect that gallic acid has on both immortalized gastric cancer cell lines and freshly obtained primary human stomach cancers. We have found that gallic acid at concentrations similar to what would be experienced through the normal consumption of berries induces G0/G1 phase cell cycle arrest in human gastric cancer cells. Gallic acid also suppressed additional cellular pathways that would normally allow the gastric cancer to proliferate and invade other tissues. Our data provides molecular evidence that implicates the consumption of berries may be able to prevent the formation and growth of many types of gastrointestinal cancers.

Specified Source(s) of Funding: RI INBRE

1:00–1:15 PM

Variability of Storage Root Yield, Size, and Shape of Sweetpotato Mericlones

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Viruses and mutations can accumulate through vegetative propagation of sweetpotato resulting in reduced yield and quality. It is recommended that growers purchase foundation seed roots so that production fields are no older than three to four generations. Foundation seed production begins with using virus-tested (VT) plant stock maintained in vitro. A VT plant is derived from meristem tip culture and the resulting plant is tested on a virus susceptible indictor plant. If no symptoms are found after several rounds of testing, it can be declared VT. Many meristem tip cultures are done for a given variety with expectations that some still possess demonstrable viruses. The process of removing viruses from plants via meristem tip culture may introduce changes in phenotype due to mutations or somaclonal variation. The objective of this research is compare in field trial yield, shape, and trueness to type for a number of mericlones for several varieties. Results showed most mericlones were not variants and thus redundancy was reduced in the tissue culture collection by eliminating some mericlones. Several mericlones did appear less robust and off-type and not suitable for using as a parental source for foundation seed.

1:15–1:30 PM

Within-week Turning Frequency May Not Strongly Impact In-vessel Food Waste Composting

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Composting is one way to reduce landfill inputs, while simultaneously producing a soil amendment that can act as a fertilizer and moisture moderator. Composting can occur outside in piles or windrows or in a closed, in-vessel system such as an Earth Tub™ . In-vessel systems are purported to provide better control of temperature and moisture conditions to facilitate the composting process. Earth Tub™ vessels have screw augers for mixing and aerating materials, which is important for efficient thermophilic composting. The goal of this research was to determine if daily mixing is required to effectively compost pre- and post-consumer food waste feedstock with a woodchip bulking agent. A turning frequency (treatment) of 3 days/week compared to 7 days/week was evaluated throughout two vessel filling and composting processes. Temperature, pH, electrical conductivity (EC), and moisture content were measured weekly during vessel filling followed by a final 30-day composting interval during which no new inputs were added to the vessels. Additionally, compost C:N ratio and water soluble carbon concentrations were measured at the conclusion of composting. Moisture ranged from 36% to 68% with the 7 days/week and 37% to 68% with the 3 days/week treatment. The pH ranged from 5.0–8.3 with 7 days/week and 4.5–7.8 with 3 days/week turning, while EC

An asterisk (*) following a name indicates the presenting author.

ranged from 1.5–8.2 mS/cm with 7 days/week and 1.0–7.2 mS/cm with 3 days/week turning. Moisture, pH, and EC all vary throughout time but, across the two mixing frequencies, moisture, pH, and EC were similar in the last weeks of composting. The 3 days/week treatment did reach 55°C for a period of 28 days during one run; however, the 7 days/week treatment only crossed the 55 °C threshold at only two sampling points during the same run. Composting in Earth Tubs™ does not appear to be strongly affected by a 3 days/week compared to 7 days/week turning frequency, reducing labor requirements, which may have implications for sustainable commitment of volunteer groups involved in composting. For in-vessel composting of food waste feedstock with wood chip bulking agents, optimization of parameters other than aeration frequency may be required to facilitate effective thermophilic compost processing and to produce a high quality final compost product.

Specified Source(s) of Funding: University of Arkansas Honors College; Bumpers College Undergraduate Research and Creative Project Grants Program

1:30–1:45 PM

Evaluation of an Aquaponics System

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Aquaponics is an agricultural system that symbiotically combines aquaculture and hydroponics in a recirculating, closed-loop system. Nitrifying bacteria, once established, convert fish waste into plant fertilizer for hydroponic plant growth, while simultaneously acting as a biofilter for aquaculture. The objectives of this research included evaluation of water quality and plant health in an aquaponics system. To achieve this, an aquaponics system was designed, constructed, and implemented with a media-filled-bed (MFB). The system was designed to be low-cost, easily assembled from readily available components, and modular. Once designed, constructed, and placed into operation, the aquaponics system was maintained over nine months with water quality parameters and plant growth data recorded. This nine-month period consisted of two phases: 1) initial system cycling, maturation, and viability assessment; and 2) plant health and growth evaluation. During phase one titration tests were regularly conducted to measure fluctuations in pH, ammonia, nitrite, and nitrate levels. The goals of these tests were to determine whether the system had "cycled," defined by the effective microbial conversion of fish waste by-products (ammonia) into nitrates for plants. During phase two, a variety of plants were transplanted into the system and observed over a four-month period. The plants were photographed and measured at weekly intervals and titration tests were conducted for pH, nitrates, and ammonia. Nitrate, nitrite, ammonium, and pH data will be presented. Plants were observed for nutrient deficiencies and pest populations. The system was able to produce vigorous plant growth in varieties with high nitrogen demand due to consistently high levels of nitrates. However, overall plant health varied due to observed deficiencies in other nutrients, such as potassium and iron. It was concluded after phases one and two, that the aquaponics system, as designed and constructed, was a viable agricultural technology with certain important limitations.

Specified Source(s) of Funding: Sam Houston State University

Tuesday, 4 August 2015

Nursery Crops

Moderator: Yan Chen
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1:45–2:00 PM

Carbon Footprint and Costs of Pot-in-Pot Production System Components Using Life Cycle Assessment

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Input materials and operations for the components of a model pot-in-pot (PIP) production system were analyzed using life cycle assessment methods. The impact of each component on global warming potential [GWP; kilograms of CO_2-equivalent (CO_2e)], or carbon footprint, and variable production cost was determined for 5-cm-caliper *Acer rubrum* L. 'October Glory' in a #25 container. Greenhouse gas emissions (GHG) of inputs and processes invested in the product at the nursery gate approached 17 kg CO_2e. Carbon sequestration weighted over a 100-year assessment period was estimated to be 4.6 kg CO_2, yielding a nursery gate GWP of approximately 12 kg CO_2e. The major contributors to the GWP at the nursery gate were the substrate, production container, the 3.17-cm-caliper, bare root liner, and PIP system installation while the liner and production container also contributed significantly to the variable costs. Input materials and labor constituted about 72% and 25% of variable costs, respectively. Unlike field production systems, equipment use in PIP production accounted for only 10% to GHG emissions and 2% of variable costs.

Specified Source(s) of Funding: Horticultural Research Institute

2:00–2:15 PM

Rice Hull Ash as Substrate Amendment

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Nursery production of woody ornamentals uses pine bark in various sizes as the main component of potting substrate. Pine bark has a low water holding capacity in the beginning of production, which is coupled with a young plant that does not utilize a lot of nutrients, resulting in high leaching and low fertilizer and water use efficiency. Several amendments such as peat moss can increase water-holding capacity but will decompose overtime and may result in poor drainage during rainy season or major storms. Rice hull ash (RHA) is a by-product from power plants and available to Louisiana growers at a low price. It has the potential to increase water holding capacity and less likely to decompose within 6- to 12-month production cycles. In our first experiment, RHA was mixed into pine bark at 0, 5%, 10%, and 20% (by volume) to determine its water holding capacity and leachate chemical properties. In the second experiment, growth and quality of Knock Out rose 'Double Red' in response to RHA at above rates were evaluated for six months. Results indicated that RHA stayed in the 5-gallon container and increased water holding capacity of a grower's pine bark mix by 16% or 18% at 10% mixing rate when overhead or drip irrigation were used, respectively. 'Double Red' Knock Out roses grew larger with greater biomass in the 10% and 20% RHA treatments possibly due to the additional nutrients provided by RHA. However, pH and EC in leachates of 20% rate were significantly higher than the ranges commonly considered safe for many plant species. These results suggest that RHA has the potential to be used as a potting substrate amendment to increase water holding capacity of pine bark but is limited to grow plants that can tolerate high pH and EC, and further study is needed to determine total leachate of nutrients over a longer production cycle before RHA can be recommended for being used in container production.

2:15–2:30 PM

Plant Growth and Nutrient Uptake of Encore Azalea in Response to Nitrogen Availability and Container Type

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An efficient nutrient management program is crucial to maximize success (high quality finished product as well as profitability) in the nursery production of ornamental crops. Generally, the goal of nutrient management is to identify a rate of fertilizer high enough to satisfy the nutrient requirements for the target crop while avoiding excessive plant growth, or leaching of nutrients to the environment. However, the nutrient requirement of a crop does not remain constant during a growing season. Therefore, the objective of this study was to investigate on a biweekly interval the nutrient uptake of Encore azalea 'Chiffon' through one growing season. The results will serve as a guide for the timing of fertilizer application at rates according to plant requirements at a given stage of production. One-year-old azalea liners were potted in April 2013 to two types of one-gallon containers: a conventional black plastic container or a biodegradable container made from recycled paper. Plants were fertilized twice per week with 250 mL of modified Hoagland's solution containing either 0 or 15 mM nitrogen (N). From May to December 2013, five plants from each treatment combination were harvested every two weeks for nutrient analysis. Plant height, width, and leaf SPAD were measured before each harvest. The higher N rate (15 mM) increased tissue N concentration (leaf, stem, and root), tissue and total plant dry weight, plant growth index, and leaf SPAD readings at most harvest dates. Container type did not influence N concentration in the leaves. Plants grown in plastic containers started to show higher N concentration in stems and roots in September compared to those in biocontainers. Biocontainers didn't influence plant dry weight from May to August, but increased tissue and total plant dry weight from September to December.

2:30–2:45 PM

National Survey of Ornamental Grower Practices

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In order to better understand ornamental grower production practices nationwide, an extensive survey was released through a variety of sources, including Extension agents and grower contacts at tradeshows. The survey asked growers for detailed information about a number of topics including their water source(s), total income, income from ornamental production, production costs, irrigation type, and plant loss rates. These results were then compiled into a database for analysis. Regional and national trends in ornamental production will be discussed, based on survey results. This information is helpful for determining current grower practices and provides a baseline to measure changes over time.

Specified Source(s) of Funding: Award # 2009-51181-05768
NIFA Award# 2014-07875

2:45–3:00 PM

Root Disease Incidence and Severity in Nursery Crops with Soil Moisture Sensor-based Automated Irrigation

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Conventional (e.g. timer-based) irrigation control in commercial ornamental production is based largely on grower intuition and experience with a crop. When in doubt, growers typically irrigate excessively out of precaution. Elevated soil moisture content has been shown to predispose crops to root pathogen infection and thereby increase crop losses. Losses from disease for some specialty crops can approach 30%, significantly impacting growers' profitability. Preliminary data and observations from studies conducted in commercial nurseries have suggested a relationship between the use of soil moisture sensor based automated irrigation and a reduction in disease-related mortality. In this study, an irrigation controller, connected to dielectric moisture sensors, was used to maintain substrate volumetric water content (θ) when θ dropped below a programmed threshold. Three irrigation treatments were examined, with the first two treatments maintaining θ at 0.20 $m^3 \cdot m^{-3}$ and 0.30 $m^3 \cdot m^{-3}$, respectively. The third treatment sought to replicate the soil moisture profile of conventional irrigation patterns by allowing θ to dry to 0.20 $m^3 \cdot m^{-3}$ before an irrigation event that raised θ to 0.30 $m^3 \cdot m^{-3}$. Three species (*Rhododendron sp*. 'Roseum Elegans', *Kalmia latifolia* 'Sarah', and *Pieris japonica* 'Prelude') were grown under each irrigation treatment. Half of the plants in each irrigation treatment were inoculated with *Phytophthora nicotiana* and growth and mortality were tracked throughout the trial. Variations in mortality were observed among treatments and only noted in inoculated plants.

Specified Source(s) of Funding: Georgia Department of Agriculture

Tuesday, 4 August 2015

Vegetable Breeding 1

Moderator: Changbin Chen
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3:15–3:30 PM

Exploring Phenotypic and Genotypic Diversity and Freedom to Operate in Commercially Available Carrot Cultivars

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Over the past 50 years, the freedom to use plant genetic diversity has become increasingly complicated by a variety of intellectual property rights (IPR). While the majority of these protections have been in agronomic crops, there is an increasing use of IPR in horticultural crops as well. This trend impacts plant breeders' and farmers' freedom to operate and the ability to use, access and share plant genetic diversity. We examined what freedom to operate looks like in a single crop: carrot, beginning with a set of 142 commercially available carrot cultivars. Three datasets were collected: 1) phenotypic diversity on root and shoot characteristics of each cultivar grown on two organic farms in 2013 and 2014; 2) Illumina genotype by sequencing information for each cultivar; and 3) an accounting of any form of legal protection or restrictions associated with each cultivar that may impact future breeding efforts. These datasets were used to map clusters of phenotypic and genotypic diversity in carrot, overlaid by data indicating where this diversity may be used and where this diversity is restricted for breeding. Cultivars comprising all of the different market classes in carrot were planted. There was variation in root phloem color ranging from light orange to dark orange, purple, red, yellow, and white. Additionally, there were several different types of use restriction placed on carrot cultivars including contracts, "bag tag" licenses, and utility patents. In order to demonstrate the effect of intellectual property rights on plant breeding within this crop, and to ensure at least some of this diversity remains available into the future, we created eight synthetic populations using the 87 cultivars that had freedom to operate out of the 142 cultivars included in the study. The eight synthetic populations were developed based on market class and root color. The market class populations were classified as Nantes, Danvers, Chantenay, and Parisienne, and are meant to represent those root shapes. The root color populations are red, purple, white, and yellow. Populations were developed from a synthetic of intermated roots that were composed of 3–19 cultivars with replicated roots of each cultivar. These populations are now in the Syn2 generation. Understanding access to and utilization of diverse germplasm will help facilitate the development of new cultivars with useful traits for farmers and will ensure genetic diversity essential for resilient agricultural systems.

Specified Source(s) of Funding: Seed Matters, UW-Madison, NCR-SARE, Ceres Trust

3:30–3:45 PM

Mapping of the Tomato Begomovirus Resistance Gene *Ty-6* and the Resistance Provided to Two Viruses by *Ty-6* Alone and in Combination with *Ty-3* or *ty-5*

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Whitefly-transmitted begomoviruses are a major disease problem for many tropical and sub-tropical tomato production regions of the world. The bipartite *Tomato mottle virus* (ToMoV) was the first begomovirus identified in Florida in the early 1990s, but by the late 1990s ToMoV was displaced by the monopartite *Tomato yellow leaf curl virus* (TYLCV). Multiple resistance genes (termed *Ty* genes) have been introgressed into cultivated tomato, primarily from wild tomato species, and these provide an effective means of disease control. Some of these genes, however, are ineffective against certain begomovirus species and/or strains. A better understanding of each gene's efficacy against various begomoviruses, along with availability of linked molecular markers for each, is necessary for the efficient and durable deployment of resistance in commercial cultivars. Earlier*Ty-6* mapping efforts were unsuccessful due to a lack of molecular markers that saturated the tomato genome, but recent genomic advances have overcome this problem. The *Ty-6* gene was mapped on chromosome 10 near 63 Mb according to the SL2.50 tomato genome assembly. Whole genome re-sequencing of *Ty-6* inbred breeding lines revealed a *Ty-6* genic region with very few polymorphisms and no evidence of a typical wild species introgression. These findings shed new light on our previous difficulties locating *Ty-6*, and our data provides a valuable resource for robust molecular marker development and potential *Ty-6* cloning efforts. The effect of *Ty-6* alone and in combination with either *Ty-3* or *ty-5* against two different begomoviruses was investigated. *Ty-6* alone provided moderate and high levels of resistance against TYLCV and ToMoV, respectively. The greater effect of *Ty-6* against ToMoV suggests that this gene may be particularly useful for control of bipartite begomoviruses. In general, the highest levels of resistance were obtained when *Ty-6* was combined with either *Ty-3* or *ty-5*.

3:45–4:00 PM

Genetics and Breeding of Tomatoes for Short-season Locations and Unique Cultural Interest

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Tomato (*Solanum lycopersicum*) is the world's second most consumed vegetable by humans and one of the most popular home garden plants and field crops. Most of the 7000 currently available tomato cultivars are adapted to high tropical and subtropical climates. Only a very few cultivars are suitable for short season locations such as northern Minnesota and often result in low yields. We have been breeding tomatoes for eight years to meet special horticultural needs, such as for northern gardens and farms with short growing seasons and for the special interests of various human cultural backgrounds. Three novel dwarf tomato varieties are being commercialized, each of these new varieties is dwarf, only need a very short growing season, and obtain high yields in greenhouses, home gardens, and large scale farm fields. We also select tomatoes with special fruit forms that are of interest to certain cultures. For example, we have developed a variety that forms very unique "8" shaped tomato fruits, which has great potential for consumers in the oriental countries, since "8" is a fortune number to many people in these countries. In China, the pronunciation of "8" is similar to "good fortune." From a genetic perspective, each of the four varieties we report develops structurally improved flowers that promote self-pollination.

Specified Source(s) of Funding: MAES (Minnesota Agricultural Experimental Station)

4:00–4:15 PM

The Use of Seed Germination Rate as an Indicator of Heat Tolerance in Spinach (*Spinacia oleracea* L.)

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Spinach is a cool season crop with very specific optimum temperatures requirements. Heat tolerant cultivars would allow production to be improved so that spinach may be grown in early summer or as a year-round vegetable crop in greenhouses or high tunnels. Breeding for heat tolerant varieties requires that heat tolerance can be assessed efficiently, and seed germination under heat stress could potentially serve as a screening tool. The objective of this study is to determine whether germination rate could be used to indicate and screen for heat tolerance. Two experiments are conducted in this research in growth chamber conditions. In Experiment 1 of the seed germination test, four cultivars are evaluated for seed germination at 20 °C (the optimum temperature for spinach germination) and at 35 °C (the temperature for heat stress) using a randomized complete-block design (RCBD) with three replicates. Seeds are pretreated for surface sterilization and then placed in petri dishes with moistened blotter paper. To avoid water loss, dishes are placed in plastic zip closure bags. Germinated seeds are counted and removed on 7-day intervals starting the seventh day after germination and

continuing through 21 days. Seed germination is recorded and percentage is calculated. Based on Experiment 1, Experiment 2 incorporates the seed germination test into the whole spinach plant growth. Seeds are sown in trays filled with pre-moistened Sun Gro Horticulture Sunshine Mix #1 and allowed to germinate for 10 days at 20 °C. Then, the seedling group for heat stress is transferred to 35 °C while the control group is maintained at 20 °C. Plants are grown for an additional 20 days. Shoot height, leaf number, and the dry weight of the biomass are used for evaluating growth. Germination rate is considered a predictor of heat tolerance if the performance of the cultivars in Experiment 1 of the seed germination test is analogous to those in the Experiment 2 of the whole plant test.

4:15–4:30 PM

Preliminary Studies on Obtaining Haploid Plants in Spinach

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This presented study contains the preliminary results of the project numbered as "TAGEM/BBAD/12/A09/P10/01" carried out by Republic of Turkey Ministry of Food, Agriculture and Livestock to develop protocol for obatining haploid embryo in spinach. Pollination with irradiated pollen and anther culture methods were used to obtain haploid plants in this study. For the study of anther culture, three spinach varieties (Koto, Favorit, and Greenstar) and 4 different growth media (MS+2 $mg \cdot L^{-1}$ NAA+0.5 $mg \cdot L^{-1}$ GA3, MS+4 $mg \cdot L^{-1}$ NAA+0.5 $mg \cdot L^{-1}$ GA3, MS+ $mg \cdot L^{-1}$ NAA+1 $mg \cdot L^{-1}$ BAP+ MS+4 $mg \cdot L^{-1}$ NAA+1 $mg \cdot L^{-1}$ BAP) were tested to obtain haploid embryos. Gynogenesis studies using irradiated pollen was performed with again same three spinach varieties and three gamma ray doses (100, 150, and 200 Gy) coming from Co^{60}. The MS nutrient medium containing 1 $mg \cdot L^{-1}$ IAA was used for embryo germination. Outcame of this study showed that different varieties produce different results on the doses of gamma ray. Embryo germination and plant regeneration from these embryos were provided from 100, 150 Gy gamma ray doses of Koto and Greenstar varieties and 150, 200 Gy of Favorit variety. Molecular studies revealed that plants obtained from the embryos were spontaneous dihaploid. In terms of both the number of embryos and the number of plants obtained, Koto variety was found to be the most successful variety and 150 Gy most successful dose.

Specified Source(s) of Funding: GTHB-TAGEM

Tuesday, 4 August 2015

Viticulture and Small Fruits 2

Moderator: Jessica Lilia Gilbert
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4:30–4:45 PM

Blueberry Flavor Biochemistry

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In an attempt to identify specific biochemical breeding targets associated with blueberry flavor, the use of consumer-assisted selection was implemented through large consumer sensory panels in conjunction with biochemical profiling of blueberry fruit. Over the course of three years, 217 repeat-panelists rated the fruit quality parameters of overall liking, texture, sweetness, sourness, and flavor intensity for 19 blueberry cultivars in 30 sensory panels. Glucose, fructose, sucrose, soluble solids (SS), titratable acidity (TA), pH, and 53 volatile compounds were quantified for each sample. Linear regression was employed to visualize relationships between sensory measurements and the primary biochemical components. Of 153 total blueberry samples assayed in sensory panels, every sample scored in the positive region of the hedonic scales for overall liking and texture liking. Overall liking of blueberries was significantly related ($P < 0.001$) to favorable texture (R^2=0.60), and intensities of sweetness (R^2 =

An asterisk (*) following a name indicates the presenting author.

0.49), flavor (R^2 = 0.45) and sourness (R^2 = 0.04). The relationship between flavor intensity and texture liking was also very linear (R^2 = 0.47) and highlights the integration of discrete senses in the brain. Perceived sweetness was best explained by measures of sugars, including SS (R^2 = 0.30), fructose (R^2 = 0.30), total sugars (R^2 = 0.27), and glucose (R^2 = 0.19). Although significant, measures of sucrose were much less suitable as a predictor of sweetness (R^2 = 0.05) likely due to very low concentrations in blueberry fruit. Overall liking and sweetness were negatively correlated with TA (R^2 = 0.19, R^2 = 0.30), while TA explained over half of perceived sourness (R^2 = 0.53). An even better explanatory variable of perceived sourness was pH (R^2 = 0.58). A partial least squares (PLS) regression analysis was constructed to reveal further interactions of volatile compounds contributing to liking and sensory intensities. Volatiles have previously been implicated in sweetness and flavor intensity in fruits such as strawberry and tomato, and comparatively it appears that blueberry volatiles behave uniquely. This model can be used to target up- and downregulation of particular compounds in blueberries for increased consumer favor. To please the greatest number of consumers, focus should be placed on developing sweeter, more flavorful blueberries with good texture attributes, in addition to common commercial traits such as yield and disease resistance.

Specified Source(s) of Funding: UF Plant Molecular Breeding Initiative

4:45–5:00 PM

Strategies for Maintaining Fruit Quality in Northern Highbush Blueberry under Water-limited Conditions: Deficit Irrigation and Reduced Crop Loads

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Many commercial blueberry (*Vaccinium* sp.) fields are irrigated, but mandatory water restrictions may soon limit the availability of irrigation water in several important blueberry growing regions such as California and eastern Washington. New strategies are needed to maintain fruit quality with less water. Two potential options, including crop thinning and deficit irrigation, were evaluated for two years in a mature planting of northern highbush blueberry (*V. corymbosum* L. 'Elliott'). Treatments included a combination of normal and 50% reduced crop loads and either no drought or 6 weeks of drought (little rain and no irrigation) during early (Stage I-II) and late stages (Stage II-III) of fruit development. Plant water potential declined to –1.2 to –1.3 MPa with drought during the early stage of fruit development and to –3.0 to –3.2 MPa with drought during the late stage. Early drought had no effect on effect on yield, while late drought reduced yield at both crop loads by an average of 40%. Crop load reduction had no effect on plant water potential or photosynthesis during drought at either stage but, compared to the normal crop load, increased berry diameter and average berry weight by 2% to 20%. Plants exposed to early drought had greater fruit bud set than those that were well-irrigated, while plants exposed to late drought had lower fruit bud set. Overall, the results suggest that blueberry may be minimally affected by drought during early stages of fruit development, and thinning the crop to 50% may result in larger fruit at harvest when plants are exposed to drought at any stage of fruit development.

5:00–5:15 PM

Major and Minor Anthocyanins and Anthocyanidins Recovered during Juice Processing Steps in Rabbiteye Blueberries by LC MS-MS and UPLC-UV

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Blueberry-rich diets deliver anti-inflammatory, anti-carcinogenic, and anti-mutagenic components that help protect the brain, cardiovascular and central nervous system, and apparently reduce cancer, obesity and type 2 diabetes. Heightened consumer awareness of the health benefits of consuming phytonutrient-rich fruits and aggressive marketing have resulted in expanding markets for blueberries, and their associated products. Over the last decade (2002–12), the southeastern United States (Alabama, Arkansas, Florida, Georgia, Mississippi, and North Carolina) blueberry production and utilization has increased 3.4-fold while the national value of the utilized blueberry crop increased over four-fold from $194.6 million to $781.8 million. One of the major classes of phytochemicals in blueberries are the phenols; specifically the anthocyanins. Blueberry juice processing has multiple steps with each one affecting the chemical composition of the berries. Anthocyanin decreases have been reported in thermally processed commercial juices. We therefore set out to improve juice quality by using HTST pasteurization in a not-from-concentrate (NFC) regime. The NFC blueberry juice was made from heating and enzyme treating berries before pressing, followed by ultrafiltration and pasteurization. Using LC-MS-MS, major and minor anthocyanins were identified and semi-quantified. Ten anthocyanins were identified, including five arabinoside and five pyrannoside anthocyanins. Three minor anthocyanins not reported before in rabbiteye blueberries were identified. These were delphinidin-3-(p-coumaroyl-glucoside), cyanidin-3-(p-coumaroyl-glucoside), and petunidin-3-(p-coumaroyl-glucoside). These compounds did not significantly change with ultrafiltration and slightly decreased with HTST pasteurization. The five known anthocyanidins (cyanidin, del-

phinidin, malvidin, peonidin, and petunidin) were quantified with standards using UPLC-UV. Raw berries and press cake contained the highest total anthocyanidin contents with 0.519 mg/mL and 2.656 mg/mL respectively. There was a 46% to 60% loss in total anthocyanidins from fresh fruit to non-clarified and clarified (ultrafiltered) juices, respectively. Yet, increases of 17% in anthocyanins and 26% in anthocyanidins were seen in ultrafiltrated juice (versus unfiltered) due to membrane concentration during filtration. Pasteurization of NFC juices resulted in only roughly 4.7% to 5.3% anthocyanidin loss.

Specified Source(s) of Funding: USDA–ARS

5:15–5:30 PM

Xylella fastidiosa in Rabbiteye Blueberry: Detection of the Bacterium and Association with Yield Loss

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Previous greenhouse work at the University of Georgia suggested that *Xylella fastidiosa* was not a major concern in rabbiteye (*Vaccinium ashei* Reade) blueberry. Sampling of twenty orchards in Louisiana and Mississippi, however, has revealed infection in a limited number of orchards, in rabbiteye bushes in various states of vigor. Analysis of data collected on forty naturally infected or non-infected plants (*V. ashei* 'Tifblue') in Louisiana during the 2013 and 2014 seasons revealed a significant difference in total yield per plant between those in which *X. fastidiosa* was (5.2 kg, n = 9) and was not (12.8 kg, n=31) detected. The difference in average berry weights, based on 25 berry samples at each harvest date, was marginally significant, with berries from *X. fastidiosa*-positive plants averaging 1.3 g and those from *X. fastidiosa*-negative plants averaging 1.4 g. Soluble solids concentrations were higher, on average, in *X. fastidiosa*-positive (11.5%) than *X. fastidiosa*-negative (10.1%) plants, based on a non-parametric analysis of samples from one harvest date in 2014. Plant samples taken bimonthly have revealed variation in the detectability of the pathogen in different plant parts. Repeated sampling of two plants from February through June suggested that detection of *X. fastidiosa* by real-time polymerase chain reaction (qPCR) on DNA from root sap was more reliable than detection by qPCR on DNA from stem sap or by enzyme-linked immunosorbent assay (ELISA) on petiole/midrib tissues or most recent shoot growth (sampled when leaves were absent). Tracking of detectability of the pathogen continues, with an increased sample size. Additional work is being done to determine the genotype(s) of *X. fastidiosa* isolates from rabbiteye blueberry and to identify rabbiteye cultivars that are resistant or tolerant to *X. fastidiosa*.

5:30–5:45 PM

Microbial Iron Reduction: A Secondary Source of Fe^{2+} in the Southern Highbush Blueberry Rhizosphere

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Iron reduction from Fe^{3+} to Fe^{2+} by plasma membrane ferric chelate reductase (FCR) is the rate-limiting step in the iron uptake mechanism of the southern highbush blueberry (SHB, *Vaccinium corymbosum* hybrids) and other strategy I plants. Although FCR activity is typically measured from root tissue, root and rhizosphere-associated microorganisms are also able to reduce iron. We hypothesized that microbial iron reduction could increase Fe^{2+} availability in the SHB rhizosphere. The ex situ FCR activity of fungi and oomycota isolated from roots of hydroponically grown SHB was measured, and the taxonomic identity of the isolates was determined by sequencing of ITS genomic regions. Three of the 47 isolates were then selected based on their ex situ FCR activities for an in vitro compatibility study based on their relative growth rate. Basidiomycete *Phanerochaete sordida*, ascomycete *Penicillium polonicum*, and oomycete *Pythium irregular*e were successfully co-cultured to create a microbial consortium, which was used to inoculate roots of sterile, micropropagated SHB cv. Snowchaser plants. The effect of inoculation on the iron nutrition of SHB under iron limiting (–Fe) and iron sufficient (+Fe) conditions was tested in two separate experiments carried out in an in vitro growth system. Inoculation with the microbial consortium did not affect root FCR activity or localization, regardless of iron concentration. Iron uptake by inoculated plants was lower than uptake by non-inoculated controls under +Fe conditions, but not under –Fe conditions. Under +Fe conditions, inoculation with the consortium led to increased Fe^{2+} concentration in the medium. The microbial consortium increased Fe^{2+} concentration in the rhizosphere without directly affecting plant FCR activity, suggesting that microbial iron reduction could be a neglected source of Fe^{2+} in the blueberry rhizosphere.

5:45–6:00 PM

Grapevine Recovery from Herbicide Damage

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Grapevines are notoriously susceptible to damage from herbicide drift, especially phenoxy herbicides such as 2,4-dichlorophenoxyaceticacid (2,4-D). Two causes of injury occur: damage from particle contact with the leaves, shoots and/or flowers, and epinastic responses to volatilization of the herbicide that

subsequently moves to the plants by diffuesive and air current movement. This report focuses on recovery from serious herbicide damage events of 2012 and 2013, with emphasis on differences related to genotype. We reported previously that these hericide incidents exhibited significantly different responses among several cultivars, with several genotypes being severely damaged, wheras there was less damage observed on a select small number of genotypes. Observations after two and three years indicated varying recovery rates that were not always consistent with the earlier observations; that is, some genotypes that had severe symptoms recovered better than others that had appeared to be initially affected to a lesser degree. Death of some plants (e.g., 'Chambourcin') may have been accelerated by the herbicide damage, or it may have been simply a matter of predictable winter kill. Conversely, a genotype exhibiting the most severe herbicide damage following the 2012 incident ('Sabrevois') recovered better than predicted. Questions regarding genotype susceptibility to herbicides as impacted by growing season and other environmental factors will be presented for further discussion.

Tuesday, 4 August 2015

Growth Chambers and Controlled Environments 1

Moderator: Xiuming Hao
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4:45–5:00 PM

Water Use Efficiency of Four Types of Lettuce (*Lactuca sativa*) in Response to Different Drought Severities

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Lettuce is the most consumed vegetable crop, according to a 2008 USDA product summary. Climate change may increase the frequency and severity of droughts, which can adversely affect lettuce production. The economic importance of this crop and its sensitivity to drought create the need to understand the response of lettuce to drought stress. The goal of this study was to understand growth and water use efficiency of lettuce under drought. Four types of lettuce ('Bibb', 'Romaine', 'Iceberg', and 'Loose Leaf') were grown in a glass-covered greenhouse under a range of irrigation treatments to induce different drought stress conditions. To achieve different irrigation volumes and drought severities, five different drip emitters (2, 4, 6, 8, and 10 L/h) were used on each irrigation line. Each type of lettuce had a soil moisture probe in a pot with a 10 L/h emitter. When the volumetric water content in this pot dropped below 0.40 $m^3 \cdot m^{-3}$, an irrigation valve was opened for 10 s, irrigating all plants of that particular cultivar. The use of different drip emitters assured the different plants received different amounts of water. Chlorophyll index increased with increasing drought severity in all four lettuce types. No significant difference was found in leaf chlorophyll fluorescence among the different lettuce types. Total leaf area, total leaf number, and shoot dry weight decreased significantly with increasing drought severities in all types, except for 'Iceberg'. All four types showed an increase in water use efficiency under increasing drought severity, with 'Loose Leaf' lettuce being the most responsive. Our results show that water use efficiency in lettuce increases under drought stress conditions, which is important to consider when growing lettuce in areas with limited water availability.

5:00–5:15 PM

Hybrid Lighting Configurations with Top HPS Lighting and LED Inter-lighting and N:K ratios in Nutrient Feedings Affected Plant Growth, Fruit Yield, and Light and Energy Use Efficiency in Greenhouse Tomato Production

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Year-round greenhouse vegetable production with artificial lighting in northern regions is capital and energy intensive. To be successful, the lighting system and crop/nutrient management must be optimized to maximize crop productivity and light and energy use efficiency (LUE and EUE). Light emitting diodes (LEDs) is energy-efficient, and can be used as inter-lighting inside crop canopy (because of its low surface temperature) to improve canopy vertical light distribution and LUE and EUE. However, it is much more expensive than HPS (high pressure sodium lamps, high operation temperature). Therefore, it will be more economical feasible to use a hybrid lighting system using HPS as top light and LED as inter-lighting. In this study, two greenhouse trials were conducted from Fall 2012 to Spring 2013 to evaluate various lighting configurations with top HPS lighting and LED inter-lighting and nutrient treatments (N:K ratio) to develop and optimize the hybrid lighting system and nutrient supply for greenhouse tomato production with lighting. Trial one evaluated nine lighting configurations [3 top light levels (0, 120, or 200 $\mu mol \cdot m^{-2} \cdot s^{-1}$ of HPS) x 3 inter-light levels (0, 37, or 74 $\mu mol \cdot m^{-2} \cdot s^{-1}$ of LED inter-lighting)] on a vigorous

An asterisk (*) following a name indicates the presenting author.

beefsteak tomato cultivar DRW7749. Trial two tested various 3 levels of top HPS lighting and LED inter-lighting on a generative cluster tomato cultivar Komeet. Three nutrient (N:K ratio, 1:1, 1:2, and 1:3 ppm:ppm) treatments were applied within each lighting configuration in both trials. The best lighting configuration for 'DRW7749' seemed to be 120 μmol·m^{-2}·s^{-1} top HPS lighting plus 74 μmol·m^{-2}·s^{-1} of LED inter-lighting (a top to inter-lighting ratio of 3:2), which had the highest LUE and EUE. The lighting configurations with various ratios of top HPS and LED inter-lighting had similar LUE and EUE in the early stage of fruit production. However, the LUE and EUE of the lighting configurations with higher proportion of LED inter-lighting was higher than those with low proportion of LED inter-lighting in late stage of fruit production, indicating LED allowed the plant to maintain its vigour until late stage of fruit production. This was especially true for the generative cultivar Komeet. The highest fruit yield was achieved with a N:K ratio of 1:2 in the nutrient feeding for cultivar DRW7749 while it was achieved with N:K ratio of 1:1 for 'Komeet', especially in late production period, indicating the generative cultivar required higher nitrogen supply to maintain vegetative growth/plant vigour when grown with lighting.

5:15–5:30 PM

Effect of Different Ratios of Red and Blue LED Light on Lettuce Production and Phytochemical Accumulation

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Light-emitting diodes (LEDs) emit a short span, monochromatic light, which permits the creation of a custom light spectrum that can more closely resemble the light spectrum needed by plants for photosynthesis. 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 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 the 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 lettuce and pepper fruit production. In this study three red to blue ratio levels (5:1, 10:1 and 19:1) compared to 100% red light for lettuce (*Lactuca sativa*). Seedlings were cultured in a growth chamber at 25 °C (+/–2.5 °C), ambient CO_2, and a 16-hour light, 8-hour dark photoperiod under fluorescent light. Seeds were germinated and two-week-old seedlings were planted in 1-inch rockwool cubes in trays for soilless hydroponic culture with half-strength Hoagland's solution and transplanted in LED light chamber. Lettuce plants were harvested after 4 weeks of transplant. The fresh biomass (aerial and fruit) was dried according to the ASABE standard (2007), with a temperature of 95 °C for no less than 72 hours and subsequently weighed. Leaf tissue samples were frozen before lyophilization (Gamma 1-16 LSC; Martin Christ, MBI, Kirkland, Quebec, Canada). Pigments were extracted and analyzed from freeze-dried tissues. Among the treatments of light, red to blue ratios of LEDs were found superior. The lowest significant growth (fresh mass and dry mass) and phytochemicals accumulation were observed in 100% red LED. This research will facilitate the improved selection of LEDs for control environment production.

5:30–5:45 PM

The Photosynthesis Action Radiation (PAR) Curve of Lettuce plants using Blue Narrow Spectrum LEDs

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Controlled environment food production is becoming more important globally because of increases in productivity. Moreover, the environmental factors that directly impact photosynthesis including temperature, humidity, light, CO_2concentration, and nutrient source are controlled through the computer-based, automated control. The electricity expenses of lighting systems, however, are still high since light is the driving factor limiting plant growth and yield. More detailed plant response data is required for the selection of optimal lighting systems to maximum plant production with minimum operation costs. Our research group is investigating the photosynthetically active radiation (PAR) curve of lettuce plant using narrow spectrum light emitting diodes (LEDs) under controlled conditions. These experiments are focusing on the plant response across a narrow wavelength range (430–500 nm) at light intensity of 30 μmol·m^{-2}·s^{-1} with a bandwidth of 10 nm. Our results will 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.

An asterisk (*) following a name indicates the presenting author.

5:45–6:00 PM

The Effect of Different Ratios of Red and Blue LED Light on Greenhouse Tomato Production

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Tomato is one of the most consumed crops in the world. In northern climates, tomatoes have a short time period for growing in the field; thus, to maintain supply and reduce shipping costs, tomatoes are grown locally in greenhouses. Conventional lighting systems for greenhouses utilize broad-spectrum light sources, such as high-pressure sodium (HPS) or fluorescent lamps. These lamps are excellent luminous sources for the human eye, but are not the most efficient light sources for plant production due to their low levels of blue light and other photosynthesis-sensitive wavelengths. Light-emitting diodes (LEDs) are a 50-year-old-technology that is showing potential in the greenhouse industry. With LEDs, specific wavelengths can be produced, creating a custom light spectrum targeted for maximum plant production. The purpose of this study was to determine which combination of red and blue LED light ratio was optimum for greenhouse tomato production. In this study three red to blue ratio levels (5:1, 10:1 and 19:1) were compared to HPS light for tomato. Seedlings were cultured in a growth chamber at 25 °C (+/–2.5 °C), ambient CO_2, and a 16-hour light, 8-hour dark photoperiod under fluorescent light. Seeds were germinated and in two weeks seedlings were planted in 1-inch rockwool cubes in trays for soilless hydroponic culture with half-strength Hoagland's solution and transplanted in LED light chamber in greenhouse. The greenhouse set points were 21 °C during the day and 16 °C during the night. The supplemental lighting was left on for 16 hours a day, from 06:00 HR to 22:00 HR. A central computer in the greenhouse was used as the control system. It controlled the lighting (on at 06:00 HR and off at 22:00 HR) and the ventilation, coupled with a mister, in order to keep the temperature close to the set points. The internal greenhouse temperature was monitored and controlled; relative humidity was monitored, but not controlled. Tomato fruits were harvested after four months of transplant. Fruit and flower numbers were counted at two-week 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. The lowest significant growth (number of flower, fruit, fresh mass, dry mass) was observed in control. This research will facilitate the improved selection of LEDs for commercial control environment production.

Tuesday, 4 August 2015

International Horticulture and Issues

Moderator: Robin G. Brumfield
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4:45–5:00 PM

Urban and Peri-urban Agriculture Agriculture/ Horticulture in the Developing World

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In the developing world, towns and cities are growing at fast rate. About 10 years ago, an estimated 40% of the developing world's population and 2 billion people lived in urban areas and by 2025 more than half of the developing world population (3.5 billion) is expected to be urban. In urban areas, the demand for food, job, space, energy, water, and other facilities are increasing. In this context, the contribution of urban and peri-urban agriculture (UPA) becomes a necessity and steps to be undertaken as essential to feed the teeming urban population. In order to augment UPA, it is incumbent on all stakeholders to recognize the contribution of UPA, to address the challenges to have progressive, dynamic and successful urban and peri-urban agriculture in a country. In UPA, among the inputs and outputs of agriculture, horticulture makes a large contribution. The developmental process demands for inter-ministerial, interdepartmental, and interdisciplinary approaches and an implementation mechanism in line with conservation and appropriate utilization of natural resources and the environment.

Specified Source(s) of Funding: Dr. P.N. Agricultural Science Foundation (PNASF), Bangalore

5:00–5:15 PM

Small Plot Farming to Ensure Food Security

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Small plot agricultural production can provide increased food security in areas adapting to climate change, primarily due to an increased flexibility and diversity in the choice of crops grown and more efficient water use. Case studies of small plot production in Nepal, India, Afghanistan, and the United States show an ability of farmers to select crops each season in response to weather and market conditions and to use up to 100% of available irrigation water with zero waste. These abilities increase the resilience of any given farm because the farmer can reduce the risk of failure with a variety of crops while selecting highly marketable crop varieties, conserving water and increasing income potential.

Specified Source(s) of Funding: USAID and USDA–FAS

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5:15–5:30 PM

Vegetable Landraces in the Souss Region of Morocco

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Landraces (or traditional crop varieties) are highly heterogeneous crop genotype mixtures that often provide slightly differing phenotypes under field conditions. The genetic heterogeneity contained within landraces is a valuable part of maintaining global diversity and is of paramount importance for world crop production. Subsistence farmers directly use traditional crop varieties as key component to sustaining their cropping systems. Landraces are diverse and dynamic gene pools that evolve over time under both farmer and natural selection pressures, and this high amount of genetic diversity allows landraces to adapt to drought, heat, saline soil, or other extreme environmental conditions, which is essential to maintaining long-term productivity in extreme environments. In Morocco, small landholders often use vegetable crop landraces and the genetic diversity within their landraces may be the only resource available to these farmers that allows them to cope with changing environmental conditions to optimize crop production. An assessment of vegetable crops maintained as landraces was conducted in the Souss region of Morocco in April 2014. From this evaluation, it was determined that some vegetable crops are still widely maintained as landrace populations (e.g., carrot, onion, turnip, melon, pumpkin, and watermelon), while others (e.g., tomato) are no longer maintained as landraces for several reasons. Thus, landraces still play an important role in vegetable crop production systems for small landholders in the Souss region of Morocco. Since vegetable landraces can adapt to local environmental conditions over time, they are critical components of crop production systems for these small farmers.

5:30–5:45 PM

Lasting Impacts of a Business Management Training Program for Turkish Women Farmers

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To empower Turkish women farmers through education, *Suzanne's Project* provided training in business planning and management and also included computer literacy, alternative production systems, soil productivity, plant nutrition, and other best management practices training. The courses resulted in 100% of the women completing most sections of an agricultural business plan by the end of the course using guided worksheets. A survey of women who participated in *Suzanne's Project* 1.5 years after they took the course indicated that it had lasting, positive effects on them. One hundred percent of the women felt more personally empowered after the course than before participating in *Suzanne's Project*. Eighty-nine percent of the women had established short and long term goals as a result of participating in *Suzanne's Project*. For 78% of the women, paying off debt was one of their short term goals. Seventy-eight percent of the women had construction of more greenhouses as one of their long-term goals. Sixty-seven percent of them wanted to build greenhouses to give their children a better life. Eighty-nine percent of the women improved their farming techniques as a result of participating in *Suzanne's Project*. The types of changes they made are related to fertilization and insect and disease control. One hundred percentof the women changed or are planning to change their business management practices as a result of participating in *Suzanne's Project*. Eighty-nine percent of the women said the networking aspect of *Suzanne's Project* was important for them. It gave them a sense of comradery with other women and more confidence in their own abilities. While 100% of the women would take more classes and would recommend *Suzanne's Project* to other women, all but one of them had suggestions for improvement. Fifty-six percent of the women indicated that the course needed to be longer. Twenty-two percent said they would prefer to have evening courses. Women mentioned specific areas where they would like more training: computers, technical topics and cost accounting. They would like similar courses to be offered to their husbands, but they appreciated the "women only" setting for their classes.

Specified Source(s) of Funding: Rutgers University and Akdeniz University

5:45–6:00 PM

Long-term Revegetation Success on Acid Infertile Subsoils in the Amazon

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Amazonian soils have recently been exposed to erosion through construction, extractive industries, and agriculture. Due to low fertility, heavy rainfall, and repeated disruption, revegetation of these sites can be challenging. The Amazonian Highway BR-319 from Manaus to Porto Velho was opened in 1973. Over much of its length, the construction of the highway exposed subsoil and parent material that failed to support spontaneous vegetation and the parent material was extremely vulnerable to erosion. At the initiative of the Brazilian national highway department, then DNER, native and introduced grasses and legumes were evaluated for their ability to thrive under the local conditions with a minimum of fertilization and liming and without maintenance. The trials were part of a larger DNER supported revegetation research program conducted by the IRI Research Institute, Matão, São Paulo, from 1975-1978. In one trial a total of 209 lines of 149 species were planted. Of these only 57 lines were considered usefully vigorous for maintaining soil stability after three years. Only 35 lines persisted after eight years. After 37 years of intermittent grazing and other disturbances, only 7 species remained. A second replicated trial using 15 grasses and 9 legumes was planted in 1976 using a Latin square experimental design with three replicates. After two and a half years, 13 grasses and 3 legumes were considered useful for revegetation, and after eight years 10 grasses and 3 legumes persisted. After 36 years with little to no further disturbance, only three of the planted species, two grasses and one legume, could be found at the site, and only *Urochloa brizantha* (palisade grass, '*Brachiaria brizantha*') covered more than its original planted area. Both experimental sites retained vegetation cover and have been succeeded by mixtures of plant species shaped by the management of the sites. Given the observations over the past 37 years, the criteria for desirable revegetation species should be reconsidered based on the ability of the plants to vigorously protect the soil and then give way to other species through natural plant succession. There are few signs of erosion in the planted areas, and soil formation is occurring at both trial sites. Meanwhile, extreme rates of erosion have occurred outside the boundaries of the planted areas.

Marketing and Economics

Moderator: Bridget K. Behe
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8:15–8:30 AM

Consumer Preference for Quality in Three Leafy Vegetables in Kenya

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African indigenous vegetables are an important source of nutrition and income for smallholder farmers in Kenya. There is a growing urban market for these vegetables that is divided between the traditional informal markets (e.g. open air markets) and the rapidly expanding formal markets, or supermarkets. Though our results suggest that the growing formal market includes fewer smallholder farmers, there is an opportunity for increased profits for growers able to meet the needs of urban consumers. Though grading of produce and investment in postharvest handling is limited, this study showed a strong consumer preference for high quality leafy vegetables at a premium price. A choice experiment approach was used to evaluate consumer preference for high quality in three Kenyan cities for three vegetable species: nightshade (*Solanum spp.*), spider plant (*Cleome gynandra*), and amaranth (*Amaranthus* spp.). Female consumers and those who generally spend more on produce were more likely to select high quality vegetables, but this tendency varied depending on the species of vegetable being purchased. Consumers were more likely to choose high quality nightshade in the market if they also had a home garden. Preference for high quality spider plant varied between surveyed cities to a greater extent than for either nightshade or amaranth. Contrary to previous literature reports, no differences occurred in preference patterns among consumers in informal and formal markets. These results suggest that growers who invest in postharvest handing or grading produce may be able to charge a premium for these indigenous vegetables. Growers should also consider the differences between consumer preference for each of these vegetables when marketing their product in order to best address these market gaps. Overall, our results show that 71% of consumers surveyed chose at least one high quality vegetable at a premium price, indicating that urban consumers in Kenya are willing to pay more for African leafy vegetables of the best quality. If smallholder farmers can fill this unmet demand, they may be able to increase their profits and avoid exclusion from the changing urban market for fresh produce.

Specified Source(s) of Funding: U.S. Borlaug Fellows in Global Food Security

An asterisk (*) following a name indicates the presenting author.

8:30–8:45 AM

The Role of Plant Brands in Consumer Quality Perceptions of Herb and Vegetable Transplants

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Our research question was whether (or not) consumers would perceive branded plants to be of higher quality than unbranded plants. In our survey, we showed subjects images of two vegetable (tomato, pepper) and two herb (basil, parsley) transplants and collected survey data at one Michigan location using eye-tracking equipment. The survey contained questions about vegetable and herb consumption, past purchases, and demographics. Participants were recruited in May 2014 through Craigslist and an existing survey Listerv. Participants were shown images of plants in a 15-cm container. The containers were green, white, or yellow and were either left blank or randomly assigned one of three national brands. We recruited 75 participants but had useful data for 72. After informed consent was collected and subjects were paid a $25 incentive, the study began with the subjects answering the demographic questions. Next, half of the participants proceeded to the eye-tracking experiment with the other half responding to the remainder of the survey questions. The eye-tracking device was calibrated for each respondent then participants were asked to respond verbally to each image on the screen. The participants were asked to select the plant with the highest quality, or to tell us that all of the plants appeared to be relatively the same in terms of quality. Overall, the branded package had a powerful visual impact. The branded container had a faster attention grabbing power (lower time to first fixation) and longer retention power (greater total visit duration). We also saw that branded packaging held attention four times as long as unbranded, attesting to the attention holding power of the brand logo. With regard to quality perceptions, 60.1% said the plants were equal in quality. However, 11.8% said the unbranded plant was higher in quality while 28.1% reported one of the three national brands was higher quality. In conclusion, we found that a substantial segment (approximately one third of the sample) reported that branded plants were of higher quality compared to unbranded plants, even though the plants were identical.

Specified Source(s) of Funding: USDA–FSMIP

8:45–9:00 AM

Age Influence on Product Involvement and Expertise for Vegetable and Herb Transplants

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Drucker wrote that changes in demographics are one of the easiest ways for a business to remain innovative, yet few business managers follow or act upon demographic changes (Drucker, 2002). Generation X and Generation Y are two distinct age groups that are of concern to the horticulture industry because of their apparent lack of horticultural purchases. Experts are individuals who know more, solve problems faster, and use their information in a different manner (Herling, 2000) compared to individuals lacking expertise (Tanaka and Taylor, 1991) and product expertise affects purchase decisions. Product involvement is another important influence on the purchase decision (Maoz and Tybout, 2002; Park, 1995; Park et al., 2007). We developed an online survey instrument that consisted of questions regarding involvement with herbs and, separately, vegetables and expertise with those products. The online instrument was active from 14 May until 16 May 2014. We screened for potential respondents who had made > 0 plant purchases in the six months prior to the study and attempted to achieve a sample with ~33% Baby Boomers (≥ 50 years of age), ~33% Gen X (ages 30 to 49 years) and ~33% Gen Y (ages 18 to 29 years) in order to have a sufficient respondents with which to make comparisons between age cohorts. Our factor analyses on the herb and vegetable related items yielded four discrete factors and were tested for reliability as independent scales. Factor 1 of the herb-related items emerged as an 18-item scale and was labelled "herb expertise". Herb-related Factor 2 emerged as an 8-item scale and was labelled "herb involvement." Factors 1 and 2 of the vegetable-related items were identified as 20-item and 6-item scales labelled "vegetable expertise" and "vegetable involvement," respectively. Comparing the involvement and expertise levels of the three age groups, we found differences for three of the four factors. Both Gen X and Gen Y participants had higher mean herb expertise compared to Boomers. We also found that Boomer participants had lower herb involvement than both Gen X and Gen Y. With regard to vegetable expertise, we found that both Gen X and Gen Y had a higher mean score compared to Boomers. However, we found no difference in mean score for vegetable involvement. Marketers can take these differences into account in their marketing strategies to different age cohorts.

Specified Source(s) of Funding: USDA–FSMIP

9:00–9:15 AM

Economic Analysis of Using Alternative Containers in a Greenhouse Production System

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Plant production facilities are high-input systems that require large amounts of material and energy. Fortunately, the use of renewable and biodegradable inputs can reduce the amount of negative environmental impacts associated with using large quantities of water, fertilizers, chemical pesticides, plastics, and electricity. This is an area of growing interest, however sustainable practices will not be widely accepted and implemented until their benefit to the environment outweighs their cost. Recent research identifies the potential environmental benefit of replacing plastic pots with containers made from alternative materials, because the pot accounts for about 16% of the carbon footprint of a finished *Petunia* ×*hybrida* plant. The objective of this study is to explore the economic cost of integrating alternative containers into greenhouse production of a petunia plant. Cost of production (COP) budgets for a petunia plant grown in alternative containers were extrapolated from the cradle-to-gate carbon footprint assessment of these containers from previous research. This study addresses the economic feasibility of incorporating such containers in greenhouse production system, which can contribute to the long-term sustainability of the horticultural industry.

9:15–9:30 AM

Using Real Money to Promote Extension Horticulture Programming

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Extension professionals have a long tradition of promoting their educational programming efforts via a creative variety of outlets, the majority of which are at no real cost to the Specialists other than their time. Many of these include newsletters (hard copy and online), trade magazine listings, email lists, direct emails, calendars of events, and more recently blogs, websites, Facebook, Twitter, and a great myriad of other social media platforms. What would happen if actual dollars were spent to market Extension horticulture events to the public? The Greenhouse Tomato Short Course (GHSC) was used as an example and has been promoted over the years in an assortment of free and paid methods. The GHSC is a national conference held in Jackson, MS, each March, which is designed to train commercial growers of greenhouse tomatoes and other hydroponically grown vegetables (http://greenhousetomatosc.com). Having just completed 25 years, the methods of promotion will be examined. The free promotion techniques utilized include those avenues mentioned above. While helpful, the reach of free methods to new audiences will always be limited. However, by spending real dollars, new clientele can be accessed. Advertising in trade magazines reaches a wide circulation of paid subscribers. This is often augmented by online versions of the publications that may or may not include an extra fee. Facebook marketing is a sophisticated instrument for tailoring exactly who the audience is for each paid ad. The target audience can be defined with a series of keywords, states, or countries of the user's residence, and various population demographics (age, education level, etc.). Furthermore, by using well-designed ads and posts, clientele who would most likely benefit from the program can be enticed to become engaged. The GHSC Facebook page (https://www.facebook.com/GreenhouseTomatoShortCourse) attracted over 6000 page likes in a four-month period. In addition to the above, marketing promotional items have been carefully selected so that producers will enjoy them when they return home, yet also continue to promote the program to others in the community for years into the future. Costs to be incurred need to be incorporated into grant proposals to insure that they are allowable charges. The caveats of navigating this path will also be addressed.

Wednesday, 5 August 2015

Postharvest 1

Moderator: Shehbaz Singh
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8:00–8:15 AM

Respiration Rate and Ethylene Production of Ackee (*Blighia sapida* Köenig) Fruit Harvested at Different Stages of Maturity

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Within the Caribbean communities in southern Florida, ackee (*Blighia sapida*) trees are popular as part of the home landscape. The fruit is widely consumed as a cooked item. The consumption of raw ackee has recently gained popularity among food enthusiasts, particular in raw vegan cuisine. Immature ackee fruit are known to contain toxic levels of hypoglycine A; but upon reaching maturity the level of toxicity is considerably reduced, making the fruit safe for consumption. The objective of this study was to determine the respiratory pattern, ethylene production, color change, and weight loss of ackee fruit harvested at five maturity stages and stored for 72 hours at 20 °C. The maturity stages were based on the progression of dehiscence and color change from; 1) small in size green unopened pods; 2) medium sized, yellow immature unopened pods; 3) full size unopened pods, red in color, can be rack ripened; 4) slightly dehisced pods, aril and seed visible, edible; and 5) fully dehisced pods with seed and aril clearly visible, edible. The respiration rates for stages 4 and 5 were significantly higher, at 64.6 and 97.9 mL/kg/h CO_2, respectively, than the respiration rates for stages 1, 2, and 3, at

43.3, 49.1, and 52.5 mL/kg/h CO_2, respectively. Stage 5 had the highest rate of ethylene production at 12.4 μL/kg/h C_2H_4, followed by stages 4, 1, 3, and 2 with rates of 7.24, 6.62, 3.93, and 3.25 μL/kg/h C_2H_4, respectively. There were no significant changes in hue angle (H*) of the pericarp surface during storage of ackee fruit. However, a decrease of 59.5% was observed in H* from stages 1 to 5, corresponding to a change from greenish yellow to scarlet red. Weight loss during storage increased from 8.79% to 15.65% for stages 2 to 5. The maturity stage at which the ackee fruit were harvested significantly affected the physiological parameters investigated in this experiment. The $RRCO_2$ and ethylene production were elevated upon ripening, coinciding with dehiscence, suggesting that the ackee fruit follows a climacteric pattern of ripening.

8:15–8:30 AM

Effectiveness of Chitosan Coatings on the Quality of Strawberry (cv. Monterey) during Simulated Air-ride Truck Distribution

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Strawberry is highly preferred by consumers due to its delicious taste and attractive appearance. However, strawberries are very sensitive to handling and transportation conditions because of their high softening and respiration rate. Therefore, edible films and coatings can be used as an alternative method to prevent undesirable changes during transportation. Chitosan, an edible film, improves firmness and maintains postharvest quality of fruit by modifying the internal atmosphere and reducing respiration rate of fruit. It also inhibits the microorganism growth due to antimicrobial activity. The aim of this study was to evaluate the effect of chitosan coatings at different concentrations (1%, 2%, and 3%) on the quality of strawberry during International Safe Transit Association (ISTA) 3H procedure, which simulates air-ride truck vibrations on a vibration table. Strawberries (cv. Monterey) were obtained from Apio Inc. (Guadalupe, CA) and transported to the Cal Poly Industrial Technology Department. Chitosan with the amounts of 10, 20, and 30 g were dissolved in 1000 mL water by using acetic acid. Then strawberries were immersed in the coating solutions for 1 minute and taken out. Strawberries dried at ambient temperature. Uncoated strawberries were chosen as control. Then, 6 kg of strawberries were placed in IFCO 6408N reusable plastic containers (RPC) (Sydney, Australia) and subjected to International Safe Transit Association (ISTA) 3H procedure that simulates air-ride truck vibrations on a vibration table (Lansmont Electrol-Hydraulic Vibration System Inc., Monterey, CA). Firmness, weight loss, and respiration rate measurements were performed. After simulated distribution, all coated samples had higher firmness values compared to the uncoated samples. It can be concluded that chitosan coatings generated a protective layer on the fruit surface and prevented the damage during distribution. Uncoated strawberries exhibited higher weight loss than coated fruits. It is possible that the semipermeable structure of chitosan reduced the migration of water from strawberry. Chitosan inhibited the enzymes responsible for destruction of middle lamella. It is known that distribution conditions can increase the respiration rate of fruits due to physical damage. In our work respiration rate of coated samples were lower than the uncoated samples. A possible explanation for this might be that chitosan reduced the physical damage of fruit during transportation and also controlled the exchange rate of gases due to excellent gas barrier properties. [M.S. Aday thanks the Scientific and Technological Research Council of Turkey (TUBITAK) BIDEP-2219 for postdoctorate support.]

8:30–8:45 AM

Environmental Factors on the Incidence and Development of End Rot on Sweetpotato

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Sweetpotato storage decay is a significant economic loss to producers. Ethylene treatments used to kill vines have been implicated as contributing to internal necrosis and the incidence of end rots. However, end rots, which have a complex etiology occur in stored roots with no an ethylene application. The objective of this research is to evaluate the influence of abiotic factors such as flooding, severity of harvest (skinning), curing, and storage conditions on the incidence and development of end rots in storage roots. Beauregard was planted in a randomized complete block with three replications in 2012 and 2013. Factorial combinations consisted of flooding/non-flooding; skinned/non-skinned; cured/non-cured; recommended storage/ambient storage. Storage roots were in all possible combinations and were recorded every month for six months. Similar trends were observed in both years. Skinned/non-skinned; cured/non-cured; recommended storage/ambient storage factors were significant in the percentage of weight loss and incidence of end rot while flooding/non-flooding factor was significant only in the percent-

An asterisk (*) following a name indicates the presenting author.

age of weight loss. End rot incidence occurred in proximal, distal or both ends. However, the incidence tended to occur the most in the proximal end. The treatments that consisted of non-cured and ambient storage had higher weight loss than the other factorial treatments. Moreover, this combination had higher incidence of end rot (5% to 10% in 2012 and 24% to 28% in 2013) compared to the treatments that consisted of cured and recommended storage (1% to 2% in 2012 and 2% to 5% in 2013). The most important factors in the study mitigating end rot were curing and recommended storage.

8:45–9:00 AM

Improving Shelf Life, Quality, and Safety of Locally Grown Vegetables in Kansas

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Limited access to refrigerated facilities, as well as gaps in knowledge regarding postharvest handling and food safety, are significant barriers for local growers to increase vegetable production. Data collected at the 2015 Great Plains Growers Conference indicate that only 32% have access to quick cooling facilities, and 6% to refrigerated trucks. The aim of this project was to investigate the effect of modified atmosphere packaging (MAP) and postharvest washing with ozonated water on the shelf life of locally–grown vegetables. Local organic spinach were divided into six treatments: unwashed stored in open produce bag (OPB) (*CC*) and stored in MAP bags (*CM*); washed in cold water (4 °C) and stored in OPB (*WC*) and stored in MAP bags (*WM*), washed in ozonated water stored in OPB (*OC*) and in MAP bags (*OM*). All groups were stored at 13 °C/85% RH until the end of storage. Daily CO_2 and O_2 concentrations inside the MAP bags were measured. Subjective and objective quality was evaluated on the day of harvest and every three days during storage. Numerical rating scales for overall quality, and off odors were used to evaluate the groups. Additionally, 50 leaves from each group were individually rated for subjective analysis of visual quality, decay, color, texture, and wilting. Color (CIE L*a*b*) and texture (compression shear-test with 5-blade probe) was also evaluated. Microbiological analyses were conducted to enumerate psychrotroph, total aerobic microorganism (APC), generic *Escherichia coli*, coliform, yeast and mold populations (Y&M). Internal atmosphere reached equilibrium in three days, and ranged from CM 6.8% to 8.26% CO_2 and 5.40% to 7.47% O_2; WM 6.11% to 6.56% CO_2 and 6.34% to 10.70% O_2; and OM 7.04% to 7.47% and 2.68% to 9.75% O_2. The CC was brighter (higher L* of 47.35 compared to 41.12–43.07 of other groups), less green with OC (lower a* of –13.86 and –13.33, respectively, compared with –15.83 to –16.67) and more yellow (higher b* of 36.82 compared to 28.54–30.57). The most effective treatments were the combination of washing procedures (independent of water type) with MAP (*WM* and OM), both of which lasted for 18 days in comparison to 6–9 days for *CC*. *Escherichia coli* and coliform populations were < 1.0 Log_{10} CFU/g throughout storage for all treatments. In general, psychrotroph, APC and Y&M populations steadily increased throughout storage, regardless of treatment. Thus, the treatments appeared to have a greater impact on quality than microbial populations. Further experiments with other crops (broccoli, asparagus, and beets) will be conducted to validate these results.

Specified Source(s) of Funding: KDA Specialty Crop Block Grant

9:00–9:15 AM

The Effects of Carvacrol and Thymol on Growth of *Guignardia citricarpa*, the Causal Agent of Citrus Black Spot on 'Valencia' Orange Fruit

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Citrus black spot (CBS), caused by *Guignardia citricarpa*, is a fungal disease in Florida that was first discovered in Southwest Florida in 2010 and is slowly spreading within the state. Lesions on the fruit can develop after harvest and become a grade defect at destination markets. Essential oils are aromatic oily liquids obtained from plant organs that have been used to control plant diseases. Essential oils may have direct antifungal activity and/or induce plant systemic acquired resistance. This study evaluated the activity of thymol and carvacrol against *G. citricarpa*in vitro and on naturally infected 'Valencia' orange fruit. In amended agar medium, the in vitro test demonstrated that both essential oils and a 1:1 mixture of the two were effective in inhibiting mycelial growth of *G. citricarpa*, with the highest efficacy displayed by thymol. Half-inhibition concentration of thymol, carvacrol, and the 1:1 mixture against mycelium growth was 0.017, 0.057, and 0.028 mg/mL, respectively. The same essential oil concentration were mixed in water or a commercial shellac wax to test in vivo efficiency against

An asterisk (*) following a name indicates the presenting author.

black spot development on fruit. After harvest, fruit were divided into asymptomatic or symptomatic groups, treated, and evaluated separately. After treatment, fruit were kept at 12 °C with 90% relative humidity and exposed to 5–10 ppm ethylene and continuous light to speed lesion appearance. On asymptomatic fruit, no treatment significantly affected disease incidence, but treatments did significantly affect the disease severity. Dipping fruit in water with 0.5 mg/mL of thymol, carvacrol, or the 1:1 mixture for one minute inhibited lesion appearance by 52%, 40%, and 48%, respectively, compared to control. Fruit coated with shellac containing 2 mg/mL of thymol, carvacrol, or the combination developed 59%, 49%, and 57%, respectively, fewer lesions than the control during storage. None of the treatments significantly inhibited lesion development on fruit that were symptomatic prior to treatment. Both essential oils and the 1:1 mixture at 2 mg/mL in water resulted in phytotoxic peel injury, with the most severe damage caused by thymol that also caused peel injury at 1 mg/mL . No injury was detected in treatments using the same concentrations in the shellac wax. Future tests will test higher essential oil concentration in the wax treatments.

9:15–9:30 AM

Effect of Chemicals on Keeping Quality and Vase Life of Carnation (*Dianthus caryophyllus* L.) 'Eskimo'

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This experiment was carried out to check the effect of different concentrations of sucrose (2%, 4%, 6%), $CuSo_4$ (200, 300, 400 ppm) and GA_3 (25, 50, 75 ppm) and combinations of sucrose and GA_3 (2% + 25 ppm), (4% + 50 ppm), and (6% + 75 ppm) on the carnation cut flower. Visual symptoms of flower senescence, changes in weight (g) of flower was observed and recorded by using weight balance. The experiment was laid out according to CRD (complete randomized design) with three replications using the Statistix software. According to which the $CuSo_4$ 300 ppm and 75% GA_3 showed the best results among all the treatments.

Specified Source(s) of Funding: University of the Punjab, Lahore, Pakistan

9:30–9:45 AM

Enhancing Vase Life of Rose Flower 'Cardinal' by the Use of Different Chemicals

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A lab experiment was conducted to study the effect of different doses of certain preservative solutions, i.e. sucrose and chemicals, i.e. copper sulphate and kinetin on cut rose flower ('Kardinal'). There were 12 treatments replicated three times. Data regarding vase life, dry weight, solution uptake, and percentage of petal drop were collected and analyzed statistically by using completely randomized design (CRD) with factorial arrangement of flowers and interpreted according to LSD test. Cut rose flowers were obtained from commercial grower and treatment was done with $CuSO_4$ at three concentrations of 200, 300, and 400 ppm, kinetin with 25, 50, and 75 mg/L, sucrose at 2%, 4%, and 6% w/v, and mix solutions of $CuSO_4$ and kinetin with three concentrations, $CuSO_4$ (200ppm) + kinetin (25 mg/L), $CuSO_4$ (300 ppm) + kinetin (50 mg/L) and $CuSO^4$ (400 ppm) + kinetin (75 mg/L) and tap water (control). After treatment the cut roses had been kept at room temperature (25 °C) under normal daylight and natural ventilation. Results indicated that 6% sucrose treatment significantly increased vase life among all other treatments and improved postharvest visual quality of this cultivar by retaining leave freshness even at the end of vase life.

Wednesday, 5 August 2015

Herbs, Spices, & Medicinal Plants/ History of Horticulture

Moderator: Changbin Chen
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10:15–10:30 AM

Vitamin C and Phenolic Compound Concentrations in the Leafy Vegetables *Solanum scabrum* and *Gynandropsis gynandra*

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Leafy vegetables are an important source of vitamins, phenolic compounds, and various health-beneficial compounds such as minerals and carotenoids. *Solanum scabrum* and *Gynandropsis gynandra* are leafy vegetables that are consumed in rural areas around the world as a main food, food ingredient, or traditional medicine. Currently, there is limited information about their nutritional and bioactive composition. Therefore, the goal of this research was to evaluate the concentration of vitamin C (reduced, oxidized and total), and phenolic compounds (free, bound, and total) in the leaves of two accessions of *S. scabrum* and eight accessions of *G. gynandra*. Seeds were obtained from the USDA National Plant Germplasm System (Columbus, OH). Plants were grown in synthetic soil in an environmental growth chamber for five weeks. Plants of each accession were grown in triplicate. Vitamin C and phenolic compounds were quantified using spectrophotometric methods. Results are normalized per gram fresh weight (g FW). The concentration

of total vitamin C in these leaves was from 0.94 to 1.40 mg ascorbic acid (AA)/g FW. The highest concentrations of total vitamin C were found in *G. gynandra* PI 500650 (1.40 ± 0.08 mg AA/g FW), *G. gynandra* PI 490299 (1.34 ± 0.07 mg AA/g FW) and *S. scabrum* PI 643126 (1.28 ± 0.09 mg AA/g FW). On the other hand, the total phenolic compound concentrations were from 2.29 to 4.42 mg gallic acid equivalents (GAE)/g FW, with free phenolic compounds predominating (43% to 81% of total). *Gynandropsis gynandra* PI 500650 (4.42 ± 0.32 mg GAE/g FW) had the highest concentration of total phenolic compounds, followed by *S. scabrum* Grif 14198 (3.42 ± 0.45 mg GAE/g FW) and *G. gynandra* PI 500677 (3.28 ± 0.32 mg GAE/g FW). A serving size (1 cup: 30 g FW) of these leafy vegetables contains from 28 to 42 mg AA. By comparison, a one-cup serving of a fresh leafy vegetable, such as spinach, mustard greens, or collard greens, has 8.4, 21, or 10.6 mg AA, respectively (according to the USDA National Nutrient Database for Standard Reference). A single serving of *G. gynandra* PI 500650 or *G. gynandra* PI 490299 would contribute approximately 67% of the daily value (DV) of vitamin C (DV = 60 mg; as established by the U.S. Food and Drug Administration).

Specified Source(s) of Funding: This research has been supported by a CONACYT Postdoctoral Fellowship Grant to DMJA and by the USDA Agricultural Research Service through Cooperative Agreement no. 58-6250-0-008 to MAG.

10:30–10:45 AM

Medicinal Plants as Specialty Crops for Midwest Growers

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Each year, approximately $150 billion of plant based medicine, herbal products, and food supplements are sold over the world, including approximately $50 billion of herbs and herbal products sold and consumed in China alone. There is an increased need for high quality herbal products. We have been working on testing about 40 species of most commonly used medicinal plants for Midwest growers as specialty crops. After five years of garden trial, a list of 25 species of highly demanded medicinal plants have shown great potential for the Midwest growers. Most of the 25 species are for medicine and functional food (tonic food). We have initiated a medicinal plant network for growing, harvesting, and marketing. Participants of this network include growers, alternative medicine clinics, stores, etc. The goal is to locally grow and consume high quality herb.

10:45–11:00 AM

Seed Yield of Fenugreek in Response to Planting Date, Irrigation, and Harvest Time

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Fenugreek (*Trigonella foenum-gracecum*) is an important medicinal legume crop known for millennia with properties such as a source of metformin for type 2 diabetes. India produces 75% of the world supply of fenugreek, mostly in the State of Rajasthan. There, fenugreek is grown under conditions similar to western Nebraska, such as soil type, pH, rainfall, and temperature. Can the U.S. High Plains be a source of fenugreek products in North America? The objective of this study is to identify agronomic requirements for growing fenugreek in western Nebraska. The addition of N did not improve yield, as the residual soil N was sufficient. Planting date for fenugreek ranged from mid-April to 2 June. Flower and pod formation occurred from late June to mid-July, depending on planting date, and was not affected by irrigation. Irrigation levels were 0, 1.3, and 2.5 cm/week. Irrigation promoted plant growth as measured by height and weight. Harvest date ranged from mid August to early October. There was an evident interaction between planting date, irrigation level, and harvest date with respect to seed yield. Seed yields greater than 1680 kg/ha (1500 lb/a) were achieved under the following conditions: 1) if irrigation is not limiting, then the highest yields were achieved by planting close to June and harvesting between mid-August and mid-September; and 2) if irrigation is limited, planting is best in late May and harvest in September.

Specified Source(s) of Funding: USDA–Specialty Crop Block Grant

11:00–11:15 AM

Carolinas Therapeutic Horticulture Network

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Many horticulture therapists operate in isolation, disconnected from other professionals and resources. In North and South Carolina we have created The Carolinas' Therapeutic Horticulture Network, an organization of professionals. Through biannual workshops, a Facebook page, a listserv, and an Extension Portal with content, an interactive calendar and resources, over 100 professionals are connecting to share information, tools, and support. Organized and managed by Extension Agents and Specialists the meetings are hosted at different sites focusing on different programs and coordinated by a team of members

from across the region. They include networking opportunities, hands on workshops and tours. Social media is used to share information and promote programs and strategies. The listserv is used to announce opportunities, ask questions and share resources. The Extension Portal has resources for participants, volunteers, interns, professionals, and service providers. It contains information on accessibility, gardening, getting connected, health, programs, how to find a professional, research, and resources.

11:15–11:30 AM

The Voynich Manuscript as a MesoAmerican Herbal

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The bizarre Voynich Manuscript, discovered in 1912 in Italy by the Polish book dealer Wilfrid Voynich (1930–1965), has eluded decipherment despite repeated attempts by world-renowned cryptologists. The style of the plant illustrations is similar to 16th century codices from Mexico (e.g., Codex Cruz-Badianus). Of the 309 plants or plant parts illustrated, 51 (17% of the total), have been identified as indigenous to MesoAmerica from Texas, west to California, and south to Nicaragua, pointing to an Aztec botanic garden in central Mexico, quite possibly Huaztepec (Morelos) or the palace gardens of Netzahualcoyotl (Tezcoco, México). Of the 18 animals in the manuscript, 16 are indigenous and two are cattle introduced by the Spanish. One mineral crystal identified (boleite) is only found in any quality and quantity in MesoAmerica. A search of surviving codices and manuscripts from Nueva España in the 16th century, reveals that some of the calligraphy of the Voynich Manuscript is similar to codices such as the Codex Osuna (1563–1566, Mexico City). The text is based on a combination of an unknown alphabet or syllabary in an unknown language. The alphabet/syllabary was identified because 153 of the plants in the pharma section are accompanied by names in the symbolic language we call Voynichese. Association of the Nahuatl names of the plants allowed the transliteration of the alphabet/syllabary and made it possible to decipher the names of 12 plants, one animal, and one mineral, which appear to be loan words from classical Nahuatl, Spanish, Mixtec, and Taino. In addition, two cities were deciphered that were associated with a map identified of the New City of Jerusalem (Puebla de los Angeles) founded by Fray Toribio de Benavente Motolinía, one of the 12 priests who accompanied Cortes to Nueva España. The main text, however, defies decipherment and seems to be in an extinct language related to Nahuatl from central Mexico, possibly Acohucatlatolli, since there are many Classical Nahuatl cognates. We surmise that the scribe and the artist (*tlacuiloque*) of the Voynich Manuscript were the sons of Aztec nobility trained in the Colegio de Santa Cruz de Tlatelolco by Franciscan friars, and the manuscript can be dated based on internal evidence to ca. 1565. We believe the complete translation will demonstrate that this Aztec manuscript is one of the most valuable historic texts of the 16th century since it was not filtered through Spanish editing.

Specified Source(s) of Funding: Lillian Goldman Foundation

Wednesday, 5 August 2015

Fruit Breeding 1

Moderator: Jill M. Bushakra
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10:15–10:30 AM

Fertile Hybrids between Tetraploid Highbush Blueberry Cultivars (*Vaccinium* section *Cyanococcus*) and Colchicine-induced Tetraploid *Vaccinium stamineum* (section *Polycodium*)

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Open-pollinated seed of *Vaccinium stamineum* were collected from a dry, upland forest in northeast Florida. Six tetraploid plants were identified by screening for large pollen tetrads after seeds and young seedlings had been treated with colchicine. The selected plants shed pollen abundantly. Most of their pollen occurred in well-formed tetrads, which appeared, at 250x, to be potentially viable. In Spring 2013, four selected *V. stamineum* plants were used to pollinate emasculated flowers of 14 tetraploid highbush cultivars. From 2700 pollinated highbush flowers, more than 1800 seedlings were obtained. Eight hundred seedlings were grown in a high-density field nursery for nine months. These were notably weaker than seedlings of both parent taxa growing in the same nursery, and nearly all had bronze-colored leaves rather than green. Seventy seedlings that appeared large enough to flower were potted in December 2014, held at 5 °C for a month, then moved to a warm greenhouse. Forty-eight plants flowered. Their hybridity was confirmed by three characters that are present in *V. stamineum* but absent in highbush blueberry: flowers that are open in the bud, anthers that extend beyond the corolla at anthesis, and presence of anther awns. Most of the 48 hybrids shed pollen abundantly, but the median plant had only 25% of the individual pollen grains well-formed and potentially viable. Twenty F_1 plants that had enough flowers were backcrossed to highbush cultivars. As females, 12 F_1 hybrids had fruit set above 70%. Fruit set was variable on highbush pollinated with F1 pollen, but numerous plump backcross seeds were obtained. It appears rather easy to move genes from *V.* stamineum into the cultivated highbush blueberry gene pool. Traits of interest in *V. stamineum* include adaptation to sandy, upland soils, flower structure more amenable to honeybee pollination, berries with purple flesh color, and exotic flavors.

Specified Source(s) of Funding: Florida Foundation Seed Producers, Inc.

An asterisk (*) following a name indicates the presenting author.

10:30–10:45 AM

Linkage and QTL Analysis of a Tetraploid Interspecific Pseudo-backcross Between *Vaccinium corymbosum* and *V. arboreum*

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Vaccinium arboreum (Va), commonly known as sparkleberry, is a wild blueberry native from southeastern North America that is well adapted to sandy soils and often has a tree-like growth habit. Our objective was to construct a linkage map and perform the phenotypic characterization necessary for QTL analysis using an interspecific pseudo-backcross population between *Vaccinium corymbosum* (Vc) and Va. Twenty-five vegetative and reproductive traits were evaluated for two seasons on 100 individuals obtained from the cross between the Vc cultivar Southern Belle (southern highbush) and the selection FL08-467. 'FL08-467' is an interspecific hybrid resulting from a cross between 'Primadonna' (Vc, southern highbush) and the selection 'FL06-753', a Va selection resulting from colchicine chromosome doubling. To build the tetraploid linkage map, two types of markers were used: simple sequence repeat (SSR) and single nucleotide polymorphism (SNP). A total of 352 SSR markers identified from genomic and EST libraries were tested for amplification and segregation, and a single *PstI* restriction enzyme digestion of genomic DNA of all progeny pooled for genotyping by sequencing resulted in 2553 SNP markers. TetraploidMap software was used to build the linkage map as well as to perform the QTL analysis. Twelve linkage groups were identified covering a total of 1401 cM. A total of 386 markers were placed on the resulting linkage map with an average distance between markers of 3.6 cM. QTL analysis was performed using trait data averages per season by year, and regions of interest for both plant architecture and reproductive traits were identified.

Specified Source(s) of Funding: Scholarship from CONACYT Mexico, and the USDA–NIFA Specialty Crop Research Initiative Award Number 2009-51181-06021.

10:45–11:00 AM

Genomic Selection: A New Approach in Blueberry Breeding

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Worldwide blueberry production is rapidly growing due to both a rise in consumer demand and an expansion in available production area resulting from new low-chill cultivars. Currently, the University of Florida blueberry breeding program uses phenotypic recurrent selection to create new cultivars. This method focuses on overall population improvement by increasing the frequency of favorable alleles, and typically takes 10 to 15 years to release a new cultivar. To better meet the needs of an expanding industry the selection should be more efficient and the breeding cycle needs to be decreased. Genome-wide selection (GWS) has been used with great success in animal, crop, and forestry breeding programs for efficient and timely development of improved products. GWS is accomplished using best linear unbiased prediction (BLUP) to estimate breeding values and heritability of economically important traits and whole genome marker scans to develop prediction models for the traits based on genotype. One limitation of GWS in blueberries is that it is an autotetraploid, and BLUP assumes disomic inheritance. The objective of this study was to compare BLUP models assuming disomic inheritance to those of tetrasomic inheritance. To do this, a training population consisting of 2000 pedigree-linked seedlings were evaluated in 2014–15 for 10 economically important traits: yield, firmness, stem scar diameter, stem scar tear, fruit weight, fruit size, pH, Brix, flower bud density, and bloom earliness. Heritability and breeding values were estimated using ASReml software. The accuracy of these results were analyzed using the jack-knife procedure. Heritability estimates were the same between the two models. Breeding values and ranking differences were not significantly different between the two models. In conclusion, the diploid BLUP model can be an accurate tool to estimate breeding values and heritability in blueberry. The more easily derived BLUP model assuming disomic inheritance will allow for accurate selection of superior parents to increase genetic gains, while decreasing the selection time.

11:00–11:15 AM

Molecular Evaluation of Aphid-resistant Black Raspberry Germplasm for Improved Durability in Black and Red Raspberry

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Over the last century, the black raspberry (*Rubus occidentalis* L.) industry in the United States has undergone a slow but steady contraction because of a lack of adapted and disease resistant cultivars. The Pacific Northwest (PNW) is the major black raspberry production region in North America, with the value of utilized production in Oregon in 2014 valued at $9.6 million over 1650 acres. Continuing research on health benefits of a diet rich in phytonutrients, and black raspberries in particular, has led

to a resurgence of interest in this fruit and a renewal of breeding efforts. While the crop faces numerous challenges in the PNW that are being addressed with breeding and genomics, one of the major problems is the severe impact Black raspberry necrosis virus (BRNV) has on plant health and the industry's viability. BRNV is an aphid (*Amphorophora agathonica* Hottes)-borne virus that, in the industry standard cultivar (Munger), causes a rapid decline in vigor leading to plant death. In addition to black raspberry, aphid resistance is important to the red raspberry processing industry in Washington and Oregon, where aphid-vectored viruses are a major component of a crumbly fruit disease complex. Three sources of aphid resistance were identified in wild black raspberry germplasm collected from Ontario, Canada (ON), Maine (ME), and Michigan (MI). The evaluation of the aphid resistance sources are being studied on three full-sib black raspberry populations designated ORUS 4304 (ME), ORUS 4305 (ON), and ORUS 4812 (MI). A major focus of this study is to better characterize and develop DNA-based markers that can be used in breeding programs to enable pyramiding of different sources of resistance in new breeding material to ultimately provide resistance that will not easily be overcome by the aphids. At present, the ability to combine these sources effectively is limited by a lack of knowledge regarding their mechanisms and linkage. To date, 17 black raspberry populations with single and combinations of sources of aphid resistance have been phenotyped. Preliminary molecular evaluation for aphid susceptibility of the 17 populations suggests two unique genes in those with sources of resistance from MI and ON.

11:15–11:30 AM

RosBREED2: More Traits, Additional Crops, Expanded Germplasm, New Science

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U.S. rosaceous crops industries have prioritized the development of new cultivars that combine disease resistance and superior horticultural quality and thereby mitigate production, handling and market risks. For decades, rosaceous crop breeders have identified and introgressed resistance from wild and/or unadapted germplasm, but few have achieved commercial success due to linkage drag, scant genetic information, resource-intensive phenotyping, and limited selection tools. The USDA–NIFA–SCRI project entitled "RosBREED: Combining disease resistance and horticultural quality in new rosaceous cultivars" ("RosBREED 2" for short) is addressing this need through a multidisciplinary effort that will empower breeding programs of rosaceous crops to routinely apply modern genomics and genetics tools to efficiently and effectively deliver cultivars with producer-required disease resistances and market-demanded horticultural quality. The project builds on the recently concluded USDA-NIFA-SCRI project "RosBREED: Enabling marker-assisted breeding in Rosaceae". This project enabled the first successful routine adoption of DNA-based information for fruit quality improvement in U.S. apple, peach, cherry, and strawberry breeding programs, directly and quickly increasing breeding efficiency, accuracy, and creativity. Four crops are newly included in RosBREED 2 (blackberry, pear, rose, and *Prunus* rootstocks) and 16 disease threats are newly targeted. These activities involve 23 breeding programs from 12 states. The use of DNA information will be expanded from individual QTL/major trait loci to develop a genome-wide understanding of effects of minor and major loci and enrich breeding families. Additionally, genomic and statistical tools will be applied to account for non-genetic effects on trait variation.

Specified Source(s) of Funding: "RosBREED: Combining disease resistance with horticultural quality in new rosaceous cultivars" is supported by the USDA–NIFA–Specialty Crop Research Initiative by a combination of federal and matching funds (grant number 2014-51181-22378).

11:30–11:45 AM

Consideration of Cost and Accuracy for Trial Design of Advanced Apple Selections

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Field evaluation of advanced apple selections is expensive and, with limited resources, the design of these trials is a trade-off between maximizing accuracy of identifying truly elite candidates and minimizing cost. Here we investigate the effect of alternative trial designs on the cost and accuracy of fruit quality assessment using instrumental and sensory traits in the Washington State University Apple Breeding Program as a model. Critical percentage difference, response to selection, and correlated response were used as measures of accuracy. The number of locations, years and harvests per year were decreased from the current design of three to either two or one. For most traits, the loss in accuracy from a reduced design was less than 5%. Reduction in the number of harvests resulted in the smallest loss in accuracy for all traits, but only a negligible decrease in program cost. Reducing both number of harvests and locations to two resulted in a greater loss in accuracy, but still relatively small, and would allow the program to evaluate twelve additional candidates per year for a similar total program cost. Overall, the total cost of the program could be reduced if the design is reduced, with minimal loss in accuracy and the additional capability to trial more selections. The methods employed in this analysis offer a framework for other tree fruit breeding programs to investigate their own trial design accuracy and efficiency questions.

Wednesday, 5 August 2015

Vegetable Crops Management 1

Moderator: Nicholas Andrews
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10:30–10:45 AM

Crop Time: Degree-day Models and an Online Decision Tool for the Vegetable Industry

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Degree-day (DD) models have been used since at least the 1960s. In general they predict development of ectothermic organisms (e.g. plants, insects and fungi) more accurately than calendar days. Many in the tree crops industries have adopted pest DD models to support integrated pest management decisions since the 1990s, but most vegetable growers in the Pacific Northwest do not use DD models to manage crops. Exceptions are sweet corn and garden pea, where DD models have been developed for some cultivars. Small and mid-sized vegetable farmers try to schedule their harvests to supply fresh produce consistently during the market season. Direct market farmers often schedule Community Supported Agriculture pickups or restaurant sales on a weekly basis. Mid-sized wholesale growers also attempt to supply produce on time and in the right quantity. Market share of the top 20 U.S. retailers grew from 39% to 64% from 1992–2009, this consolidation increases pressure on shippers to maintain contracts with customers. They often err on the side of over-production to avoid weather or pest related shortfalls, and improved crop scheduling could help them fill contracts and maintain buyer loyalty. We have developed Crop Time to support vegetable crop management and DD model verification. Threshold temperatures, DDs to harvest and intermediate growth stages have been verified for transplanted broccoli, direct-seeded slicing cucumber, transplanted sweet pepper, and direct-seeded sweet corn cultivars using single sine curves and lowest coefficient of variation. Growth stage descriptions and threshold temperatures are available on the site to invite open sharing of data for future model development. Crop Time is integrated with the Oregon State University (OSU) Integrated Plant Protection website (http://uspest.org/dd/model). The user interface has been modified to facilitate rapid selection of automatic weather stations (AWS) using a custom Google Maps interface. Collaborative networks provide access to data from more than 15,000 AWS in the United States. Model input now allows simultaneous model runs of up to four planting dates to schedule succession plantings. Output formats have been modified to summarize the most useful phenological events predicted by DD models. Educational outreach is provided through the OSU Small Farms website: http://smallfarms.oregonstate.edu/croptime. Usability is being tested to make the website as self-explanatory to new users as possible.

Specified Source(s) of Funding: Western SARE

10:45–11:00 AM

Environment and Production System Influence Fresh Cilantro Yield and Quality in a Five-state Trial

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Cilantro (*Coriandrum sativum*) is a cool season biennial herb, although it is primarily grown in an annual production system. The fresh leaves, with a pungent odor and citrus flavor, are used in many ethnic food dishes. The market potential of many specialty crops, such as cilantro, is expanding since ethnic cuisine is becoming increasing popular in the United States. Furthermore, cilantro is easily adaptable to production systems, such as raised-beds, and many consumers are familiar with its

preparation. Thus, cilantro fits well in many local food production systems and direct markets. Cilantro is grown under a wide range of climatic conditions, although temperatures between 10 °C and 27 °C are optimal for plant growth. Since cilantro can be grown in various climatic conditions, the purpose of this study was to determine how different environmental regions effect the growth, yield, and quality of cilantro. Collaborators from Mississippi State University (Crystal Springs and Verona), Washington State University, University of Rhode Island, and Virginia Tech evaluated cilantro cultivars Calypso, Leisure, Merino, Santo, and Turbo II. Raised beds were prepared in Fall 2014. Each location prepared beds and spaced rows 10 to 12 in. between rows. Raised beds were fertilized with 50 lbs/ac of N, P, and K according to local soil test and Extension recommendations. Cilantro was direct seeded into single or double row at a rate of 50 lbs/acre. Fertilization, row spacing, and seeding rates were based on recommendations given in the 2014 Southeastern Vegetable Production Guide. The middle section of each single or double row was harvested at approximately 45 days after seeding. The petioles were cut 2–3 inches above the soil surface. Weeds and discolored (yellow, necrotic), unmarketable leaves were discarded. The remaining marketable leaves were bunched, removed from the field, and their total weight recorded as marketable yield. At the Virginia location there were significant ($P \leq 0.05$) yield differences among the five cultivars. Marino was the highest yielding cilantro cultivar, followed by Santo, Turbo II, Leisure, and Calypso. At both Mississippi locations there were not significant differences in cultivar yields. In addition, there were significant ($P \leq 0.05$) differences in yield when comparing all five locations. The Verona, MS, location yielded significantly higher cilantro yields, followed by Virginia and Crystal Springs, MS. Results demonstrate that different regional environmental conditions may be factors that can lead to differences in growth, yield, and quality of different cilantro cultivars.

11:00–11:15 AM

A Bitter Crop with Sweet Potential for Producers and Human Health

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Relatively little information is available with regard to the cultivation of bitter melon (*Momordica charanita)* in the United States. Bitter melon has been reported to have various health benefits including anti-cancer and anti diabetic activities. Considering the conventional wisdom and recent scientific evidence, it is important to promote the use bitter melon in the United States and demonstrate to producers about its potential of growing as a specialty crop. In this study, we present a yield comparison of five bitter melon varieties (Indian Green, Indian White, Hong Kong Green, Japanese Spindle, and Large Top) grown in College Station, TX. The total ascorbic acid content and total saponin content of these varieties were compared. Bitter melon fruit yield cultivated in College Station in 2013 ranged from 1.04 kg/plant in 'Japanese Spindle' to 2.32 kg/plant for 'Hong Kong Green'. For 2014, yields were drastically reduced due to several factors such as plant disease and climatic conditions. The levels of total ascorbic acid among five varieties were compared for the immature fruit, mature fruit and pulp material. Levels of total ascorbic acid in immature fruit ranged from 42.69 mg/100 g in 'Hong Kong Green' to 162 mg/100 g in 'Japanese Spindle'. Total ascorbic acid levels in mature fruit ranged from 19.10 mg/100 mg in 'Large Top' to 91.56 mg/100 g for 'Indian Green'. Furthermore, the levels of total ascorbic acid in bitter melon pulp material were at least two-fold higher than the level of total ascorbic acid of the respective immature fruits. The level of total ascorbic acid ranged from 279 mg/100 g in 'Large Top' to 409.02 mg/g in 'Japanese Spindle'. Additionally the levels of total saponins were evaluated to estimate the levels of possible cucurbitane-type compound in various extracts of the five bitter melon varieties. Data from this study illustrate the feasibility of growing bitter melon in Texas as a specialty crop that is rich in health promoting compounds.

11:15–11:30 AM

Stip: A Physiological Disorder of Pepper Fruits

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Stip, a physiological disorder affecting bell and New Mexico (NM) pod type green chile pepper cultivars (both *Capsicum annuum*) has received limited formal academic attention. Symptoms present on fully developed fruits as black, brown, and yellow ovoid subcutaneous chlorotic lesions approximately 1.3 cm in length and 0.6 cm in width extending from the endocarp to the mesocarp without apparent expression in the cuticle. In this study, stip was characterized via microscopy and metabolomics assays, in addition to a greenhouse cultivar susceptibility experiment. Symptom development was induced in a greenhouse and the incidence, severity, and location of symptomatic pods was quantified for one reported resistant bell pepper cultivar, Cal Wonder 300, and one susceptible green chile pepper cultivar, AZ 1904, over two harvests. Fifteen potted plants of each cultivar were completely randomized on a greenhouse bench,

and four temperature probes were deployed to monitor air and soil temperatures. Greenhouse temperature set points of 14.4 °C and 28.9 °C (low and high, respectively) were used. Beginning in July, for a period of ten days, the temperature was allowed to reach 41.1 °C. At that time, symptoms of the disorder become apparent, pods were harvested, and stip incidence and severity were recorded. There was no statistically significant difference between the node location of symptomatic pods, incidence, or severity between the two cultivars indicating that the resistance reported in field studies may not be applicable to greenhouse conditions. More than 85% of symptomatic pods were located at or below the fifth node of the plant; of symptomatic plants, average stip incidence was 23%; and mean severity was four lesions per symptomatic pod. Under microscopic analysis, both cultivars presented identical fluorescent and confocal imagery; stip affected tissue was most apparent under green fluorescent protein and violet filters, which presented as a halo only around the lesions. These microscopy signals occurred only in close proximity to chlorotic lesions, and were not apparent in asymptomatic tissue from symptomatic pods, asymptomatic pods from symptomatic plants, nor asymptomatic tissue from asymptomatic plants. To gain additional insight into this disorder a polar and non-polar metabolite profile of green chile pods, and carotenoid analysis, was performed using tissue from susceptible cultivar AZ 1904 tissues collected from six different commercial fields in southern New Mexico in 2014. Sustained research emphasis is needed to fully understand the causes of this disorder, its effects on growers, and possible remedies.

Specified Source(s) of Funding: New Mexico Chile Association, NMSU Agricultural Experiment Station

11:30–11:45 AM

Sweet Onion (*Allium sativa*) Yield as Affected by Potassium Rates

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After nitrogen, potassium (K) is the nutrient required in largest amounts by plants. Potassium deficient plants show reduced growth and limited photosynthesis, and, under severe deficiency, can present chlorosis. Objective was to evaluate the effect of potassium rate on sweet onion bulb yield and quality. Experiments were conducted at the Horticulture Farm, Tifton Campus, University of Georgia, in Winter 2013–14. Soil was a sandy-loam soil with a pH of about 6.5. Plants were grown on raised beds. Each bed had four rows 23-cm apart, with a plant spacing of 15 cm. Beds were covered with black plastic film mulch and there were two lines of drip tape per bed, each drip tape being located midway between rows in alternate rows. Starting eight weeks after transplanting, N (as 28–0–0) and K [as 0–0–25 (potassium thiosulfate)] were applied through the drip tape. Total N applied was 169 kg/ha. Five total K fertilizer levels (67, 134, 202, 269, and 336 kg/ha K_2O) were evaluated in a randomized complete-block design. Experimental plot consisted of a 6.1-m long bed (1.8-m centers) section. Marketable and total number and weight of onion bulbs were not affected by K rate. This indicates that a rate of 67 kg/ha K_2O was sufficient to cover the K needs of onion plants. Incidences of bolting (mean = 5%), sour skin (caused by *Burkhordelia cepacia*; mean = 11%) and double-bulbs (mean = 1%) were also unaffected by K levels. Bulb dry matter content, soluble solids content, and pungency were positively correlated among them, but they did not show linear relationships with K rate. Thus, K rates above 67 kg/ha K_2O had minimal effects on bulb yield and quality.

Specified Source(s) of Funding: Vidalia Onion Growers Association

11:45 AM–12:00 PM

Response of Grafted Tomato to Nitrogen

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Grafting tomatoes (*Solanum lycopersicum*) onto disease resistant rootstocks is a proven method for managing numerous soil-borne diseases. Recent studies have demonstrated the ability for rootstocks to enhance scion vigor in the form of increased vegetative growth and yield. One theory explaining this increased vigor is that these vigorous rootstocks can more efficiently uptake nitrogen. To investigate this theory, a two-year study was conducted at the Sandhills Research Station in Jackson Springs, NC, to determine how open-field grown grafted tomatoes respond to different levels of nitrogen fertilizer. The tomato cultivar 'Tibute' was utilized as the non-grafted control and scion for two commercially available rootstocks ('Maxifort' and 'RST-106'). Five nitrogen rates (0, 50, 100, 150, and 200 lbs/acre) were imposed on the non-grafted and grafted treatments through drip irrigation under a traditional plasticulture system. Plant height data was collected weekly for seven weeks in both 2013 and 2014. Mature fruit at the breaker stage was harvested for three and five weeks in 2013 and 2014, respectively. Fruit were graded by size as regular (between 1-28/32" and 2-28/32"), jumbo (> 2-28/32"), and culls (< 1-28/32" or damaged due to pest or disease). No significant variety x fertilizer treatment

An asterisk (*) following a name indicates the presenting author.

was observed in plant height or yield data. The main effect of variety was significant on yield in both years. Plants grafted on 'Maxifort' rootstocks yielded 15% and 30% more marketable fruit than non-grafted treatments in 2013 and 2014, respectively. No significant difference was observed in marketable yield between plants grafted onto 'RST-106' rootstocks and non-grafted plants in 2013. However, in 2014 marketable yield was significantly higher (23% more) in 'RST-106'-grafted plants compared to the non-grafted controls. Our results suggest, depending on rootstock variety, grafting may significantly increase marketable yields for open-field grown tomatoes in North Carolina under conditions lacking severe soil-borne disease pressure

Wednesday, 5 August 2015

Floriculture 1

Moderator: Jared Barnes
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1:45–2:00 PM

Modeling the Effects of Macronutrients on Fallow Soilless Root Substrate pH

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The chemical fertilizer effect contributes to the overall acidification of substrate pH. To quantify the chemical fertilizer effect, a multifactorial experiment was conducted to test macronutrient effects. Five nutrient factors, including N carrier ratio (NH_4^+ versus NO_3^-) and concentrations of P (as $H_2PO_4^-$), K, combined Ca and Mg, and S, were varied at five levels, each encompassing the proportionate range of these nutrients in commercial greenhouse fertilizers. A unique statistical method known as the central composite design (CCD) was used to reduce the treatment number to 30. Fertilizers were applied to fallow 14-cm-diameter pots (1.29 L) filled with a 3 peat : 1 perlite (v/v) substrate amended with readily soluble powdered calcium carbonate to raise the substrate pH to approximately 5.4. Sampling occurred after 34 and 59 days. The resulting statistical model described substrate pH over time, with significant effects including three main effects of day, N carrier ratio, and K; two squared terms of N carrier ratio and K; and an interaction effect. The resulting model was used to calculate substrate pH levels between 34 and 59 days after planting, and N carrier had the greatest impact on substrate pH contributing 51.9% to the model R^2 of 71.3%. At 34 and 59 days, the calculated difference in substrate pH values between the high NO_3^- and high NH_4^+ levels were 0.41 (5.15–4.74) and 0.51 (5.06–4.55), respectively. The acidification most likely originated from nitrification and proton displacement via cation exchange.

Specified Source(s) of Funding: Fred C. Gloeckner Foundation, Rockwell Farms, and USDA–ARS

2:00–2:15 PM

Influence of Nutrient Accumulation in *Chrysanthemum* ×*morifolium* on Root Substrate pH Over Time

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Changes in substrate pH during crop production are closely tied with the relationship between uptake of cations and anions. We utilized a central composite design to investigate how macronutrient applications influenced substrate pH and total shoot accumulation trends in a crop and the effect of a species and crop duration different from *Salvia* grown for 45 days from a previous study. Five nutrient factors, including N carrier ratio (NH_4^+ versus NO_3^-) and concentrations of P (as $H_2PO_4^-$), K, combined Ca and Mg, and S, were varied at five levels each encompassing the proportionate range of these nutrients in commercial greenhouse fertilizers. 'Pittsburgh Purple' chrysanthemum (*Chrysanthemum* ×*morifolium* Ramat.) was grown in 14-cm-diameter pots (1.29 L) in a 3 peat : 1 perlite (v/v) substrate amended with non-residual powdered calcium carbonate to raise the substrate pH to approximately 5.6–5.8. Harvests occurred after 35 and 65 days of growth. A statistical model explained 98.1% of the substrate pH data, with statistically significant effects including four main effects of N carrier ratio, P, K, and S; four squared terms of N carrier ratio, P, K, and Ca+Mg; and nine interaction effects. The resulting model was used to calculate substrate pH levels between 35 and 65 days after planting, and N carrier had the greatest impact on substrate pH. Calculated pH ranges for the two N carrier extremes were 2.04 (6.31–4.27) and 2.00 (6.17–4.17) for harvest 1 and 2, respectively. Changes in substrate pH were then compared with trends observed from models generated to describe uptake for P, K, Ca, and Mg. Decreases in substrate pH for increasing concentrations of applied K, Ca, and Mg matched

An asterisk (*) following a name indicates the presenting author.

with increasing accumulation with these three elements. For P, increasing accumulation was observed as P concentrations in the nutrient solution increased; however, substrate pH initially rose and then decreased at higher P concentrations possibly due to protons generated from the formation of precipitates. We also observed different effects on substrate pH with *Chrysanthemum* from the previous experiment with *Salvia farinacea*, indicating a species effect exists.

Specified Source(s) of Funding: Fred C. Gloeckner Foundation, Rockwell Farms, and USDA–ARS

2:15–2:30 PM

Efficacy of Various Nutrition Regimes on Growth, Flowering, and Seed Yield of *Calendula officinalis*

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Effects of fertilization with N, P, or K alone or in various combinations were studied on production performance and seed yield of calendula (*Calendula officinalis*), a popular bedding plant used extensively in Pakistan. Plants fertilized with NPK or with treatments containing N had vigorous growth due to greater plant height, higher number of leaves and lateral branches per plant, greater stem and plant diameter, and higher leaf chlorophyll contents. Plants supplied with N alone or along with P or K produced earliest flowering and had greater number of flowers and seed yield/plant. Fertilization had no effect on flower diameter or fresh or dry weight of flowers. In a second study, different levels of NPK were tested to optimize calendula production. Application of 20:10:10 or 10:20:10 $g \cdot m^{-2}$ NPK resulted in vigorous plant growth with highest plant height and diameter; number of leaves, lateral branches and flowers; earliest flowering; and highest seed yield. Higher concentration of N at 20 g m^{-2} along with 10 $g \cdot m^{-2}$ each of P and K produced higher leaf chlorophyll contents than 10:10:10 or 20:20:20 $g \cdot m^{-2}$ NPK. However, the different NPK levels produced similar flower and stem diameter. Results demonstrated that nitrogen is vital for quality calendula flower and seed production and growers may use 20:10:10 $g \cdot m^{-2}$ NPK for optimal flower and seed yield of calendula.

2:30–2:45 PM

Silicon Improves Flowering Characteristics of Sunflower and Petunia at Low Phosphorus Rates

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Silicon (Si) is recognized as a beneficial element for plant growth. In addition, it has been shown to reduce the severity of biotic and abiotic stress. The objective of this study was to determine the effects of Si on plant growth and development at low to moderate phosphorus (P) concentrations. Sunflower (*Helianthus annus* 'Pacino Gold') and petunia (*Petunia hybrida* 'Bravo Pink') seedlings were transplanted into 12-cm diameter pots, one plant per pot, filled with an 85 peat : 15 perlite substrate amended with 1.55 $kg \cdot m^{-3}$ $CaCO_3$ and 0.52 kgçm^{-3} $MgCO_3$ (pH adjustment) and a wetting agent. Plants were irrigated as needed with a complete nutrient solution providing 0.08, 0.16, 0.33, 0.5 or 0.66 mM P, with or without 2 mM Si (potassium silicate). Plants were harvested nine weeks after transplant. Sunflowers grown with Si supplementation flowered 2 days earlier than non-amended plants. Phosphorus application rate affected relative chlorophyll content, flower diameter, stem diameter, and shoot dry weight of sunflower. Relative chlorophyll content at harvest increased as P increased from 0.08 to 0.33 mM P, then decreased at higher P rates. Sunflower flower diameter, stem diameter, and shoot dry weight increased as P increased from 0.08 to 0.33 mM, with no further increase above 0.33 mM P. Net photosynthetic rate of sunflower increased as P increased, from 12.0 $\mu mol \cdot m^{-2} \cdot s^{-1}$ CO_2 at 0.08 mM P to 14.2 $\mu mol \cdot m^{-2} \cdot s^{-1}$ CO_2 at 0.5 mM P. Petunia shoot dry weight increased and days to flower decreased as P increased, but were unaffected by Si. Petunia flower number increased as P increased. Flower number in the 0 and 2 mM Si treatments was similar at 0.08 mM P (7 and 6.4, respectively), but Si-supplemented petunias had increasingly more flowers than non Si-supplemented plants as P increased (17.3 and 22.3 with 0 and 2 mM Si, respectively, at 0.66 mM P). Overall, Si supplementation did not strongly affect vegetative growth of sunflower or petunia across the range of P concentrations trialed, but did enhance flowering characteristics.

2:45–3:00 PM

Quantifying the Effects of Chelated Calcium and Salicylic Acid on the Leaf Mechanical Strength of Poinsettia

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Vegetatively-propagated unrooted cuttings for the U.S. market are typically imported from off-shore production facilities. Cutting quality, defined as the resistance to external forces such as

physical damage and pathogen infection, impacts postharvest durability during shipping and propagation. During previous studies, foliar application of calcium chloride ($CaCl_2$) increased mechanical strength of leaf tissue of unrooted cuttings. Concentrations at or above 800 mg·L^{-1} were associated with phytotoxicity symptoms in poinsettia (*Euphorbia pulcherrima*). Therefore, the potential of alternate calcium sources, such as chelated calcium CaEDTA (40, 80, or 160 mg·L^{-1}), and salicylic acid (150 or 300 mg·L^{-1}) to increase the mechanical strength of the leaves of poinsettia was investigated. Mechanical strength of leaves was assessed using a force-displacement graph generated from a texture analyzer using a ball probe to penetrate a clamped leaf. The peak force to fracture the leaf (g) and the work of penetration or area under the force-displacement curve (g·mm) were utilized as indicators of mechanical strength. Calcium content in the leaves increased by 27% with increased application of CaEDTA from 0 to 160 mg·L^{-1}. Peak force was 26% greater in treatments with CaEDTA at 80 or 160 mg·L^{-1} compared to the control. Work of penetration was also 24% and 29% greater for treatments with CaEDTA at 80 and 160 mg·L^{-1} compared to control. Following application of salicylic acid, peak force and work of penetration were 18% and 19% greater, respectively, at 150 or 300 mg·L^{-1} compared to control. Provision of foliar CaEDTA at 40 or 80 mg·L^{-1} or salicylic acid at 150 mg·L^{-1} to stock plants can improve mechanical strength of cuttings in poinsettia without phytotoxicity symptoms.

Specified Source(s) of Funding: American Floral Endowment

3:00–3:15 PM

Growth and Development of Poinsettia (*Euphorbia pulcherrima*) under Reduced Temperature Finishing and Bench-top Root-zone Heating

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Greenhouse heating is an essential aspect of holiday poinsettia (*Euphorbia pulcherrima*) production, especially during the finish stage. Previous studies have shown that cultivars with early response attributes (initiation to finish in 6–8 weeks), moderate to high vigor, and naturally large bracts are most suitable for reduced finish temperature (RFT) production. We postulate that RFT in combination with root-zone heating (RZH), can further reduce energy use. The objective of this study was to quantify how RFT in combination with bench-top RZH influences time to anthesis and marketability, bract area, and height of three red poinsettia cultivars. Rooted cuttings of poinsettia 'Early Prestige Red', 'Premium Red', and 'Viking Red' were transplanted and grown at day/night temperature of 24/19 °C (12 h/12 h) until 15 Oct. and under a 16-h photoperiod consisting of natural day lengths with day-extension lighting until 1 Oct. On 15 Oct., the air temperature was reduced to 19/13 °C (8 h/16 h) and plants were placed on a bench without RZH or with RZH set points of 21, 24, or 27 °C; or plants were moved to a greenhouse without RZH and an air temperature set point of 21 °C (commercial control). Time to anthesis from the start of short days was reduced by 6, 4, and 7 d, respectively, for 'Early Prestige Red', 'Premium Red', and 'Viking Red' when plants were finished on a RZH set point of 27 °C compared to a RZH set point of 21 °C. Time to marketability was significantly longer for all plants grown without RZH compared to all other treatments. Although plants grown under RFT with RZH matured at a similar rate to those in the commercial control, bract area index was significantly reduced in most cases. For example, bract area index of 'Early Prestige Red' was reduced by 166.7, 107.1, 62.9, or 93.3 cm^2 when finished without RZH or with a RZH set point of 21, 24, or 27 °C, respectively, compared to the commercial control. Stem elongation responses varied by cultivar. Change in height from the RFT initiation to anthesis was similar for 'Viking Red', whereas change in height of 'Premium Red' was significantly lower when plants were grown under RFT. Our data suggests that when RZH temperatures > 24 °C are utilized during poinsettia finishing, air temperatures can be further reduced from the 20/14 and 21/17 °C (12 h/12 h) recommended by previous research.

3:15–3:30 PM

Inhibition of Premature Flowering of *Phalaenopsis* Orchids by High Temperature Interruption

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This study was conducted to determine the premature flowering inhibition of *Phalaenopsis* plants by high temperature interruption. Eight-month-old young *Phalaenopsis* 'Hwasu 355' and *Doritaenopsis* 'Mantefon' plants were treated with four different temperature treatments: continuous low temperature (no interruption), 1 week of high temperature every 1 week of low temperature, 1 week of high temperature every 2 weeks of low temperature, and 2 weeks of high temperature every 2 weeks of low temperature. The low temperature and high temperature were set at 25/20 °C and 28/28 °C, respectively, and maintained for 16 weeks. In 'Hwasu 355', flower-stalks of all plants grown at no interruption conditions emerged, whereas flower-stalk emergence of plants treated with high temperature interruption was not observed. However, 'Mantefon' plants showed flower-stalk emergence in all treatments. The percentage of visible inflorescence (flower-stalk longer than 0.5 cm) increased with increasing the interval between high temperature interruptions. The number of days to visible inflorescence was increased with increasing total high temperature duration during cultivation. These results suggest the possibility of using high temperature insertion during relatively low temperature cultivation in winter to prevent premature flowering and to save the heating

cost. However, since 'Mantefon' plants were more sensitive to low temperature and showed flower-stalk emergence in all interruption treatments, the modification of interruption method is needed in order to inhibit premature flowering more effectively.

Specified Source(s) of Funding: Rural Development Administration

Wednesday, 5 August 2015

Genetics & Germplasm 1

Moderator: Mark Ehlenfeldt

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1:45–2:00 PM

Fungicide Treatment of Avocado (*Persea americana* Mill.) Trees for Management of Laurel Wilt Disease

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Laurel wilt is a lethal disease of *Persea borbonia* (redbay) and other tree species in the Lauraceae family. Laurel wilt has been found in the field on several other Lauraceae species including avocado (*Persea americana*), sassafras (*Sassafras albidum*), and other endangered species pondberry (*Lindera melissifolia*). The disease is caused by the fungus *Raffaelea lauricola* that is transferred into host trees by a non-native pest, the redbay ambrosia beetle (*Xyleborus glabratus*). The disease has spread to trees in forests, parks, orchards, and residential areas in the southeastern United States. Avocado, is the utmost important agricultural crop vulnerable to the disease. The disease threatens commercial avocado production in Florida, centered in Miami-Dade County ($54 million/year), as well as the National Germplasm Repository (NGR) for avocado in Miami (USDA–ARS). Elsewhere in the United States, major (California, $342 million in 2006) and minor commerce in the fruit (Hawaii and Puerto Rico) could be impacted if the disease continues to spread. Policies for reducing its impact in *Persea* species (especially *P. americana*) are been studied. The NGR in Miami, FL, is responsible for the conservation of the USDA–ARS avocado collection. The collection contains over 300 accessions and includes all three races, as well as hybrids between them. Presently the collection is free from the ambrosia beetle and the fungus, it is believed to be only a matter of time before this disease reaches the collection. Macro infusion of fungicides such as Propiconazole® has shown to control the disease in oaks and other species. Propiconazole was macro infused through the root system of the tree at the recommended doses. Approximately 270 mature avocado trees, one per accession, were selected for treatment based on tree health and infection status with Avocado Sunblotch Viroid (ASBVd). Plants were infused in February 2011 and again in June 2013. Following propiconazole application (at one day, and at 14 months, respectively), randomly selected branches above dbh of selected trees were collected. From each of the selected trees, segments were removed and placed in cold storage (40 °F) for further analysis for the presence of propiconazole. Then, the samples were sent to the University of Georgia for propiconazole analysis. The rate of application fluctuated significantly with the size of trees. Propiconazole was present in branches and fruits (below EPA standards) of trees injected 12–14 months after treatment. Results suggest that correctly applied fungicide may provide protection on avocado for periods beyond one year.

2:00–2:15 PM

Unlocking Genetic Potential of the Peach Collection at the National Clonal Germplasm Repository in Davis, California

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Genotyping by sequencing (GBS), a low-cost, high-throughput sequencing technology, has been used to analyze diversity in 510 *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 were catalogued as *Prunus persica* (85%), with 8% of them considered wild relatives (*P. mira, P. davidiana, P. kansuensis and P. ferganensis*) and 7% categorized as hybrids between peach and other related species and *Prunus spp* (unknown). The method produced on average 1.2 million sequence reads per accession, with majority of the accessions having more than 500,000 reads. We identified 23,402 single-nucleotide polymorphism (SNP) markers, with allele frequency > 0.05, present in at least $\geq 90\%$ of all analyzed accessions distributed across the entire genome. Population structure revealed 5 groups. *Prunus persica* population was structured in three groups and remaining two groups constituted of *P. davidiana* and *P. mira* individuals, respectively. Population structure uncovered origin of accessions catalogued as *P. kansuensis* (1) and *P. ferganensis* (2) to be *P. davidiana and P. persica,* respectively. In addition, accessions catalogued as *Prunus spp*. were assigned to the related group, mostly *P. persica*, or remained

unstructured together with other interspecific hybrids. 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 for water use efficiency and data available through Germplasm Resources Information Network (GRIN), will be discussed.

Specified Source(s) of Funding: USDA

2:15–2:30 PM

Advanced Genetic and Genomic Resources for the American Cranberry (*Vaccinium macrocarpon* Ait.)

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The American cranberry (*Vaccinium macrocarpon* Ait.) is a small statured North American commercial fruit crop with a relatively short seed to seed period. An improved genetic map comprising 12 linkage groups and totaling 1177.84 cM (i.e., 96% of the estimated 470 Mb genome) has been constructed by genotyping two full-sib mapping populations using more than 600 simple sequence repeat (SSR) markers. Furthermore, more than 373,639 single nucleotide polymorphisms (SNPs) within genomic scaffolds and predicted coding DNA sequences (CDS) have been identified using genotyping-by-sequencing and are being integrated into the SSR linkage map. This linkage map is the most saturated in *Vaccinium* to date, and it will be the backbone of future QTL and GWAS studies that identify genomic regions linked or associated with important cranberry agronomic traits. In fact, QTL have already been identified for average fruit weight, biennial bearing, total yield, total anothocyanin content, total soluble solids, and titratable acid within the two mapping populations. Additionally, many of the positioned SSR markers are cross-transferable in other economically important *Vaccinium* species such as blueberries, lingonberries, huckleberries, and bilberries; and therefore, could be used in future comparative genomic studies and marker-assisted selection (MAS) strategies for introgressing species-specific traits through interspecific hybridization. These genetic resources, when combined with the recently published preliminary nuclear genome and transcriptome and a high-throughput field-independent nursery system, could allow cranberry to become a model woody fruit crop for identification of candidate genes involved in fruit development, fruit physiology, and insect and disease defense pathways.

Specified Source(s) of Funding: National Science Foundation (DBI-1228280), Wisconsin State Cranberry Growers Association, Cranberry Institute, WI-DATCP (SCBG Project #14-002), and USDA–ARS (project no. 3655-21220-001-00)

2:30–2:45 PM

Progress in Precision Breeding for Genetic Improvement of Muscadine Grapevine

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Precision breeding (PB), in which only defined genetic elements from sexually-compatible parents are utilized, is a logical extension of conventional breeding (CB), inasmuch as it is fully consistent with the plant lifecycle. PB builds upon decades of research aimed at bypassing the disruption of sexual reproduction (meiosis) by allowing gene insertion to be accomplished via the significantly more stable and predictable mitotic cell division pathway. For an increasing number of crop plants, it is now possible to transfer only pre-tested genes and other genetic elements that express known traits among sexually-compatible relatives. The PB approach has particular promise for muscadine grape (*Vitis rotundifolia*), which is unique among all grapes due to its ability to thrive in the southeastern United States. However, while vegetatively very resistant to both bacterial (Pierce's disease) and a host of fungal diseases, the ripe berries remain to be highly susceptible to rot fungi, to the extent that muscadine fruit cannot be stored long enough for wide distribution. In ongoing studies to increase shelf-life, a number of putative disease resistance genes have been inserted into several mainstream muscadine cultivars. Plants are being placed into three disparate field test sites. Fruiting of the first putatively rot resistant line will commence in Summer 2015. A number of new lines containing various grape-derived genes are being readied for field tests. The taste of muscadine fruit tends to be highly desirable to a wide range of consumers. Extending its shelf life will make muscadine grape available to a greatly expanded geographic range of clientele.

An asterisk (*) following a name indicates the presenting author.

2:45–3:00 PM

Mutagenesis Analysis of Acetolactate Synthase (ALS) Genes from *Vitis vinifera* for Use as a Selectable Marker to Facilitate Precision Breeding of Grapevine

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Acetolactate synthase (ALS) is a critical enzyme in the biosynthesis pathway of amino acids leucine, isoleucine and valine. Many mutations in this gene have been found to confer resistance to various inhibiting herbicides. However, the reliability/usefulness of herbicide resistance provided by single site-mutant *ALS* genes in plants is often limited by the lack of stringent selectivity. In this study, multi-site mutagenesis was studied in order to exploit the potential of *ALS* gene(s) from grapevine as a selectable marker for in vitro selection of improved elite cultivars via precision breeding. Seven grapevine genes homologous to *AtALS* of *Arabidopsis* were identified from the genome of 'Pinot Noir'. Among these genes, *VvALSc* and *VvALSg* were utilized as candidates for mutagenesis analysis. A total of eight mutations standardized to *AtALS* were incrementally introduced into the candidate genes to evaluate their efficacy in inducing herbicide resistance in grapevine and tobacco. These mutations were reported previously to be associated with novel resistance to five herbicide families including imidazolinones (IMI), pyrimidinylthiobenzoates (PTB), sulfonyl-aminocarbonyl-triazolinone (SCT), sulfony lureas (SU), and triazolopyrimidines (TP). Mutant genes were placed in a binary vector under the direction of a double CaMV 35S-derived bi-directional dual promoter complex along with an EGFP-NPTII fusion marker gene. Following *Agrobacterium*-mediated gene delivery to somatic embryos of grapevine and leaf disks of tobacco, selective culture using either kanamycin or related herbicides yielded stable GFP-expressing transgenics. Progress is underway to evaluate comparatively the selection efficiencies of mutant *VvALS* genes harboring various mutations. The implication of using a multi-site mutagenesis approach for the improvement of an herbicide-based selectable marker will be discussed.

Specified Source(s) of Funding: Florida Dept. Agri. & Consumer Serv. Viticulture Trust Fund

3:00–3:15 PM

Breeding and Hybridization of *Vaccinium corymbodendron* Dunal: Unexpected Triploidy

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V. corymbodendron (Section *Pyxothamnus*) is a tetraploid species native to high-altitude locations in Peru, Colombia, and Venezuela. This species is of considerable interest because it flowers at times when nighttime temperatures drop below freezing, and it is also notable for its profuse flowering, and monopodial plant structure. Initial hybridization experiments that crossed *V. corymbodendron* to a range of diploid material found that despite a strong triploid block in conventional *Vaccinium* germplasm, virtually all hybrids generated from *V. corymbodendron* × 2*x* species were triploids. Although the triploids expressed low fertility as both males and females, several were used successfully in crosses. A single hybrid using 2*x V. vitis-idaea* (lingonberry) as the male was unexpectedly found to be tetraploid and was highly fertile. These crossing results suggest *V. corymbodendron* either possesses no ploidy barriers to hybridization, or possesses genomic dosage factors that differ from Section *Cyanococcus* species. Understanding these crossing relationships may open new avenues for exploitation of this germplasm.

3:15–3:30 PM

Wild *Vaccinium* Species in Turkey

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Turkish flora has several species of *Vaccinium* and *Ericaceous*. Wild *Vaccinium* and *Ericaceous* plants grow naturally in the Southeastern part of the Black Sea Region of Turkey. This region is one of the main gene centers of Caucasian whortleberry (*Vaccinium arctostaphylos*), bilberry (*Vaccinium myrtillus*), lingonberry (*Vaccinium vitis-idea*), and bog bilberry (*Vaccinium uliginosum*). These wild *Vaccinium* species have different distribution areas mostly correlated with elevation. Although blueberry cultivation in the region was initiated by Huseyin Celik, there is no commercial cultivation for these wild species in Turkey. However, for centuries inhabitants of the Black Sea Region have picked the berries of these wild species from forests and plateaus. These berries are used as fresh or frozen fruits and/or to make jelly, jam, or juice. In this presentation, we will summarize the wild phenological characteristics, berry chemicals and germplasm of some wild *Vaccinium* and *Ericaceous* species, their distributions and plant and fruit characteristics. We will also present some unique horticultural characteristics of these wild species, such as cyclic-flowering, which might be of value for blueberry cultivar improvement.

Wednesday, 5 August 2015

Produce Quality, Safety, and Health Properties

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1:45–2:00 PM

Using Light to Manipulate the Nutritional and Sensory Properties of Greenhouse Tomatoes with Red, Blue, and Far-red Supplemental LEDs

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Greenhouse tomatoes tend to have a reputation of inferior nutritional and sensory quality compared to their field-grown counterparts. It has been long known that light is a critical mediator of secondary metabolism in plants, signaling the production of nutritionally important phytochemicals and regulating the emission of volatile organic compounds that may influence the sensory attributes of edible tissues. By leveraging photobiological principles, we are using supplemental light from light-emitting diodes (LEDs) to determine if supplemental red, blue, far-red, or various combinations of those wavebands can improve the quality of greenhouse tomatoes. We hypothesize that enriching the amount of blue light tomatoes receive will positively impact the amount of carotenoids and phenolic compounds that accumulate in tomato fruits through cryptochrome and/or phototropin-dependent signaling pathways. On the contrary, we hypothesize that additional far-red light will decrease these phytochemicals by increasing the amount of inactive phytochrome in leaf and fruit tissues, thereby down-regulating secondary metabolic pathways related to the nutritional content of tomato fruits. To test these hypotheses, tomato fruits were subjected to a battery of physicochemical metrics that include total soluble solids, citric/ascorbic acid content, pH, and electrical conductivity. Phenolic compounds were broadly quantified using the Folin-Ciocalteu method and specific flavonoids in fruit tissues (e.g. quercetin-3-O-rutinoside) were quantified using HPLC-ESI(-)-MS. Two major tomato carotenoids, lycopene and β-carotene, were quantified spectrophotometrically. Lastly, consumer sensory panels were used to assess the impact of supplemental light quality on the flavor and overall quality of tomato fruits.

Specified Source(s) of Funding: 2010-51181-21369

2:00–2:15 PM

Effect of Day and Night Temperature on Red Russian Kale Mineral Nutrient, Vitamin C, and Fiber Content

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Red Russian Kale plants (*Brassica napus* var. *pabularia*) were germinated in a 24 °C/13 °C (day/night) greenhouse under an eight-hour photoperiod and were then moved to controlled environmental growth chambers maintained to achieve a 10 °C , 15 °C , 20 °C, 25 °C, and 30 °C leaf temperature after four true leaves had unfolded. Plants were moved among chambers at 0800 and 1600 HR daily to yield a total of 25 day/night temperature regimes. Irradiance was maintained at 300 $\mu mol \cdot m^{-2} \cdot s^{-1}$ and plants were fertilized with 15–5–15 Cal-Mag fertilizer twice a week (400 ppm N) and watered as needed otherwise. The experiment was replicated four times in time. After 56 d, plants were removed from growth chambers and leaf number per plant was counted, individual leaf fresh and dry weight were determined (fifth leaf from bottom of stem), and foliar nutrients (P, K, Ca, Mg, Fe, Mn, B, Cu) were determined using an inductively-coupled plasma spectrophotometer. Total dietary fiber and vitamin C levels were also measured from tissue frozen at –80 °C for the pooled triplicate samples analyzed. Vitamin C levels were highest (46.9 mg/100g) and lowest (14.1 mg/100g) for the plants maintained at 15 °C /20 °C and 10 °C /30 °C (day/night) temperature, respectively. Plants maintained under a 30 °C night temperature had the lowest fresh weight, and in most regimes, significantly lower vitamin C content. Results indicated that for optimal growth (fresh weight) and leaf vitamin C content, day temperatures should be maintained between 15 °C and 20 °C and night temperatures between 15 °C and 25 °C. Day/night temperature regime effects on fiber and leaf mineral content will also be discussed.

Specified Source(s) of Funding: Minnesota Agriculture Experiment Station, USDA–ARS FNRI and MN-DRIVE

2:15–2:30 PM

Preharvest Effects on Postharvest Quality of Strawberries Grown in High Tunnels

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The incorporation of high tunnels for specialty crop production in the Great Plains region has dramatically increased. The utilization of high tunnels for spring-planted high tunnel strawberry production with day-neutral varieties could provide growers with both early and late-season income. However, it's unclear if this system will produce adequate yields of high quality fruit during the extreme summer temperatures that are typical in the region. Our objectives were to identify day-neutral strawberry cultivars that succeed in a spring-planted, high tunnel system and investigate the treatment effect of evaporative cooling on the yield, quality, and shelf life of strawberries. The trial was conducted at the Kansas State University Olathe Horticulture Research and Extension Center during Summer 2014 and was planted in a three-season high tunnel with 30% shade cloth. The experimental split-plot, randomized complete-block design (RCBD) with four replications where the main plots consisted of the evaporative cooling treatment (with and without) and the sub-plots included the six commercially available cultivars (Albion, Evie2, Monterey, Portola, San-Andreas, and Seascape). Evaporative cooling was applied twice daily for five minutes when temperatures rose above 30 °C throughout July and August. Fully ripened fruit were harvested twice per week and the marketable and total yield (lbs/plant) was monitored. After harvest, the strawberries were stored at 3 °C for 8 days. Shelf life was monitored daily with respiration rate, water loss, and decay by using a scale with scores from 1 (very poor) to 5 (excellent). Strawberry quality was evaluated by measuring color (CIE L*a*b*), total soluble solids, texture (firmness), and titratable acidity. Fruit nutritional quality on the day of harvest was evaluated by measuring total phenolic and total antioxidant content with hydrophilic and lipophilic oxygen radical absorbance capacity (ORAC) and ferric reducing ability of plasma (FRAP). The results indicate that throughout the entire season (10 May to 7 October), 'Portola' had the highest yield (1.32 lbs/plant), while 'San-Andreas' had the lowest yield (0.72 lbs/plant). Shelf life results illustrate that 'Seascape' and 'Evie2' decayed quicker with significantly more water loss in comparison to 'San-Andreas' and 'Portola' ($P < 0.001$). Similarly, texture measurements of 'Evie2' and 'Seascape' exhibit low firmness levels throughout the season ($P < 0.001$). Our results indicate that growing day-neutral strawberries in a high tunnel could be a successful system in the Great Plains when proper varieties are utilized. Further research is needed to investigate the utility of the cooling treatments across multiple growing seasons.

Specified Source(s) of Funding: NSSI

2:30–2:45 PM

Enumeration of Sanitizer-injured Coliform Bacteria in the Production and Harvest Environment of Vegetables

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Chemical sanitizers to inactivate coliform bacteria may induce no injury (bacteria survive), sublethal injury (bacteria are injured), or lethal injury (bacteria are dead). The degree of coliforms injured sublethally by sanitizers used in the production and harvest environment of vegetables was evaluated using the thin agar layer (TAL) method. The TAL method involves laying a nonselective medium for recovering injured bacteria over a solidified selective medium containing selective agents to facilitate detection of target bacteria but inhibit the repair of injured bacteria that are sensitive to selective agents. Thus, the difference between the counts on TAL medium that includes both injured and noninjured cells and the counts on selective medium that includes noninjured cells represents the number of injured target bacteria from the background bacterial flora of samples. This number was comparable to an accurate enumeration of injured coliforms as determined by a flow cytometry that stains bacteria with permeant and impermeant DNA dyes depending on their viability. With pure cultures of *Enterobacter cloacae*, *Escherichia coli*, and *E. coli* O157:H7, the degree of sanitizer-injured cells was 68% to 80% for a dilute electrolyzed acidic water containing an available chlorine level of 2 ppm and 68% to 95% for a dilute alcohol agent containing an ethanol level of 1.6%. When agricultural water in a production environment was treated with electrolyzed acidic water, the percentage of chlorine-injured coliforms in agricultural water was 75%. The isolation and identification of bacteria on TAL and selective media suggested that the chlorine-stress caused injury to *Ent. kobei*. Sublethally injured coliform bacteria on the equipment in a harvest environment of cabbage following exposure to alcohol agent was detected with 60% of the total coliforms detected on the knife but none on the container and gloves. A comparison of isolated coliforms between TAL and selective media indicated the possibility of ethanol-injured *Ent. Amnigenus* and *Ent. asburiae*. Injured bacteria were not detected on cabbage because no species of bacteria found in cabbage (14 species belonging to 11 genera) were transferred from the knife to the cabbage. These results suggest the necessity of adjusting the sanitizer concentration at level to kill coliforms in the production and harvest environment of vegetables so as not to cause sanitizer-induced cell injury.

Specified Source(s) of Funding: A Research Project to Improve Food Safety and Animal Health sponsored by the Ministry of Agriculture, Forestry and Fisheries of Japan

An asterisk (*) following a name indicates the presenting author.

2:45–3:00 PM

Epicuticular Physicochemical Properties on Porcine Rotavirus Attachment to 24 Leafy Green Vegetables and Tomatoes

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Foodborne diseases are a persistent problem in the United States. Fresh produce, especially those used as raw foods like salad vegetables, can be contaminated, causing food illness. About 50% of foodborne illness was caused by viral pathogens. In this study, we conducted viral attachment assays with group A rotaviruses (The Ohio State University strain) as a foodborne viral pathogen model on 24 genotypes of leafy vegetables and tomato fruits. Up to 10.8% of the originally applied viral particles adhered to produce surfaces after three washing treatments of phosphate buffered saline, suggesting a potential public health concern regarding rotavirus contamination of produce. The numbers of porcine rotaviruses attached to produce surfaces varied among salad genotypes. We also characterized the physicochemical properties (contact angle, surface roughness, epicuticular wax concentration, stoma size, and length of adaxial leaf surfaces) of each produce's outermost surface layer, known as the epicuticle. We found significant negative correlations between viral attachment and the concentrations of alkanes (r = –0.498), fatty acids (r = –0.466), and total waxes (r = –0.473) on the epicuticular surface. A partial least square model suggested that alkanes, ketones, fatty acids, alcohols, contact angle, and surface roughness together can describe 62% of the variation in the number of viral particles attached to produce surfaces. Three-dimensional crystalline wax structures on the epicuticular surface were found to significantly contribute to the inhibition of viral attachment to the produce surfaces. This information can be used to identify and breed for salad cultivars that can be more effectively sanitized to remove microorganisms associated with foodborne illness.

3:00–3:15 PM

A National Effort That Helps Improve Food Safety of Potato Products

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Acrylamide, a suspected human carcinogen, has been found in a series of processed food. Acrylamide is formed mostly between a reducing sugar glucose and a free amino acid asparagine during cooking at high temperature (>120 °C). Potato products such as French fries and chips are one of the main dietary sources of acrylamide. In the past two years, both the FDA and its European counterpart have published information for industry and consumers to raise awareness about acrylamide in foods and to suggest strategies for reducing public exposure and improving food safety. The U.S. potato industry recognizes that the development of new varieties with low acrylamide-forming potential is one of the most critical approaches to mitigate the acrylamide issue. Consequently, a National Fry Processing Trial (NFPT), was started at Idaho, North Dakota, and Washington State in 2011, and expanded to Maine and Wisconsin in the following two years. During the three years of trial, more than 140 advanced breeding lines primarily from the major potato breeding programs in the country were assessed for their agronomic and biochemical properties during short-, intermediate-, and long-term storage. Dozens of breeding lines were identified with a more than two folds reduction in acrylamide compared to the standard check 'Russet Burbank' and 'Ranger Russet', both of which are commonly planted and processed commercial varieties. Of these, several stood out for also having high marketable yield, the industry desired size distribution and specific gravity for good processing quality. Similar to previously published reports, the glucose content in raw tubers of NFPT lines was highly predictive of acrylamide in finished fries all through the storage time (R^2 = 0.64 – 0.77), but asparagine was not a significant predictor of acrylamide, potentially due to its presence at an order of magnitude higher concentration than glucose in the raw tubers. Analysis of covariance has indicated that in addition to glucose, genotype was highly significant ($P \leq 0.001$) for predicting acrylamide at early and late stage of storage, suggesting there are some unidentified genetic loci to target for future breeding. The NFPT has demonstrated that reducing acrylamide is an easy breeding objective to achieve, and the bigger challenge is to find new potato varieties with low-acrylamide-forming potential but also meets the complex processing quality standards set by the food industry. Phenotyping methods are being developed to efficiently assess effects of some raw tuber traits related to quality after processing.

3:15–3:30 PM

Frying Performance Testing of *Camellia oleifera* Oil

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The oil derived from the seeds of *Camellia oleifera,* commonly referred to as tea-seed oil, has been used in China and Southeast Asia for hundreds of years. Although it has many industrial uses, Camellia oil is most commonly consumed as a cooking oil with roughly one-seventh of the Chinese population using it for this purpose. Camellia oil has certain physiochemical properties that are beneficial to human health and these properties also contribute to the heat stability of the oil. This study examined how Camellia oil and oils with similar chemical characteristics, peanut and soybean, respond to high heat stress during frying and what degradation products were produced. Over five consecutive days, each oil was subjected to high temperatures by frying potatoes. An oil sample was taken each day to determine how the oil changed physiochemically over time. A series of analysis were conducted to determine the fatty acid profile, peroxide value, acid value, and total polymeric materials of each oil for each day. These tests are important to determine how the beneficial and potentially negative nutritional aspects of the oil change during heating as this could have effects on human health. Overall, peanut oil was most stable under high heat and frying conditions followed by Camellia and soybean oils, respectively. The fatty acid profile for peanut oil changed the least during frying, peroxide values peaked at 2.1 mg peroxide/kg oil, acid values at 0.4mg KOH/g oil, and total polymeric material values topping 11 units. Even though the physiochemistry of peanut oil remained most unchanged, there are still potentially greater health benefits with using Camellia oil for the purpose of frying under high heat. Further research is being conducted to determine the biodiesel potential of tea-seed oil. The remaining oil from the frying portion of the project will be chemically converted into biodiesel. Each oil will then be subjected to a number of tests to determine the quality of product that can be produced from a highly oxidized feedstock.

Specified Source(s) of Funding: University of Georgia Department of Horticulture

Wednesday, 5 August 2015

Vegetable Crops Management 2

Moderator: Ajay Nair
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1:45–2:00 PM

Cropping System and Vegetable Production in Miami-Dade County, Florida

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Under sub-tropical climate, Miami–Dade County is an ideal place in the United States to produce winter fresh market vegetables in open field. For instance, with more than 11,000 acres a year, it is ranked as No. 1 County in the United States for producing snap beans. However, the major challenge for local growers is pest control because of the favorable weather that makes all pests live year round and creates a lot of pressure for producers. Appropriate cropping system, including growing cover crops and implementing crop rotation, plays a critical role that can break up the food chain and life cycles of pests. Field trials have demonstrated that among all tested summer cover crops, sunn hemp (*Crotalaria juncea* L. cv. Tropic sun) can grow vigorously during the rainy summer, cover the land quickly and perfectly, and produce a large amount of biomass in two or three months. More important, sunn hemp can suppress soil root-knot nematodes via secreting some nematicides through its roots and decomposition of residues. Therefore, growing cover crop—sunn hemp during the summer season and rotating with valuable vegetable crops in the winter has become a promising cropping system.

2:00–2:15 PM

Growing Vegetables for Local Consumption in the Northern Great Plains

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Vegetable growing in the northern great plains of the United States presents many challenges and advantages. A short growing season with 90–130 frost-free days, a wide range of temperature fluctuations during the early growing season, and the early arrival of first frost in the late growing season are the major challenges. Abundant sunlight with a long photoperiod and large diurnal temperature differences during the growing season positively contribute to the flavor and nutritional quality of many vegetables grown. Compared to vegetable production in the southern states, there is less pest and disease pressure in the northern plains because the severely cold winter temperatures kill many of the soil-borne pathogens and insect pests. As demand for locally grown foods increase, growing vegetables for personal consumption and sale at farmer's markets is on an upward trend. While selection and proper cultural methods of raising early maturing cultivars is needed, the use of high tunnels for season extension is becoming more common. Community gardens and school gardens also play an important role in providing locally produced vegetables and fruits to children and students. Current trends and future potential for vegetable growing for local use in the northern climate will be discussed.

Specified Source(s) of Funding: ND Specialty Crop Block Grant

2:15–2:30 PM

Photosynthetic Responses of "Specialty Greens" to Irradiance and Carbon Dioxide

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Specialty greens crops are often high value crops in which there is a local demand that is not being filled. We assessed the impact of temperature (10 °C to 28 °C), irradiance and carbon dioxide on photosynthesis of a variety of these crops to provide growers with information to maximize their yield. Here, we summarize results of photosynthetic responses of a number of these specialty greens crops to irradiance and carbon dioxide. Irradiance (0–1200 $\mu mol \cdot m^{-2} \cdot s^{-1}$; 200 $\mu mol \cdot m^{-2} \cdot s^{-1}$ increments), and carbon dioxide concentration (50–1200 ppm; 200 ppm increments) effects on photosynthesis of the uppermost fully expanded leaf of eleven specialty greens crops plus a number of cultivars/varieties of kale, chard, cress and spinach (3 kale cultivars, 4 chard cultivars, 2 cress cultivars, 3 spinach cultivars, collards, arugula, beet greens, sorrel, pea shoots, broccoli raab, and nasturtium shoots) were determined. Irradiance or carbon dioxide was varied while the other variable and temperature was held constant (irradiance was held at 300 $\mu mol \cdot m^{-2} \cdot s^{-1}$, carbon dioxide was held at 400 ppm; temperature held at 22 °C). One leaf from each of five plants was measured for each cultivar/species. At ambient carbon dioxide (400 ppm) and at 22C, maximum photosynthetic rate under high irradiance (1200 $\mu mol \cdot m^{-2} \cdot s^{-1}$) varied from 16.5 $\mu mol \cdot m^{-2} \cdot s^{-1}$ carbon dioxide fixed on crinkly cress, to 26.5 $\mu mol \cdot m^{-2} \cdot s^{-1}$ carbon dioxide fixed on Melody spinach. In contrast, at ambient irradiance (300 $\mu mol \cdot m^{-2} \cdot s^{-1}$) and at 22 °C, maximum photosynthetic rate at a high carbon dioxide concentration (1200 ppm) varied from 13.2 $\mu mol \cdot m^{-2} \cdot s^{-1}$ carbon dioxide fixed on crinkly cress to 19.8 $\mu mol \cdot m^{-2} \cdot s^{-1}$ carbon dioxide fixed on Melody spinach. As irradiance increased, Crinkly cress photosynthesis saturated at 600 $\mu mol \cdot m^{-2} \cdot s^{-1}$ and Melody spinach photosynthesis saturated at 1000 $\mu mol \cdot m^{-2} \cdot s^{-1}$. As carbon dioxide concentration increased, Crinkly cress photosynthesis saturated at 800 ppm and Melody spinach photosynthesis saturated at 1000 ppm. Results here determined which crops benefit most, and to what extent, from altering irradiance or carbon dioxide with respect to impacting photosynthesis.

Specified Source(s) of Funding: Minnesota Agriculture Experiment Station and USDA–ARS NFRI

2:30–2:45 PM

Evaluation of Activated Charcoal as a Remedy for Soil Residual Herbicide Injury

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An experiment was conducted in Fall 2014 to evaluate activated charcoal as a remedy for residual soil herbicide injury on vegetable crops. The experiment consisted of 4 herbicides and a control as main blocks and 4 activated charcoal rates as sub-plots. Aminopyralid (Milestone), aminocyclopyrachlor (MAT28), and picloram (Tordon) were applied at suggested label rates. Activated charcoal was used at 0, 1/2x, 1x, and 2x rates with 1x equivalent to 300 lb/acre. Eight vegetable crops (tomato, cucumber, corn, bean, lettuce, okra, cabbage, and pepper) were evaluated for reduction of fresh harvest weight 30 days after treatment. In the absence of herbicides, the 2x rate of activated reduced fresh harvest weight of corn, but had little or no effect on the other crops evaluated. The 1x rate of activated charcoal had no significant reduction of fresh weight on all crops while the 1/2x rate increased fresh weight of cucumber, bean, lettuce, and cabbage. In the absence of activated charcoal, of the 3 herbicides tested, aminocyclopyrachlor resulted in the most reduction in fresh weight of cucumber, bean, lettuce, and cabbage. When activated charcoal was used, there were no consistent effects of increasing activated charcoal rates on cabbage or lettuce for all three herbicides. With aminopyralid, increasing rates of activated charcoal had a positive effect on fresh weight of tomato, pepper, and corn. With aminocyclopyrachlor and picloram, all rates of activated charcoal increased fresh weight of all crops, except for cabbage, cucumber, and pepper. Initial results are promising that soil residual herbicide injury can be ameliorated with activated charcoal. Additional field research is needed to determine the benefit of activated charcoal on yield.

2:45–3:00 PM

Application of Biochar in Potato Production and Its Effects on Soil Properties, Crop Yield, and Quality

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Biochar is an organic amendment produced by a process called pyrolysis, which is the burning of biomass in a limited oxygen environment. This study investigated the effect of biochar in potato (*Solanum tuberosum* L.) production. The study comprised of a randomized complete-block design with following rates of biochar: 0, 6.2, 12.4, or 24.8 t/ha. Each treatment plot was 81 m^2 and was replicated four times. Biochar was applied and disked in on 12 April, 2012. A mid-season chipping potato (cv. Atlantic) was seeded on April 12 and April 22 in 2012 and 2013, respectively. Herbicide and fertilizer applications were made later in the season based on Midwest Vegetable Production Guide. Potato was harvested on 26 July and 1 August in 2012 and 2013, respectively, and graded into marketable and non-marketable category. At the end of the growing season in 2012, soil pH ranged from 6.1 to 6.4 but there were no statistically significant differences. In 2013, soil pH increased with highest pH recorded in 24.8 t/ha biochar treatment. There was no effect of biochar on soil electrical conductivity. Plant height and canopy width was also not affected by biochar. There was

a general trend of increased yields with increasing biochar rates but differences were not statistically significant. Similarly microbial biomass carbon also increased with higher application rates but did not show significant differences. The effect of biochar on vegetable crop yields are not widely available, however, row crop studies have shown yield reductions in the first couple of years of biochar use followed by increases in subsequent years. Increases in crop yields have been attributed to better water holding capacity, higher cation exchange capacity, increased nutrient retention, and the ability of biochar to reduce bulk density. Since this study was conducted during the first two years after biochar application, it is early to speculate long-term effects of biochar on soil properties, crop growth, and yield. Biochar could be a valuable tool for management of soils that are either degraded or have poor nutrient status; however, it could take time to observe significant changes in soil and crop attributes after biochar addition.

3:00–3:15 PM

Biochar Soil Amendment to Save Water and Enhance Vegetable Productivity

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Biochar is a carbon-based product similar to charcoal increasingly produced and marketed as an organic soil amendment. Biochar is created through pyrolysis, superheating organic biomass (such as wood) in an enclosed environment with limited oxygen to produce bio oils, heat energy, and biochar. As pyrolysis industries grow and expand, there is increasing opportunity to utilize locally produced biochar for its value in sustainable agriculture. In 2014, a greenhouse trial was performed to identify optimal pyrolysis production temperatures and soil application rates to conduct subsequent field studies. Lettuce (Parris Island Cos) was used due to its short growing season and compact size. The lettuce was grown in 3-gallon plastic pots filled with silt loam field soil, and amended with 4-4-4 organic fertilizer and biochar made from Utah-sourced cherry wood. We evaluated three pyrolysis temperatures (375 °C, 475 °C, and 575 °C), three application rates (1%, 2%, and 3% by weight), and two particle sizes. Mean weight (g) of plants was determined in a single harvest nine weeks after seeding. Variation in plant weight within and among treatments was high; likely caused by inconsistent irrigation due to emitter malfunction on several occasions, and defoliation by caterpillars. Lettuce growth was decreased with the addition of biochar in all treatments except 375 °C, which is a common short-term observation in similar studies. Soil amended with biochar produced at 375 °C, pulverized, and applied at the 2% rate produced the largest lettuce. In 2015, we will test biochar for enhancement of tomato and melon growth and yield at four cooperating vegetable farms and evaluate its protection of tomato roots from a common soil disease, phytophthora root rot. We anticipate that biochar amendment will enhance plant growth and yield, and may reduce plant water needs in these longer-term field studies.

Specified Source(s) of Funding: Western SARE

3:15–3:30 PM

Winter Produce Potential in Conventional and "Deep Winter" Greenhouses in the Upper Midwest

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There is increasing public demand for locally produced food across seasons. In collaboration with the Minnesota greenhouse industry and local restaurateurs and grocers, we identified six vegetable (miniature cucumber—*Cucumis sativus* var. *jawell*, red Russian kale—*Brassica napus* var. *pabularia*, spinach—*Spinacia oleracea* var. *tyee*, and a mesclun mix of arugula—*Eruca sativa*, mizuna—*Brassica rapa* var. *nipposinica*, and red giant mustard—*Brassica juncea*) and one fruit crop ("day-neutral" strawberry—*Fragaria* ×*ananassa* cv. *Albion*) that could be used and/or sold in high volume if locally produced from late fall to early spring. We initiated a study in nine greenhouses across the state of Minnesota to determine the potential of existing facilities for successful off-season production of the aforementioned crops. The environment in each facility was monitored, and potential production issues of each crop were determined at each site. Sites ranged in location from 44.0717°N to 46.8172°N latitude, resulting in a variety of temperature and daylight conditions. Irradiance, day/night temperature, and humidity were measured every 15 minutes at each location from November 2014 to February 2015 using dataloggers, and carbon dioxide concentration was taken once in January 2015 in each facility. In addition to geographic location, differences between "conventional" greenhouses (6) and "deep winter" greenhouses (3) were evaluated. Deep winter greenhouses are passive-solar, greenhouses built for growing produce from late

An asterisk (*) following a name indicates the presenting author.

fall to early spring with little energy input. Sites varied markedly in day/night temperature, irradiance, and humidity. For instance, deep winter greenhouses had considerably greater fluctuations in temperature than conventional greenhouses. Fresh weight of leaves and fruit were collected from the crops identified at each location over different harvest times (November–February). In addition, photosynthetic irradiance and carbon dioxide response curves were collected at each site on each crop on a fully mature leaf. Variation in the photosynthetic potential of each crop at each facility and differences in yield and nutritional value will be discussed.

Specified Source(s) of Funding: Minnesota Agriculture Experiment Station and MN-DRIVE

3:30–3:45 PM

Growing Food with Garbage: Waste Amendments for Vegetable Production

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Organic wastes are abundant sources of C to build soil organic matter and nutrients for crop production, yet over 50 million tons a year in the United States are not being put to beneficial use. Some, like gelatin waste and dehydrated food waste, remain relatively unstudied, whereas others, like biosolids and paper waste, have been extensively studied, but data about their effects on soil and crops are often conflicting. In a two-year field trial (2013 and 2014) on a silt loam in southern Rhode Island, I compared the effects of paper fiber sludge/chicken manure (PF), biosolids/yard waste co-compost (BS), multi-source compost (MS), yard waste compost (YW), dehydrated food waste (FW), gelatin waste (GW), and a mineral fertilizer (20–20–20) control on soil quality and the yield of sweet corn (*Zea mays* cv. Applause, Brocade, and Montauk), butternut squash (*Cucurbita moschata* cv. JWS 6823), and potatoes (*Solanum tuberosum* cv. Eva). The experiment was arranged in a randomized block design (n = 4) and amendments were applied to supply 10,000 kg/ha of C over two seasons. Amendment with wastes did not negatively impact soil moisture, bulk density, electrical conductivity or the concentration of heavy metals in soil or plant tissue. Amendment with MS significantly ($P < 0.05$) increased soil pH and amendment with FW significantly decreased bulk density in comparison to the control. Amendment with YW and BS increased soil organic matter, although not consistently across all plots. Waste amendment application was not a reliable way to increase soil inorganic N later in the growing season, or potentially mineralizable N (PMN), a measure of the organic N mineralized to inorganic forms, in comparison to the control. Yields from plots amended with GW, BS, and FW were comparable to the control for all crops. While YW, PF, and MS underperformed for corn and/or squash production, they performed as well as the control for potatoes. Although potatoes from plots amended with PF showed inhibition of emergence and early growth, their quality in 2014 was significantly better than the control, possibly due to less disease and/or insect damage. While all crops and treatments had sufficient tissue concentrations of N, P, Ca, Mg, Mo, Cu, and Fe, some were deficient in K, Mn, B, and Zn. However, there was no clear connection between nutrient deficiencies and treatments with reduced yields. All waste amendments studied showed promise as effective replacements for mineral fertilizers for at least one of the crops grown.

Wednesday, 5 August 2015

Plant Nutrient Management 1

Moderator: Charles A. Sanchez
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2:15–2:30 PM

Variable Rate Fertilizer Application for Desert Vegetable Production

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Fields used for vegetable production in the southwest United States often require large amounts of P fertilizer for optimal production and quality. The field production units (many alluvial) in this region are typically highly variable in soil physical and chemical properties. However, the prospects of variable rate (VR) P fertilization practices had not been evaluated for vegetable crops in this region. Studies were conducted in commercial production fields with grower–cooperators in 2013–2015 with lettuce (*Lactuca sativa L*), broccoli (*Brassica oleracae* Italica Group), and potato (*Solanum tuberosum* L.). In these evaluation we compared grid sampling based VR fertilizer recommendations and zone sampling based VR fertilizer recommendations to the grower standard fertilizer practice, which was usually based on composited soil sampling. This presentation will include a detailed description of commercial-grade application equipment upgraded with specialized hardware and software used for VR applications of pre-plant phosphorous fertilizer, the scientific framework used to convert soil P levels into prescribed fertilizer amounts, and hardware and software for the collection of production data. Preliminary data collected show potential economic and environmental benefits to VR P fertilizer management for vegetables produced in the desert.

Specified Source(s) of Funding: CDFA FREP

An asterisk (*) following a name indicates the presenting author.

2:30–2:45 PM

Effects of Mulching and Micronutrient Management on Growth and Yield of Onion

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Onion (*Allium capa* L.) belonging to the family Alliaceae is one of the most important spices as well as vegetable crops in the world including Bangladesh. As the bulb yield of onion is insufficient in Bangladesh, we have to depend on imports to meet the shortage. Artificial mulching by using polythene sheet and micronutrient management are very important for successful onion production. The experiment was conducted at the farmer's field of Gobindopur, Rajshahi, Bangladesh, under High Ganges River Floodplain Soils (AEZ-11) to study the effects of mulching and some micronutrients (boron/B and zinc/Zn) on the growth and yield of onion during the period from November 2011 to April 2012. The trial with one onion cultivar (Taherpuri) involved two separate experiments using different micronutrient levels (3 levels of B: 0, 0.20, 0.40 $g \cdot m^{-2}$ and 4 levels of Zn: 0, 0.50, 0.80, 1.25 $g \cdot m^{-2}$) with plastic mulch without irrigation, and without mulch with irrigation. The experiments were laid out in a split-split plot design with three replications. Results demonstrated that most of the yield and yield contributing parameters were significantly influenced by applying plastic mulch and different doses of B and Zn. The plant height (35.55 cm) at 60 DAP (days after planting), number of leaves (5.53), fresh weight of leaves (12.13 g), dry weight of leaves (1.41 g), fresh weight of bulb (27.78 g), dry weight of bulb (2.54 g), pseudo-stem diameter (1.16 cm), diameter of bulb (4.04 cm), and bulb yield (14.86 $t \cdot ha^{-1}$) were found to be greater when grown in plastic mulching. Interaction between mulching and boron, mulching and zinc, boron and zinc, and mulching and boron with zinc at different levels had significant effects on all growth and yield parameters with few exceptions. The combination of the highest doses of B at 4 $kg \cdot ha^{-1}$ and Zn at 12.50 $kg \cdot ha^{-1}$ with plastic mulching gave higher yield (18.71 $t \cdot ha^{-1}$) of onion bulb and other parameters than those of yield without mulching (15.56 $t \cdot ha^{-1}$). However, it can be concluded that most of the yield contributing characters and yield were significantly influenced by plastic mulching along with the interaction effect of different levels of B and Zn with it.

2:45–3:00 PM

Microbial Bio-fertilizers for Pepper Production

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Current fertility systems used in agriculture overwhelm the environment with nutrients above crop demands, which lead to water pollution and multiple environmental problems. Biofertilizers (or microbial soil inoculants) can be used to reduce current fertilizer inputs while maintaining or improving crop plant growth and yield. *Pseudomonas putida* is a plant growth promoting rhizobacteria (PGPR) and biofertilizer that is known to improve plant growth by assisting with nutrient availability, managing plant hormones, and acting as a biological control of several plant pathogens. Therefore, a field study was conducted in 2014 at the Southern Illinois University Horticulture Research Center in Carbondale, IL, assessing the effects of application timing and dosage of two plant growth promoting rhizobacteria (PGPR) strains of *P. putida* [(17-29) and (G11-35)] on 'Revolution' bell pepper growth and yield. Results indicated that the inoculum population denisity increased early-season vigor, plant height and caliper, and flower bud count ($P < 0.0001$), as well as late-season leaf SPAD values ($P < 0.0001$) for both strains. Although early season fruit yield (first two harvests) increased with rhizobacteria inoculum population density ($P < 0.0007$ and $P < 0.0005$ for total fruit weight and number, respectively), late-season fruit yields (last three harvests) were not affected. It appears that higher early-season yields resulting from increasing rhizobacteria inoculum population densities were greater due to increased flower bud formation on more vigorous plants.

3:00–3:15 PM

Storage Root Shape Determination in Sweetpotato: Fifty Shades of Phosphorus

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Phosphorus is a critical macronutrient required in all metabolic processes in the plant, including energy transfer, signal transduction, biosynthesis of macromolecules, photosynthesis, and respiration. Plants acquire phosphorus in the form of phosphate (Pi), the availability of which varies in agricultural soils. To cope with spatial and temporal Pi supply, plants have developed adaptive responses that remobilize internal Pi and maximize external Pi acquisition. The latter response involves the redesign of root system architecture to accelerate soil exploration. In sweetpotatoes, knowledge about how the root system adapts to temporal variability of Pi is limited. Past studies have generally shown that Pi treatments did not influence sweetpotato yields. Field experiments conducted in 2014 have revealed a differential response among sweetpotato cultivars to the presence or absence of supplemental Pi application. Some of these responses include variation in root mass and storage root shape. Using an aeroponics system, intra-cultivar

variation in root development attributes was also observed. The absence of phosphorus in the nutrient medium did not prevent storage root formation but was associated with constrictions in storage roots. Results from the current work can help shed light on the role of phosphorus in storage root formation and shape determination and have potential direct agricultural applications through the development of cultivar-specific Pi recommendations.

Specified Source(s) of Funding: Louisiana Sweet Potato Commission

3:15–3:30 PM

Physiological and Molecular Basis for the Low Nitrate (NO_3-) Assimilation in Blueberry

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Blueberry (*Vaccinium* spp.) has recently emerged as a crop of significant economic value with multiple health benefits driving the increased demand. Blueberries require very specific soil conditions (pH < 5.5, high organic matter, and ammonium form of nitrogen) to maintain profitable fruit production. Increased acreage is forcing producers to plant blueberries in agricultural soils (pH > 6.0, low organic matter, and nitrate form of nitrogen), requiring costly soil amendments. In most woody perennials, nitrate is primarily assimilated in the shoot, yet blueberries have been shown to assimilate little to no nitrate in the shoots. A decreased ability to uptake and assimilate nitrate in the shoots may be a key factor for the strict soil requirements. Nitrate reduction to nitrite is the rate-limiting step requiring nitrate reductase (NR) to catalyze the process. Using different methods to supply nitrate to the shoots may induce NR activity indicating that the shoots can assimilate nitrate. 'Sweet Crisp' (*V. corymboseum*) and 'Alapaha' (*V. ashei*) were acclimated to only ammonium nitrogen using a deep-water culture hydroponic system. After three weeks, plants were supplied with nitrate nitrogen in one of the following three treatments: 5 mM nitrate supplied to the roots using the hydroponic system; 5 mM nitrate supplied directly through a cut stem; 5 mM nitrate supplied to the leave surface through a foliar application. Leaf samples were collected from the first treatment at 0, 5, 10, and 15 d after treatment. Leaf samples from cut-stem and foliar applications were collected at 0, 24, 48, and 72 h after treatment. An in-vitro method using frozen leaf samples was used to quantify NR activity. Very low levels of NR activity were measured in the nitrate supplied to the roots, while the foliar applied nitrate significantly induced NR activity. These results indicate that blueberry shoots are capable of assimilating nitrate if nitrate is translocated to the shoots.

Specified Source(s) of Funding: University of Georgia Horticulture Department

Wednesday, 5 August 2015

Water Utilization & Management

Moderator: Bruk Belayneh
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4:00–4:15 PM

Using Wireless Sensor Networks for Irrigation and Nutrient Management in Strawberry Production

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Increasing the efficiency of water and fertilizer resources used in strawberry production is vital as evidenced by the serious water shortage that is affecting growers in California and regulations limiting nutrient runoff from agricultural operations in mid-Atlantic regions such as Maryland. Sensor networks have the potential to be successfully applied in order to achieve these goals for an economically and environmentally sustainable strawberry production. We have installed sensor networks on two commercial strawberry farms in Maryland to provide the growers real-time data on environmental conditions and soil moisture and electrical conductivity levels that can be used to make better irrigation and nutrient management decisions. Sensor-controlled irrigation is implemented in production beds on the farms with the objective of quantifying its effect on plant growth, yield, fruit quality and irrigation water use as compared to current practices followed by growers (grower-controlled irrigation). The sensor-controlled irrigation is implemented by control nodes that start irrigation events whenever average real-time volumetric water content (VWC) readings in the root zone drop below user-defined (set-point) soil moisture levels. Irrigation water applications are continuously measured using flow meters to compare the two irrigation treatments whereas soil electrical conductivity data are being collected at two depths to estimate nutrient leaching below the root zone. Continuous data from soil moisture, electrical conductivity sensors, environmental sensors, and flow meters installed at the farms is collected by Em50R and nR5 data loggers (Decagon Devices, Inc., Pullman WA) and transmitted to a base station computer. Using software (Mayim LLC, Pittsburgh, PA), the real-time data is organized and accessed by growers and researchers on any internet-enabled device. We are conducting a replicated field study to compare deficit irrigation treatments and a control in a plasticulture strawberry production system, using wireless sensor network to implement sensor-controlled irrigation based upon real-time VWC and soil water potential data. Irrigation water volumes are continuously measured using flow meters to compare irrigation water use efficiencies for the deficit irrigation and control treatments. Plant growth, fruit yield and fruit quality data are being collected and will be analyzed to identify optimum deficit irrigation levels.

An asterisk (*) following a name indicates the presenting author.

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4:15–4:30 PM

Demonstration of Improved Citrus Irrigation Using Soil Balance Model and Soil Moisture Sensors

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The Citrus Water Management System (CWMS) is a computer software package that allows the user to store information required to simulate a water balance for each individual zone. Daily ET data can be manually entered by the user or automatically downloaded from the Florida Automated Weather Network (FAWN) once an appropriate station location is entered for each irrigation zone. The CWMS was demonstrated from 2012 to 2014 on a citrus grove that is irrigated in 178 irrigation zones controlled by the Motorola system. Rainfall and irrigation application for each irrigation zone are provided daily using two files generated by the irrigation control system and read by CWMS. Soil moisture data was collected using a series of multi-level capacitance sensors installed at selected locations in blocks irrigated by one of three irrigation scheduling methods. The three methods are: 1) control with irrigation practices following University of Florida Institute of Food and Agricultural Sciences (IFAS) recommended seasonal schedules; 2) manually adjusted irrigation schedules using soil moisture sensors; and 3) manually adjusted irrigation schedules using the CWMS model. Soil moisture data was automatically collected daily by a proprietary program supplied by the sensor manufacture. Average soil moisture for the 10-, 20-, 30-, and 50-cm depths ranged from 0.08 to 0.13 cm^3/cm^3 with the lowest values during the dry months and the highest values during the rainy season. The measured soil moisture was not significantly different than the simulated soil moisture for either 2012/2013 or 2013/2014 growing seasons. Average monthly water use in the IFAS recommended blocks decreased in 2013/2014 but were in the same range as average monthly water use reported by neighboring groves on a grove area basis Significant differences in water use were found in 2012/2013 and 2013/2014, when blocks irrigated with conventional irrigation scheduling was compared with blocks irrigated using soil moisture sensor data or model simulations on both a grove area basis and a per tree basis. Likewise, comparable reductions in irrigation system run time were found for sensor and model irrigation schedules. Water use savings of approximately 18% for blocks irrigated using sensors and 11% compared with the IFAS recommended schedule Fruit yields for all three irrigation schedules were not significantly different in 2012/2013 or 2013/2014 and were similar to the initial year. Thus yearly water use can be reduced by approximately 15% using soil moisture sensors or model simulation with no significant reduction in yield.

Specified Source(s) of Funding: Southwest Florida Water Management District

4:30–4:45 PM

Surface Irrigation Degradation of Water Quality in Streams

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Gravity fed irrigation systems were built in Malheur County, Oregon, in the early 20th century to serve intensive horticulture and livestock production. Reservoirs, dirt canals, and surface systems were constructed relying on gravity fed water distribution and catchment and reuse of return flow. Over the last forty years various programs have collected and analyzed water samples from throughout the intensely managed parts of the watersheds. Data were compiled and evaluated to examine how irrigation practices may affect surface water quality. The results demonstrate that water is enriched in total phosphorous, orthophosphate, *E. coli*, and dissolved solids. Options to reorganize water delivery systems are being studied and implemented. Innovative practices are being adopted at the producer level to mitigate the effects of irrigation induced erosion and runoff from farms.

4:45–5:00 PM

Dormant Stem Water Potential Responds to Cycles of Hydration as Well as Changing Environmental Conditions in Deciduous Tree Crops

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As California farmers face growing water insecurity, the need for winter (dormant) irrigation of deciduous tree crops has arisen as an important issue. Measurement of midday stem water

potential (SWP) with a pressure chamber during the growing season has become a practical and widely adopted tool for irrigation management in many annual and perennial crops, but this technique has not been applied to perennial crops during dormancy. Indeed, the reliability of pressure chamber readings on the twigs of dormant trees has been questioned due to concerns that a low percentage of living tissue and/or a high level of embolism may cause inaccurate results. Psychrometric measurements of water potential are made in the vapor phase and do not depend on the degree of embolism or the percentage of living tissue, and hence should be useful in evaluating the accuracy of pressure chamber measurements in dormant trees. Measurements of water potential using both pressure chamber and thermocouple stem psychrometer methods were compared on dormant branches exposed to different levels of hydration in the laboratory. A very highly significant ($P < 0.0001$) linear regression was found between the two methods over a wide range of SWP values (0 to about –2 MPa) in almond, cherry, and walnut, with r^2 values of 0.98, 0.91, and 0.90, respectively, and in the case of almond and cherry the slope of the regression was close to 1:1. Field measurements on dormant almonds in two winter seasons with contrasting rainfall showed systematically lower SWP during a dry winter compared to a wet winter, and during a third season, SWP was found to increase in response to a winter irrigation. This evidence strongly supports the validity of SWP as a measure of dormant tree water status, and hence its use as a tool to evaluate the need for winter irrigation in dormant tree crops.

5:00–5:15 PM

Irrigation Requirements for Seed Production of Five Native *Lomatium* Species

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Lomatium species are important components in the rangelands of the Intermountain West. Relatively little is known about the cultural practices necessary to produce *Lomatium* seed for use in rangeland restoration. Research at the Oregon State University Malheur Experiment Station in Ontario, Oregon, was initiated in 2006 and 2009 to evaluate the seed yield responses of native *Lomatium* species to irrigation. The seed yield responses of five *Lomatium* species to four biweekly subsurface drip irrigations applying either 0, 25 mm, or 50 mm of water (total of 0, 100, or 200 mm/season) were evaluated over multiple years on silt loam in a semi-arid environment. Irrigations were started at flowering initiation, which varied by species from mid-March to mid-April. Precipitation from January through June ranged from 67 to 224 mm. *Lomatium grayi* and *L. triternatum* started producing seed in the second year after fall seeding. *Lomatium nudicaule, L. dissectum,* and *L. suksdorfii* started producing seed in the third, fourth, and fifth years after fall seeding, respectively. Optimum irrigation was determined by regression on seed yield for each species each year. Over six production seasons, *Lomatium dissectum* seed yield averaged 972 kg/ha and was maximized by 125 mm of applied water per season in cooler, wetter years and by 200 mm of applied water per season in warmer, drier years. Over eight production seasons, *Lomatium grayi* seed yield averaged 927 kg/ha and was maximized by 0 to 125 mm of applied water per season in cooler, wetter years and by 125 to 200 mm of applied water per season in warmer, drier years. Over eight production seasons, *Lomatium triternatum* seed yield averaged 1487 kg/ha and was maximized by 100 to 200 mm of applied water per season in cooler, wetter years and by 200 mm of applied water per season in warmer, drier years. In two years of seed production, *Lomatium nudicaule* seed yield averaged 605 kg/ha, but was not responsive to irrigation. In the first and only seed production season observed so far, seed yield of *Lomatium suksdorfii* did not respond to irrigation.

Specified Source(s) of Funding: U.S. Forest Service

Wednesday, 5 August 2015

Growth Chambers and Controlled Environments 2

Moderator: Geoffrey Weaver
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4:30–4:45 PM

High-intensity Blue Light as a Night Interruption Can Regulate Flowering of Photoperiodic Ornamentals

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Under a short photoperiod, lighting at the end of the day (day extension, DE) or during the middle of the night (night interruption, NI) can regulate flowering of photoperiodic crops. Low-intensity (≈2 μmol·m^{-2}·s^{-1}) red (R; 600–700 nm) and far-red (FR; 700–800 nm) light controls flowering of a wide range of plants, whereas low-intensity blue (B; 400–500 nm) light generally does not. However, the effects of high-intensity B light, alone or when added to R and FR light, on flowering and photomorphogenesis have not been fully elucidated. We grew five long-day plants [calibrachoa (*Calibrachoa ×hybrida*), coreopsis (*Coreopsis grandiflora*), petunia (*Petunia ×hybrida*), rudbeckia (*Rudbeckia hirta*), and snapdragon (*Antirrhinum majus*)] and two

An asterisk (*) following a name indicates the presenting author.

short-day plants [chrysanthemum (*Chrysanthemum* ×*morifolium*) and marigold (*Tagetes erecta*)] in a greenhouse at a constant set point of 20 °C under a 9-hour short day with or without 5.5-hour DE and/or 4-hour NI lighting from light-emitting diodes. The B light was delivered at 0, 1, 15, or 30 μmol·m^{-2}·s^{-1}, in some cases with R + white (W) + FR light at 2 μmol·m^{-2}·s^{-1} between 400 and 800 nm. The peak maxima of B, R, and FR light were 450, 666, and 738 nm, respectively. The B light at 30 μmol·m^{-2}·s^{-1} created long days in most crops as effectively as R + W + FR light. Flowering of calibrachoa and petunia was 2–4 days earlier, and flowering of chrysanthemum was 11 days later, when B light at 30 μmol·m^{-2}·s^{-1} was added to R + W + FR light. For all crops except rudbeckia and marigold, an NI was more effective than a DE. Rudbeckia and chrysanthemum were 14% to 19% and 22% to 36% shorter, respectively, at flowering under B light at 30 μmol·m^{-2}·s^{-1} than under mixtures of B and R + W + FR light, but there were few or no height differences among treatments in other crops. We conclude that NI lighting with high-intensity B light, alone and when added to R and FR light, can regulate flowering of various ornamentals.

Specified Source(s) of Funding: USDA National Institute of Food and Agriculture's Specialty Crop Research Initiative and Michigan State University's Project GREEEN

4:45–5:00 PM

The Effects of Daily Light Integral and Nutrient Solution Concentration on Growth of Several Basil Species (*Ocimum* spp.)

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Basil (*Ocimum* L. spp.) is an herb commonly produced in hydroponic greenhouses. Nutrient solution concentrations are selected based on crop species, stage of growth, and environmental conditions. We have not found recommended nutrient solution concentrations for different basil species. Our objective was to quantify the effect of mineral nutrient concentration of a nutrient solution on the growth of basil species and cultivars grown under high and low daily light integrals (DLIs). Seeds of four cultivars: sweet basil (*Ocimum basilicum* L. 'Nufar'), holy basil (*O. tenuiflorum* L. 'Holy)', lemon basil (*O.* ×*citriodorum* Vis. 'Lime'), and lemon basil (*O. basilicum* L. 'Sweet Dani') were chosen. Seeds were sown into 162-count sheets of phenolic foam propagation cubes, placed in a growth chamber with a target air temperature of 24 °C, and irrigated with deionized water or a nutrient solution. Two weeks after sowing seeds, seedlings were transplanted into nutrient film technique (NFT) systems in a greenhouse with high (15.0 mol·m^{-2}·d^{-1}) or low (6.9 mol·m^{-2}·d^{-1}) DLI with a mean air temperature of 21.7 °C. The NFT systems contained five different nutrient solution concentrations (0.5, 1.0, 2.0, 3.0, or 4.0 mS·m^{-1}) comprised of 16N–1.8P–14.3K complete fertilizer. Nutrient solutions were adjusted daily to maintain target ECs using a stock solution and a pH of 6.0 with buffers. Three weeks after transplanting, height, node number, branch number, and fresh mass were recorded. For plants grown under either a low or high DLI, there was no difference in fresh mass between plants grown in different nutrient solution concentrations. For example, sweet basil grown under a high DLI in a nutrient solution of 0.5 mS·cm^{-1} had a mass of 27.4 g compared to 27.3 g for plants grown in 4.0 mS·cm^{-1} nutrient solution. Alternatively, there were differences between plants grown under a low and high DLI. Fresh mass of sweet basil plants grown in a 1.0 mS·cm^{-1} nutrient solution under a low DLI was 22.0 g less than plants grown under high DLI while plants were 3.9 cm shorter. Under low or high DLIs, the concentration of nutrient solution has no effect on fresh mass. Therefore selection of nutrient solution concentrations should be based on meeting required tissue concentrations while minimizing the amount of fertilizer used.

5:00–5:15 PM

Using Normalized Difference Vegetation Index (NDVI) as a Proxy for Plant Size in Water Use Models to Facilitate Precision Irrigation

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Precise irrigation of greenhouse crops based on plant water needs not only allows for optimal plant growth, but also conserves water and alleviates environmental pollution from fertilizer and pesticide runoff. A thorough understanding of crop-specific water requirements is essential for more efficient irrigation. However, plant water use changes on a daily basis, driven by variations in environmental conditions as well as increases in plant size over time. While environmental conditions are relatively easy to measure, direct determination of plant size is often destructive and time consuming. Remote sensing of vegetation indices, such as the normalized difference vegetation index (NDVI), provides a continuous and non-destructive method to estimate canopy size for use in water use models. The objective of this study was to develop quantitative models that predict daily water use (DWU) of four bedding plant species based on environmental factors and NDVI, a proxy for plant size. In addition, we also determined the feasibility of using NDVI in place of 'crop coefficients' (the ratio of crop DWU to reference evapotranspiration) that are commonly used in agronomic applications. The NDVI increased linearly over time during vegetative growth, until canopy closure was nearly complete. However, flowers reflect light at the two wavebands of interest (centered at 650 nm & 810 nm, respectively) differently from green leaves. The NDVI measured from three of the plant species that flowered within the course of the study showed little increase or declined gradually when flowers started to form and shade the leaves. The crop coefficients increased linearly over time as plants grew, but NDVI increased quadratically with increasing crop coefficient, indicating decreasing sensitivity of NDVI to increasing plant size.

An asterisk (*) following a name indicates the presenting author.

Nevertheless, multiple linear regression models developed using reference evapotranspiration and NDVI were able to explained 80% to 96% of variation in DWU of each individual species, suggesting that NDVI may be used as a reliable proxy for plant size.

5:15–5:30 PM

LED Light Screening Method for Better Quality and Quantity of Lettuce

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Growing green vegetable is limited by the availability of light in cold countries. Increasing population and the demand for fresh, quality green vegetables have been the major concerns about using efficient light technology, which can be used 365 days in a year. Light emitting diodes (LEDs) is the best choice over a conventional lighting system. These lights generate lesser heat, require less power supply, and have the ability to customize the required intensity and the wavelength (light spectrum) with efficient light quality and longer life span. Overall, LEDs play a very important role in urban agricultural economy. The objective of this study is to determine the effect of different wavelength and light intensity ratio on the growth of 'Breen' lettuce using a circulating hydroponic system. The lettuce was grown in the lab, under a combination of wavelengths: 640 nm, 450 nm, and 590 nm (red, blue, and amber), and 24 different light intensity ratios. At the end of the experiments, significant results will be analysed, such as, variations in fresh weight, dry weight, root length, and leaf area. Pigment analysis of total carotenoids, Chl-A, Chl-B, and anthocyanin, will be analysed for every intensity ratio. In conclusion, the screening method will provide the information of plant response to different light intensity ratios. The optimized light ratio can be economic and produces the better quality and quantity of lettuce in an urban agriculture method.

Specified Source(s) of Funding: NSCRC, Urban Barns

5:30–5:45 PM

Blue Light Dose-response of Growth and Morphology of Tomato Seedlings under Different Blue and Red Photon Flux Ratios Using LEDs

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Light-emitting diodes (LEDs) are a potential light source for the production of transplants because of their increasing energy-to-photon conversion efficiencies and capability to customize the light spectrum. However, more research is needed in order to find optimal light recipes for different horticultural plant species. The objective of this experiment was to evaluate different blue and red photon flux (PF) ratios using LEDs for seedling production of tomato (*Solanum lycopersicum*) and their rootstock (*S. lycopersicum* × *S. habrochaites*). 'Komeett' tomato and 'Beaufort' rootstock were grown in a growth chamber until the second true leaf stage with 100 $\mu mol \cdot m^{-2} \cdot s^{-1}$ photosynthetic photon flux of LED lighting, 18-hour photoperiod, 25 °C temperature, and ambient CO_2. The treatments consisted of six blue-red (B-R) percent PF ratios of 0B-100R, 10B-90R, 30B-70R, 50B-50R, 75B-25R, and 100B-0R, one blue-green-red percent PF ratio of 20B-28G-52R, and a cool-white fluorescent (CWF) control. Peak wavelengths were 455 nm and 661 nm for the B and R LEDs in the B-R ratio treatments and 473 nm, 532 nm, 660 nm for the B, G, and R LEDs in the B-G-R treatment. For 'Komeett', hypocotyl length decreased with the increase of percent blue PF up to the 75B-25R. Plants under CWF showed the shortest hypocotyl of all treatments and plants under 100B-0R showed as high hypocotyl length as the ones in 10B-90R treatment. Chlorophyll concentration per leaf area was no significantly different in plants grown under the 10B-90R, 20B-28G-52R, CWF, 30B-70R, 50B-50R, 75B-25R treatments, but it was lower in the 0B-100R and 100B-0R treatments. Stem diameter, leaf number, fresh mass, and dry mass increased with the increase of the percentage of B PF from 0B-100R up to 30B -70R and 50B-50R, and then it decreased from 50B-50R to 100B-0R. Plants under the 30B-70R and 50B-50R showed 66% and 59%, respectively, greater dry mass and plants under the 0B-100R treatment showed 65% lower dry mass than plants under the CWF control. For 'Beaufort' all the measured parameters were negatively affected by severe intumescence symptoms. Plant dry mass was reduced by an average of 178% compared to the CWF control (no intumescences in the control). Intumescence development in leaves decreased with the increase of percent B PF. The 0R-100B treatment did not show any intumescence symptoms but leaf yellowing/bleaching affected plant growth. More research is needed to find the optimal spectrum for tomato transplants production grown under sole-source lighting.

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5:45–6:00 PM

Chlorophyll Fluorescence Measurements Can Indicate Carbon Fixation Rates of Lettuce

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Chlorophyll fluorescence is a fast, easy, and reliable method for gaining information about the light reactions of photosynthesis. This technique is highly versatile and invaluable for plant physiological studies because it is non-destructive and responsive to a variety of biotic and abiotic stressors. Recently, we developed a prototype biofeedback control system that uses chlorophyll fluorescence to automatically adjust the intensity of light-emitting diode (LED) grow lights to maintain a constant electron transport rate (ETR). However, chlorophyll fluorescence is not a direct indicator of the rate of carbon fixation. We conducted a series of studies to determine the effect of LED light intensity on net photosynthesis (P_n), and to elucidate the relationship between electron transport rate and P_n. Dark-adapted lettuce plants were placed in a growth chamber under warm-white LED lights. After dark-adapted fluorescence values were recorded, the plants were exposed to a constant light intensity for 20 hours. Chlorophyll fluorescence, leaf gas exchange, and light intensity were continuously monitored during this time, and for 4 hours of darkness immediately after the 20-hour light exposure period. This experiment was repeated over a range of light intensities (100 to 800 $\mu mol \cdot m^{-2} \cdot s^{-1}$). In all experiments, ETR and quantum yield of photosystem II initially reached a high level then decreased gradually. There was a strong positive correlation between P_n and ETR averaged over 20 hours (r = 0.87). When the lights were turned off, ETR decreased to near-zero, P_n became negative (because of respiration), and quantum yield rapidly increased to levels similar to dark-adapted values. These results suggest that chlorophyll fluorescence can be used as an indirect measure of carbon fixation. Future research will focus on how LED light intensity can be adjusted to optimize photosynthetic processes for the most efficient conversion of light into biomass, and thereby developing methods for reducing the overall energy cost of indoor crop production.

Wednesday, 5 August 2015

Organic Horticulture 1

Moderator: Brian Ward
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4:45–5:00 PM

Rice as a Vegetable: An Organic Perspective of System of Rice Intensification

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System of Rice Intensification (SRI) is an agro-ecological method of growing rice in an upland moist ground scenario without flood. In arid regions where resources like water, seed, and fertilizer are scarce, SRI provides an opportunity for growers to obtain rice yields equal and greater to flood systems. The wide spacing experienced in SRI is the main reason for increased yields due to the plants ability to produce multiple runners and panicles compared to flood systems. This rice cultivar trial was conducted at Clemson Coastal Research and Education Center Organic Research Farm in Charleston, South Carolina, utilizing raised bed plasticulture typically used to grow vegetable crops. Cultural practices included 160 pounds per acre of 8–5–5 Nature Safe preplant incorporated, with black plastic mulch and two rows of drip tape. Rice cultivars Carolina Gold, Charleston Gold, Presidio, Tesanai II, IAC 600, XL 753, Jefferson/*O. rufipogon*, and Dragon Eyeball were seeded in 288 cell packs 1 May 2014, and transplanted 15 May 2014, three rows to a plot in a 25 cm^2 grid pattern in a completely randomized block design with four replications. Moisture levels were maintained between saturation and field capacity. Days to flowering, heading, and height data were collected prior to harvest. At harvest, 0.03 m^2 area plot subsamples were hand harvested and graded for narrow brown leaf spot, brown leaf spot, bacterial panicle blight, and straight head. The graded bundles were then hung in a drying greenhouse for approximately 36 hours until rice kernels achieved 12% moisture and then the bundles were threshed with a Kincade plot combine and then weighed. Average field yields in pounds per acre were as follows; 'Carolina Gold' = 1,366, 'Charleston Gold' = 4155, 'Presidio' = 10,427, 'Tesanai II' = 8889, IAC 600 = 2090, XL 753 = 15,311, 'Jefferson'/*O. rufipogon* = 6144, and 'Dragon Eyeball' = 2094. 'XL 753' is a modern hybrid and yielded significantly greater yields than the other cultivars. Commonly cultivated 'Presidio' and 'Tesanai II' yields were statistically similar. The remaining lines in this trial were heritage types yielded consistent with flood culture. A flood trial was conducted alongside the SRI trial with six of the eight cultivars, and of the comparable yields SRI 'XL 753' yielded 4469 pounds per acre more than flood and 'Presidio' yielded 3514 pounds per acre more than flood. Considering command pricing for organic heritage rice, SRI rice as a vegetable has potential to fill a niche in commercial horticulture with more research.

Specified Source(s) of Funding: Carolina Gold Rice Foundation and Anson Mills

5:00–5:15 PM

Establishment of a Sustainable Production System for Chaya (*Cnidoscolus aconitifolius*) in Quintana Roo, Mexico

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Spinach tree, or chaya (*Cnidoscolus aconitifolius* Mill.), is an autochthonous mesoamerican euphorbiaceous. Wild types of chaya are characteristic species of the rainforests of the Yucatan Peninsula. A domesticated subvariety of chaya is frequently observed in local home gardens, as the boiled leaves of this plant are an essential component of traditional Mayan cuisine

and medicine. The leafy perennial shrub is an excellent source of vitamins and minerals; it is also rich in antioxidants. Yet, it is the high protein content of chaya that sustains the seminal potential of this plant as food, forage, and medicinal crop. However, there is no intensive production of the spinach tree so far, which is why an entire production system has to be developed. In José María Morelos (central Yucatan), several field trials have been dedicated to the establishment of a sustainable crop management for chaya. Since 2014, as the first and essential parameter, the optimum arrangement for cropping the spinach tree has been determined. Three variants were compared: 1) Monocropping of chaya with a density of 50,000 plants/ha; 2) monocropping with 25,000 plants/ha; and 3) intercropping the spinach tree with roselle (*Hibiscus sabdariffa*) for its similar nutrient and water demand. In the latter variant, both plants were established at a density of 25,000 plants/ha. The trial was arranged in a randomized block system. The management was organic with emphasis on using local resources. There was no irrigation. Clones of the so-called sweet chaya, the most common phenotype in local gardens, were established in rows 2 m equidistant (with varying planting distances in between the rows). The effect of this arrangement on the development of chaya was evaluated by the vegetative growth of the recently established cuttings. Height increment was identical in all three variants. Foliar size and number, as well as stem growth, were inferior in the intercropped variant, but they were at the same level in the case of monocropping. In the denser variants, a tendency of slower vegetative growth in the dryer months is monitored. So far, no substantially harmful pests and diseases have been observed. Although agrobiodiversity is consequently useful for sustainable production, first results show that intercropping the chaya with roselle is not a recommendable strategy for obtaining this diversity.

5:15–5:30 PM

Comparison of Fruit Qualities of Melons (*Cucumis melo* L.) from Around the Globe Grown on a Heavy Soil Using Organic Agricultural Practices

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The demand for fruit and vegetables has increased over the past few decades due to the growing awareness of their contributions in nutrition and health. Melon growers in the United States are seeking to diversify the varieties and rotate them every season to sustain melon production and protect them from the devastating diseases. Development of resistant and high quality melon varieties is critical to the economic prosperity of U.S. melon growers. The main objective of our melon research program is to implement whole genome level characterization of diverse melon groups and breed superior melon types by pyramiding favorable allele combinations into the U.S. melons for their fruit quality, disease resistance, adaptability, and yield. Fruit quality attributes were evaluated for 103 melon cultivars grown under organic conditions in a two year field study on Memphis silt loam in southwest Mississippi. These melon types have unique textures and flavors and vary in their sweetness and shelf life. Fruit quality attributes including total soluble solids, rind pressure, flesh thickness, fruit length, width, and weight, flesh pressure, and cavity length and width were evaluated. There were significant variations among cultivars, in all quality attributes. Frequency distributions of total soluble solids and fruit weight were positively skewed, suggesting some major genes contributing to these quality attributes. The frequency distribution of flesh thickness was normal suggesting that this trait is under the control of minor genes. On the basis of the quality analysis, 20 varieties have been selected for seed distribution in the nation.

Specified Source(s) of Funding: USDA–NIFA

5:30–5:45 PM

Comparing Yield of Baby-Leaf Lettuce with Salanova™ 'Baby-Leaf' Head Lettuce Production in Northwest Washington

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Head lettuce cultivars Eazyleaf™, Multileaf™, and Salanova™ are unique in that when they are mature, the head contains approximately 200 short (10–15 cm) leaves as compared to 60 leaves for conventional head lettuce. We compared the yield of the two baby-leaf production systems, "baby leaf" head lettuce with Salanova™ (Johnny's Select Seeds) and traditional baby-leaf lettuce in two separate but adjacent field studies using organic practices in Northwest Washington. Eight Salanova™ cultivars were transplanted into a 30-inch wide bed covered with black plastic, with three rows spaced 8 inches apart. For traditional baby-leaf production, cos lettuce cv. Flashy Trout's Back was direct seeded on a 30-inch wide bed, with six rows spaced 4 inches apart and seeds spaced 1/2-inch apart in the row. Salanova™ cultivars were seeded in the greenhouse 9 April, transplanted on 18 May, and harvested 52 days after transplanting. 'Flashy Trout's Back' was seeded 14 and 30 April, and harvested 28 May and 17 June (average 36 days after seeding). The total and

marketable yield of Salanova™ cultivars was measured for a single harvest, while traditional baby-leaf lettuce yield was calculated for one, two, and three cuts, following common grower practices. Yield of Salanova™ lettuce was 70.5 kg per 100-foot bed, with a value of $317 wholesale ($4.49 per kg) and $1275 retail ($18.08 per kg). Traditional baby-leaf lettuce yield was 14.8 kg for a single harvest with a value of $67 wholesale and $268 retail, 29.5 kg for a double harvest with a value of $145 wholesale and $539 retail, and 44.3 kg for a triple harvest with a value of $199 wholesale and $801 retail. Yield of Salanova™ lettuce was 1.6 to 4.7 greater and value was 0.6 to 3.8 times greater than for traditional baby-leaf lettuce. A 100-foot bed of Salanova™ lettuce with three rows requires approximately 300 seeds at an average cost of $0.064 per seed and a total cost of $19.20. A bed of traditional baby-leaf lettuce with the same dimensions requires approximately 14,400 seeds at an average cost of $0.0006 per seed and a total cost of $8.64. The cost of seed was $10.56 greater for Salanova™ lettuce than for traditional baby-leaf lettuce, but this difference was insignificant considering the increased yield of Salanova™ lettuce.

Specified Source(s) of Funding: Washington State University CAHNRS Extension Grant

5:45–6:00 PM

Yield Performance of Sweetpotato as an Alternative Agriculture Enterprise in Delaware

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Sweetpotato (*Ipomoea batatas*) can be a potential alternative agriculture enterprise for underserved producers of limited resources. Also, it is an efficient, drought-tolerant crop to grow in 120 days with respect to yield/unit area in comparison to other crops. Moreover, sweetpotato is a nutritious crop, being rich sources of carbohydrates with precursor of vitamin A, C, and E, and it is fat-free. Therefore, four sweetpotato accessions were evaluated during the 2012, 2013, and 2014 growing seasons at the Delaware State University research center. The specific objectives were: 1) evaluate the adaptability of four sweetpotato accessions under Delaware conditions; and 2) develop an organic production system to grow sweetpotato in response to soil and nutrient management. We conducted the field research on sandy loam soil pH with 6.8 in a randomized complete-block design with four accessions replicated three times 'Birmingham' (V2) showed the highest yield (34833 kg·ha^{-1}) followed by TUI-001 (V6) (31847 kg·ha^{-1}), A-193-217 (V1) (28935 kg·ha^{-1}), and TI-6008 (V4) (26481 kg·ha^{-1}), respectively. Without using any chemicals, average storage root yield of all cultivars observed was higher than the U.S. average yield (26223 kg·ha^{-1} in 2012 and 27478 kg·ha^{-1} in 2013) (NASS, 2013). Results imply that these accessions are of good potential to be evaluated in scaled-up organic production system.

Specified Source(s) of Funding: NIFA, USDA

Wednesday, 5 August 2015

Plant Nutrient Management 2

Moderator: Menahem Edelstein
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5:00–5:15 PM

Nitrogen, Phosphorous, and Potassium Uptake and Partitioning on Open-field Tomato Production with Seepage Irrigation in Florida

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Florida had the second largest fresh-market tomato production in the United States, with a value of $455 million and 10,700 ha harvested in 2013. Despite the development of Best Management Practices and the existence of University of Florida/Institute of Food and Agricultural Sciences (UF/IFAS) irrigation and fertilizer recommendations, growers often tend to apply fertilizers above recommended rates. Lack of confidence in the recommendations, limited knowledge on how to implement recommendations, and limited data on actual crop nutrient uptake and efficiency are the possible explanations for this practice. Therefore, objective of the study was to evaluate nitrogen (N) rate effects on tomato plant growth, fruit yield, N, phosphorus (P), and potassium (K) uptake and plant partitioning. The study was conducted on seepage-irrigated tomato, in a commercial farm located in Immokalee, FL, during the 2006 spring season. The UF/IFAS N-recommended rate (224 kg·ha^{-1}) was compared with a grower-commercial rate (358 kg·ha^{-1}). Both rates were applied pre-plant and incorporated at bedding with 61 and 554 kg·ha^{-1} of P and K fertilizer, respectively. Plant growth was determined at 30, 60, 90, and 120 days after planting (DAP) by measuring roots, stems, leaves and fruit biomass. Plant tissues were analyzed to determine total N, P, and K content and uptake. Fruit yield was measured on 10 plants per plot for three consecutive harvests. At 120 DAT total plants biomass was 11.5% higher in the grower-commercial N rate than with UF/IFAS N rate. Total N, P, and K uptake were 250.4, 55.6 and 285 kg·ha^{-1} in plants grown with the grower-commercial N rate and were 23.3%, 5.2% and 22.5% lower in the UF/IFAS N rate, respectively. In terms of nutrient partitioning, at 30 and 60 DAP, leaves and stems represented

An asterisk (*) following a name indicates the presenting author.

the major allocation for N, P, and K accounting for 90% of the nutrients uptake. While at 90 and 120 DAP, more than 50% of the N, P and K were allocated to the fruits. The higher nutrient uptake observed with the grower-commercial N rate resulted in 14.4% higher tomato yield (107.6 $Mg \cdot ha^{-1}$) as compared to the UF/IFAS N rate. However, at grower-commercial N rate, N use efficiency, expressed as crop productivity per kg of applied N was 28.4% lower than UF/IFAS rate (300 vs. 420 kg of fruits per kg of N). Thus, further investigations with higher N rates than UF/IFAS recommended rate must include an environmental and economic analysis to be considered a viable BMP.

5:15–5:30 PM

Nitrogen- and Carbon-stable Isotopes in Organic and Conventional Fertilized Greenhouse Tomatoes

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Tomatoes require high amounts of nitrogen to maximize productivity. The type of nitrogen and timing of fertilizer applications are important in tomato production systems to reduce nitrogen losses while optimizing yields. Thus, a greenhouse study was conducted in 2014 to determine the effects of various organic and inorganic nitrogen fertilization treatments on nitrogen ($\delta^{15}N$) and carbon ($\delta^{13}C$) stable isotopes found in tomato plant leaves and fruit at two stages of plant growth. 'Better Boy' tomatoes were grown in 8-L plastic pots filled with 1:1:1 steamed-sterilized sand:silt loam soil:peat mix. Eight fertility treatments were set up in a randomized complete-block design using 3 replications: no fertility, synthetic Miracle Grow® (MG), Organic bonemeal and bloodmeal (BB), BB with liquid Earthjuice (BBL), BB with 25% vermicompost (VC), BBL with 25% VC, MG with 25% VC, and no fertility with 25% VC. The results indicated that for both growth stages, $\delta^{15}N$ differed ($P \leq 0.05$) between fertility treatments, while no differences were observed for $\delta^{13}C$. The $\delta^{15}N$ in the tip leafs from three different branches, fruit skins from the first two fruit clusters, and soil samples indicated that the organic treatments with VC had significantly higher $\delta^{15}N$ than the synthetic fertilizer or no added fertility treatments. This project indicated that greater amounts of $\delta^{15}N$ were found in tomato plants that had VC applications, and this form of nitrogen is thought to provide better fertility management since it is associated with less soil leaching and volatilization. Also, that by using nitrogen isotopes, organic, and conventional fertilizers can be distinguished in tomato foliage and fruit that are grown in a controlled environment.

5:30–5:45 PM

Comparative Yield Response of Lettuce to a Commercial Seaweed Extract in Two Hydroponic Systems: A Preliminary Evaluation

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Small-scale limited resource hydroponic growers continually seek new strategies to improve the production efficiency and yield of their crop plants. Two hydroponic experiments were conducted to test the effects of a proprietary extract from the brown seaweed *Ascophyllum nodosum* (Simplex™; Acadian Agritech, Nova Scotia, Canada), which has been reported to improve the growth of horticultural crops–on the yield of two lettuce (*Lactuca sativa* L.) cultivars (Concept and Nevada). Lettuce seedlings were transferred into either an Ebb-N' Flow (Ebb&F) or Nutrient Film Technique (NFT) hydroponic system at the two-leaf stage, and grown until market maturity. The nutrient solution treatments comprised of a commercial fertilizer (15N–2.2P–12.5K plus micronutrients) at 200 mg N/liter (N_{200}), 150 mg N/liter (N_{150}) and 150 mg N/liter plus 0.5 ml Simplex™ /liter (N_{150}+S). Ambient maximum/minimum (day/night) temperature and RH of the greenhouse during the cropping cycles were 26.6/12.2 °C and 77.5/34.5%, respectively, during October–December for the Ebb&F experiment; and 28/18 °C and 82/42.0%, respectively, during August–October for the NFT experiment. Nutrient solution pH was maintained within 6.5–7.2 with sulfuric acid, and EC ranged from 1.38–1.98 mS/cm for both Ebb&F and NFT systems. In Ebb&F, 'Concept' had consistently higher head fresh weight (HFW) and dry weight (HDW) than 'Nevada' ($P = 0.05$). The N_{150}+S treatment increased HFW over N_{200} and N_{150} by 15% and 20%, respectively; and HDW over N_{150} ($P = 0.05$), but head dry: fresh weight ratio (HDWR) was higher at N_{200} than either N_{150} or N_{150}+S ($P = 0.05$). With 'Nevada', N_{150}+S increased HFW and HDW over N_{150} ($P = 0.05$), however, there were no differences in HFW or HDW between N_{150}+S and N_{200}. HDWR was significantly higher at N_{200} than either N_{150}+S or N_{150} (*$P = 0.05$*). In NFT, there was no cultivar effect on HFW (*$P = 0.05$*), but 'Concept' had significantly higher HDW and HDWR than 'Nevada' ($P < 0.0001$). Similarly, HFW of 'Concept' was higher with N_{150}+S than N_{200} and N_{150} by 14% and 24%, respectively; and HDW was increased over N_{150} by 16% ($P = 0.05$), however, HDWR was lower with N_{150}+S than either N_{200} or N_{150} ($P = 0.05$). With 'Nevada', N_{150}+S increased HFW and HDW over N_{150} ($P = 0.05$), however, there were no differences in HFW or HDW between N_{150}+S and N_{200}. Unlike 'Concept', neither nutrient solution level nor addition of Simplex™ had any effect on the HDWR of 'Nevada' (*$P = 0.05$*).

Specified Source(s) of Funding: The work for presentation is funded by USDA–NIFA project MOLU-HYDROPONICS-05 of Lincoln University of Missouri.

An asterisk (*) following a name indicates the presenting author.

5:45–6:00 PM

Use of Enriched Fertilization to Overcome Nutritional Deficiency in Grafted Melons

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Melon plants grafted on *Cucurbita* rootstock can suffer from nutritional deficiencies due to reduced absorption and translocation of minerals to the foliage. Melon (*Cucumis melo* L.) cultivar 6023 was grafted onto two interspecific rootstocks (*C. maxima* × *C. moschata*)-TZ 148 and 53009. Nongrafted melons were used as controls. A fertilization experiment was conducted in a greenhouse in southern Israel. Two fertigation regimes were used: standard and enriched to Mg (150 mg/L), Mn (7.5 mg/L) and Zn (0.75 mg/L) to increase the concentrations of the lacking elements. Total contents of macro- and micronutrients (N, P, K, Ca, Mg, Na, Cl, Fe, Mn, Zn, and B) were determined in leaves of control and grafted plants. The rootstocks increased K and decreased Ca, Mg, Na, Mn and B in the leaf tissue relative to nongrafted plants. The enriched fertilizer significantly increased Mn and Zn contents in the leaf tissue, and decreased B concentration. Concentrations of N, P, Cl, and Fe were not affected by the enriched fertilizer. There were almost no deficiency symptoms in grafted plants supplied with the enriched fertilizer.

Thursday, 6 August 2015

Ornamental Plant Breeding

Moderator: Phillip A. Wadl
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8:00–8:15 AM

Search for Genetically Conditioned Resistance to Rose Rosette Disease Among Garden Roses

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Rose rosette disease (RRD) is caused by a negative-sense RNA virus (genus *Emaravirus*) that is transmitted by the windborne eriophyid mite (*Phyllocoptes fructiphilus*). This disease is fatal to members of the rose genus and is causing substantial losses of garden roses in the Midwestern to eastern portion of the United States. The few studies that have investigated resistance to RRD have identified a few North American rose species (*Rosa setigera, R. palustris, R. carolina*) as sources of resistance, but nothing is known about the resistance of garden rose cultivars. A survey was done to collect observational information about which rose cultivars showed or did not show RRD symptom development in regions with high RRD pressure. A total of 564 observations representing ~400 unique cultivars or rose species were obtained. Of these, about 50 garden rose cultivars and 10 species roses showed no RRD symptom development. The other 330 cultivars/rose species showed mild to severe RRD symptoms. The survey made the process of identifying roses resistant to RRD more efficient by eliminating susceptible roses from further evaluation. The next step in breeding for resistance is to develop a series of populations from crosses among RRD resistant species, potentially RRD resistant garden roses, and well-adapted commercial garden roses.

8:15–8:30 AM

Optimizing Polyploidization of In Vitro-grown *Prunus* ×*cistena*

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Interspecific crosses generally lead to offspring with reduced fertility and can limit further breeding efforts. Polyploidization of allodiploid hybrids to generate amphidiploids is a popular method to restore balanced chromosome pairing during meiosis and increase fertility. *Prunus* ×*cistena* (purpleleaf sand cherry; *P. pumila* var. besseyi × *P. cerasifera* var. atropurpurea) is a popular, near sterile, allodiploid landscape shrub which is very cold hardy and has attractive dark purple foliage. Polyploidization agents (e.g., colchicine, oralyzalin, and trifluralin) can cause significant stress to plant tissues and high mortality rates are common. Trehalose is a non-reducing disaccharide suspected to play a role in stress responsive plant activities. The objective of this study was to optimize polyploid recovery of purpleleaf sand cherry exploring different durations of trifluralin (a,a,a,-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine) exposure and the effect of the disaccharide trehalose in reducing plant stress and impacting continued growth. Longer exposure times and lower concentrations of the trifluralin were expected to reduce the occurrence of mixaploids. Trifluralin was incorporated into hormone free Murashige and Skoog (MS) media at 0.01% for exposures of 0, 2, 4, 7, and 10 days. Trehalose at 0.005% was either present or absent during treatment or for a period of three weeks posttreatment in MS media containing 2 μM benzyladenine (BA) as a factorial arrangement

on doubling treatments. Recently propagated shoots at 7 days postsubculture were completely submerged in the solid media treatments. Trehalose availability during exposure to doubling treatments had a significant negative effect ($P = 0.05$) on the shoot proliferation rate while no significant effect was observed when added in the recovery medium. Samples for flow analysis were taken from two to three well-developed leaves from two to three newly formed axillary shoots developed on a single treatment sample. Flow cytometric analysis of recovered plantlets showed that 2 days of exposure were sufficient for induction of tetraploid plantlets. Treatments between 4 and 7 days of exposure had increased peak tetraploid fluorescence levels meaning fewer diploid tissues were screened during the sampling process. Higher proportions of diploid plant sampling and higher propagation rates arising from treatments void of trehalose during trifluralin exposure suggest higher diploid or mixaploid escapism rates. The results support narrowing exposure window of in vitro grown *P.* ×*cistena* shoots between 4 and 7 days with the use of trehalose.

8:30–8:45 AM

Heritability of *Rosa* spp. Plant Architecture in Diploid Rose

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The plant architecture is a crucial trait in plant breeding as it has been shown to be linked to crop yield. For ornamental crops such as roses, plant architecture is key for its aesthetic and economic value. The objectives of my study are to evaluate the segregation and inheritance of plant architecture in selected rose populations. Four rose populations and their parents both in the field and greenhouse were characterized for twenty architectural traits. As this process is very time-consuming and not practical for the characterization of large numbers of plants, this data was subjected to a variance and correlation analysis with the objective of identifying the measurements that best describe plant architecture. This analysis and previous work led to six plant architectural components that describe rose plant architecture: number of primary shoots per plant, number of nodes on primary shoot, number of secondary shoots per primary shoot, number of tertiary shoots per primary shoot, length of primary shoot, and plant height. These traits will be used to characterize fifteen diploid rose populations for which the genetic variance components of the traits will be calculated.

8:45–9:00 AM

Microsatellite Development from *Fothergilla* ×*intermedia* and Cross-transferability to Other Genera in the Hamamelidaceae

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The Hamamelidaceae includes many popular horticultural species of woody shrubs and trees, including witch hazel (*Hamamelis*), winter hazel (*Corylopsis*), Persian ironwood (*Parrotia*), *Fothergilla*, and *Loropetalum*. Along with representing many ornamental species, the family also has importance to conservation. Both *Loropetalum* and *Fothergilla* include threatened or endangered species, and *Parrotia* has only one extant species, which could soon face endangerment. Microsatellite markers were developed from *Fothergilla* ×*intermedia* to establish loci capable of distinguishing species and cultivars, to assess genetic diversity for use by ornamental breeders, and for cross-transfer to other genera in the Hamamelidaceae. A small insert genomic library enriched for microsatellites was sequenced and 12 polymorphic microsatellite loci were characterized on accessions from five genera. The number of detected alleles per locus ranged from four to nine across the five genera included in the study. A total of 128 alleles were identified, with 90 of them unique to single genera. One locus only amplified *Fothergilla*, making it unique to the genus, while five loci amplified across all genera. Ten loci amplified in *Corylopsis*, ten in *Hamamelis*, nine in *Parrotia*, and five in *Loropetalum*. All 12 loci amplified in *Fothergilla*, as expected from the hybrid library. Shannon's information index among markers ranged from 0.07 to 0.14. The microsatellite loci provide molecular tools to be used in evaluation of genetic diversity in natural and horticultural collections. Ornamental plant breeders can also use them for cultivar identification and relationships for five popular genera of woody ornamental plants.

Specified Source(s) of Funding: USDA

Thursday, 6 August 2015

Propagation 1

Moderator: Andrew King
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8:00–8:15 AM

Timing, Root Zone Temperatures, and Auxin Concentrations Affect Quantity and Quality of Adventitious Roots Regenerated on Shoot Cuttings of Native Texas Groundcovers

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During previous selection efforts, four commercially promising native Texas groundcovers were identified; *Borrichia frutescens* (L.) DC, *Erigeron procumbens* (Houst. *ex* Mill.) G.L. Nesom., *Oenothera drummondii* Hook. and *Phyla nodiflora* (L.) Greene. Studies, conducted independently for each species, were designed to test cutting propagation methods that would yield optimum adventitious root quantity and quality. Factors tested included concentrations of root growth regulator applied (potassium salts of indole-3-butyric acid (K-IBA); 0, 1000, 2000, 4000, or 8000 $mg \cdot L^{-1}$), bottom heat treatments [none, low (26.7°C) and high (35.0°C)], and propagation time (warm season and cool season). Measurements at the end of the experiments included a binomial indication of the presence of roots (0 = no roots; 1 = rooted), cutting height, height of root system, width of root system, root growth index (RGI), length of five longest roots, and root and shoot dry masses. Visual quality ratings were assessed by two independent raters and a mean of the two scores were used for analysis. All species rooted at 90% in at least one of the factorial combinations tested with greater rooting percentages generally observed in cuttings treated with 1000–2000 $mg \cdot L^{-1}$ K-IBA and low bottom heat when propagated in warm seasons. Species-specific results included similar rooting percentages (~100%) for *E. procumbens* treated with 0, 1000, and 2000 $mg \cdot L^{-1}$ K-IBA, all warm season treatments of *O. drummondii* rooting at ~100%, and all treatment combinations including the low and high heat treatment rooting at near 100% for *P. nodiflora*. Root quality was more variable among species than rooting percentage. Mean root length and mean root dry masses were greater in the cool season for *E. procumbens* while all other species exhibited greater measurements in the warm season. Mean root length measurements decreased for *O. drummondii* with increasing K-IBA concentration, a result that was not observed for any other species. Increasing K-IBA levels for *O. drummondii* decreased mean root dry masses during warm season propagation while greater K-IBA concentrations increased the measurement in the cool season for the non-heat treatment. Generally, the mean visual quality ratings confirmed what had been observed by the empirical measurements. The current work demonstrated that cuttings of *B. frutescens*, *E. procumbens*, *O. drummondii*, and *P. nodiflora* could be rooted successfully utilizing conventional propagation techniques.

8:15–8:30 AM

Utilizing Anti-auxin to Increase Axillary Shoot Proliferation Rate of Japanese Elm

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There are a number of propagation techniques used for elm cultivar production including softwood cuttings, micropropagation and bud grafting. In the nursery trade it is highly desirable to propagate elm cultivars on their own roots. Micropropagation is an ideal propagation method to quickly increase a new cultivar. Japanese Elm [*Ulmus davidiana* var. japonica (Sarg. ex Rehd.) Nakai] is an outstanding shade tree and because of its inherent Dutch elm disease resistance, several selections and hybrids have been made. In 2014, North Dakota State University released Northern Empress® Japanese elm (*U. davidiana* var. *japonica* 'Burgundy Glow') in 2014. Northern Empress® is a very hardy, small to medium sized (28') growing elm with a rounded crown and attractive summer and fall foliage. Fall foliage changes from green to apricot-orange to burgundy-red before leaf drop. Frontier Elm [*U.* (*carpinifolia* × *parvifolia*) 'Frontier'] has similar fall color to Northern Empress® but is not reliably hardy in zone 4. American elm has been shown to perform well in tissue culture except that high levels of shoot basal callus is produced reducing resources for shoot proliferation with Northern Empress® having similar results in preliminary studies. The objective of this study was to establish a micropropagation protocol for Northern Empress® Japanese elm utilizing anti-auxin compound 2-(p-chlorophenoxy)-2-methylpropionic acid (PCIB) to reduce basal callus and increase axillary shoot proliferation. A 3 × 3 factorial of three nutrient salt formulations (DKW, LP, and WPM) and three concentrations of PCIB (0, 5, 10 μM) were used determine shoot growth and shoot proliferation of viable axillary shoots. Nodal explants were 5mm in length and initiated into cultures on the various factorial media plus 2.2 μM 6-benzylaminopurine (BA), 3% sucrose, pH of 6.0 with 0.7% agar. 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 number, which entailed two nodes that were 5±1 mm length of shoot. Based on number of shoots produced per nodal segment and propagation number there was a significant interaction between nutrient salt formulation and PCIB concentration with DKW and 10 μM PCIB significantly producing the most axillary shoots, propagules per nodal segment with reduced basal callus production as compared to other combinations evaluated.

8:45–9:00 AM

Scion Root Affects Flowering, Yield, and Nutrient Status in 'Shiranuhi' Mandarin Hybrid

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Deep plantation caused scion root in 'Shiranuhi' Mandarin. That made problems on flowering, yield, and fruit quality in many farmlands in Korea. Usually, the scion root appears from the joint between rootstock and scion if the rootstock is deeply planted or insufficiently exposed from the soil surface. To know the effect of scion root on the 'Shiranuhi' Mandarin, we evaluated the photosynthesis, growth, nutrition of root, flowering, and fruit quality. Flowering and yield of scion rooted tree severely declined. In mature fruits, quality such as size, weight, and soluble solid contents were reduced. Growth of scion rooted tree was vigorous and increased a trunk size. Response of photosynthesis (Aco_2, gs, *E*, *Ci*) was increased in the scion rooted tree, but, VpdL was decreased. Nitrogen stock in root was increased, however, carbon stock was lowered in scion rooted tree. Also, accumulation of macronutrients such as P, Ca, and Mg in root was slightly lowered, but K was significantly higher in scion rooted 'Shiranuhi' Mandarin.

Specified Source(s) of Funding: This study was carried out by RDA funds

9:00–9:15 AM

Rooting Single-node Floricane Blackberry Cuttings

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Adventitious root formation on single-node cuttings of dormant floricane blackberries could allow their use in an alternative production system in colder climates or during the off-season. Greenhouse grown blackberries during the off-season or selling to a consumer as an annual could increase blackberry availability to a local market. Single-node dormant floricane cuttings of 'Siskiyou' and 'Triple Crown' taken from long lateral canes on 12-year-old field-grown plants and younger (< 2-year-old) potted plants that were held in a cooler on the North Dakota State University campus. Four indole-3-butyric acid (IBA) treatments (0.1% IBA talc, 0.3% IBA talc, 1000 ppm KIBA quick dip, and 3000 ppm KIBA quick dip) were applied to the cuttings and compared to a non-treated control. Half of the cuttings were placed in cell packs in a 50/50 peat and perlite media mixture and half were placed between moistened paper towels. All of the cuttings were placed in partially sealed plastic bags and were subjected to low light conditions of approximately 15 $\mu mol \cdot m^{-2} \cdot s^{-1}$ for eight hours a day. Cuttings were misted the first week to maintain moisture and data were collected on rooting after 14 days. Most of the adventitious roots developed at the base of the bud of the single-node cuttings. There was an increase in the number of roots on 'Siskiyou' cuttings taken from older plants. Additionally, the rooting of 'Siskiyou' cuttings in the media was better than when cuttings were placed between moistened paper towels. Cuttings taken from older plants of 'Siskiyou' placed in the media mixture were found to have significantly longer roots than any of the other cultivar-media-IBA treatment combinations. The root rating of cuttings taken from older plants was found to be significantly higher than the cuttings from younger plants, and 'Siskiyou' had a significantly higher root rating than 'Triple Crown.' The IBA treatment had no effect on rooting. Studies with other blackberry cultivars for rooting potential and fruiting from containerized, miniature plants will be performed.

Thursday, 6 August 2015

Tropical Horticultural Crops

Moderator: Edgar L. Vinson III
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8:00–8:15 AM

Pitahaya or Dragon Fruit: A New Crop with a Future for Southern California Small-scale Farmers

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Pitahaya or dragon fruit (*Hylocereus* spp. and Selenicereus megalanthus) is the name of a vining cactus and the edible fruit it produces. The fruit has been very popular among Southeast Asian consumers as a fresh fruit and is also important to their culture and traditions. However, the appeal and interest for this fruit has also increased among mainstream American consumers demanding new, exotic, and nutritious fruits for their diets. Most fresh pitahaya or dragon fruit consumed in the United States (U.S.) is imported from Southeast Asia or grown in the U.S. (Florida and California) from white-fleshed cultivars of Asian origin. Consequently, most consumers' first experience with pitahaya or dragon fruit has been with white-fleshed varieties, which often do not meet consumer's flavor expectations based on the exotic look of the fruit. Tastier, more colorful varieties were needed to meet consumer demand and to help growers capitalize on this

opportunity. Pitahaya or dragon fruit plants adapt quite well to field growing conditions in subtropical climates in the United States, and can be a profitable crop alternative for small-scale producers Southern Coastal California. In addition, dragon fruit is a cactus and it is perceived as a drought-tolerant, water-efficient plant that requires less water for successful commercial production than citrus and avocados—two of the primary crops grown in the region. Interest among growers and the acreage planted has increased over the past few years. However, lack of performance data and information regarding the pollination requirement for the many cultivars available limited the expansion of this crop and increased the risk of failure for producers. Pitahaya or dragon fruit cultivars were screened for flesh color, flavor, and their ability to produce fruit without hand pollination. Eighteen cultivars were identified, sourced from various geographic origins (United States, Nicaragua, Mexico, Colombia) and propagated from 2004 to 2005. A replicated field trial was established in late 2005 at the University of California South Coast Research and Extension Center in Irvine, CA to evaluate these cultivars for adaptation and overall performance. Most pitahaya or dragon fruit cultivars evaluated adapted to the local environment, grew well under field conditions, and produced marketable quantities of fruit without hand pollination. We will present results and observations from this research, discuss cultural practices, pest management issues and postharvest management guidelines for the successful production and marketing of this crop, while also highlighting current and future research efforts.

Specified Source(s) of Funding: UC-ANR, UC-Hansen REC, USDA IPM

8:15– 8:30 AM

Assessment of Phenological and Morphological Characteristics of Banana (*Musa* sp.) to Determine Potential for Fruit Production in Coastal Alabama

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Banana (*Musa* sp.) cultivation has expanded beyond tropical origins and into the subtropics due largely to the development of cold-tolerant, short-cycle banana cultivars. A study was initiated in Coastal Alabama to determine feasibility of banana fruit production and best-suited cultivars. Thirteen banana cultivars representing four genetic groups and three groups based on plant height—dwarf, medium, and tall, were planted in Fairhope, AL on 5 June 2013. Bananas were blocked according to plant height and were arranged using a completely randomized design with five single plant replications. Mother plants (plants of the initial season) were subjected to winter temperatures of –10 °C during late December 2013 and early January 2014, which were uncharacteristically low for coastal Alabama. Mother plants succumbed; however, the first ratoon plants (R1), or suckers generated from the lateral meristems below the base of the mother plant began to emerge in early spring 2014 and exhibited vigorous growth. Cultivars 'Cardaba' (ABB genetic group) and 'Gold Finger' (AAAB genetic group) fruited in a single season, which was unexpected in a variable and extreme subtropical environment. Data were collected at various days from the juvenile stage of R1 suckers (DFJ). At each DFJ, 'Cardaba' plants were statistically larger than 'Gold Finger' as exhibited by taller pseudostems with thicker circumferences. Pseudostem height: circumference ratio (HCR) of 'Gold Finger' was consistently lower than 'Cardaba' at each DFJ and therefore was theoretically less prone to lodge due to crop load or high winds. At the time of flowering, total leaf number (TLN) of 'Cardaba' and 'Gold Finger' was 26 and 28, respectively. Flower emergence is expected to occur at a total leaf number of 30–50. Leaf emergence rate (LER) reached maxima in August and declined in September and October as temperatures lowered. Leaf area index (LAI) was significantly higher for 'Cardaba' than 'Gold Finger' at 60 and 88 DFJ but was statistically similar at subsequent DFJ. The number of leaves present (NLP) increased quadratically for both cultivars and at flower emergence, 16 and 15 leaves were present for 'Cardaba' and 'Gold Finger', respectively. A minimum of four leaves is required to promote bunch maturity. Flower emergence occurred at 197 and 238 DFJ for 'Cardaba' and 'Gold Finger' respectively. These preliminary results are encouraging: Banana cultivars exhibited vigorous growth and fruiting of banana cultivars support the hypothesis that environmental conditions of Coastal Alabama are sufficient for subtropical banana fruit production.

Specified Source(s) of Funding: USDA–NIFA–HATCH–AAES, Alabama Fruit, Nut, and Vegetable Industries

8:30–8:45 AM

Potential Ethnic Vegetable Crops for Production in the Southeastern United States

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The value of fresh market vegetables in the United States (U.S.) was $10.9 billion in 2010, but the U.S. remains a net importer of these vegetables, mainly from Mexico. Alabama, with 7,100 acres of vegetable production ranked 25th in the U.S. Thus, Alabama has the potential and the need for increasing vegetable production. The overall U.S. organic foods market exceeded $31 billion in 2011and demand for organic foods continues to increase. Alabama's Hispanic and Asian populations grew by 145% and 71%, respectively, between 2000 and 2010. The increasing demand for both ethnic foods and organic foods offers U.S. farmers tremendous opportunities to diversify, expand, and gain by catering to these multicultural foods. Production of high value ethnic crops that are much sought after by ethnic immigrants in the southeastern U.S. can help keep small farm enterprises viable because of greater returns from lower land and capital investment. A two-year field research was conducted with the objective of evaluating the potential for production of a wide range of tropical vegetable crops popular in India, China, and Mexico. About 26 different ethnic vegetable crops were established in replicated field plots and grown using organic production methods. Indian eggplants (*Solanum melongena*) produced profusely and had about six to seven flushes of harvestable fruits. For the Indian variety, the harvested fruits from the round and long varieties were about 11 and 10 kg/plant, respectively. The Chinese variety produced about 5 kg/klant. The yield of Chinese peppers ranged from 1.4 to 2.0 kg/plant whereas the Indian type produced about 1.3 kg/Plant. Hispanic types ranged from 0.3 to about 1.1 kg/plant. Among cucumbers, Chinese wax gourd (*Benincasa hispida*) or Indian ash gourd gave similar yields of about 45 kg/plant whereas Indian Sambhar yellow cucumber was the highest yielding with about 80 kg/plant. Striped snake gourd (*Trichosanthes cucumerina*) with 32.5 kg/plantout yielded the plain stripeless type by about 10 kg/plant. Four Indian okra (*Abelmoschus esculentus*) types produced about 6–9 kg/plant. Due to time and labor limitations, all fruits and all plants could not be harvested. Therefore, the yield results must be viewed with caution. However, the study showed that many tropical vegetable crops can be grown as summer annuals for marketing to immigrant populations in the southeastern United States.

Specified Source(s) of Funding: NIFA–USDA Specialty Crops Block Grant-ADAI

8:45–9:00 AM

Sunn Hemp (*Crotalaria juncea* L.) Intercrop and Mulch Reduces Wind Stress and Increases Growth and Development of Papaya (*Carica papaya* L.)

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In some areas, including south Florida, papaya is subject to stress from high wind speeds during crop establishment. The objectives of this study were to test the effects of a sunn hemp intercrop and mulching system on reducing potential wind stress and increasing the growth and yield of papaya. Sunn hemp was planted as an intercrop between rows of 'Red Lady' papaya plants. After papaya establishment, the sunn hemp intercrop was mown and used as mulch by retaining all the aboveground biomass on the soil surface in the papaya bed. There were three treatments: 1) control (no sunn hemp) and two sunn hemp treatments; 2) early mown (sunn hemp mown 10 weeks after field planting papaya); and 3) late mown (sunn hemp mown 16 weeks after papaya planting). Weeding was done by hand and the time taken to weed each treatment was recorded. Measurements in the papaya crop included leaf gas exchange, stem length and diameter, first flowering date, and yield. Prior to mowing, wind speeds at the top of the papaya canopy were reduced in the sunn hemp treatments as compared to the control treatment. The degree of reduction varied by external wind speed and direction. Also, prior to mowing, papaya plant growth was reduced by approximately 25% in the late mown treatment compared to the other treatments, probably as a result of sunn hemp shading the papaya plants. However, by one month after mulching, the stem diameter in the early mown treatment exceeded that of the control by approximately 30%. For both sunn hemp treatments, mulching increased net CO_2 assimilation and growth of papaya, and hastened the beginning of harvest. Weeding time was reduced by about 75% in both sunn hemp treatments compared to the control. The data indicate that use of sunn hemp as an intercrop and subsequent mulch for papaya can reduce potential wind stress and increase papaya crop vigor and growth and hasten harvest time due to enhanced physiological performance leading to more rapid reproductive development.

9:00–9:15 AM

Tropical Cover Crop Mulch Systems for Low-external-input Reduced-tillage Vegetable Production

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Tropical smallholder farmers that operate within the confines of low-external-input agroecosystems must often rely exclusively on farm-derived resources for soil fertility management and pest solutions. Cover crops (CC) have been shown to provide many agroecosystem benefits that include soil quality improvement and weed suppression. This experiment compares three cover crops terminated with a roller-crimper and tests the resulting surface sheet mulch as a weed suppressor in Jalapeno pepper (*Capsicum annuum* L.) production in the tropics. Four randomized treatments with three replications consisting of a weedy fallow control (WF) treatment with no CC and three CC treatments were evaluated. Cover crops tested included pigeon pea [(*Cajanus cajan* cv. BRS Mandarim) PP], sunn hemp [(*Crotalaria juncea* cv. IAC-1) SH], and sunflower [(*Helianthus annuus* cv. Black Oil) SF]. Cover crops were established as rainy season covers and terminated with a roller-crimper at maturity. Jalapeno peppers (JP) were transplanted into WF treatments (conventional full-tillage) and into CC treatments with residual surface sheet mulch (conservation tillage) seven days after CC termination. Weed biomass was determined for two weeding frequencies (standard weekly weeding vs. reduced weeding at three-week intervals) at 3, 6, 9, and 12 weeks after pepper transplant. Jalapeno fruit was harvested to evaluate treatment effects on pepper yield. Sunn hemp yielded the highest amount of CC shoot biomass at termination. Sunn hemp provided the greatest level of weed control and suppressed both grass and broad leaf weeds during the CC rotation. Plant tissue nitrogen content and SH shoot biomass contributed to greater potentially available nitrogen content from SH biomass compared to that from PP and SF. Both SH and SF provided weed control by reducing weed development following pepper transplant compared to the WF and PP treatments. Sunflower did not exhibit any regrowth following termination and was effectively killed with the roller-crimper. Jalapeno yields were greatest in SH and SF treatments. Results indicate that the use of SH and SF as CCs terminated with a roller-crimper in tropical conservation tillage cropping systems can reduce weeds and support equitable yields of JPs compared to JPs produced by conventional full-tillage cropping systems.

Specified Source(s) of Funding: Southern SARE Research and Education Grant

9:15–9:30 AM

Effect of Manuring with Commercial Products and with Local Resources on the Output of Organic Dragonfruit (*Hylocereus undatus*)

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The dragonfruit [*Hylocereus undatus* (Haworth) Briton & Rose] is a crop of growing economic relevance in the Mexican Yucatan Peninsula due increasing demand on the international market for this climbing cactus, its relatively high pest and disease tolerance, the fruit's low nutrient and water demand along with dragonfruit's general adaptation to the subhumid climate and to the (flat and calcareous) soils of this region. Even the only challenging management aspect of this plant, its dependence on trellises, is feasible in this region since selected trees of the local forest can be used for this purpose. Despite this considerable applicability for sustainable farming, organic dragonfruits from Yucatan are still rare. In a series of trials implemented (2010–13), a dragonfruit organic crop management was established in Chun Yah, central Yucatan. The goal was to create a production system highly independent from external inputs, due to the poorly developed infrastructure of this region. Regarding the manuring of the crop, a management based on a commercial organic foliar treatment was compared, first, to the soil amendment of decomposed cow manure and wood ash and, second, to a control group without fertilization. Weed management was selective. Pests and diseases were controlled using extracts from native species. *Bursera simaruba* and other endemic trees served for staking. There was no irrigation. The dragonfruits were established in 2010; harvesting (three to four times a year) started in 2011. The arrangement was a randomized block system adapted to the local ecosystem. Yearly harvest results showed that the control variant (4.8 t/ha) was on a par with the local conventional production. Bromatological data suggests that an unsatisfied demand for K was the only seriously limiting fertility factor prevailing in the local ecosystems. However, both organic treatments recorded in a significantly higher annual yield of 6.4 t/ha. Yet, annual management and investment costs of U.S.$1970 per hectare (at a yearly output of U.S.$3340 per hectare) are 154% higher when using commercial products than when applying cow manure and ash. Consequently, sustainable production of the dragonfruit, embedding the plant to the local forests and using organic management, results in competitive yields compared to the production based on synthetic products. Furthermore, this strategy is cheaper for local producers, provided that cow manure as well as ash are used for manuring instead of commercial organic nutrition products.

Specified Source(s) of Funding: Fundación Produce Quintana Roo

An asterisk (*) following a name indicates the presenting author.

Thursday, 6 August 2015

Vegetable Breeding 2

Moderator: Mark W. Farnham
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9:15 AM - 9:30 AM

Using Weighted Trait Indices to Select the Best-performing Broccoli Hybrids in Multi-site and Multi-year Trials

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Understanding and implementing evaluation data from vegetable trials conducted across multiple years and environments by multiple raters presents numerous challenges. In order to select new broccoli hybrids suitable for eastern production, the SCRI East Coast Broccoli Project has conducted over 32 phase I and 80 phase II trials that have included over 120 unique broccoli hybrids grown at different locations along the eastern seaboard (SC, NC, NY, ME, VA). These broccoli hybrids were evaluated for ten traits including bead uniformity, head color, head firmness, head smoothness, bead size, color, and overall quality. Initially, hybrid selections and recommendations were based predominately on the "overall quality" trait. Theoretically, this trait rating takes into account many different attributes; however, it is also likely the most susceptible to human perceptual bias. In Spring 2014, two East Coast Broccoli phase I trials conducted at the U.S. Vegetable Laboratory in Charleston SC, were concomitantly evaluated by three different raters in an effort to elucidate and account for potential rater bias. Four evaluation instruments or indices (e.g., different weighted linear combinations of traits) were proposed including an instrument that accounted for variation in overall quality relative to the more specific traits measured. Intra-class correlation (ICC), a statistic used to quantify both rater agreement and rater consistency, was used to compare methods. The evaluation instrument that accounted for human perceptual bias was shown by these experiments to significantly increase both ICC agreement and consistency between raters ($P < 0.001$). This improved evaluation instrument allows for both greater selectivity and precision in the analysis of multi-site and multi-rater data sets, and also for use with comparative methods such as stability or principal component analysis. Moreover, this work should be readily applied to trials of other horticultural crops.

9:30–9:45 AM

Genotypic and Maturity-related Variation in Anthocyanin Quantity and Quality in Crucifer Vegetables

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Crucifer vegetables comprise a unique family of commercial market classes based on harvestable plant morphotypes. Several classes contain genotypes with anthocyanin expression in their tissues, including market classes of *Brassica oleracea* (cabbage, kale, Brussels sprouts), *Raphanus sativus* (radish), *Brassica juncea* (mustard), and *Brassica rapa* (pak choi, bok choi). Anthocyanins in crucifer vegetables have antioxidant activity giving a wide range of health benefits and also provide novel aesthetics that can be utilized for cultivar development. The HPLC and MS protocols were utilized to provide insight into anthocyanin variations among different species and genotypes. These were coupled with microscopy to determine cellular localization of anthocyanins among the different species. The ratios of anthocyanin species differed within market classes, and among market classes themselves, as did the localization of anthocyanins on a cellular level. The anthocyanin profiles differed between mature and juvenile plants of the same genotype, especially in those exhibiting a different plant morphotype at maturity such as cabbage and Brussels sprouts. Total anthocyanin content ranged from 0.2 mg/g to 22.11 mg/g (dry weight, cyanidin 3,5-diglucoside equivalent) in germplasm accessions of mature red cabbage evaluated, indicating that there is significant genetic diversity to select and develop crucifer vegetables high in anthocyanin content. The types of anthocyanins also varied considerably among different crucifer vegetable species with cole crops containing primarily cyanidin based anthocyanins and radish producing primarily pelargonidin based anthocyanins. While *B. oleracea* morphotypes produce cyanidin based anthocyanins, chromatograms show that the profile of these anthocyanins can vary due to different glycosylation and acylation possibilities. Imaging shows the ability of *R. sativa* species to be able to produce anthocyanins in all tissue types while *B. oleracea* has only been able to produce anthocyanins within the epidermal, outer mesophyll layers, and vascular xylem and phloem tissue only. This information is being used to develop crucifer vegetables high in desirable anthocyanins that are expressed in tissues with aesthetics that are appealing to consumers.

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9:45–10:00 AM

Determination of High-temperature Tolerance of Some Pepper Genotypes

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Heat tolerance is generally defined as the ability of the plant to grow and produce economic yield under high temperatures. Heat stress due to high ambient temperatures is a serious threat to worldwide crop production. This study was conducted t o determine the high temperature tolerance of some pepper genotypes suitable for open field and greenhouse production. Tolerance was determined in a growth chamber and at two different locations. Twenty-three pepper genotypes, (5 reported to be sensitive and 18 reported to be tolerant), were screened in the growth chamber at night (14 °C), at daylight (40 °C). Fruit number (number/plant) and total fruit weight (g/plant) were determined and it was found that genotypes 32, 36, 414, 407, 441, 425, 100, 213, 414, 1747, and 475A were tolerant. These genotypes were also tested at two locations, Alata and Sanlıurfa, which have high temperatures of 38 °C and 43 °C, respectively, and had high performance. These lines can be used to develop high temperature-tolerant genotypes for the open field and greenhouse.

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Thursday, 6 August 2015

Genetics & Germplasm 2

Moderator: Phillip A. Wadl
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10:15–10:30 AM

Mapping of the Bacterial Leaf Spot Resistance Gene in Lettuce PI358001-1

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Lettuce is a diploid (2n = 18) with a genome size of 2639 Mbp, and belongs to the family of Compositae. It is one of the top ten most valuable crops in the United States with an annual value of over $2 billion. Bacterial leaf spot (BLS) is a major disease of lettuce and is caused by *Xanthomonas campestris* pv. *vitians*. Severe outbreaks of the disease have occurred in the areas of lettuce production in the United States since 1990s, and also have been reported in other lettuce production countries in the world. Leaf lettuce PI358001-1 has been characterized as a highly resistant accession to BLS. A $F_{2:3}$ segregating population with 162 families has been developed from the cross PI358001-1 (resistant leaf lettuce accession) x Tall Guzman (a susceptible Romaine lettuce variety). The segregation ratio for the $F_{2:3}$ families was showed to be 32 homozygous resistant: 82 heterozygous: 48 homozygous susceptible by seedling inoculation with BLS L7 strain, fitting to 1:2:1 ($X^2 = 3.19$, $P = 0.20$). The results indicate that a dominant gene controls the resistance in PI358001-1. A genetic linkage map with AFLP and CAPs markers is under development. Based on testing 64 MseI+3/EcoRI+3 primer combinations among 62 F_2 progenies and 2 parents, a total of 368 polymorphic markers were scored. On average, 5.75 polymorphisms were detected for each combination. The AFLP results comply with the previous report that the polymorphism was relatively low in lettuce.

10:30–10:45 AM

Analysis of Resistance to Fusarium Wilt Race 3 in Accessions of the Wild Tomato Species *Solanum pennellii*

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Fusarium wilt of tomato (*Solanum lycopersicum*), caused by the soil-borne fungal pathogen *Fusarium oxysporum* f. sp. *lycopersici*

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(*Fol*), is a common tomato disease in most tomato production regions worldwide. Developing tomato cultivars resistant to fusarium wilt has been an effective means of controlling *Fol*. A dominant resistance gene (*I-3*) to *Fol* race 3 was identified from the wild tomato species *Solanum pennellii* accession LA716, and the *I-3* gene has been fine-mapped on chromosome 7. Though tomato cultivars with *I-3* have been commercially available since the early 1990s, they have some undesirable traits associated with *I-3*, such as a higher susceptibility to bacterial spot disease and weaker vines. We have initiated a search for alternative sources of *Fol* race 3 resistance that might not be associated with these negative traits. Furthermore, such resistance sources may prove effective against new races of *Fol* that could emerge in the future. We evaluated 42 *S. pennellii* accessions for resistance to *Fol* race 3, and nearly all accessions were highly resistant. Interspecific hybrids from crosses between each accession and the *Fol* race 3 susceptible 'Suncoast' were also evaluated, and most were resistant to *Fol* race 3 but less so than the accessions. The F_1s were backcrossed to 'Suncoast' to produce F_1BC_1 progeny, and each of these was evaluated for resistance to race 3. We used molecular markers tightly linked with *I-3* to determine if this gene played a role in the resistance of each accession. Genetic analysis indicated that resistance is conferred by the *I-3* locus in approximately half of the accessions tested. Analysis also determined that one or more alternative loci are also affecting resistance alone or in combination with *I-3*.

10:45–11:00 AM

Exploring the Transcriptome of the Glucosinolate/Myrosinase System in Broccoli (*Brassica oleracea* var. *italica*)

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The glucosinolate/myrosinase system is a plant defense system found in the Brassicaceae family, which includes the genera of *Brassica* and *Arabidopsis*. This system has been linked primarily to plant defense against insect herbivory and pathogen infection, but also has been shown to affect human health. Several glucosinolate hydrolysis products, the active compounds created from the reaction of glucosinolates and myrosinase, have been shown to be bioactive in humans. Specifically, the ingestion of these compounds can increase the transcription rates, and consequently the enzymatic activity, of certain detoxification enzymes in the human body. This has led to these compounds being described as having cancer-preventive activity, making the ability to accurately manipulate this system an important breeding objective in the Brassica vegetable market. In this research, we show the effect of spraying the stress elicitor compound, methyl jasmonate (MeJA), on the transcriptome of the glucosinolate/ myrosinase system as well as final glucosinolate content and measurable cancer-preventive bioactivity. In addition, we have explored the feasibility of using transcriptomic data of genes from this system to build predictive models for final phenotypes, such as glucosinolate levels or measureable cancer-preventive bioactivity. If viable, this type of transcriptomic selection could be used in breeding programs focused on manipulating these traits.

11:00–11:15 AM

Genetic Relationships Between Basil (*Ocimum* spp.) Germplasm Provide Insights for Downy Mildew Resistance Breeding

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Basil is a diverse genus of approximately 64 species that exhibit extensive variation in phenotype and essential oil chemistry. The most economically important species, *Ocimum basilicum*, includes sweet basil that is used primarily in fresh, culinary, and food flavoring industries. Sweet basil production is being threatened by the destructive disease downy mildew (*Peronospora belbahrii*), which was first introduced to the United States in 2007 and now affects all major basil growing regions. Resistant breeding lines are in development at Rutgers University through introduction of genetic resistance by inter- and intraspecific hybridization. A major obstacle to breeding efforts has been the prevalence of sexual incompatibility and hybrid sterility when attempting to introgress resistance genes from *Ocimum* spp. to commercial sweet basil. To better understand genetic relationships and characterize resistant and tolerant genotypes within the *Ocimum* genus, a genetic diversity study was performed using simple sequence repeat (SSR) markers developed from the NCBI basil expressed sequence tag (EST) database. In silico analysis provided 786 SSR primer pairs, from which 16 polymorphic EST-SSR markers were used to evaluate 95 basil genotypes including commercial varieties, USDA–NPGS accessions and Rutgers breeding lines, all of which were evaluated for response to downy mildew in greenhouse and/or field screening. Population structure analysis was performed using NTSYSpc, STRUCTURE 2.3.4 software and an AMOVA was used to determine whether resulting basil populations were statistically significant. Results indicate that sources of downy mildew resistance can be found throughout the *Ocimum* genus, but most commonly outside of the *O. basilicum* species.

Specified Source(s) of Funding: USDA–SCRI grant #2011-51181-30646

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11:15–11:30 AM

Exploring Genetic Drift within the Endangered Species *Pityopsis ruthii* (Asteraceae)

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Pityopsis ruthii, or Ruth's golden aster, is a federally endangered perennial of the Asteraceae that is found only in southeastern Tennessee. The species grows on unshaded phyllite rock outcrops along the Hiwassee and Ocoee Rivers and is at risk for short-term extinction. Due to the small number of individuals, the species can be relatively easily sampled in its entirety and so is an ideal complex in which to conduct population and conservation studies. While morphology of the species has been examined in depth, molecular studies provide novel information to conservationists. In conjunction with previously developed markers, plastid microsatellites can be used to discover genomic variation and gene flow in natural plant populations, as well as seed dispersal mechanisms. Chloroplast microsatellite markers were used to provide a counterpart to previously published nuclear markers. Twenty-one chloroplast microsatellite markers were identified from genome sequencing of a single genotype, and five markers were seen to be polymorphic among a subsample using tissue from several locations along both the Ocoee and Hiwassee River habitats. Using the polymorphic loci, 11 individuals each from six discrete locations were genotyped. We assume the discrete locations are subpopulations. A total of 16 alleles were identified from the five loci. STRUCTURE was used to examine population structure, and three revealed clusters. Populations did not cluster by river. All three clusters were seen in populations of both rivers. Understanding maternal gene flow within populations of *P. ruthii* will impact the current conservation methods and plans, as well as provide further information on reintroduction of an endangered species and genetic drift.

11:30–11:45 AM

Development of Microsatellite Markers from *Erysiphe pulchra* (Dogwood Powdery Mildew) for Analyzing Genetic Diversity

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Flowering dogwood (*Cornus florida*), and kousa dogwood (*C. kousa*) are economically significant ornamental plants in the nursery and landscape industry. Flowering dogwood has been severely affected by dogwood anthracnose (*Discula destructiva*) and powdery mildew (*Erysiphe pulchra*). Kousa dogwood is more tolerant than flowering dogwood to both diseases. Powdery mildew resistant flowering dogwood cultivars are available commercially. The life history of powdery mildew on dogwood has been investigated, however population structure and genetic diversity of *E. pulchra* is unexplored. Genome sequencing of the flowering dogwood powdery mildew fungus *E. pulchra* was used to develop microsatellite markers. A total of 6,163,317 sequences were assembled de novo into 118,161 contigs and 18 microsatellite loci were identified from 500 randomly selected contigs. Screening of these loci against four *E. pulchra* samples revealed that nine loci were suitable for further characterization. The nine loci were used to genotype total DNA isolated from 47 powdery mildew infected leaves from Maryland, Mississippi, New Jersey, and Tennessee. Fourteen alleles were detected, but only four lociloci were polymorphic and informative. Shannon's information index was 0.12 and ranged from 0.00 to 0.45. Private alleles were detected in the Mississippi and Tennessee samples. Clustering of the samples using two-dimensional principal coordinates analysis explained 65% of the variation and clustered independent of geographical location. This research demonstrates that genome sequencing of an obligate biotroph fungal pathogen is valuable for developing microsatellites for population studies of *E. pulchra* and the low genetic diversity indicates primarily asexual reproduction by the pathogen.

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Thursday, 6 August 2015

Plant Biotechnology 1

Moderator: Megan Muehlbauer
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10:15–10:30 AM

Targeted Gene Mutagenesis in Citrus to Produce Citrus Canker Resistance

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Targeted gene mutagenesis is a powerful tool for elucidating gene function and facilitating genetic improvement in plants.

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TALENs (transcription activator-like effector nucleases), consisting of a custom TALE DNA binding domain fused to a nonspecific FokI cleavage domain, are one of the most efficient genome engineering tools developed to date. The technology of TALENs allows DNA double-strand breaks (DSBs) to be introduced into predetermined chromosomal loci. DSBs trigger DNA repair mechanisms and can result in loss of gene function by error-prone non-homologous end joining (NHEJ), or they can be exploited to modify gene function or activity by precise homologous recombination (HR). In this study, we describe a detailed protocol for constructing TALEN expression vectors GFP-TALEN:Cslobp, assessing nuclease activities using a citrus protoplast-based transformation system. Citrus protoplast-transformation vector GFP-TALEN:Cslobp was developed to edit the CsLOB1 (lateral organ boundaries 1 of *Citrus sinensis*) promoter in citrus to thwart the virulence strategy of *Xanthomonas citri* subspecies *citri*, which causes citrus canker disease. Vector GFP-TALEN:Cslobp has been introduced into citrus protoplast cells using a polyethylene glycol (PEG) system. More than 100 embryos expressing GFP have been recovered. Several transgenic lines have successfully generated, and the detailed analysis is being carried out. This method could have great potential for producing citrus plants resistant to citrus canker and possibly citrus greening or Huanglongbing (HLB) as well once the virulence strategy of CandidatusLiberibacter asiaticus has been identified.

10:30–10:45 AM

Transgenic Strategies for Huanglongbing-resistant Citrus at the USDA–ARS

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Huanglongbing (HLB) seriously threatens the sustainability of the Florida citrus industry. The predominate HLB pathogen is *Candidatus* Liberibacter asiaticus (Las), a phloem limited bacterium vectored by the Asian citrus psyllid. No HLB-resistance has been identified within cultivated citrus scions, making it a high priority to create transgenic citrus that would permit economic citrus production where HLB is endemic. Several strategies are being explored to create practical transgenic citrus with HLB-resistance. Single antimicrobial peptide (AMP) transgenics have had modest efficacy but transgenics expressing chimeral peptides, with a modified citrus thionin linked to an AMP are showing promise against citrus canker and are being challenged with Las. Flagellin proteins from bacteria are often recognized by plant FLS2 receptors to elicit defense responses. Las flagellin appears not to induce resistance responses in citrus but is recognized by other plants to trigger defense responses. An FLS2 from a plant that recognizes Las flagellin is being expressed in citrus cultivars. Las produces a LuxR protein required for quorum sensing, but not LuxI, which provides the signal perceived by LuxR. We are expressing LuxI transgenically to see if early quorum sensing prevents systemic infection. Efficacy of RNA interference has been demonstrated using a virus expression vector to produce dsRNA in citrus directed at psyllid genes encoding essential proteins. Transgenics producing these dsRNA are in early development. Small chain variable fragment antibodies have been designed against exterior epitopes of Las and numerous transgenics are now being analyzed for effects on Las survival and proliferation. Recently, a family of Small Cyclic Amphipathic Peptides (SCAmpPs) has been demonstrated to be highly expressed in citrus phloem. Even though the final predicted peptide sequences of diverse phloem SCAmpPs are quite variable, there is almost complete identity in the promoter, first exon and intron. We are functionally dissecting phloem SCAmpPs sequence components, analyzing expression of marker genes and ultimately resistance genes for control of phloem-limited Las. A recombination/ exchange system is being implemented to control the integration and the excision of DNA allowing the precise integration of transgenes at specific sites, with the simultaneous removal of marker genes and/or any other unneeded sequences. This tool will permit future stacking of traits into transgenic cultivars and provides for efficient comparison of transgenic vector components to optimize construct development.

Specified Source(s) of Funding: Citrus Research and Development Fund

10:45–11:00 AM

Categorization of Expressed Sequence Tag Microsatellites for Marker Optimization and Genotype Evaluation in Peach

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Exponential growth of genomic and expressed sequences has allowed thousands of microsatellite motifs and primers to be easily mined out of them by pipelined bioinformatics programs. But it remains economically and practically difficult to synthesize and screen such a great number of primers to develop useful microsatellite markers of desired amplification reliability, allelic polymorphism, and chromosomal distribution. Preselection

of desired primers depends on computational prediction and optimized selection criteria. In this study, over ten thousand expressed sequence tag microsatellite primer sequences were generated from *Prunus* expressed sequence tags, analyzed by BLAST against the peach reference genome, and categorized into eight subgroups based on the alignment status and the size difference between the genomic and expressed amplicons of each primer. Based on the categorizations and predicted performance and distribution, a subset of three hundred eighty-four primers were optimally chosen and arranged in four ninety-six-well plates for genotyping evaluation of selected peach genotypes. Only two of the primers failed in the peach cultivars evaluated, suggesting the reliability of optimally chosen primers was substantially improved. A majority of the primers also yielded high average allele numbers and polymorphism information content values among the screened peach genotypes. Further utilization of these new gene-based microsatellite markers in peach genetics and breeding studies are discussed.

11:00–11:15 AM

Optimization of a High-throughput Assay Enabling Early Detection of *Anisogramma anomala* in Hazelnuts

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Anisogramma anomala (Peck) E. Müller is a fungal pathogen that causes eastern filbert blight (EFB) of hazelnuts (*Corylus* sp.). Developing commercial-quality plants resistant to EFB is a major objective of hazelnut breeding programs in the United States. However, the disease cycle of *A. anomala* makes screening for resistance difficult as symptoms (stromata and cankers) are only typically expressed sixteen to eighteen months after infection. An assay was previously developed using real-time PCR (qPCR) to detect the fungus in young hazelnut seedlings. However, it was based on a small sample size and was not optimized for screening large numbers of breeding progeny in an efficient and cost-effective manner. Our goal was to develop a lower-cost qPCR method suitable for high-throughput sampling. In this study, we examined several components of the assay. We developed a second set of robust qPCR primers specific to hazelnuts to limit the occurrence of false negatives. Further, we used the qPCR assay to track the movement and spread of *A. anomala*over a period of eight weeks to determine the optimal location and timing of sampling to further minimize false positives and escapes. Next, we examined methods to scale up to a high-throughput format in terms of DNA extractions and the qPCR assay. As a final control, we compared the results of the qPCR assay with subsequent canker development in several large progenies of seedlings. Based on these improvements, we can now rapidly sample high numbers of plants and determine the presence and quantity of the fungus within only a few weeks after inoculation, making the assay much more useful for applied breeding.

11:15–11:30 AM

Understanding the Role of Floral Genes in Gall Formation on Grape Leaves Caused by the Grape Phylloxera

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The initiation and maintenance of the highly specialized galls on grape leaves induced by the grape phylloxera (*Daktulosphaira vitifolia* Fitch) has been proposed to be through the activation/redirection of flower and/or fruit development pathways via plant hormones. To gain molecular insights into the mechanisms underlying this complex insect–plant interaction, RNA sequencing data were generated from galled tissues in four stages and also from non-galled leaf tissue. The expression of several key genes involved in floral development and hormone signaling has been found to vary during gall development as compared to non-galled leaf tissue. Among these genes, noticeably include the *Vitis* homologs of a key gene regulating transition to flowering, LEAFY, and a carpel-identity gene, AGAMOUS. To fully understand their role in gall formation, antisense constructs to target and silence these floral genes were designed and introduced into a highly susceptible French-American hybrid *Vitis* spp. 'Seyval Blanc' via *Agrobacterium*-mediated transformation. A bidirectional dual promoter complex (BDDP) was used to simultaneously drive expression of the antisense target sequence and a selectable marker gene NPTII fused with a visual reporter gene enhanced fluorescent protein (EGFP), thus allowing for visual screening of transgenics. The use of transgenic plants with targeted silencing of floral genes will help demonstrate the correlation between successful galling and the changes in expression of such genes. The dependence of the insect's ability to initiate galls on the transition from vegetative to reproductive development through manipulation of these genes will be evaluated.

Specified Source(s) of Funding: National Science Foundation

An asterisk (*) following a name indicates the presenting author.

Thursday, 6 August 2015

Pomology 2

Moderator: Todd Einhorn
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10:15–10:30 AM

Local Effect of Fruiting on Different Anatomical and Physiological Traits in Apple

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Flowering is a key stage of plant development. The deceivingly simple appearance of flowers is in reality a complex interaction of puzzling endogenous pathways and environmental conditions. It has been well established that the crop load directly impacts the flowering cycle of biennial bearing fruit trees. This effect occurs on a molecular level; affecting the endogenous pathways that are responsible for flower formation. In this study, we investigated the local effect of fruiting on the physiological and anatomical traits of bourse leaves adjacent to the fruiting structures in six apple cultivars. We hypothesized that the physiological and anatomical traits of bourse leaves may be the source of different flowering habits between annual and biennial cultivars. In six different cultivars, three biennial cultivars (Honeycrisp, Fuji, and Golden Delicious) and three annual cultivars (Gala, Pink Lady, and Ruby John) we tagged fruited and de-fruited spurs at time of initial fruit set, we collected samples throughout the growing season to measure stomatal density and leaf area and measured stomatal conductance, photosynthesis, assimilation, and transpiration. At the end of the season we looked at flower formation in fruited versus de-fruited spurs. We observed differences in these anatomical and physiological traits among the six cultivars and occasionally within the fruited and de fruited spurs of the same cultivar. These findings should help us to create better understanding on the source of flowering regulations in biennial versus annual cultivars and the effect of these physiological and anatomical traits on endogenous flower formation of fruit trees.

10:30–10:45 AM

Trunk Injection of Fruit Thinners to Regulate Fruit Set and Return Bloom in Apples

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Various strategies and methods have been used to achieve and appropriate crop load on a tree to assure high quality fruit are harvested and sufficient return bloom is achieved for a commercial crop the following year. Normally, thinners are applied as a foliar spray and delivered with an airblast sprayer or similar sprayer. Problems associated with this method of application include unfavorable weather at the time of spray application, spray drift, restricted reentry time following applications, and the potential for chemical trespass on residences in close proximity to the spray application. We have evaluated abscisic acid (ABA), aminoacyclopropane-1-carboxylic acid (ACC) and Metamitron, all of which have abscission-promoting properties. Our goal was to see if we could successfully apply these thinners via trunk injection and achieve similar or comparable fruit abscission when comparable doses of these were applied by traditional sprayer-applied foliar application. Trunk injections were made to either mature Empire/M26 or Delicious/M.26 during the normal thinning time when fruit were of the appropriate size to thin. Thinning was successfully achieved by trunk injection of ABA and metamitron and a marginal amount of thing was done with ACC. Fruit size at harvest was a reflection of the amount of thinning that was achieved but no thinner influence fruit quality at harvest. There was some phytotoxicity associated with the trunk injections that was associated with uneven distribution of the thinners in the trees. Gibberellins GA_3 GA_{4+7} were also applied on Delicious/M.26 apple trees in July. There were no visible effects of the GA treatments. Return bloom on trees that were injected with GAs will be discussed and compared with similar applications made as a foliar spray.

10:45–11:00 AM

Integration of Renewable Canopy Architectures and Precocious Rootstocks Optimize Sweet Cherry Yields, Fruit Quality, and Labor Efficiency

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Sweet cherry (*Prunus avium* L.) production systems have been evolving since the commercial advent of precocious and dwarfing rootstocks in the 1990s. A multi-institutional coordinated regional research trial (NC140 project) was planted at 13 locations across North America in 2010 to study the impact of precocious rootstocks of varying vigor levels on development of four different canopy architectures, their management, and performance in terms of productivity and fruit quality. The trial at Michigan State University utilized 'Benton' on dwarfing Gisela (Gi) 3, semi-dwarfing Gi 5, and semi-vigorous Gi 6 rootstocks. The canopy architectures include 1) a multiple leader bush with vertically-oriented fruiting units having primarily spur-fruiting sites (aka Kym Green Bush, KGB); 2) a spindle/central leader tree with lateral fruiting units having both spur- and non-spur fruiting sites (aka Tall Spindle Axe, TSA); 3) a trellised fruiting wall comprised of an oblique-horizontal cordon-leader with vertically-oriented fruiting units having primarily spur-fruiting sites (aka Upright Fruiting Offshoots, UFO); and 4) a fruiting wall comprised of very closely-planted single leader trees with very

short lateral fruiting units having primarily non-spur fruiting sites (aka Super Slender Axe, SSA). Across all canopy architectures, trees on Gi3 were most precocious and productive through Year 4; in Year 5, trees on Gi5 generally achieved similar productivity as those on Gi3. Across all rootstocks, SSA trees were most precocious and productive through Year 4, but in Year 5 yields declined, with UFO and TSA trees becoming most productive. These changing yield trends, as trees completed establishment and filling of allotted orchard space through maturation and renewal of canopy fruiting units, relate somewhat to the inherent differences (due to canopy training and management) in fruiting populations (spur vs. non-spur fruit clusters), which will be discussed. In Year 5, the most yield-efficient "fruiting wall" architecture was UFO and the most yield-efficient "three-dimensional" architecture was TSA. All canopy architectures except KGB have the potential for partial mechanization by summer hedging to reduce pruning costs. Differences in timing of hedging on re-growth, flower formation, and summer–winter pruning labor efficiency were quantified in 2014–15 and also will be discussed, along with yields for Year 6 (2015).

Specified Source(s) of Funding: International Fruit Tree Association, Michigan Cherry Committee, Project GREEEN

11:00–11:15 AM

Use of Maxcel and Promalin to Produce Feathered Trees

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The adoption of high-density orchards during the last decade has resulted in a significant improvement in yield and fruit quality. With the use of highly feathered trees, important yield can be achieved in the second and third years after planting, which is an essential asset to help pay for increased tree numbers and establishment costs. As the benefits of highly feathered trees were discovered, it became necessary to develop nursery management techniques to stimulate lateral branch development. The number of feathers on U.S.-grown nursery trees has also improved significantly in the last decade. Prior to 2009 most nurseries used a single spray of Promalin combined with leaf removal to obtain trees with three-to-five feathers. MaxCel, a cytokinin plant growth regulator already labeled for several uses on apples, was registered for chemical branching of nursery apple trees in 2013. To further study the use of MaxCel and Promalin to induce lateral branching, we conducted four nursery branching studies in Washington State (2012 and 2013), Pennsylvania (2013) and Chile (2012/2013). To reduce flowering in the first year after planting and susceptibility to fire blight, the effect of Gibberellin sprays in the nursery was evaluated on 'Gala' and 'Pink Lady' apple trees in Washington State (2013). There were significant variety effects with 'Gala', 'Fuji', 'McIntosh', and 'Empire' producing more lateral branches compared to 'Macoun' and 'Cameo'. Maxcel and Promalin both induced significant numbers of feathers. The number of feathers increased linearly with increasing number of sprays from six feathers per tree up to 20 feathers with five sprays. There was little difference in the two rates of Maxcel and Promalin (500 mg/L and 1000 mg/L). However, Maxcel at 1000 mg/L induced more feathers than Promalin or Maxcel at 500 mg/L. Promalin was a slightly less effective branching agent than Maxcel, conversely, Promalin stimulated leader growth rate resulting in improved final tree height. Maxcel reduced leader growth rate and final tree height slightly but gave the widest branch angles. Multiple sprays of Gibberellins 4+7 applied to nursery trees in the late summer inhibited flower bud development and flowering in the orchard the next year. This reduces the risk of fire blight in newly planted trees. Maxcel effectively induced lateral branching in the orchard in years 1 and 2 when developing a new Tall Spindle orchard. We suggest 15 days after bud break and 500–1000 ppm.

Specified Source(s) of Funding: NNII IFTA ARDP

11:15–11:30 AM

The Effects of Rootstock and Fertilizer Selection on Apple Orchard Productivity and Soil Microbial Community Ecology

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In apple (*Malus* ×*domestica* Borkh.) orchards, rootstock genotype and soil fertility management practices potentially impact soil health and nutrient status, plant associated soil microbial communities, and orchard productivity. Apple growers select specific rootstocks to confer beneficial traits, including size control, precocity, and pest and disease resistance. Rootstocks may also influence microbial communities, resulting in changes to microbially facilitated ecosystem services, such as nutrient availability, that affect tree growth and productivity. Many apple growers apply synthetic nitrogen (N) fertilizers to improve fruit yield and quality. In excess of tree requirements, nitrogen fertilizers have been shown to decrease crop yield and quality, and contaminate ground and surface waters. The addition of carbon-based fertilizers, such as compost, has been shown to reduce N loss, increase soil organic matter (OM), cation exchange capacity (CEC), water holding capacity and the availability of certain minerals. In 2013, a pot-in-pot study was implemented

An asterisk (*) following a name indicates the presenting author.

to determine the effects of yard waste and chicken litter composts, fertigation with calcium nitrate [$Ca(NO_3)_2$] fertilizer, and combinations of compost and $Ca(NO_3)_2$ fertigation on apple tree growth and nutrient status, soil health, and microbial activity. For this study, 'Brookfield Gala' scions were grafted onto five rootstocks, 'Budagovsky 9', 'Malling 9', 'Geneva 41', 'G.214', and 'G.935'. Trees were planted in pots containing Poplimento Silt Loam series orchard soil. Four individual tree replicates of each rootstock were treated with 40 kg·ha^{-1} N from either chicken litter compost, yard waste compost, $Ca(NO_3)_2$ or a combination of 20 kg·ha^{-1} from compost and 20 kg·ha^{-1} from $Ca(NO_3)_2$. Unfertilized containers served as a control. Applications occurred in 2013 and 2014. In 2013, relative to the untreated control, yard waste increased OM by 66% and CEC by 49%, and chicken litter increased OM by 24% and CEC by 40%. In 2014, relative to the untreated control, yard waste increased OM by 88% and CEC by 56%, and chicken litter increased OM by 69% and CEC by 65%. Leaf nitrogen concentration was not significantly different among rootstocks or fertilizer treatments. However, both rootstock selection and fertilizer treatment affected leaf phosphorous, potassium, magnesium, and boron concentrations. Neither rootstock selection nor fertilizer treatments affected microbial community composition, as measured by terminal restriction fragment length polymorphisms, during the 2013 growing season. Leaf nutrient status, microbial respiration, trunk cross sectional area, soil carbon to nitrogen ratio, microbial biomass, and microbial community composition will continue to be measured in 2015.

11:30–11:45 AM

A Generalized Scaling Approach to Improve Variety Selection in Orchard Fruit

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Generalized scaling relationships are observed in plants between morphological characteristics such as branch diameter and mass. Broad invariance of scaling relationships across plant species indicates conserved patterns in plant growth and architecture. Such patterns can be used to better understand physiological limitations acting on plant development. Recently, a test of two orchard tree species (apple: *Malus domestica*, cherry: *Prunus cerasus*) reveals scaling relationships in agreement with generalized scaling expectations of the Metabolic Scaling Theory (MST). This finding broadens the scope of the MST beyond naturally-occurring plant species to include orchard trees that experience intense human manipulation such as grafting for complex genetics, pruning for biomass removal, and extreme manipulations of the agricultural environment for optimal growth and fruit production. Despite conserved patterns in morphological characteristics, clear differences arise among the *Malus* varieties tested in regards to growth potential and fruit production. We propose a novel approach to breeding trials in horticulture that uses generalized scaling expectations to expose differences in growth and architecture that can lead to the selection of varieties for further research and commercial planting. The *Malus* varieties tested are all eight-year-old 'Golden Delicious' apples. They differ by rootstock grafting that imposes various growth potentials leading to trunk diameters ranging from 5–19 cm. Of the six varieties tested, clear differences appear when standardizing by the generalized scaling expectations of the MST. When using the mass ~ diameter relationship at a branch level, three of the six roots have slightly higher mass than expected by diameter while the other three have slightly lower mass than expected by diameter. The three rootstocks with higher mass ~ diameter relationships appear to be preferred for commercial planting for their relatively increased yield potential. All rootstocks expressed higher branch length than expected by mass and higher length than expected by diameter. However, some individuals overlap with the length ~ diameter expectation. When all rootstocks deviate significantly from scaling expectations of the MST, the mean estimated scaling exponent can be used to differentiate the rootstocks. Generalized scaling theory is a valuable tool for horticulture that reveals important differences among research varieties. Generalized scaling theory links physiological limitations of plant growth and architecture to the optimized growth, reproduction, and resource use goals of plant breeding.

11:45–12:00 PM

Abscisic Acid Reduces Photosynthesis But Does Not Consistently Thin 'Bartlett' Pears in Oregon

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Flower and/or fruitlet thinning is required to achieve commercially acceptable fruit size of 'Bartlett' pear (*Pyrus communis)* in Oregon. Suboptimal temperatures during sensitive stages of fruit development, however, often limit the efficacy of commercially available thinning agents. As a consequence, hand thinning is required. Efficacy of the plant hormone, abscisic acid (ABA) was evaluated to thin 'Bartlett' pears between 2012 and 2014. ABA reduced fruit set with increasing rate (0 to 500 ppm) in three of five field trials, despite producing similar reductions in net photosynthesis (Pn). Depending on ABA rate, Pn was reduced 75% to 90% within 1 day of ABA application, but returned to ~80% of control levels within 4 to 6 days and fully recovered by 10 to 14 days. When effective, ABA thinned well at ~100 ppm. Rates exceeding 400 ppm were phytotoxic. ABA did not negatively affect fruit growth, fruit weight, or quality at harvest. Return bloom was positively related to ABA rate. In general, pear trees likely have ample carbohydrate reserves to ameliorate short-term limitations to Pn, such as those induced by ABA. The best thinning occurred in combination with low, daily solar radiation (~30% of clear sky conditions) within the first several days from application. To assess the additive effects of shade and ABA on fruit set and gas exchange, a separate, two-way factorial design comprising two levels of ABA (0 and 125 ppm) and three levels of whole-canopy shade (0%, 44% and 77%) was administered. 'Bartlett' trees were shaded immediately

An asterisk (*) following a name indicates the presenting author.

following ABA application for a period of 15 days. ABA reduced Pn by 10-fold (i.e. from 10 to ~0 μmol·m^{-2}·s^{-1}) within several hours of application, relative to controls. Pn recovered to ~75% to 80% of control levels by day 3 as similarly observed in field trials. Fruit set of ABA-treated trees was reduced by ~35%, compared to untreated controls, although this effect may have been influenced by non-forecasted, cloudy conditions during day 3 to 5 after application. Moderate shade (44%) produced only a minor reduction of Pn (i.e., ~90% of control) and similar fruit set compared to controls. Increasing shade to 77%, however, had a markedly stronger effect on thinning and Pn. An interaction between shade and ABA was not significant for fruit set.

Specified Source(s) of Funding: Fresh Pear Committee

Thursday, 6 August 2015

Postharvest 2

Moderator: Peter Toivonen
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10:30–10:45 AM

Preharvest Plant Growth Regulators and Conditioning Treatment Effects on Flesh Browning on 'Gala' Apples

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Development of a flesh browning disorder in 'Gala' apples, which develops initially at the stem end of the fruit, has become an increasing problem for storage operators in part because of the need to store larger volumes of fruit for longer periods of time. We have investigated the effects of the preharvest plant growth regulators (PGRs) ReTain (aminoethoxyvinylglycine; AVG) and Harvista (1-methylcyclopropene; 1-MCP) over two harvest dates. At each harvest date, fruit were either untreated or treated with SmartFresh (postharvest 1-MCP), and then either kept in air at 0.5 °C or at 10 °C (conditioning) for a week. Conditioned fruit were cooled overnight and then all fruit were stored in controlled atmosphere conditions of 2% oxygen and 2% carbon dioxide at 0.5 °C for four months. The SmartFresh treatment did not affect browning incidence, but was a necessary treatment to avoid loss of texture associated with conditioning. Browning incidence was not affected by ReTain treatment, but it was reduced by Harvista treatment. Except for the Harvista treated fruit in which browning incidence was low, conditioning markedly reduced browning. Overall, the results indicate that preharvest PGRs, especially Harvista, reduce browning incidence by delaying fruit maturity, but that ethylene metabolism is not involved in the ameliorating effects of conditioning on browning after harvest.

Specified Source(s) of Funding: New York Apple Research and Development Program, AgroFresh, Inc., USDA Multistate (NE-1336) project, "Improving Quality and Reducing Losses in Specialty Fruit Crops through Storage Technologies."

10:45–11:00 AM

Storage Temperature and 1-MCP Treatment Affect Storage Disorders and Physiological Attributes of 'Royal Gala' Apples

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'Royal Gala' apples [*Malus* ×*domestica* (Borkh.) Mansf.] can develop postharvest disorders such as flesh browning, senescent breakdown, peeling, cracking, or shriveling during and after cold storage. The objective of this study was to examine the effects of storage temperature and a range of 1-methylcyclopropene (1-MCP) concentrations on fruit quality attributes and incidence and severity of postharvest physiological disorders during and after cold storage. Storage temperature significantly affected internal ethylene concentration (IEC), fruit circumference, and cortex color. The 1-MCP treatment resulted in significant effects on fruit quality attributes and severity of physiological disorders, regardless of storage temperature. Incidence and severity of diffuse flesh breakdown, shriveling, cracking, and peeling were highest in control fruit stored at 3 °C but radial stem-end flesh breakdown only appeared in 1-MCP treated fruit. Incidence of radial stem-end flesh breakdown was highest following storage at 0.5 °C compared with 3 °C. 1-MCP treatment prior to storage had the most influence on disorder incidence/severity or quality attributes while treatment concentration of 1-MCP was not significant. Overall, the results indicate that 1-MCP treatment can reduce the incidence of 'Gala' diffuse flesh breakdown but may enhance sensitivity to radial stem-end flesh breakdown when fruit are stored at 0.5 °C or 3 °C. Evidence supports that incidence of diffuse flesh breakdown and radial stem-end flesh breakdown are influenced differentially by storage temperature or by 1-MCP treatment, respectively indicating they may be different disorders.

11:00–11:15 AM

Carbon Dioxide Injury in 'Honeycrisp' Apple: Dose Response and Induction of Fermentative Volatiles

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Controlled atmosphere (CA) storage at low temperature has been widely used to successfully extend the marketing period of many apple [*Malus sylvestris* (L.) Mill. var. *domestica* (Borkh.) Mansf.] cultivars. However 'Honeycrisp' fruit are very sensitive to injury by CA storage, developing brown lesions and lens-shaped cavities in the cortex in response to elevated CO_2 and, to a lesser extent, to low O_2. To investigate the effect of CA conditions on injury of 'Honeycrisp', fruit were subjected CO_2 levels of 0, 1.5, 3, 10, and 20 kPa in combination with 3 kPa O_2during storage at 3 °C. In addition, fruit were treated with diphenylamine (DPA) drench (1000 μL·L^{-1}, 30 s) to control CO_2 injury and held in two different CA conditions (3 kPa CO_2 + 3 kPa O_2; 10 kPa CO_2 +3 kPa O_2). Fruit were assessed on day 7, 14, 21, 28, 35, 42, 56, 70, 84, 112, 140, and 168 of storage for incidence and severity of CA injury, bitter pit, and decay and fermentative volatile emissions (acetaldehyde, ethanol, and ethyl acetate) were measured on tissue samples removed from the cortex. None of the CA conditions affected incidence of bitter pit or decay. Controlled atmosphere injury increased with increasing CO_2 levels and with increasing storage duration for the first 50 days of storage. Fruit exposed to 10 and 20 kPa CO_2 had somewhat elevated levels of fermentative volatiles relative to fruit stored at lower levels of CO_2. DPA completely suppressed CA injury at 3 and 10 kPa CO_2. Interestingly, there were approximately the same levels of fermentative volatiles under both CA regimes. It is suggested that fermentative metabolism is influenced by CA conditions, but that the volatiles may not be indicative of CA-related injury per se. The role of DPA in suppressing CA-related injury needs to be investigated.

11:15–11:30 AM

Peel Maturity Only Correlates with Soft Scald in a Highly Susceptible Orchard of Ambrosia™ Apple

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The relationships of peel or flesh maturity of apples and susceptibility to soft scald has been suggested in the existing literature. In British Columbia, the new apple cultivar Ambrosia™ has been documented to have significant susceptibility, especially in certain orchards that appear to have consistently more occurrence of soft scald than others. Two orchards in the Cawston area of British Columbia (Similkameen Valley) were selected for their close proximity to each other and because they have historically had significant differences in incidence and severity of soft scald. The two orchards are across the road from each other, the first having a northwest by north row orientation and the second having a northeast by east row orientation. In the first orchard the incidence of soft scald reached a maximum of 16% of the fruit being affected and only having slight severity rating. In the second orchard incidence ranged from 23% to 55% of the fruit being affected, and severity ratings approached moderate on a relative scale. Maturity of the apples was determined with a DA meter, which can be used to measure peel maturity. In the first orchard, incidence and severity of soft scald were not correlated with DA meter values (R = 0.0031 and 0.026, respectively), while in the second orchard, the incidence and severity were strongly correlated (R = 0.86 and 0.77, respectively) with DA meter values. These results suggest that apple maturity is only associated with soft scald incidence and severity for orchards that have a higher susceptibility to soft scald. Clearly the factors affecting soft scald susceptibility and severity are complex in nature and dependence on maturity sorting for segregating potentially susceptible fruit may not be warranted for all orchards, at least for Ambrosia™ apples.

11:30–11:45 AM

Impact of Atmosphere Modification on Red Raspberry Fruit Quality

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Atmosphere modification has been shown to prolong the market life of red raspberry fruit primarily by the reduction of fruit decay. Decay reduction has been attributed to carbon dioxide partial pressures of 10 kPa or greater. However, the interactive effect of carbon dioxide and oxygen partial pressures on decay and other fruit quality parameters is not well understood. Therefore, the objective of this study was to determine the effects of high carbon dioxide and low oxygen concentrations on the quality, volatile metabolism and storage life of four red raspberry cultivars. Fruit from the cultivars Octavia, Moutere, Nova, and Lauren were harvested from commercial fields. A total of three harvests were obtained for each cultivar and 150-g samples of

fruit in clamshells were stored for 21 days at 1 °C and 95% relative humidity (RH) in air, 2 kPa O_2/0 kPa CO_2, 2 kPa O_2/12.5 kPa CO_2, or 7.5 kPa O_2/12.5 kPa CO_2. Fruit quality was assessed on the day of harvest (initial) and after 21 days of storage in each of the four atmospheres. Fruit were assessed for decay, physiological breakdown, marketability, firmness, color, soluble solids, titratable acidity, pH, sugars, acids, ethanol, volatiles, and anthocyanins. Storage atmospheres with 12.5 kPa CO_2 reduced fruit decay after 21 d storage, averaging 2.7% (2 kPa O_2/12.5 kPa CO_2) and 4.3% (7.5 kPa O_2/12.5 kPa CO_2) compared to those stored with no CO_2 that averaged 16.7% (air) and 13.0% (2 kPa O_2). Atmosphere composition had no significant effect on physiological breakdown of the fruit during storage, which averaged 26.3% after 21 d. Firmness was reduced in fruit stored in 12.5 kPa CO_2 (24.6 g/mm in 2 kPa O_2/12.5 kPa CO_2 and 25.8 g/mm in 7.5 kPa O_2/12.5 kPa CO_2) compared to those with no CO_2 (38.2 g/mm in air and 2 kPa O_2). Loss of acids during storage, which averaged 19% to 22% in fruit stored in air, 2 kPa O_2/0 kPa CO_2 and 7.5 kPa O_2/ 12.5 kPa CO_2, was reduced to 7% in fruit stored in 2 kPa O_2/12.5 kPa CO_2. The impact of atmosphere modification on volatile metabolism will be discussed.

11:45 AM–12:00 PM

Possible Commercial Protocols for Recovering Ripening Capacity of 1-MCP-treated European Pears

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A continuing challenge for commercializing 1-methylcyclopropene (1-MCP) to extend the storage life and control superficial scald (SS) of European pears (*Pyrus communis* L.) is how to initiate ripening capacity (RC) in 1-MCP treated fruit following cold storage. The objective of this study was to develop commercially feasible protocols for controlling postharvest disorders of pears through postharvest application of 1-MCP at commercially manageable dosage (i.e., 150 ppb) while allowing ripening to outstanding eating quality. The following strategies were investigated: 1) storing 1-MCP treated 'Anjou' pears at elevated storage temperatures; 2) simultaneous application of 1-MCP and ethylene; 3) post-storage ethylene conditioning (PSEC); 4) delaying 1-MCP application; and 5) late harvest. As expected, 1-MCP inhibited ethylene production in 'Anjou' pears during cold storage and the 1-MCP treated fruit developed neither SS nor RC in 7 d at 20 °C following eight months of storage at the traditional storage temperature of –1.1 °C. A storage temperature of 1.1 °C facilitated initiation of RC in 1-MCP treated fruit with relatively low SS following six to eight months of storage through recovering the expression of ethylene synthesis (*PcACS1*, *PcACO1*) and signal (*PcETR1*, *PcETR2*) genes. 'Anjou' pears treated with 1-MCP + ethylene simultaneously at 300:300–600ppb recovered RC with low SS following 6–8 months of storage at –1.1 °C. PSEC could ripen the 1-MCP treated 'Anjou' pears produced at high elevations (i.e., 610 m) and its bud mutation 'Columbia Red Anjou' pears following six to eight months of storage at –1.1 °C. *PcACO1* plays an important role in initiating RC in 1-MCP treated red 'Anjou' pear upon PSEC treatment. Delaying 1-MCP application after harvest and late harvest may not be useful protocols for ripening 1-MCP treated 'Anjou' pears due to inconsistent efficacies among production lots and years.

Thursday, 6 August 2015

Viticulture and Small Fruits 3

Moderator: Elina D. Coneva
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10:30–10:45 AM

Elderberry Rust: A Conspicuous Disease of *Sambucus*

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Interest in growing elderberry has surged in the past few years due to the potential for high economic returns for producers and increased consumer interest in health-promoting food products. As commercial growers expand their acreage and plantings mature, production problems have been identified, including elderberry rust. This disease is caused by the fungus, *Puccinia bolleyana*. Elderberry rust requires two living hosts to complete its life cycle, including elderberry and a sedge (*Carex*) species. Although elderberry rust symptoms have been described, plant response to this disease has not been reported. Thus, a study was conducted to determine the effect of rust on vegetative growth, fruit yield, and berry puree of American elderberry plants inoculated on 22 April. By 17 June, pycnia were observed 34% of elderberry leaves per plant. Preliminary results indicate that fruit harvest was delayed on rust-infected plants. Inoculated plants also had lower fruit yield and average berry weight than uninfected plants. Soluble solids were higher in fruit puree from rust-infected plants than from uninfected ones.

10:45–11:00 AM

Managing Anthocyanin Concentration, Proportion, Acylation and Hydroxylation of 'Autumn Royal' Table Grape with Plant Growth Regulator and Applied Water Amount Interaction

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'Autumn Royal', a black seedless late-season table grape variety has a high retail demand with naturally large berries, good flavor, and attractive color. One limiting factor for 'Autumn Royal' grape production is proper color development due to its propensity to overcrop. Plant growth regulators are widely used to increase berry size and enhance color development. Research emphasis has recently focused on the concept of water productivity, which is the amount of marketable product produced per unit of water consumed in evapotranspiration (ET_c). Table grape growers tend to over-irrigate to ensure optimum quality grapes. Plant growth regulator treatments included gibberelic acid (GA_3) and Ethrel® applications and a combination of both with an untreated control. Three irrigation treatments were applied: grower control at 120% ETc; early regulated deficit irrigation (RDI) initiated at fruit set irrigated at 80% ET_c until veraison; and late RDI initiated at veraison irrigated at 80% of ET_c until harvest. Initial results showed that the combination of irrigation regimes with PGR treatments had no significant effect on berry size (g) or cluster weight (g), but the cumulative number of 19-lb boxes packed was higher for the early RDI treatment. Total skin anthocyanin content (mg/kg) was significantly higher for the Ethrel® and combined PGR treatments during early RDI. The late RDI treatment showed higher skin anthocyanins for only the combined PGR treatment. Berry firmness was higher for the combined PGR and early RDI treatments. After cold storage trials berry firmness was significantly higher for GA_3 and the combined PGR treatments. The late RDI treatment had the firmest berries of the three irrigation regimes. Preliminary results showed that the RDI early treatment was the better performer, even in drought situations, but must be combined with PGR's. PGR applications are needed in 'Autumn Royal' production and they have an additive effect on yield and berry color. Using PGRs can enhance berry firmness and storage ability. Also, the combined effects of early RDI and PGR applications would increase yield and storage ability and enhance color development. Irrigation savings of 2 acre-inches was achieved with RDI treatments and resulted in full berry color development. This is an ongoing project that presented initial results based on the 2014 growing season.

Specified Source(s) of Funding: California State University Agriculture Research Initiative

11:00–11:15 AM

The Effect of Irrigation Amounts during Fruit Ripening on Skin Anthocyanins in Forced Cabernet Sauvignon Grapevines

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Grapevines can be forced to regrow so fruit ripening can be shifted to the cooler portion of the growing season while enhancing fruit quality for wine making, including significantly higher content of skin anthocyanins. In order to determine if irrigation management can further increase skin anthocyanins in forced fruit, a study was conducted in 2013 and 2014 with mature 'Cabernet Sauvignon' grapevines on Freedom in Fresno, CA, a warmer region for wine grape production. Vines were forced in mid-June by hedging primary shoots to six nodes and removing all clusters, leaves, and summer laterals. The forced vines were irrigated at 100% crop evapotranspiration (ET_c) until veraison, and then at 40%, 60%, 80%, or 100% ETc in a completely randomized block experiment. Berries were sampled randomly from fruiting zone at commercial maturation of 24 to 26 °Brix, while their skins were analyzed for individual anthocyanins, using a HPLC system. Fifteen individual anthocyanins were detected, including non-acylated, acetylated, and p-coumaroylated glucosides of delphinidin, cyanidin, petunidin, peonidin, and malvidin aglycones. Tri-hydroxylated anthocyanins accounted for more than 85% of the total skin anthocyanins, and more than half of the trihydroxylated anthocyanins were malvidin-based. Total skin anthocyanins, acylated anthocyanins, and tri-hydroxylated anthocyanins were significantly higher, by approximately 15% to 35%, in vines irrigated at 40 and 60% ETc than those at 80 and 100% ETc. The concentration of malvidin-based anthocyanins, especially malvidin-3-glucoside and malvidin-3-acetyl-glucoside, was also higher when vines were irrigated with less water. However, irrigation amounts did not affect either skin content of *p*-coumaroylated anthocyanins or proportion of each individual anthocyanins. The study demonstrated that post-veraison reduction in irrigation amounts can increase skin anthocyanins, primarily the trihydroxylated and malvidin-based anthocyanins, in forced grapevines to further enhance fruit quality.

11:15–11:30 AM

Growing Pierce's Disease-resistant Grapes in the Southeast

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Grape growing has increased significantly on a national and local scale in the last decade; however, current information on growing Pierce's disease (PD) resistant grapes in Alabama and the Southeast is lacking. Eleven PD-tolerant American and French-American hybrid bunch grape cultivars including 'Black Spanish', 'Blanc du Bois', 'Champanel', 'Conquistador', 'Cynthiana', 'Favorite', 'Lake Emerald', 'Stover', 'Villard Blanc', 'Seyval Blanc', and 'Seyval Blanc' grafted on Coudrec 3309 rootstock ('Seyval Blanc'/3309C) were planted at the Sand Mountain Research and Extension Center in Crossville, AL, in 2008 to study the feasibility of growing PD-resistant hybrid bunch grape cultivars in Alabama's hot and humid environment. Three recently developed PD-resistant 87.5% *V. vinifera* selections from the University of California, Davis, grape breeding program were planted at the Chilton Research and Extension Center near Clanton in 2010 and vines were trained to a vertical shoot positioning trellis system. Our results indicate 'Villard Blanc', 'Cynthiana', and 'Black Spanish' were the best performing hybrid bunch cultivars in our test. The preliminary results of our study on PD-resistant *V. vinifera* selections are

very encouraging based on plant vigor, high yields, and good fruit quality. The PD-resistant grape cultivars have the potential to advance the environmental and economic sustainability of viticulture in the Southeast.

11:30–11:45 AM

Deacclimation Rate in Cultivated and Wild Grapes is Dependent on Dormancy Stage and Temperature

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Grapevine buds must survive the winter in order to burst and produce shoots and flowers during the following spring. During the winter, buds are acclimated and can survive temperatures below –30 °C due to supercooling. In the spring, accumulation of growing degree-days leads to deacclimation of these tissues, however the rates of deacclimation can vary depending on the dormancy stage of the buds. The objective of this study was to determine the rate of deacclimation of four different grapevines exposed to different temperatures at endodormant and ecodormant stages: *Vitis vinifera* 'Cabernet Sauvignon', *V. vinifera* 'Riesling', *V. amurensis*, and *V. riparia*. All plant material was collected from vineyards located in Geneva, NY. Endodormant material was collected on 11 Nov. 2014, and rate of deacclimation was evaluated at continuous 4 °C or 22 °C regimen for 7 days. Ecodormant material was collected on 10 Mar. 2015, and was evaluated for 10 days at the same temperatures as endodormant, and also with daily changes between 4 °C and 22 °C (4/22 °C). Buds were sampled daily and subjected to differential thermal analysis to evaluate the temperature to which buds were able to supercool. For endodormant buds, there was no deacclimation observed in the period observed. All grapevines maintained their supercooling ability unchanged over the course of 7 days regardless of the temperature of storage ('Cabernet Sauvignon': –18.7 °C ± 0.4 °C; 'Riesling': –21.1 °C ± 0.5 °C; *V. amurensis*: –21.7 °C ± 0.5 °C; and *V. riparia*: –24.0 °C ± 0.5 °C). For ecodormant buds however, the rate of deacclimation was dependent on the interaction between temperature of storage and grapevine. At 4 °C, 'Cabernet Sauvignon', 'Riesling' and *V. riparia* had similar deacclimation rate (~0.32 °C/day), while *V. amurensis* had a much higher rate (1.03 °C/day). At 4/22 °C, 'Cabernet Sauvignon' and 'Riesling' had an average deacclimation rate of 0.86 °C/day, while *V. amurensis* and *V. riparia* averaged 1.40 °C/day. At 22 °C, there were no differences between the grapevines tested (~1.43 °C/day). All grapevines had higher rate of deacclimation at 4/22 °C compared to 4 °C, but only 'Cabernet Sauvignon' and 'Riesling' had a higher deacclimation rate in the 22 °C treatment compared to 4/22 °C. All species had a similar pattern in deacclimation rates, with deacclimation rates being positively correlated to exposed temperatures. *V. amurensis* had the highest deacclimation rate at 4 °C, which may indicate that this species has a lower base temperature.

11:45–12:00 PM

The Vineyard Advisor Mobile Application for Pest Management Recommendations

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The Vineyard Advisor mobile application was designed to provide up-to-date recommendations on disease and pest management for commercial grape production, including the most current federal pesticide labels. For a given grape disease or pest, the Vineyard Advisor delivers management recommendations following a standardized format with the following sections: problem name; when to take action; cultural management practices; organic materials; registered pesticides; and references. Recommendations are derived from published resources including viticulture books and Extension pest management guides from several states. Current federal pesticide labels are retrieved from the U.S. Environmental Protection Agency (EPA) using a modification of the system employed by the Mobile Access to Pesticides and Labels tool produced by the National Pesticide Information Center. The Vineyard Advisor operates both as a standalone product and as an optional resource linked from the Vineyard Doctor diagnostic system. As a standalone app, a vineyard manager who has observed a disease problem can use it; for example, to look up the recommended cultural practices to manage the disease as well as a list of pesticide products labeled for control of that specific disease on grapes. The pesticide product is linked to PDF files of the most current national product labels. Alternatively, the vineyard manager could use the app to search directly for a specific pesticide product labeled for grapes. This feature is particularly valuable as changes occur in pesticide product availability or directions-for-use. The Vineyard Advisor pesticide label database is updated in concert with EPA updates to their database, which typically occur on a weekly schedule. The Vineyard Advisor also seamlessly integrates with the Vineyard Doctor diagnostic system, through the Problem Profile pages of the Vineyard Doctor. An example of this use would be a vineyard manager using the Vineyard Doctor to identify an insect problem in the vineyard, and following the management recommendations link on the Problem Profile to the corresponding insect management recommendations page on the Vineyard Advisor. The scope of vineyard problems for which the Vineyard Advisor provides

management recommendations fully coincides with the 150+ problems within the Vineyard Doctor system, and additionally provides weed management recommendations including links to herbicide labels. The Vineyard Advisor app is functional across several platforms, including multiple internet browsers, smartphones, tablets, and other mobile devices.

Specified Source(s) of Funding: American Vineyard Foundation

12:00–12:15 PM

Performance of Two Southern Highbush Blueberry Cultivars Grafted onto *Vaccinium arboreum*

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Production of southern highbush blueberries (SHB) in Florida requires soil amendments that decrease pH and increase organic matter; however, soil amendments increase production costs and are not environmentally sustainable. *Vaccinium arboreum* is a wild species that has potential as a rootstock for SHB, because it grows in sandy soils and tolerates high soil pH and low organic matter. The hypothesis tested in this research is that SHB plants grafted onto *V. arboreum* rootstocks exhibit increased soil adaptability compared with own-rooted SHB plants when cultivated on non-amended soil. The specific objectives are to evaluate the effects of two soils (pine-bark amended versus non-amended) and root systems (own-rooted versus grafted plants) on growth, yield, and fruit quality in two SHB cultivars (Farthing and Meadowlark). Four rootstock-scion combinations (own-rooted 'Farthing' or 'Meadowlark'; 'Farthing' or 'Meadowlark' grafted onto *V. arboreum*) were field planted in 2011 on either amended or non-amended soil. In the first three years, own-rooted 'Farthing' on amended soil had greater canopy volume than own-rooted 'Farthing' on non-amended soil or grafted 'Farthing' on either soil. In the fourth year, own-rooted and grafted 'Farthing' had the same canopy volume, while 'Farthing' on amended soil had greater canopy volume then those on non-amended soil. For 'Meadowlark', own-rooted plants on amended soil had greater canopy volume than own-rooted plants on non-amended soil or grafted plants on either soil in the first two years. In the third year, own-rooted 'Meadowlark' on amended soil or grafted 'Meadowlark' on either soil had greater canopy volume than own-rooted 'Meadowlark' on non-amended soil. In the fourth year, canopy volume was greater in 'Meadowlark' on amended versus non-amended soil and on grafted versus own-rooted plants. In 2013, own-rooted plants of both cultivars grown on amended soil had higher yields than own-rooted plants on non-amended soil or grafted plants on either soil. In 2014, regardless of the root system, plants on amended soil yielded more than plants on non-amended soil for both cultivars. Across soil types, grafted plants yielded more than own-rooted for 'Meadowlark', however, yields were the same for 'Farthing'. Fruit quality (sugar:acid ratio) was not consistently different across treatments and years for either cultivar. These results indicate that grafting delayed plant growth, and consequently reduced yield during the first two years after planting. Fruit quality was not affected by grafting or soil treatments.

Specified Source(s) of Funding: USDA–NIFA–SCRI 2009-5481-06021

Friday, 7 August 2015

Genetics & Germplasm 3

Moderator: Chandra Sekhar Thammina
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8:00–8:15 AM

Analysis of Genetic Diversity and Relatedness of Boxwood Accessions Using Genic-simple Sequence Repeat Markers

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Boxwood *(Buxus* L. spp., Buxaceae) are popular woody landscape shrubs grown for their diverse forms and broad-leaved evergreen foliage. Each year, more than 13 million boxwood plants are sold in the United States, with an annual market value of $103 million. Boxwood plants grown in temperate zones are now threatened by a destructive new blight disease caused by the ascomycete fungus *Calonectria pseudonaviculata* Henricot (syn. *Cylindrocladium pseudonaviculatum, Cylindrocladium buxicola*). The disease was first identified from the United Kingdom in 1994 and it has spread throughout continental Europe, parts of western Asia, New Zealand, and into North America. This fungal pathogen causes dark brown to black lesions on leaves and severe defoliation leading to plant death in nurseries and established landscapes, hence the need to develop blight-tolerant boxwood cultivars. The National Boxwood Collection at the U.S. National Arboretum (USNA) contains more than 700 *Buxus* accessions, making it one of the most complete collections in the world and a valuable genetic resource for developing blight-tolerant varieties. However, genetic relationships and diversity among these accessions have not been determined. We developed genic simple sequence repeat markers (genic-SSRs) by cDNA library sequencing in

Buxus sempervirens 'Vardar Valley'. Twenty-three genic-SSR primer pairs that amplified polymorphic loci in preliminary tests were used to estimate genetic diversity and relatedness of 268 boxwood accessions. Genic-SSR loci were highly variable among the accessions, detecting an average of 5.7 alleles (amplicons) per locus. However, six of the primer pairs amplified allele numbers that were inconsistent with known ploidy in some accessions, so were not used in the analysis. Amplified allele data from the remaining 17 primer pairs were analyzed using the R polysat package, with a distance matrix based on Jaccard's similarity index, followed by UPGMA clustering. Five major clusters were identified consisting of individual accessions from *B. balearica*, *B. harlandii*, *B. microphylla*, *B. sempervirens*, *B. sinica*, and their interspecific hybrids. The accessions generally clustered by cultivar, provenance, or species. This information will be used for breeding programs and collection management, and for identifying possible sources of disease tolerance in boxwood.

8:15–8:30 AM

Genetic Relationship between *Lactuca georgica* and Five Other *Lactuca subsection Lactuca* Species as Revealed by TRAP Markers

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Lettuce, *Lactuca sativa*, is one of the most popular and economically important leafy greens. Wild relatives of lettuce have been and continue to be explored as a source of valuable traits such as disease resistance for this crop. The genus *Lactuca* L. contains approximately 100 species, with *L. serriola, L. altaica, L. saligna, L. virosa, L. aculeata, L. scarioloides, L. azerbaijanica, L. georgica,* and *L. dregeana* being placed in section *Lactuca* L. subsection *Lactuca* L. along with cultivated lettuce. All of these species have been placed in the primary gene pool for the crop with the exception of *L. saligna* and *L. virosa* which have been placed in the secondary and tertiary pools, respectively. *L. georgica* has not been included in previous studies assessing the genetic relationships among these species. As a result, the relationship of *L. georgica* to other species is not known. Using the target region amplification polymorphism (TRAP) technique, we genotyped 236 plants from 63 accessions representing six species, *L. georgica, L. virosa, L. aculeata, L. saligna, L. serriola,* and *L. sativa*. Based on 50 polymorphic markers, these species were grouped in four distinct clusters: *L. serriola, L. sativa* and *L. aculeata*; *L. virosa*; *L. georgica*; and *L. saligna*. It seems *L. georgica* is most closely related to *L. virosa*.

8:30–8:45 AM

Characterization of 11 Hybrid Rose Populations for Petal Number under Cool- and Warm-season Conditions

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Rose (*Rosa* spp.) is an important ornamental crop that is commercially utilized for garden plants, cut flower, and food/medicinal/aroma industry. Heat stress is a major abiotic stress that reduces the flower size and value of the rose. The average petal number was estimated by counting the petals per flower for three flowers per plant in August 2013 (warm season, mean temperature 30.7 °C) and in November 2013 (cool season, mean temperature 13.6 °C). As these populations are segregating for single (5–8 petals) versus double (> 8 petals) flowers as conditioned by a major dominant gene for double flowers, it was decided to concentrate on the petal numbers of the double flowers in the analysis. Although the petal numbers were well correlated between seasons ($R^2 = 0.60$), the double flowers generally had more petals per flower during the cool (average petal number 53) vs. the warm (average petal number 38) season. Among the populations only a few showed a significant decrease in petal numbers in the warm versus cool season. Genetic variance was calculated using restricted maximum likelihood (REML) method with all factors considered as random effects. This analysis indicated a small GxE effect. Most of the variance was due to additive effects as indicated by the high narrow sense heritability ($h^2 = 0.80$).

8:45–9:00 AM

Perspectives from Soybean Breeding: A Combination of Classic and New Technologies to Map and Fine Map Aphid Resistance in Soybean and Its Application in Horticulture

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As one of the most planted crops in the United States and the world, soybean is currently under intensive study. Breeding and research in horticultural plants is still a rising area. There is a huge market demand and also many areas of research to explore. The paper will provide perspectives from soybean breeding and explore a career of breeding for horticultural plants. The soybean aphid has become one of the most devastating pests to soybean in North America since its invasion in 2000. Soybean breeders have been seeking resistance sources and incorporating them into elite cultivars ever since 2000. As technology keeps updating over time, the process of mapping the aphid resistance QTL and facilitating it into the breeding scheme has become faster

An asterisk (*) following a name indicates the presenting author.

and easier. The results of mapping and fine mapping soybean aphid resistance gene in PI567537 will be presented. Based on fine mapping results, marker-assisted selection (MAS) system was well established, making the breeding scheme much more efficient than ever before. The MAS system will be discussed as well. We will also discuss how to use the resistance source screening system and new technologies (52K SNP Chip and next generation sequencing) toward horticultural plants.

Friday, 7 August 2015

Postharvest 3

Moderator: Randolph Beaudry
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8:00–8:15 AM

Up-regulation of Genes in Diphenylamine- and 1-Methylcyclopropene-treated Apples during Cold Storage

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Cold storage reduces the rate of quality loss and extends availability of fresh apples in the marketplace, but several cultivars develop various postharvest browning disorders of the peel or flesh tissue such as superficial scald and external carbon dioxide injury. Postharvest 1-methylcyclopropene (1-MCP) treatment inhibits ethylene perception and subsequently its production, and as a result inhibits superficial scald development in 'Granny Smith'. 1-MCP treatment of 'Empire', however, can enhance susceptibility of fruit to external carbon dioxide injury. Postharvest drenching with the antioxidant diphenylamine (DPA) reduces or eliminates incidence of both disorders. Transcriptomic changes using deep sequencing were evaluated during storage of 1-MCP or DPA treated 'Granny Smith' and 'Empire'. Multivariate analysis was used to find which genes were most associated with 1-MCP treatment during storage. Multiple genes were upregulated only in 1-MCP treated fruit during storage in both cultivars. It is suspected that genes associated with greater carbon dioxide injury risk reside within this group.

8:15–8:30 AM

Characterization of Calmodulin Gene Family during Tomato Fruit Development and Ripening

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Calmodulin, a calcium sensor, can recognize the different developmental and stress-triggered calcium changes. To investigate the function in fleshy fruit development and ripening, the expression of a family of six calmodulin genes (*SlCaMs*) were carried out. All calmodulins showed a double peak expression pattern. The first flat peak appeared at 10 to 30 days after anthesis. Then their expression declined to the basal level at mature green and breaker. Shortly after, a sharp and even higher peak appeared at turning/pink stages. *SlCaMs* showed different patterns in three ripening mutants *rin*, *No*r and *Nr*. Furthermore, *SlCaMs* (especially *SlCaM2*) were upregulated by ethylene. Transiently expressing *SlCaM2* in mature green fruit delayed fruit ripening, whereas reducing *SlCaM2* expression accelerated ripening. Thus, *SlCaMs* could play double roles to regulate fruit ripening. Prior to the ethylene burst, the ethylene-independent repression of *SlCaMs* might be critical for fruit to initiate the ripening process. After the ethylene burst, *SlCaMs* could participate in the ethylene coordinated rapid ripening. In addition, all calmodulin genes at mature green stage were upregulated by salicylic acid and methyl jasmonate. Overexpression of *SlCaM2* in tomato fruit enhanced resistance to *Botrytis*-induced decay, whereas reducing its expression resulted in increased lesion development. Calmodulin acts as a positive regulator of plant defense in fruit by activating defense pathways including salicylate- and jasmonate- signaling pathways, and *SlCaM2* is the major calmodulin gene responsible for this event.

Specified Source(s) of Funding: USDA–ARS

8:30–8:45 AM

A Targeted Quantitative Proteomic Investigation Reveals the Changes in Proteins Responsible for Flavonoid and Anthocyanin Biosynthesis in Strawberry Fruit at Different Ripening Stages

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To better understand the regulation of the biosynthesis of anthocyanins and other flavonoids, a targeted quantitative proteomic investigation employing LC-MS with multiple reaction monitoring was conducted on two strawberry cultivars ('Honeoye' and 'Mira') at three ripeness stages. Strawberry fruit were tagged at the bloom stage and harvested at white, pink and red-ripe maturity stages. Anthocyanin concentration was positively correlated with fruit maturity with higher levels of both greater cyanidin-3-glucoside and pelargonidin-3-glucoside in riper fruit of both cultivars. A quantitative proteomic workflow was improved through OFFGEL electrophoresis to fractionate peptides obtained from total protein digests of ripening strawberry fruit. A library was established of identified proteins and peptides related to flavonoid biosynthesis from the LC/MS analysis of total protein extract from red-ripe fruit. Our identification of proteins and peptides was improved for those of low abundance, which provided per arri information. Also the current analysis provided physicochemical information about the peptides that can be used to validate the peptide sequence identification. A total of 154 peptide transitions from 47 peptides covering 21 proteins and isoforms related to anthocyanin biosynthesis were examined. The normalized protein abundance measured using isotopically-labelled standards, was significantly changed greater when anthocyanin concentration was also greater in fruit of advanced maturity. The protein abundance of phenylalanine ammonia-lyase, anthocyanidin synthase, chalcone isomerase, flavanone 3-hydroxylase, dihydroflavonol 4-reductase, UDP-glucose:flavonoid-3-O-glucosyltransferase, cytochrome c and cytochrome C oxidase subunit 2 were all significantly greater in fruit of more advanced ripeness. An interaction was found between cultivar and fruit maturity with respect to chalcone isomerase. The good correlation between protein abundance and anthocyanin concentration suggested a level of metabolic control involving protein concentration. Monitoring protein levels may also reveal candidate regulatory enzymes that affect anthocyanin formation during fruit ripening.

8:45–9:00 AM

A Single Lipoxygenase in Apple and Its Free Linoleic Acid Substrate are Proposed to Constitute a Major Pathway in the Formation of Hexyl Esters during Fruit Ripening

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During apple fruit ripening, only one of 22 putative lipoxygenase (LOX) genes was found to undergo a substantial increase in transcript accumulation. The increase in expression (~100-fold) coincided with autocatalytic ethylene formation and the climacteric rise in respiration. This LOX (*MdLOX1a*) was originally annotated as a 9-LOX, which would primarily form 9-hydroperoxides and lead to the formation of 9-carbon aldehydes, which are not produced in apple. However, protein expression studies demonstrated that MdLOX1a was primarily a 13-LOX and formed 13-hydroperoxides, which are cleaved by hydroperoxide lyase to form C6 aldehydes. Unlike many 13-LOX enzymes, MdLOX1a lacked a chloroplast transit peptide and did not co-locate with chloroplasts in a heterologous system using Agrobacterium-mediated transient expression in tobacco. The increase in *MdLOX1a* transcript accumulation paralleled an increase in free oleic (18:1) and linoleic (18:2) fatty acid pools during ripening. While 18:1 would not be acted upon by a 13-LOX, 18:2 would be expected to yield hexanal. Emissions of hexanal, hexanol, and hexyl esters increased simultaneously with the abundance of *MdLOX1a* transcripts and the increase in concentration of free 18:2. Interestingly, free linoleic acid (18:3) did not accumulate. The mechanism whereby free 18:1 and 18:2 could accumulate without a concomitant increase in free 18:3 is not clear. To our knowledge, there is currently no synthetic or catabolic pathway characterized that might lead to this finding. Collectively, the data suggest that production of free 18:2 fatty acid during apple fruit ripening provides substrate for the up-regulated lipoxygenase MdLOX1a and results in the synthesis of hexanal and, subsequently, hexanol and hexyl esters.

An asterisk (*) following a name indicates the presenting author.

9:00–9:15 AM

Distribution of Apple Fruit Epidermal Non-polar Metabolites

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Apple peel epidermis provides a resilient protective barrier against external stimuli while, also, comprising much of what is considered as fruit appearance and related phenotypic components. This dynamic structure is subject to many changes throughout the production and supply chain that can impact fruit appearance and epidermal function. Apple epidermis is comprised of live cells coated with an intractable cutin layer that is both embedded in and coated with wax. Wax and cutin are constructed of secondary metabolites principally supplied by specialized epidermal cells. In this study, we examined wax and epidermal peel cells separately to determine the origination of non-polar metabolites that comprise our whole peel analysis. 'Granny Smith' peel metabolites were fractionated by submerging the whole fruit in hexanes and, subsequently, in chloroform, then peel was collected. Components of wax fractions and peel were identified using an LC-MS global analysis of non-polar metabolites. A wide variety of metabolites including isoprenoids, lipids, and triglycericides were identified and localized as non-wax cell metabolites if present in the peel extract following wax extraction, or extracellular wax components if present in hexanes or chloroform. Carotenyl pigments, chlorophylls, and photosystem components resided within the active cell region as did phytosteryl, phytosteryl conjugates and many lipids that comprise lipid bilayers. Sesquiterpenes and triterpenes and their conjugates or oxidation products were located in the waxes. Location of these metabolically and structurally important peel components is diverse and may influence any consideration of their genesis, interactions, and products in these systems and roles they may have in phenotype and disorder related physiology.

Friday, 7 August 2015

Citrus Crops

Moderator: Tracy Kahn
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8:00–8:15 AM

Update on Evaluations of Lemon Selections for the California Desert

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As the nation's leader in lemon production, California lemons continue to be the highest-value citrus crop per acre for the state. Although lemons are grown predominantly in the coastal and desert regions of the state with smaller numbers of acres in the San Joaquin Valley, this range of climatic regions in the state provides the market with year-round production. Among these regions, lemons grown in the desert occupy an important early-season market niche and are an important source of fruit for packinghouses located there and in other areas of the state. This project was designed to evaluate 12 lemon selections under desert conditions. The objectives are to provide the lemon industry with information on tree growth, yield, packout, and fruit quality characteristics for selections. These include: 'Allen Eureka', 'Variegated Pink-Fleshed Eureka', 'Corona Foothills' (a bud sport of 'Villafranca'), 'Limoneira 8A Lisbon', 'Walker Lisbon', 'Femminello Santa Teresa', 'Interdonato', 'Limonero Fino 49', Limonero Fino 95', 'Messina', 'Seedless' lemon, and 'Yen Ben'. This trial update will provide results of overall yield, experimental and commercial pack-out, and exterior and interior fruit quality. For the past seven seasons, 'Corona Foothills', 'Walker Lisbon', 'Limoneira Fino 49', 'Femminello Santa Teresa', and the controls, 'Allen Eureka' and 'Limoneira 8A Lisbon', had the highest yields; and 'Yen Ben', 'Interdonato', 'Seedless Lemon', 'Limonero Fino 95', 'Messina', and 'Variegated Pink Eureka' had the lowest yield. Of the six highest yielding selections, three stand out. 'Corona Foothills' fruit had good size, were relatively early in maturity and had the best first harvest yield and next-to-best total yield and returns with excellent cumulative yield. 'Walker Lisbon' had good first harvest yield, good total yield, good returns, and the fruit were relatively early in maturity. 'Limonero Fino 49' had excellent first and second harvest fruit size and good exterior quality with excellent first harvest yields and good second harvest yields and returns as well as excellent total yield and cumulative yield. Along with 'Corona Foothills' and 'Walker Lisbon', 'Limonero Fino 49' was the earliest of the selections. Information obtained from this trial will help to further define performance of these selected cultivars in the California desert.

Specified Source(s) of Funding: California Citrus Research Board

8:15–8:30 AM

A Reductionist Approach to the Study of Citrus Huanglongbing Disease

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Huanglongbing (HLB) is a citrus disease that has devastated the Florida citrus industry in the last decade. In addition to Florida, HLB is spreading throughout citrus in Texas. Although HLB was confirmed in California in a single residential tree (2012), there have been no additional confirmations of HLB in California;

however, the threat of HLB is serious. Huanglongbing develops in citrus trees infected with Candidatus Liberibacter asiaticus (CLas), a phloem-limited bacterium. The CLas lives in only two places, citrus phloem and the Asian citrus psyllid (ACP), its insect vector. Huanglongbing is an exceedingly challenging pathosystem to study, especially hindered by unique biological characteristics of host, pathogen and vector. To overcome some of the inherent complexities of HLB research we have taken a reductionist approach. We report here on an experiment that was conducted with the objective of determining the effect of duration of exposure to ACP on CLas infection and HLB disease development. Three hundred CLas negative 'Valencia' sweet orange grafted onto US 812 rootstock were placed into an ACP inclusionary greenhouse. At two-month intervals, groups of 60 plants were removed from the inclusionary greenhouse, treated with insecticide and then placed into an ACP exclusionary greenhouse. At the time of transfer away from ACP 2, 12, 18, 30, and 95 were CLas-positive following exposure to ACP for 2, 4, 6, 8, or 10 months, respectively. At eleven months after initiation of the experiment, 8%, 10%, 20%, 25%, and 37% of the plants were HLB-symptomatic for plants that had been exposed to ACP for 2, 4, 6, 8, or 10 months, respectively. CLas infection had pronounced impact on stem diameter and starch content in leaves and roots. Mean stem diameter 1 cm below the graft union was largest (11 mm) for plants that tested CLas-negative and smallest (7 mm) for plants when CLas titer reached 10^5 copies/100 ng nucleic acid. Starch content was low (1% to 2% dry wt) in leaves and roots of CLas-negative plants. In CLas-infected plants, leaf starch increased and root starch decreased as CLas titer in leaves increased. However, the CLas-induced decrease in root starch (ca. 50%) was low compared to the CLas-induced increase in leaf starch (1400%). Our results clearly demonstrate the value of a reductionist model for the study of HLB disease development.

8:30–8:45 AM

The Interaction Between Phytophthora spp. and *Candidatus* Liberibacter spp. Damage to Citrus Fibrous Roots

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Phytophthora nicotianae (*P.n.*) causes root rot of citrus, damaging the fibrous roots, which depletes carbohydrate reserves and reduces water and nutrient uptake capacity. Huanglongbing (HLB) is a systemic citrus disease that disrupts photosynthate transport, and is caused by phloem-limited *Candidatus* Liberibacter asiaticus (Las). High *P.n.* populations reported as HLB spreads though Florida indicate an interaction between these two pathogens on citrus root. To understand the possible interaction between these two pathogens and host, Cleopatra mandarin (*Citrus reticulata*) were inoculated with Las, *P.n.* or both in 2013 and 2014. The *P.n.* infection, Las movement within plant, root loss, and root exudation-sucrose were assayed. The *P.n.* infection increased on Las-infected seedlings, indicating that Las reduced their tolerance to *P.n.* The Las induced higher root exudation suggests that *P.n.* zoospore was more attracted to root surface by Las. Lower Las detection in Leaves when *P.n.* presented suggests Las movement was slightly influenced by *P.n.* The same pattern of *P.n.* infection and fibrous root biomass on Las positive seedlings through 5 to 11weeks after inoculation suggests that the interaction was regulated by available food supply. Both pathogens caused significant root loss alone, but in combination *P.n.* did not cause additional loss compared to the total root loss caused by Las alone at all harvest time. Based on these results, we hypothesize that: 1) early in disease development, Las increases susceptibility to *P.n.* infection by increasing zoospore attraction or facilitating penetration; 2) Las induces root loss resulting in a temporary drop in *P.n.* population by reducing available food supply; and 3) as new root flushes occur, Las moves to root with phloem sap, and *P.n.* starts the infection cycle again and repeats until there is a complete loss of the fibrous root system.

8:45–9:00 AM

Identifying Disease Resistant Pummelos for Citrus Improvement

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Citrus canker and Huanglongbing (HLB) remain scourges of the citrus industry. While citrus canker largely affects the physical appearance of the fruit, it blemishes the fruit such that it becomes unmarketable. Huanglongbing, or citrus greening disease, is lethal to trees in the long term, and while the tree is in decline produces malformed and bitter fruits. Genetic analyses of citrus have shown that the pummelo (*Citrus maxima* Burm.) is one of the ancestors of the grapefruit as well as other citrus varieties. Identifying a disease resistant variety of pummelo would be useful to breed new, disease resistant varieties of grapefruit or other citrus. Mature, seed grown pummelo trees were examined in the field for evidence of disease in groves where both citrus canker and HLB are present. Trees found to be symptom free of HLB and citrus canker were replicated and subjected to canker inoculation under greenhouse conditions, and in process for HLB positive psyllid inoculation. Identified disease resistant varieties are being used to generate new citrus varieties.

9:00–9:15 AM

Soil-Applied Controlled Release Fertilizer (CRF) Treatments Impact the Health and Growth of HLB-Infected Trees—Results from Greenhouse and Field Experiments

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Nutritional programs being used in Florida in efforts to maintain productivity from HLB-infected trees have been largely focused on foliar applications. Based on the overall improved performance of sweet orange trees on numerous rootstocks in an extensive field trial with trees being grown with ground-applied controlled release fertilizers (CRF), we conducted a one-year greenhouse study to investigate the effects of soil-applied macro- and micro-nutrient overdoses in CRF forms on HLB-infected trees of Valencia sweet orange on the somewhat tolerant rootstock UFR-3 (a "tetrazyg" hybrid of Nova+Hirado Buntan pummelo +Cleopatra+Argentine trifoliate orange). All trees received Harrell's Nursery CRF for base nutrition, except the liquid fertilizer control group. Micronutrient treatments were applied at a 3x concentration including the following: Tiger-Sul Zinc 18% (18% Zn, 65% S), Tiger-Sul Iron 22% (22% Fe, 55% S), Tiger-Sul Manganese 15% (15% Mn, 65% S), Tiger-Sul "Arnolds mix" (3.85% Fe, 7.50% Mn, 5.85% Zn, 63% S), Florikote Polymer Coated Sodium Borate (8.82% B), Florikote Polymer Coated Magnesium Sulfate (13.9%), Florikote Polymer Coated Triple Super Phosphate (40% P2O5), Florikote $FeSO_4$ Polymer Coated Ferrous Sulfate (28% Fe, 17% S) and BioChar from Southern Yellow Pine (97%). Macaronutrient treatments were applied at a 2x concentration including: Florikote Polymer Coated Mini Ammonium Sulfate (19% N), Florikote Polymer Coated Sulfate of Potash (47% K_2O) and Florikote Polymer Coated Urea (42% N). Treatments were applied at 0 and 6 months. After one year, trees were evaluated for overall health and appearance and growth, with special emphasis on comparisons of feeder root growth. Leaf midrib and root nutritional analyses, and RT-PCR to determine relative Liberibacter populations were also conducted. Results from the greenhouse study indicate that overdoses of micronutrients in the TigerSul (clay prill) form increase feeder root density, and thus overall tree growth. Manganese appears to be the most important micronutrient in this regard. The poly-coated sodium borate treatment also showed improved feeder root growth and tree health. There was an apparent synergy between the TigerSul products and the Harrell's CRF. Acidification of the root zone by the slow release of the sulfate could be increasing the efficiency of CRF nutrient uptake by the roots—leading to improved tree health. Results from field experiments supporting this hypothesis will also be discussed.

Specified Source(s) of Funding: Citrus Research and Development Foundation (CRDF)

9:15–9:30 AM

The Effect of Fruit on Floral Gene Expression in Alternate-bearing *Citrus reticulata* (Blanco)

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'Pixie' mandarin is alternate bearing. At spring bloom following the high yield on-crop, tree inflorescence number is markedly reduced, resulting in an off-crop. At return bloom following an off-crop, trees flower profusely and set an on-crop. In two separate years, the apical five buds from nonbearing shoots of off-crop and bearing shoots of on-crop 'Pixie' mandarin trees were collected from October through post-anthesis and the expression of key genes regulating floral development was determined using quantitative real-time PCR. Off-crop trees (20 and 5 kg/tree, years one and two, respectively) produced 4.8 and 4.7 inflorescences at the apical five buds of nonbearing shoots for the two years; whereas on-crop trees (236 and 184 kg/tree, years one and two, respectively) produced no inflorescences. Expression of *TERMINAL FLOWER 1* and *FLOWERING LOCUS C* was not influenced by crop load. *SUPPRESSOR OF OVEREXPRESSION OF CONSTANS 1* was expressed in buds from off- and on-crop trees from October to anthesis; expression continued post-anthesis for on-crop trees. *FLOWERING LOCUS T* was expressed from October to anthesis in buds from off-crop trees; *FT* was not expressed in buds from on-crop trees after November. In years one and two, maximum *LEAFY* expression for off-crop trees was in February and greater than on-crop trees ($P = 0.0424$), for which expression remained low post-anthesis. Similarly, in both years, for off-crop trees maximum expression of *SEPALLATA* occurred one month before anthesis and was greater than on-crop trees ($P < 0.0001$), for which low expression continued post-anthesis. For off-crop trees, *APETALA 1* and *APETALA 2* expression was greatest at one and two months before anthesis, respectively, and greater than on-crop trees ($P < 0.0001$ and $P = 0.0069$, respectively); expression continued for on-crop trees post-anthesis. For off-crop trees, *PISTILLATA* (*PI*) and *AGAMOUS* (*AG*) expression was not detected until two months before anthesis; for on-crop trees *PI* and *AG* were not expressed at this time or in subsequent months. Inhibition of *PI* and *AG* expression by the on-crop is not unique to 'Pixie'. In 'Nules' Clementine mandarin, *PI* and *AG* were expressed 1 month before anthesis in buds from nonbearing shoots of off-crop trees and not expressed in buds from bearing shoots of on-crop trees at this time or in later months. Inhibition of *FT* expression by the on-crop has been reported previously in alternate bearing citrus. This is the first report that the on-crop of citrus fruit inhibits expression of *PISTILLATA* and *AGAMOUS*.

An asterisk (*) following a name indicates the presenting author.

Friday, 7 August 2015

Floriculture 2

Moderator: Kedong Da
Institute for Advanced Learning and Research, Danville, VA; kda@ialr.org

8:00–8:15 AM

Light Intensity, Photoperiod, and Temperature Effects on Growth and Flowering of Red Firespike

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The effects of light intensity and temperature on flowering and growth characteristics of potted red firespike (*Odontonema strictum*) were examined in two experiments. In Experiment 1, plants were grown under 0%, 45%, or 65% shade under two photoperiod conditions; long-day (LD) and short-day (SD). Plants grown under 45% shade and LD were tallest at 35.9 cm while plants grown under 65% shade and SD were shortest at 22.8 cm. No shade and 45% shade in both LD and SD resulted in a greater number of inflorescences (9, 7, and 6, respectively). The first open flower was observed in the no shade control after 92 days. In Experiment 2, plants were grown in controlled environment chambers with constant temperature set points of 15 °C, 25 °C, and 35 °C and an irradiance of 150 μmol·m^{-2}·s^{-1} for nine hours/day. Plants grown in 25 °C had the greatest height (49.2 cm) and largest leaf area. Plants grown in 15 °C and 35 °C had 28% and 22% less leaf area, respectively. The average number of inflorescences in plants grown at 25 °C was 1.6 while no inflorescence development was observed in plants grown at 15 °C or 35 °C by termination of the experiment. There were no differences between plant growth index or branch numbers due to temperature.

Specified Source(s) of Funding: Mississippi State University

8:15–8:30 AM

The Effects of Photoperiod and Temperature on Growth and Flowering of *Clematis* ×*hybrida*

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Clematis is amongst the well-recognized flowering plants by the retail consumer; however, production has not traditionally fit into the vegetatively-propagated unrooted cutting market and standard greenhouse production systems. One reason is the relatively long, two-year production cycle from propagation to flowering. Experimentation was undertaken to understand the factors that influence shoot development, flowering and adventitious root formation of *Clematis* so that strategies could be developed to reduce the production time. The first experiment examined the effect of duration of cold treatment at 5 °C (0, 3, 6, or 9 weeks) followed by two photoperiods (9 or 16 hours) and on shoot growth and flowering of *Clematis* ×*hybrida* 'H.F. Young'. Plants grown without a cold treatment and a 9-hour photoperiod did not flower, while 100% of the plants within a treatment flowered only on plants that received 6 or 9 weeks of cold followed by a 16-hour photoperiod. Flower number per plant increased and time to flower decreased as both the duration of the cold treatment and the photoperiod increased. The second experiment examined the effect of temperature (21 °C or 26 °C) on shoot growth and flowering under long day photoperiods for *Clematis* ×*hybrida* 'H.F. Young'. Warmer temperatures resulted in decreased shoot number, flower number, and time to flower, while node number and stem length increased. Single-node cuttings were removed from the flowering shoots to determine the effect of the temperature provided to the growing shoots on the subsequent adventitious root formation of cuttings harvested from those temperature environments, however no effect on rooting was observed. Implications of these experiments for commercial production of *Clematis* will be discussed.

8:30–8:45 AM

Manipulation of Light Frequency by LEDs and Phalaenopsis Orchid Spike Growth

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Phalaenopsis orchids are currently the most popular potted plants in the United States. Production of these plants takes several years and requires an investment in order to efficiently produce these plants. As lighting sources transition to more efficient LED arrays, characterizing production potentials and optimal light conditions could allow for more aesthetically pleasing plants in a shorter time. Due to the different stages of production, LED lights are possible for use in both greenhouse as well as indoor controlled environment chambers. Thirty-nine Green Pixie FR 509 *Phalaenopsis* orchids were grown under Lumigrow LED bars consisting of varying percentages of red and blue light. Light intensity was 200 μmol·m^{-2}·s^{-1} in each treatment with temperatures constant between 22 °C and 23 °C. Treatments consisted of 0%, 10%, 20%, and 40% blue light in μmol·m^{-2}·s^{-1}. The amount of blue light resulted in different amounts of flowers on the inflorescence spike. In the treatment containing no blue light, plants appeared lighter in color and flowers opened in the longest amount of time. Overall spike length showed differences between treatments as well. The production time to first flowers differed significantly between treatments suggesting an optimal percentage of blue light around 10%. These differences were

An asterisk (*) following a name indicates the presenting author.

likely due to specific hormone and pigment production as a result of the blue light.

8:45–9:00 AM

Ethephon Drenches and Sprays for Height Control in Spring Bulbs

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Ethephon has long been used as a growth regulator for spring bulb production, and is commonly applied to daffodils and hyacinths as 1000–2000 mg/L sprays. Recently we showed efficacy of ethephon as a substrate drench in daffodil. Over the last three years, we have conducted numerous experiments to develop further information on ethephon as a substrate drench for spring bulb crops. These experiments have resulted in the following main conclusions that will be presented in detail: 1) ethephon substrate drenches are effective over a range of forcing temperatures that are used in the industry; 2) the height controlling response is related to dose received per pot, such that varying drench volumes and concentrations possible as long as a consistent dose (mg ethephon) is delivered per pot; 3) a continuum of application volumes from drench to heavy spray ("sprench") also gives similar results; and 4) within a rather wide range, a uniform final height is achieved with application dates varying from 1 to 10+ days in the greenhouse. In other words, plant height at treatment is not related to final height at flowering or at flower senescence, a rather unusual result. Surprisingly, given the well-known negative response of tulip bulbs to ethylene, ethephon drenches and sprays are proving effective for height control in tulip. Preliminary results showing the efficacy of ethephon in tulip will be presented.

9:00–9:15 AM

Cryopreservation of *Dendrobium* Orchid Varieties and the Potential for the Elimination of Cymbidium Mosaic Virus

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Cryopreservation offers an effective means of maintaining orchid germplasm with minimal space and time requirements once materials are prepared and frozen. These protocols have also been successfully used to eliminate crop viruses. Here, droplet-vitrification techniques were applied to *Dendrobium* orchid varieties to assess regeneration rates and the potential for the elimination of *Cymbidium mosaic virus*. Shoot tips 2–3 millimeters long were excised from in vitro orchid plantlets and precultured on a semi-solid 0.3 M sucrose media for three days. Excised materials were then placed in a loading solution (0.4 M sucrose + 2 M glycerol) for 20 minutes and then subjected to plant vitrification solution 2 (PVS2) (0.4 M sucrose + 30% glycerol + 15% ethylene glycol + 15% DMSO) for an additional 20 minutes at room temperature. Shoot tips were then suspended in PVS2 droplets on foil strips, plunged directly into liquid nitrogen, and held for one hour. After exposure to liquid nitrogen, foil strips containing shoot tips were transferred to an unloading solution (1.2 M sucrose) for 40 minutes, transferred to semi-solid media in petri dishes (2% sucrose) and placed in the dark for one week, moved to dim lighting for one week, and finally returned to normal lighting conditions. Droplet-vitrification was successfully applied to three *Dendrobium* varieties and assessed for use in virus elimination.

9:15–9:30 AM

Daylily Callus Induction and Plant Regeneration

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Hemerocallis (daylily) is an important plant deserving the attention of both molecular biologists and gardeners, and even foodies. The daylily has the potential to be a plant genetic model organism. A genetic model organism is an organism suitable for studying a specific trait, disease, or phenomenon. Several attributes of the genus are of great biological interest. These include the strict control of flower opening and, the precisely regulated floral death by a programmed cell death system. The self-incompatibility system in Hemerocallis is also noteworthy and deserves more attention. The genus is widely cultivated for food, medicinal value, and ornamental interest. We report a daylily in vitro callus culture regeneration system for the potential use in daylily molecular biology and breeding. The callus was induced from in vitro shoots in MS + BA 2mg/L medium; yellow, friable embryogenic callus were selected and maintained in BA reduced MS medium (BA 1-0.5 mg/L), and refreshed every four weeks; the regeneration of the plant occurred when embryogenic calluses were transferred to MS + BA 0.2 mg/L medium for four weeks. Random amplified polymorphic DNA (RAPD) analysis showed no somaclonal variation within two cycles of regeneration. Greenhouse flowering testing supported RAPD results.

9:30–9:45 AM

Leaf Culture Regeneration and Micropropagation of Rex Begonia

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Rex Begonia is a native plant to the humid tropical and wetlands of India. The first Rex Begonia arrived in England in 1856, and a Belgian commercial horticulturist crossed it with several other Begonia species to produce some exciting hybrids. Rex Begonias do bloom, but are not grown for their blooms, which pale in comparison to their spectacular leaves. Rex Begonias can be multiplied by seeds or vegetated naturally by rhizomes or leaf cuttings. For modern agriculture, a method for large scale multiplied artificially by minicuttings through in vitro technology is needed. We report a Rex Begonia leaf culture and micropropagation protocol potentially for commercial production. Immature leaf cuttings were surface-sterilized using 25% Clorox with two drops of Tween-20 and then cultured in the embryonic competent cell induction medium [Murashige and Skoog (MS) medium supplemented with 1 mg/L 2,4-Dichlorophenoxyacetic acid (2,4-D)] for seven days. They were then transferred to regeneration medium [Murashige and Skoog (MS) medium supplemented with 1–4 mg/L 6-Benzylaminopurine (BA)] and cultured in a dark tissue culture room for four weeks for shoot initiation and development. Ninety percent of explants regenerated new shoots; an average of 8 shoots were formed in a 1/2 cm^2 explant. Elongated shoots were transferred to MS medium with 1 g/L activated charcoal for three weeks and 100% of the shoots formed functional roots, which resulted in a 100% survival rate when acclimatized in coco coir plugs.

Friday, 7 August 2015

Local Food Systems

Moderator: Cindy Fake
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8:00–8:15 AM

Enhancing Local Food Security: A Holistic Approach

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Northern California benefits from some of the most diverse, productive agricultural land in the world. Yet, even in this region, not all residents have access to fresh fruits and vegetables. With that in mind, a diverse group representing different aspects of the local food system developed a project to enhance food security and support local specialty crop production. The Cultivating Community North Valley Project was designed to strengthen nutritional and agricultural literacy, the health and self-reliance of the community, and cooperatively enhance the region's farm-to-fork specialty crop economy. The project has employed a holistic model that addresses nutritional wellbeing from several angles—cooking demonstrations with a mobile kitchen, development and support of community gardens, and workshops on specialty crop production and processing. During the last three years, the project has sponsored over 100 workshops for over 1,000 participants, supported over 25 community gardens, and provided over 90 culinary demonstrations. In learning how to grow and cook with fresh specialty commodities, community members have been empowered to take responsibility for their health. The project has raised awareness of the value of local agriculture and the resources that support it. It has also engaged agriculture students in the local food system and enhanced their appreciation of the concept of civic agriculture in which food production is a part of the cultural fabric of the community.

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8:15–8:30 AM

County Food System Assessment and Postharvest Food Infrastructure Asset Mapping in New Mexico

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Increased interest in local and regional food markets has driven the expansion of the emerging discipline of food systems research; however, until recently, food systems have received little attention within the academic community. The overall goal of this project was to propose assessment criteria that can be used to evaluate the potential functionality of food systems at the county level, with possible scalability to regional or state levels. To achieve this goal, we qualitatively described and quantified selected local food system components in New Mexico. Through this work, we propose that local food systems are comprised of four essential components, without one, the system may be incomplete and unstable. These components include: 1) advocacy groups; 2) agricultural and horticultural production; 3) consumer demand and markets; and 4) infrastructure. This project quantified the postharvest horticultural infrastructure (PHFI), distribution routes, and advocacy organizations within three county food sheds in New Mexico. To visualize these selected components, an asset mapping effort was designed to aid with the assessment of New Mexico's PHFI. Counties for this study were originally selected based upon recent local food activity level, but a more

in-depth assessment was required. PHFI was defined as shared-use or publicly available cold storage facilities; food processing facilities; and other agricultural facilities for grading, storing, and packaging of horticultural products (primarily fresh produce). We categorized and quantified food related community groups, food policy councils, other support organizations, and distribution and transportation channels for horticultural commodities. To aid in post infrastructure identification and classification, the following methods were employed: i) communication with New Mexico State University (NMSU) extension agents and specialists, industry professionals, and other key informants via a system of feedback loop interviews; ii) the use of Internet based searches and directories; iii) ground truthing and verification of data elements identified; and iv) entry of geospatial data into a geodatabase, processing these data, and mapping key elements of the PHFI. Utilizing the four critical food system components, we developed a comprehensive post harvest asset map; a scalable county-level protocol to define and assess the local food system in New Mexico, with potential applicability across the United States; and a novel criterion tool to assess food system functionality. To the best of our knowledge, this assessment is the first of its nature on the topic, and the authors believe that it will have considerable utility to others interested in food systems research.

8:30–8:45 AM

Training the Next Generation of Farmers in the Sierra Nevada Foothills: Lessons Learned

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With an aging farm population and the loss of generational transfer of agricultural knowledge, training new farmers has become a critical need across the country. The University of California Cooperative Extension (UCCE) in Placer and Nevada Counties has developed extensive beginning farmer training over the last decade to meet the needs of a growing number of aspiring producers. A vibrant local food movement and increasing interest in small scale farming have driven the demand for beginning farmer training in the Sierra Nevada foothills. The UCCE Farm Advisors collaborate with local farmers to provide an array of workshops, field days, mentoring, and community-building programs to assist beginning farmers. This paper will report on the results of three surveys of training participants over the last decade and present strategies for developing this type of training. Lessons learned include the necessity of addressing the farm as a business; and building economic and marketing skills in addition to production skills. Training must be reality-based and focused on local conditions with examples from the agricultural community. A collaborative, participatory training approach helps develop realistic expectations and skills without dampening the enthusiasm of beginning farmers. Experienced local producers are an integral part of the training team and programs focus on building community among local farmers.

Specified Source(s) of Funding: USDA Risk Management Agency

8:45–9:00 AM

Initiating a Group GAP, Fresh Produce Safety Certification Program in Arizona

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The growing demand for local and regional food offers an unprecedented market opportunity for sustainable small and midsized farms and holds great promise for increasing the access to healthy and affordable food for those that experience limited access. Participation in the chain of supply demands that farms demonstrate effective compliance with complex, and, for the small grower, often expensive food safety practices that have evolved in response to public health challenges largely attributed to the industrial food supply chain. This requirement threatens to exclude the very farmers best suited to meet demand for local and regional food. Internationally, similar market access issues have been addressed most effectively through the development of a group food safety certification process in which a "recognized entity" maintains an internal quality management system designed to implement, monitor, and ultimately assure implementation of GAP (Good Agricultural Practices) among member farms. This system is then externally audited by a trusted third party to assure buyers that individual member farms are meeting their food safety requirements. The development and evolution of food hubs, innovative businesses whose role is to mediate between small- and mid-scale farmer needs and those of buyers, including larger institutional, retail, and food service buyers, has showcased the need for a similar approach here in the United States. One of the most important strategies to emerge from worldwide efforts to address market requirements for third-party GAP verification is the cooperative or "group approach" to food safety, based on the Quality Management System (QMS) methodology of ISO 9000, in which a group of farms develop shared quality standards and operating procedures and are audited as one body. A number of lessons learned will be outlined in a 2015 Group GAP certification process piloted in Arizona. Initial findings suggest that the overall collaboration of multiple entities, agencies, and stakeholders are needed to

support the development and implementation of a USDA AMS Group GAP certification.

9:00–9:15 AM

Approach and Accomplishments of Farm to Plate Programming in Florida's SNAP-Ed Program

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The University of Florida Institute of Food and Agricultural Sciences' (UF/IFAS) Farm to School, Farm to Community (F2SC) team was established in 2012, and since October 2014 has been funded by the UF/IFAS Extension Family Nutrition Program [Florida's Supplemental Nutrition Assistance Program—Education (SNAP-Ed)]. The team is tasked with increasing access to nutritious and fresh food and encouraging healthy eating behaviors among children and adults eligible for SNAP-Ed. The team includes five district F2SC coordinators, a statewide food systems coordinator, and a professional chef, who are all supported by state specialists and interact with several hundred staff and county agents throughout Florida. The F2SC team perceives several major challenges to a healthier population in Florida: 1) the number of citizens qualifying for SNAP-Ed is far greater than UF's resources to educate them; 2) even at a local level, food systems are culturally complex involving many individuals, companies, and partners, thus requiring significant investment to change practices including increasing the access to healthy foods and promoting healthy food choices; and 3) the state's increasingly urban population has limited opportunity to become aware of the science and culture of food. To address these challenges, the team facilitates conversations and meetings with school food service authorities, extension agents, farmers and ranchers, and market managers, to expand local food access in schools and communities. The F2SC team also interacts with school garden teachers, food service personnel, chefs, and other community partners to provide the environmental exposure needed to adopt healthy eating behaviors. The team provides support through school and community garden implementation and trainings that focus on experiential learning, curricula integration, and food production. In 2014, the F2SC team established or enhanced 78 school gardens, engaged 259 farmers, trained approximately 1200 participants, developed 300 recipes featuring fresh from Florida fruits and vegetables, conducted 30 taste tests, designed and debuted Florida Food Connect, an online platform that links farms to schools, conducted three statewide surveys and one statewide census of school gardens, and published one full-color 74-page *Guide to School Gardens* for teachers. The F2SC team relies on evaluation and monitoring activities led by three social scientists with expertise in program evaluation. Quantitative and qualitative methodologies are used to keep track of progress and assess the advancement towards project goals. Participants in F2SC activities have reported positive changes in knowledge, skills, attitudes, and behaviors related to healthy eating and access to specialty crops.

Specified Source(s) of Funding: USDA via Florida Dept. of Children and Families

9:15–9:30 AM

Specialty Crop Programming for Florida's Small Farms and Alternative Enterprises

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The Small Farms and Alternative Enterprises Extension Team at the University of Florida's Institute of Food and Agricultural Sciences (UF/IFAS) consists of state and county extension faculty who design and conduct programming for all of Florida's farmers who request support for enhancing their operation with new, alternative crops or novel methods of production, as well as to meet the emerging needs of the state's small farm industry. Nearly all of the state's 44,000 small farm operators utilize direct market channels for the sale of specialty crops. To maintain consumer confidence and solidify the role small farms have in Florida's local food system, a coordinated effort of educational programming was needed. For the past six years, the team has been supported for its specialty crop programming by Florida's Specialty Crop Block grant program. With approximately $450,000 in grant support to date, the team has focused on three major activities: conducting an annual statewide conference, designing and delivering a farm food safety education program, and implementing standardized evaluation methodology for these programs to capture progress over time. Over the past six years of the annual conference, the small farms team has educated 2664 unique individuals (nearly 4000 total attendees) on a variety of topics. The conference planning team has made every effort to include a researcher, a farmer, and an industry representative to collaborate and lead each educational session. Hands-on

intensive workshops, farm tours, social networking events and 70–90 allied-industry exhibits a year have contributed to the event's success. Participants agree the conference is a valuable event; > 90% report they were satisfied/highly satisfied, > 70% report knowledge gain and over 60% intend to or already have adapted a practice learned at the conference. Small farms food safety programming occurs throughout the year and is designed to prepare farmers to pass an independent, third-party audit. Farmers take home an editable farm food safety plan that they can begin to implement immediately. In 2014 alone, 114 specialty crop farm participants attended seven food safety trainings (a total of 52 hours), and each specialty crop farm received a resource toolkit. Attendees were satisfied or very satisfied with the overall quality of the training received (98%), and 99% would recommend this training to other farmers. Key outcomes include increased social capital among small farms industry participants and an increase in the number farmers who are compliant with state and federal food safety standards.

Specified Source(s) of Funding: Florida Department of Agriculture and Consumer Services Specialty Crop Block Grant

9:30–9:45 AM

Heirloom Dry Beans (*Phaseolus vulgaris*) in Northwest Washington

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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 (heirloom and/or colored-patterned beans), which are sold at local markets for $6 to $14 per pound. Small-scale growers have been successfully growing dry beans in northwest Washington for over 100 years. The objective for this study was to compare heirloom dry bean varieties that have been grown in northwest Washington (NW) from 20 to 130 years with standard varieties (seed grown outside the region) to determine which are more productive in the region. In May 2013, 14 NW heirloom and 11 standard dry bean varieties were planted in a replicated field trial at WSU Mount Vernon NWREC. In 2014, 17 NW heirloom and 20 standard varieties were planted. Mean days to harvest (DTH) differed significantly between heirloom (110 DTH) and standard (113 DTH) varieties ($P = 0.003$), but did not differ between years ($P = 0.58$). Of the heirloom varieties, two were among the earliest maturing both years, Rockwell and Decker. Overall mean yield of heirloom (1852 kg·ha^{-1}) and standard (1982 kg·ha^{-1}) varieties did not differ ($P = 0.22$), but there was a significant difference between years ($P < 0.0001$). Mean yield of heirloom varieties was 2240 kg·ha^{-1} in 2013 and 1550 kg·ha^{-1} in 2014, and mean yield of standard varieties was 2040 kg·ha^{-1} in 2013 and 1686 kg·ha^{-1} in 2014. This study demonstrates that dry beans are a productive crop in northwest Washington and regional heirlooms are an option. Growers in northwest Washington would benefit most from dry bean varieties that are early to mature as the onset of rains by late Sept. makes harvest difficult. Future studies should examine yield of early maturing varieties, with a focus on colored/patterned beans that are attractive for local direct markets.

Friday, 7 August 2015

Vegetable Crops Management 3

Moderator: Gordon C. Johnson
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8:00–8:15 AM

Quantifying the Impact of Low-temperature Exposure on Cauliflower Head Initiation

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Planning a harvest schedule for some cauliflower cultivars is a complex task because they require exposure to temperatures below 15 °C for the production of their inflorescences. However, it is not clearly understood when and how long this exposure at such low temperatures should occur during the course of their phenological development. The objective of this study was to determine the phenological stage of cauliflower at which the juvenile phase is completed and the crop begins to be sensitive to low temperatures. According to information available in the literature, a temperature of 10 °C seems to be the optimum temperature for this vernalisation process. In order to determine the end of the juvenile phase, 84 cauliflower seedlings (cultivar Casper) were produced in greenhouse and exposed to a temperature of 10 °C during 14 days in growth chambers beginning at the 3, 5, 7, 9, 11, and 13 leaf stages. In the greenhouse, the temperature was set at 22 °C during the day (16 hours) and at 18 °C during the night (8 hours). The phenological stage of each plant was evaluated at least twice a week in the greenhouse and in growth chambers. Plant height and head diameter were measured once and twice a week, respectively. Compared to the control treatment, exposure at the 3-leaf stage delayed head initiation and exposures at 5 to 13 leaf stages promoted head initiation. Based on these results, a second experiment was established to determine the mini-

mum exposition time required for promoting head initiation. Again, 84 cauliflower seedlings were produced in greenhouse and exposed at the 9-leaf stage to a temperature of 10 °C during 2, 4, 6, 8, 10, and 12 days in growth chambers. The results suggest that an exposure of 4 days is sufficient to promote head initiation at 10 °C. An exposure of 2 days also accelerates the head initiation but the effect is smaller than the other exposures. Such information will be integrated in a weather based dynamic phenology model in order to assist vegetable producers to improve their field planning of cauliflower planting and harvest.

8:15–8:30 AM

Summer Cover Crop and Plant Back Timing Effects on Fall Cabbage Production

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Farmers across the state of Iowa have expressed interest in more sustainable practices to supply nutrients, suppress weeds, and boost yield in vegetable production. This study conducted at the Horticulture Research Station, Ames, IA, investigated the effect of: buckwheat, cowpea, oats, and sorghum-sudangrass cover crops on soil chemical and biological properties and cabbage (*Brassica oleracea* L. 'Caraflex') yield. A no-cover crop plot was established as a control treatment. The study was a split plot design with cover crops as the whole plot factor and transplanting date as the subplot factor (planting immediately after cover crop termination or eight days later). Data was collected on: cover crop biomass, nitrate leaching, leaf chlorophyll concentration, yield characteristics, and soil microbial biomass carbon. Cover crop biomass in 2013 ranged from 5388 $kg \cdot ha^{-1}$ in sorghum-sudangrass to 2961 $kg \cdot ha^{-1}$ in cowpea. In 2014 cover crop biomass was lower with the amounts ranging from 2575 $kg \cdot ha^{-1}$ in sorghum-sudangrass to 1,160 $kg \cdot ha^{-1}$ in cowpea. Nitrate leaching was measured below the rooting zone using lysimeters. In both years cowpea had one of the highest readings for nitrate loss indicating more nitrate was available to the crop as compared to other cover crop treatments. Between the other four treatments data was inconclusive as to any relationship between them. Chlorophyll content of the cabbage had a significant interaction between the cover crop treatments and planting date in 2014 only. Chlorophyll content was highest in both years with the early planted cowpea treatment. There were no measureable differences in soil microbial biomass between any of the treatments in both years. Marketable cabbage yield for 2013 was significant between cover crops, planting date, and interactions. In 2014 cabbage yield was significant only between treatments. The highest yields in both years were in the early planted cowpea and late planted cowpea. Marketable head count followed the same significance patterns between treatment, planting date, and the interaction between treatments and planting date as the marketable yield.

8:30–8:45 AM

Rowcover Modifies Microclimatic Conditions and Increased Cilantro Yield in Virginia

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Cilantro is grown in Virginia by small farmers for its value as a fresh herb in local markets and is part of their diversified production system. To extend production into the winter, cilantro was grown under rowcover at the Eastern Shore Agricultural Research and Extension Center, Painter, VA, to associate growth with modified microclimatic conditions. Cultivars 'Calypso', 'Leisure', 'Marino', 'Santo', and 'Turbo' were sown in 19 Sept. 2014. After emergence and weeding, spun-bonded rowcover was installed as a low tunnel over metal hoops in 25 Oct. 2014. Rowcover was not removed until harvest in 19 Dec. 2014, after light freezing events had occurred in the area. Plants that were under the rowcover were still green without symptoms of cold stress in contrast to the uncovered plots that showed leaf reddening in response to freezing temperatures and wind. Differences in temperature, wind chill, evapotranspiration, and soil moisture were recorded between plots with rowcover and without. Yield of harvested foliage under the rowcover averaged 12 ton/acre, 56% higher than without cover. Yield of 'Calypso' was less than all other cultivars when grown without rowcover. There were no differences among 'Leisure', 'Marino', 'Santo', and 'Turbo'. Under rowcover, the yield of 'Marino' was larger than the other cultivars, which were no different among them. In conclusion, spun-bonded rowcover modifies microclimatic conditions and protect against wind and light freezes resulting in improved growing conditions. Therefore, it can increase production and extend the harvest season of cilantro with acceptable quality well into the winter. Among cultivars, 'Calypso' underperformed without rowcover in this study. In contrast, 'Marino' performed better than the other cultivars under the rowcover, but not without rowcover.

8:45–9:00 AM

Growth and Yield of Sequentially Transplanted Lettuce in an Organically Managed High Tunnel

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The use of high tunnels is becoming an integral part of extended and out-of-season vegetable production. Lettuce is one of the vegetable species that can be grown profitably in high tunnels but the ideal time of planting in North Carolina (headiness zone 7b) has not been studied. The objective was to identify the appropriate planting time of head lettuce for winter/spring and fall/winter production seasons in high tunnels. Organic lettuce varieties Nancy, Spretnak, and Rhazes were seeded in a greenhouse and transplanted into a 30' x 96' Quonset high tunnel at three sequential dates (TD1, TD2 and TD3) in spring and again in Fall 2014. The three transplanting dates were 27 February, 11 March, and 20 March in spring; and 17 October, 27 October, and 6 November in fall. The experiment was conducted as a completely randomized block design with three replications, 30 plants per replication. Lettuce heads were harvested at marketable mini head size. Microclimate data were measured with Spectrum WatchDog inside and outside the high tunnel. In the spring season, the number of days from transplanting to the first harvest for TD1 (44.1) was significantly higher than that for TD2 (35.6) or TD3 (35.1). For the fall production cycle, days to harvest after transplanting was 44.7 days for TD1, 43.3 days for TD2, and 45 days for TD3. The highest head weight was TD2 for 'Nancy' and 'Rhazes' (0.13 kg and 0.12 kg, respectively) and TD3 for 'Spretnak' (0.11 kg) in the spring season; while in the fall season it was TD1 for all varieties, which was 0.15 kg for 'Nancy', 0.10 kg for 'Rhazes', and 0.16 kg for 'Spretnak'. Our results suggest that TD2 may be appropriate for spring production to catch early market and TD3 be ideal for fall production to catch late market. Calculation from growing-degree-days at 4.4 °C base temperature supports this preliminary conclusion. This study will be replicated in 2015 to draw more comprehensive conclusions.

Specified Source(s) of Funding: Specialty Crop Block Grant

9:00–9:15 AM

Optimizing Processing Sweet Corn Production on the Delmarva Region of the Mid-Atlantic

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Five supersweet (sh2) processing sweet corn varieties were tested at populations of 120%, 100%, 80%, 60%, and 40% of standard population (57,400 plants/ha). Two trials were planted with the same treatments; one on 20 April 2012, and one on 16 May 2012, and data was collected yield in terms of ears per acre, weight of unhusked ears per acre, and cut corn yield. 'Overland' and GSS 1453 were able to compensate for stand loss in terms of tonnage and, even more so, in terms of cut corn yield—even with population densities that were 40% of standard planting density. Of these two varieties, Overland had higher overall yields in the trials. 'SS Jubilee Plus' also compensated well for reduced stand. 'Protégé' compensated for stand loss up to 60% of standard population density, but produced significantly lower yields in terms of cut corn and tonnage at 40% of standard population density. GSS 2259P did not compensate for stand loss effectively and produced its highest yields in terms of tonnage and cut corn at 120% of the standard population density (68,900 plants/ha), which suggests that it should be planted at a higher density to obtain maximum yield. Reduced stands did not significantly affect time to maturity of the varieties tested. In another study on gaps in stands, there were no differences in yield between evenly reduced stands and those with irregularly spaced gaps with lengths of up to 2 m. Based on the results of these experiments, yield loss from stand reduction can be estimated based solely on plant population density, without consideration for unevenness in spacing if gap sizes are less than 2 m. Processing sweet corn nitrogen rate studies in 2012 and 2013 showed that yield was maximized at 196 kg/ha N and maximum economic yield was at 168 kg/ha N. In 2014 the maximum economic yield was found at 224 kg/ha N. Tillage studies from 2012–14 showed that early spring planting (April) sh2 processing sweet corn varieties were best adapted to conventional tillage when compared to vertical tillage or no-till. An average yield reductions of 18% was found in no-till compared to conventional tillage when planted after a winter-killed forage radish cover crop. July planted sweet corn planted after wheat was equivalent across all tillage treatments: no-till, strip till, vertical till, and conventional till in 2012 and 2013. In 2014, conventional treatments yielded significantly higher than the other tillage treatments.

9:15–9:30 AM

Response of Onion Yield, Grade, and Financial Return to Plant Population and Irrigation System

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Onion plant population is an important factor in total yield and bulb size, both of which can influence economic return to growers. Different onion bulb marketing opportunities influence the plant populations that growers should target. With the transition from furrow irrigation to drip irrigation system, growers have doubts as to the onion population that should be planted to assure favorable economic outcomes. Onions were grown on silt loam at the Oregon State University Malheur Experiment Station, Ontario, OR, in 2011 and 2012 following wheat each year. Vaquero, Esteem, Barbaro, and Sedona varieties were planted heavily and thinned to five nominal populations of 222,000 to 593,000 plants/ha under furrow irrigation, subsurface drip irrigation, and "intense bed" subsurface drip irrigation. The intense

bed configuration had 50% more rows of onions with three drip tapes per bed instead of two tapes. The experiment had a randomized complete-block split-split plot design with 6 replicates. Irrigation systems were the main plots, varieties the split plots, and plant populations the split-split plots. Onion yield and grade responses to plant population for each variety and each planting system were determined by regression of yield and grade on the actual onion plant stands. In general there were few differences between irrigation systems or interactions between irrigations systems, varieties, and plant populations. Averaging over varieties, total and marketable bulb yield out of storage increased with plant population, while the bulb diameters decreased with plant population. Average marketable yield averaged 119 Mg/ha both years. Average marketable bulbs > 10.2 cm in diameter decreased with plant population. In 2011 estimated economic return increased linearly with plant population. In 2012 estimated economic return responded quadratically to plant population with maximum return at 419,000 plants/ha.Esteem

9:30–9:45 AM

The Effect of Different Light Levels on the Growth and Production of Chili Pepper and Tomato Plants

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Extreme weather conditions can have a detrimental effect on plant growth and development. Partial shade might help plant growth and production by alleviating the negative effects of excess light and heat. To investigate the effect of different light levels on plant growth and production, 'Sweet Banana' chili pepper and 'Celebrity' tomato plants were transplanted in raised beds in late April 2014, El Paso, TX. Two weeks later, shade cloth at 50% and 70% of light exclusion were installed to provide three light treatments: full sunlight, 50% sunlight, and 30% sunlight. Field plots under full sun had 9.7% and 16% less soil water moisture and 2.4 °C and 3.0 °C higher soil temperature than those under 50% and 30% sunlight, respectively. Leaf temperature in the afternoon was similar among all treatments in both June and July. In August, chili pepper plants under full sun had 2.1 °C and 4.3 °C higher leaf temperature than those under 50% and 30% sunlight, respectively, whereas tomato plants under full sun had 1.4 °C and 1.2 °C higher leaf temperature than those under 50% and 30% sunlight, respectively. Chlorophyll fluorescence indicated that plants of both crops under full sun were more stressed. Both chili pepper and tomato plants under full sun were shorter and smaller than those under 50% and 30% sunlight. Chili pepper plants grown under full sun produced 62% and 115% more number of marketable fruits and had 17% and 67% higher yields than those under 50% and 30% sunlight, respectively. Tomato plants grown full sun produced 21% and 216% more number of marketable fruits than those under 50% and 30% sunlight, respectively. The yield of tomato plants grown under full sun was 26% less than those grown under 50% sunlight, but 107% higher than those grown under 30% sunlight. However, the yield for chili pepper and tomato plants grown under full sun and 50% sunlight was not statistically different. In summary, shade cloth at 50% or 70% of light exclusion could alleviate the high light and temperature stress to some extent for chili pepper and tomato plants. However, shade cloth at 50% of light exclusion tended to reduce the yield of chili pepper plants while 70% shade significantly reduced the yield of chili pepper and tomato plants. Further research is needed to confirm if a shading percentage less than 50% would help reduce the light and heat stress without reducing yield for both crops.

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Friday, 7 August 2015

Computer Applications in Horticulture/ Teaching Methods

Moderator: Shaun Broderick
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9:15–9:30 AM

Introducing NRSP10: Database Infrastructure for Specialty Crops

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National Research Support Project 10 (NRSP10, www.nrsp10.org) "National Database Resources for Crop Genomics, Genetics and Breeding Research" is a newly funded, five-year project aimed at providing standardized database and informatics resources for undeserved or specialty crops such as tree fruit, nuts, and berries. It builds on existing database resources developed for Rosaceae (Genome Database for Rosaceae, www.rosaceae.org), citrus (Citrus Genome Database, www.citrusgenomedb.org), *Vaccinium* (Genome Database for *Vaccinium*, www.vaccinium.org), cool season food legumes (Cool Season Food Legume Genome Database, www.csfl.org) and cotton (CottonGen, www.cottongen.org). Developed using Tripal, an open-source, modular, well supported platform, these community databases provide centralized access to integrated genomic, genetic and breeding data and analysis tools for 24 crops representing a combined annual production value of over $25 B. In this

presentation we will describe plans and progress to develop and implement additional core infrastructure activities for use in breeding, gene/genome curation, and enabling field and lab-collection and upload of phenotypic data directly into databases via mobile devices as well as developing seamless database-to-database access functionality. Use cases will demonstrate the value of these resources to basic, translational and applied specialty crop research and highlight how these resources can be easily implemented for other horticultural project or community databases.

9:30–9:45 AM

Ten Tips on Capturing Great Aerial Field Imagery using GoPro Mounted UAVs

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As agricultural technologies expand toward the use of Unmanned Aerial Vehicles (UAVs) for aerial image capture, users have a need for resources that guide first-time pilots critical tips for making superior images. The GoPro camera appears to be the camera of choice when using a UAV platform since it is relatively inexpensive, lightweight, and reliably shoots incredibly high-quality footage/stills. When using a DJI Phantom with a GoPro Hero 4 camera mounted on a 2D axis gimbal, we recommend the following guidelines. 1) Shoot in 4K whenever possible, which will provide the highest quality and the most flexibility. 2) Time-lapse settings at 5 seconds are particularly useful when aligning and stitching the image during postprocessing. 3) Adjust the field of view to as narrow (1080p, 90° field of view) as possible, to minimize the "fisheye" appearance of images. 4) To minimize "jello-effects" caused by motor vibration, we recommend using a Neutral Density filter lens to drastically reduces the shutter speed while allowing enough light for a clear picture. 5) For color settings, we use the 'flat' setting since it provides the most flexibility during post processing. 6) The speed of the UAV during imaging can be a significant factor in image quality and camera movement should be minimal and remain steady and slow. 7) Plan ahead: think of where shots will start and finish to minimize unnecessary battery drain. 8) Some platforms employ autonomous or manual flight modes. The benefit of flying autonomously is the ability to control the speed and altitude of the UAV in a very repeatable way. In manual mode, control of altitude and speed is user defined during each individual mission. 9) Altitude: flying the drone to a high altitude will enable it to photograph a greater portion of a field, while at lower altitudes will allow more detail. 10) Speed is also a factor when capturing field images. Flying too fast, will exclude parts of a field, too slow will generate too many overlapping pictures. Drone technology is growing every year and applications for this technology are increasing. The use of drone imagery in agriculture will help the producers to diagnose, analyze and develop a plan of action to remedy any situation at a low cost to them.

9:45–10:00 AM

GenSAS: An Easy-to-Use, Web-Based Solution for Specialty Crop Genome Annotation

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As a result of reduced sequencing costs and increased federal funding to support specialty crop research, many horticultural crop genomes are in the process of being sequenced. Obtaining sequence data is relatively easy compared to determining the biological function encoded by the DNA or RNA sequence. In order for the sequence to be meaningful for researchers, structural and functional annotation needs to be performed to identify gene models and protein functions, respectively. The Genome Sequence Annotation Server (GenSAS) is a web-based annotation platform that packages command line annotation tools under one easy-to-use interface. The GenSAS walks researchers through each step of the annotation process and provides instructions and hints as each step progresses. These steps include: uploading of genomic sequence; uploading of supportive repeat library files, species-specific (or species-related) protein and transcript files; execution of repeat masking tools (including de novo repeat identification); execution of gene prediction tools; consensus gene prediction; manual structural annotation editing; functional annotation; and assistance with organization of files for final publication. The GenSAS is integrated with the popular JBrowse genome browser for feature visualization, and manual curation of structure and function is provided by an integrated Web Apollo interface. The Genome Sequence Annotation Server was designed with researchers as the target user group and based on feedback, is an easy-to-use, customizable, online DNA annotation pipeline that allows users with little computer science knowledge to create a custom DNA annotation for their sequence(s) of interest.

Specified Source(s) of Funding: NIFA, NRSP10

An asterisk (*) following a name indicates the presenting author.

10:00–10:15 AM

Making Plant Trial Data Accessible through a Trialing Website

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The horticultural industry releases hundreds of new plant varieties annually. These new releases often have improved garden performance or novel physical characteristics, such as flower color. However, not all plant introductions will thrive in all geographic regions and must be trialed regionally. Since 2001, trials of annual, and some perennial, bedding plants have been conducted at the Mississippi State University, Truck Crops Branch Experiment Station in Crystal Springs, MS. This region exposes plants to warm, humid weather with typical summer temperature highs of approximately 34 °C and 95% relative humidity. A goal of the trial gardens has been to evaluate plant performance, taking into consideration floral display, plant vigor, leaf health, and disease or insect resistance. Not only is it important to evaluate plant material, but to increase the awareness of top performing cultivars, which generates regional consumer demand of winning varieties. To disseminate performance data, we developed an online plant trialing database (blogs.msucares.com/ornamentals). Improved website-design software have simplified this process and made it more accessible to a broader clientele. This website allows plant suppliers, producers, developers, landscapers, breeders, Master Gardeners, and homeowners to access plant performance results in real-time, and plant growth can be visualized over a season through progressive photographs. From this information, they can identify plant material that is suitable for their individual application. Growers can utilize this website to aid in plant selection to potentially boost sales. Plant breeders can use this data to identify weaknesses in specific plant material and guide future breeding work. This process of increasing demand for top performing plant material and guiding the selection of plant material for production should result in higher revenue for growers and increased chances for successful garden performance by the end user.

Specified Source(s) of Funding: USDA National Institute of Food and Agriculture

10:15–10:30 AM

Designing a Departmental Badging System to Enhance Program Assessment for the Benefit of Students

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New forms of feedback and alternative credentialing are among the most innovative and beneficial developments in learning technology. Badging is one promising technology for responding to increased expectations from accreditation bodies, politicians, and the public to demonstrate student learning and progress toward degrees, as well as transparency of program effectiveness toward learning. Badging is a cutting edge educational tool, which faculty and administrators will need to understand soon. Our project at Ohio State University is a pilot for the deployment of badges. It combines: a manageable-sized department, whose faculty have expressed support for the pilot; advanced administrative preparation to align the system of badges with existing assessments and a project lead who combines a key departmental administrative role with technological expertise. The work of selecting courses in the major and mapping key assignments to departmental learning objectives has been completed and forms the basis for the Program Assessment of our two majors. In addition, designing and awarding badges based upon course assignments is currently underway in two courses taught by Dr. Rhodus. His final project presentation for HCS 4560 and ePortfolio assignment for HCS 5601 are used to evaluate the Communication and Life-long Learning goals. Through this work, a suitable online system for awarding and managing badges has been identified, and lessons have been learned about enhancing the motivational impact of badges. This leaves us with the next job of creating the department-wide badging system. Using open source software from Mozilla, we will set up an online system that supports key badging functions: creating, awarding, and displaying badges. In the first year, we will create approximately 40 different badges for our two majors. These badges will range from freshman to capstone courses and cover lab experiments to electronic portfolios.

10:30–10:45 AM

Teaching Undergraduate Turf Science as an Online Course: Student and Instructor Perspectives

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There is increasing demand for online courses in many collegiate curricular areas, including horticulture. To augment the transitioning of traditional lecture-only courses to online format, we have attempted to provide experiential learning along with the online activities. At Missouri State University, we offer undergraduate turf science as an online course, but combine it with experiential learning through required group or self-arranged turf management site visits. The course format includes lecture PowerPoint presentations, outside readings, online discussions, written assignments, and tests delivered through Blackboard (an online course delivery and management system). This is combined with the requirement of four field trip activities over the course of the semester. The instructor sets up five local/regional field trips for students in the area, plus assists distance students in setting up their own field trips near their home institution. Information on the benefits and disadvantages

of online delivery from the instructor's standpoint, along with student feedback on the format will be presented.

Friday, 7 August 2015

Environmental Stress Physiology

Moderator: Alexander Litvin
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10:15–10:30 AM

Abscisic Acid Induces Leaf Age-dependent Chlorosis by Limiting Nitrogen Distribution to Mature Leaves in Arabidopsis

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Abscisic acid (ABA) is involved in leaf senescence under water stress. The senescing effect is generally attributed to the up-regulation of hydrolytic enzymes involved in chlorophyll breakdown or the stimulation of ethylene production. Here, we propose a new mechanism for the ABA-induced senescence, in which preferential nitrogen (N) distribution is involved. Arabidopsis (*Arabidopsis thaliana*) plants were treated with 0, 0.1, or 1 mM ABA at the rosette stage with 7–8 leaves. The magnitude of chlorosis was pronounced with ABA concentration and leaf maturity; 1 mM ABA reduced leaf chlorophyll index (SPAD reading) of the first (oldest) leaf by 44% within 24 hours of treatment and by up to 78% thereafter, whereas neither 0.1 nor 1 mM ABA induced chlorosis on leaves younger than the third leaf. As opposed to the general assumption, ethylene stimulation by ABA was not observed regardless of leaf maturity. Uptake and distribution of N were traced using ^{15}N-labeled KNO_3 added to the growth medium immediately after ABA treatment. Similarly to the chlorophyll data, leaf N concentration was reduced by ABA only in the first leaf. Isotopic analysis of ^{15}N revealed that this N loss was due to the reduced distribution of newly absorbed N. These results suggest that ABA accumulation limits distribution of N into non-growing mature leaves, thereby inducing leaf-age dependent chlorosis. This preferential N distribution may be a stress adaptation mechanism to conserve nutrients for new growth.

Specified Source(s) of Funding: Valent BioSciences Corp.

10:30–10:45 AM

Transcriptome Analysis of *Petunia* ×*hybrida* under Water Stress Using RNA Sequencing

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Water deficit is a major environmental constraint to plant growth and development resulting in severe crop loss. While physiological and molecular experiments using individual genes have been extensively studied in various crops with regard to water stress tolerance, genome-wide understanding of water stress response in bedding plants is still limited. The objective of this research was to perform RNA sequencing and analyze transcriptome of *Petunia* ×*hybrida* 'Mitchell Diploid' under water stress. Nine-week-old petunias were irrigated daily or placed under water stress by withholding water. Leaf tissue samples were collected 1, 3, and 5 days after water was withheld. Gene expression profiling under water stress were examined using RNA sequencing. Nearly 170 million reads were sequenced by Illumina Hiseq 1500, and de novo assembly using Trinity software generated 58,628 contigs. Among all contigs, 179, 3370, and 1064 were upregulated and 84, 2416, and 250 were downregulated on day 1, 3, and 5, respectively. Gene Ontology (GO) annotation was carried out by Blast2GO. Among differentially expressed genes, genes encoding regulatory proteins such as signaling factors and transcription factors were differentially expressed at the early stage of water stress. The transcriptome data from this research will provide valuable genetic information for understanding water stress-responsive networks as well as engineering petunia with enhanced water stress tolerance.

10:45–11:00 AM

Drought Stress Reduces Stem Elongation and Down-regulates Gibberellin Biosynthesis in Tomatoes during Vegetative Growth

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Drought stress can reduce whole plant and cell elongation. Since gibberellins play an important role in controlling cell elongation, our objective was to quantify the effects of drought stress on elongation and gibberellin homeostasis. We exposed 'Moneymaker' tomatoes to drought stress to observe the effect on internode elongation and gibberellin metabolism- and signaling-related gene expression. Plants were grown from seed in 15-cm pots filled with a peat–perlite substrate in a greenhouse for 25 days. Irrigation was automated using a datalogger, which maintained substrate moisture levels of 35% and 15% (v/v) for well watered and drought stressed conditions, respectively. Drought stress reduced total plant height ($P = 0.0203$), internode length ($P < 0.0001$), and cell size ($P = 0.002$) compared to well-watered conditions. To further investigate the effect of gibberellins on

elongation, paclobutrazol was applied as a second treatment level to reduce gibberellin biosynthesis. We analyzed the transcription levels of *SlGA20ox1*, *-2*, *-3*, and *-4*, *SlGA3ox2*, and *SlGA2ox2*, *-4*, and *-5*, genes coding for enzymes catalyzing later steps of gibberellin biosynthesis. Transcript levels of *LeEXP1*, and *-2*, encoding for expansins related to the loosening of the cell wall necessary for cell expansion, was also analyzed. Down regulation of transcript levels due to drought stress was observed for *SlGA20ox4*, *SlGA2ox5*, and *LeEXP1*, but not for any of the other genes. Paclobutrazol upregulated the expression levels of *SlGA20ox1*, and *-3*, and *SlGA3ox2*. Application of paclobutrazol reduced elongation and the up-regulation of these genes suggests altered regulation of gibberellin biosynthesis to compensate for their lowered production. These findings emphasize the inhibiting effect drought can have on elongation and gibberellin metabolism during vegetative growth. Understanding the impact of drought stress on plant growth may help growers better plan for water shortage periods.

11:00–11:15 AM

Response of Water-stressed Young Peach Trees to Foliar Applications of Ascorbic Acid

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Limited water availability is a concern for fruit tree growers and nurseries in many regions in many part of the world In recent years, the exogenous (foliarly spray) application of biochemicals or natural chemicals has been proved to increase water stress tolerance in several crops. The effect of exogenous foliar applications of ascorbic acid (AA) on gas exchange, water relations, and chlorophyll fluorescence was assessed in one-year-old peach trees in order to confer resistance to water stress. Trees were grown under two water conditions: water-stressed trees and well-watered trees (control; watered to field capacity every three days). Two cultivars, Scarletprince and Carotiger, grafted onto Guardian™ rootstock were used. Ascorbic acid at 250 ppm concentration was tested. Five treatments were applied: 1) control without AA spray application (untreated control); 2) control with AA; 3) water-stressed trees without spray application; 4) water-stressed trees treated with AA only once (this application was done when soil volumetric water content in the pots of water-stressed trees fell below 50% of the values observed in the control trees); and 5) water-stress trees treated with AA twice (trees received the same application as treatment four plus another application one week later). All trees were watered to field capacity two weeks after the first application. Responses after AA application were different in each cultivar. Ascorbic acid increased CO_2 assimilation and stomatal conductance in water-stressed 'Scarletprince' trees that received only one spray application. A second application did not improve gas exchange parameters in 'Scarletprince' trees. Nevertheless, all sprayed 'Scarletprince' trees had CO_2 assimilation and stomatal conductance similar to control trees upon rewatering, but water-stressed trees that had not received AA did not recover photosynthetical functions. Also, stem water potential in AA-sprayed water-stressed 'Scarletprince' trees was similar to control trees whereas non-sprayed water-stressed trees had significantly lower values than control trees. On the other hand, gas exchange parameters were not affected by the AA treatments in 'Carotiger' during the water stress period but their performance after rewatering was better than the trees that were not AA sprayed. Neither water stress nor the ascorbic acid treatments affected the efficiency of photosynthetic apparatus based on chlorophyll fluorescence measurements in any of the cultivars. In summary, these initial results indicate that exogenous applications of AA could be used as a friendly environmental management tool for trees to cope with suboptimal water conditions.

Specified Source(s) of Funding: INIA grant 2011

Friday, 7 August 2015

Federal and International Programs

Moderator: Mathieu Ngouajio
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10:15– 10:30 AM

Promoting Horticulture: A National Initiative

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The Promotion of Horticulture Initiative began in 2013 with Longwood Gardens and ASHS. Additional collaborators include APGA, NJHA, AmericanHort, and AHS. Overwhelming support for the need to change the perception of horticulture has been received from universities, horticulture associations, public gardens, media, and industry. We agree on the following issues. 1) Horticulture industry, government, and academia need educated, well-trained employees. 2) Student numbers are declining in many academic programs. 3) Leaders are the lifeblood of the industry—who will be our next leaders? 4) Identity of horticulture

is eroding—plant science versus horticulture—do names affect enrollment? 5) Reduced contact with plants as kids grow up. 6) The lack of appreciation and awareness of plants. In 2014 FleishmanHilliard, along with Scholastic, were selected to develop a research, communication, education, advocacy, and marketing plan. Focus groups and surveys throughout 2014 revealed key information about horticulture. Although more research is being conducted, we have learned that there is universal support for the promotion of horticulture, especially as a viable and important career for young people. Other key findings to date include: to appeal to youth, it will be important for the initiative to give horticulture a face, especially a face of innovation and youth. A majority of respondents cited health and nutrition as one of the important benefits of horticulture. Awareness of the field and economics were two of the challenges noted by the more than 500 online survey respondents. While lack of awareness is one of the biggest challenges facing the industry, it is also its greatest opportunity. A strategic plan has been formulated along with an Advisory Council and a National Leadership Cabinet. A timeline and further updates will be presented on the initiative.

10:30–10:45 AM

NIFA Investments in Plant Breeding: Strategies, Achievements and Impacts in Research, Education, and Extension

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Plant breeding is critical to increasing abiotic and biotic stress resistance and nutritional quality, to enhancing yields and to meeting regional and other specialized production requirements, such as organic. Long-term capacity in public plant breeding is supported by non-competitive programs such as Hatch and Evans-Allen, which represented about half of NIFA's (National Institute of Food and Agriculture) 2014 plant breeding investments. NIFA has prioritized competitive programs in plant breeding in the 2015 Agriculture and Food Research Initiative (AFRI) Foundational and Food Security Challenge areas. One of the first and largest AFRI-funded projects to integrate genomics and plant breeding was the $25M Triticeae Coordinated Agricultural Project (TCAP) (2011) on barley and wheat germplasm for changing environments. TCAP included 56 participants in 28 institutions and 21 states. By 2014, TCAP reported 9 new varieties plus significant contributions to 53 additional varieties, representing 15% of U.S. wheat acreage, 62 germplasm releases, 21 population releases, 186 scientific publications, and training of 115 individuals. Other AFRI projects that included plant breeding are the Bean and the Solanaceae CAPs. Current AFRI support for plant breeding is mostly in the form of smaller, single investigator awards, which may, however, build on the larger awards. From 2011 to 2014, the AFRI Plant Breeding for Agricultural Production Foundational area made 27 awards for a total of $12.3 million for 21 different crops. The Organic Research and Extension Initiative (OREI) and Specialty Crops Research and Extension Initiative (SCRI) have also supported plant breeding research and extension. A downy mildew resistant cucumber cultivar was released based on initial funding from OREI for the Northern Organic Vegetable Improvement Collaborative, followed by an award from the AFRI Foundational area. Between 2009 and 2014, SCRI awarded 32 grants in plant breeding for a total of $56.5 million, including renewing a CAP program for the Rosaceae (RosBREED). OREI made 17 plant breeding awards, for a total of $25.4 million from 2009–2014. NIFA investment in plant breeding has resulted in the development of new vegetable cultivars and tools for breeders that are currently used throughout the country, such as a lettuce cultivars resistant to *Verticillium* wilt and identification of a candidate gene that encodes resistance to root rot disease in chili peppers. While NIFA has made significant strides in providing competitive funding to advance plant breeding, sustained investment is needed to address emerging issues and to train the next generation of plant breeders.

Specified Source(s) of Funding: National Institute of Food and Agriculture (NIFA)

10:45–11:00 AM

The USDA Plant Breeding Roadmap

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Plant breeding is critical for sustainable crop production for security, health, and quality of life. Horticultural crops provide many examples of plant breeding's contributions, ranging from pest and disease resistance in table grapes, to locally-adapted vegetable varieties for Northeastern and Northwestern farmers. Contemporary attention to plant breeding is increasing for a number of reasons, such as its relevance across the full range of agricultural systems and approaches; and the development of a range of new enabling tools for plant breeding. In response, in 2013 USDA's Chief Scientist held a public Listening Session on Plant Breeding. Subsequently, USDA has developed a Plant Breeding Roadmap to align its forward vision for plant breeding with USDA's strategic goals. Both documents are now posted on the web page of the Office of the Chief Scientist (OCS) at http://www.usda.gov/wps/portal/usda/usdahome?navid=OCS. Stakeholder comments to USDA included the value of USDA's work in genetic resources (including conservation, characterization, distribution, and pre-breeding); the importance of the recruitment and education of future plant breeders in active breeding programs; and the value of the federal-state partnership and associated grower-groups partnerships. Additional needs expressed for USDA's work in plant breeding included public-sector plant varieties (cultivars) when/as needed for meeting national goals; translational work in the incorporation of biological research results in new breeding methods, tools and approaches, to address ever-more complex goals; and extramural funding programs both appropriate and adequate for long-term health of the robust federal/state model for public plant breeding in the United States. These activities are important in the roadmap for USDA's work over the next 5–10 years. Some of the issues raised by stakeholders are broader than any single entity, including recruitment of young people; optimal understanding and use of intellectual property rights and tech transfer mechanisms; and fostering optimal public/private investment balance to ensure that all critical needs are addressed. Questions and discussion regarding the USDA Plant Breeding Roadmap and possible next steps are invited.

11:00–11:15 AM

Estate Planning: Transitioning for the Future of Horticultural Businesses in New Jersey

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In 2012, 137 farmers who had participated in a statewide business management program were surveyed, and 69% indicated an interest in learning more about estate planning. Almost three-quarters indicated that they anticipated passing their farms down to their children, thus transitioning the agribusiness to the next generation. Despite the reluctance of many to plan for a future without them, the need for proper estate planning and assistance is currently of vital importance in the agribusiness sector. According to the 2012 U.S. Census of Agriculture, the average age of principal farm operators in the United States and New Jersey is 58.3 and 59.5, respectively. While farmers, on average, have a median net worth 7.5 times greater than U.S. households, much of this wealth is illiquid (e.g., land, buildings, and equipment). To address the need for business continuance and estate planning, the *Preparing for Later Life Farming* program was developed to assist multi-generational New Jersey farm families in preparing for farm transition. This eight-hour, one-day program was offered in three New Jersey locations from 9–11 Feb. 2015, and was attended by over 70 producers. The programs included presentations about farm transfer methods, calculating retirement savings, sources of retirement income, rules for tax-deferred savings withdrawals, methods of increasing farm income to support multiple generations, how to find legal and financial experts, and strategies for communicating with family members about farm transfer issues. We surveyed 52 participants using a post-then-pre- evaluation design where participants were asked to rank each question on a scale of 1–5, with 1 being poor and 5 being excellent. For each question, respondents were surveyed after the class and asked to rate their knowledge on the subjects both before and after the class. Respondents found that their knowledge and confidence increased by a full point or more on: how well prepared they are to discuss farm estate planning and farm transition with family members and business partners; their ability to estimate future business financial needs for themselves, family members and business partners; their knowledge of the potential pitfalls of farm transfer and estate planning; and their understanding of how to choose an appropriate expert to assist with preparing their estate plan. Self-rankings increased slightly less than one point on their ability to estimate future personal financial needs for themselves, family members and business partners and their ability to identify potential income for the future of the business and family.

Specified Source(s) of Funding: USDA Extension Risk Management Education

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11:15–11:30 AM

Impacts Achieved via the Horticulture Innovation Lab

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Investment in horticulture for development programs 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 increased 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. In its first five years, the Horticulture Innovation Lab funded 61 projects in more than 30 countries. These projects ranged from six-month Trellis projects, which paired graduate students with developing country organizations, to three-year, multi-country comprehensive projects, which addressed bottlenecks throughout an entire value chain. Projects involved 18 U.S. public universities and more than 200 universities and organizations in the developing world. As the Horticulture Innovation Lab starts a new five-year program phase, we reflect on the impacts of phase one and plan for the next five years. Research has been funded to improve seed drying and storage, evaluate vegetable varieties, test conservation agriculture for vegetables, improve small-scale irrigation systems, test insect barrier nets, test improved postharvest handling practices, and develop market linkages for resource poor farmers. Smallholder farmers and particularly women farmers have been educated and empowered. The Horticultural Innovation Lab has built collaboration not only through projects, but also through the development of Regional Centers and one Postharvest Training and Services Center. The Regional Centers, located in Honduras and Thailand, serve as hubs that connect researchers, students, and organizations in their areas. The Centers also test horticultural technologies and host workshops and trainings. The Postharvest Training and Services Center (PTSC), located in Arusha, Tanzania, also provided resources and trainings for local growers. In the new Phase of the Horticulture Innovation Lab, we will fund significant projects on gender, nutrition and postharvest, and will work to scale promising technologies by promoting their adoption by farmers. New project foci will also be developed in the coming years.

Specified Source(s) of Funding: United States Agency for International Development (USAID)

Friday, 7 August 2015

Propagation 2

Moderator: Daniel I. Leskovar
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10:15–10:30 AM

The Effects of Leaf Removal on Adventitious Root Formation and Plant Growth of Grafted Tomatoes

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Grafting vegetables is gaining interest among tomato growers throughout the United States as a way to manage soilborne diseases and abiotic stress, in addition to increasing crop productivity. One significant barrier for growers is the low availability of grafted plants or the ability to propagate their own. A major challenge during propagation is managing the formation of adventitious roots (AR) from the scion, which if severe enough, can result in loss of rootstock function. Possible reasons that cause adventitious rooting include a poor graft union, scion water stress, high humidity, and hormone response(s) to wounding. Previous studies have shown that removing leaves increases the success rate, but it is not known how this technique affects the formation of adventitious roots. Our study investigated how leaf removal (LR) affects the formation of adventitious roots on the scion and subsequent plant growth. Three leaf removal treatments, 0% LR, 50% LR and 90% LR, were applied to the scion 'BHN 589' and grafted onto rootstock 'Maxifort' rootstock. Plants were arranged in a healing chamber using a RCBD (4 reps), and 20 plants in each experimental unit. The experiment was repeated three times using three different healing chamber designs (shade, plastic, humidifier). After 10 days in the chamber, plants were removed and rated weekly on their AR for 3 weeks. For weeks 1–3 in all 3 experiments, plants with 90% LR had significantly lower AR ratings than 0% LR plants ($P < 0.05$). In the shade chamber, 50% LR plants also had significantly lower ratings than the 0% LR plants ($P < 0.05$). We also performed an experiment to look at how leaf removal affected early plant growth. Four treatments: 0% LR, 50% LR, 90% LR, and non-grafted were applied to the scion 'BHN 589' and then grafted onto 'Maxifort' rootstock. Plants were grown in a greenhouse using a RCBD with 4 replications and 15 plants in each unit. On day 24 post-grafting, 3 plants samples in each experimental unit were measured for leaf area, shoot biomass root biomass, plant height, stem caliper, and flower count. Sampling was conducted once every 7 days for 5 weeks. By week seven, all grafted treatments performed similarly for most plant growth

parameters and were not statistically different. Our results indicate that leaf removal of the scion can increase high quality plants for growers because of the lower adventitious rooting and does not reduce the early season growth of the transplant.

Specified Source(s) of Funding: North Central Region SARE, Ceres Trust Organic Initiative

10:30–10:45 AM

Light Intensity and Relative Humidity Effects on the Regrowth of Newly Grafted Tomato Plants

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Grafting successfully and efficiently requires levels of light, temperature, and humidity that promote vascular reconnection and plant growth. Tomato plants are routinely grafted successfully in practice; however, it may be possible to further optimize the process with a heightened understanding of the separate and interactive effects of key environmental variables on plant growth during the healing phase. Therefore, we completed two studies involving a total of eight combinations of light intensity and relative humidity at standard healing temperatures. The use of light-emitting diodes (LEDs) and climate-controlled chambers was central to this purpose. Because they light with less heat than conventional sources, LEDs may be more significant in commercial grafting operations in the future. LEDs are also useful experimentally because they emit customized spectra at highly-controlled intensities. In both studies, four week-old 'Cherokee Purple' and 'Maxifort' tomato seedlings were splice-grafted and placed under LEDs emitting a 20% red, 20% white and 60% blue mixed spectrum for 12 hours each day. Study 1 light levels were 2–5, 45–65, 140–160, or 290–310 μmol·m^{-2}·s^{-1}, all– at 25±4 °C and 79±8% relative humidity (RH). Study 2 conditions were the four combinations of 45–65 or 240–260 μmol·m^{-2}·s^{-1} light with 65% or 90% RH, all at 26/20 °C. We hypothesized that these conditions would affect at least one of the nine components of plant growth we tracked after grafting, beginning with plant survival and concluding with stem and leaf traits at 7–10 days after grafting. In both studies, above ground dry weight and compactness (above-ground dwt/plant height) increased with light intensity. No across-study trends were evident in the other seven measured variables. In Study 2, the light x RH interaction influenced leaf fresh weight, leaf area relative growth, and specific leaf area. Relative humidity affected these variables only at 45–65 but not at 240–260 μmol·m^{-2}·s^{-1}, with the combination of 45–65 μmol·m^{-2}·s^{-1} at 90% RH always having the largest value. These results suggest that the common practice of placing newly grafted plants in low light conditions should be reexamined, especially if alternative light sources are available.

10:45–11:00 AM

Grafting Watermelon to Manage Verticillium Wilt in Washington State

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Grafting watermelon (*Citrullus lanatus*) for soilborne disease control is common in many areas of the world but has not yet been widely adopted in the United States. This 2014 study investigated the use of grafting to manage Verticillium wilt (caused by *V. dahliae*) at three diverse field locations: Othello and Eltopia in the Columbia Basin of eastern Washington, and Mount Vernon in northwestern Washington. The *V. dahliae* population density was estimated to be < 1.0, 5.7, and 18.0 colony forming units per gram (cfu·g^{-1}) of soil at Othello, Eltopia, and Mount Vernon, respectively. At each site, the experiment was arranged as a randomized complete block with three replications, and the treatments consisted of Verticillium wilt-susceptible 'Sugar Baby' non-grafted and grafted onto commercial rootstocks 'Marvel', 'Rampart', 'Tetsukabuto', and 'Titan'. Plots were rated visually for Verticillium wilt 4–5 times beginning at symptom onset, and fruit yield and quality were assessed. Area under disease progress curve (AUDPC) values differed significantly among treatments at Eltopia and Mount Vernon, with non-grafted 'Sugar Baby' having the highest AUDPC value (most severe disease) and 'Sugar Baby' grafted onto 'Tetsukabuto' having the lowest. At Othello, where disease pressure was lowest, AUDPC values did not differ significantly among treatments. Non-grafted 'Sugar Baby' had significantly lower marketable fruit weight per plant than all other treatments at Eltopia, while at Othello marketable fruit weight per plant did not differ significantly among treatments. Total soluble solids (TSS) differed significantly among treatments at Eltopia and Othello, although none were significantly different than non-grafted 'Sugar Baby'. Grafting 'Sugar Baby' onto 'Titan' and 'Marvel' significantly increased flesh firmness at Eltopia, but there was no difference at Othello. Lycopene content did not differ significantly among treatments at Eltopia or Othello. At Mount Vernon, fruit did not reach maturity and only total fruit weight was measured; 'Sugar Baby' grafted onto 'Tetsukabuto' had significantly greater total fruit weight per plant than all other treatments. All treatments at Eltopia and Mount Vernon were assayed for *Verticillium* spp. (at Othello, plants were removed by the grower prior to assay), and microsclerotia characteristic of *V. dahlia* were observed in all treatment samples. Results indicate that watermelon grafting can be used effectively to manage Verticillium wilt of watermelon in areas of Washington where the *V. dahliae* soil density exceeds 5.0 cfu·g^{-1}. Furthermore, grafting does not lead to reduced fruit quality and certain rootstock-scion combinations can actually improve flesh firmness.

Specified Source(s) of Funding: Emerging Research Issues grant from Washington State; Washington State Commission

An asterisk (*) following a name indicates the presenting author.

on Pesticide Registration; Northwest Agricultural Research Foundation; Skagit Men's Garden Club

11:00–11:15 AM

Abscisic Acid: Practical Application for Vegetable Transplants

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Abscisic acid (ABA) is a plant hormone that triggers adaptive responses to water stress, including stomatal closure and shoot growth suppression. Our goal is to explore the potential of ABA in practical application for vegetable transplants. First, we examined the stress control effect. In muskmelon (*Cucumis melo* L.) seedlings subjected to water withholding, pre-stress foliar spray of ABA improved the maintenance of leaf relative water content by limiting transpirational water loss. This effect was linear to ABA concentration (0.2 to 7.6 mM). Upon rewatering, the ABA-treated seedlings showed faster photosynthetic recovery and greater dry matter accumulation than the untreated seedlings. Second, we examined the height control effect for producing compact transplants. The effectiveness of height control by ABA varied among crops, cultivars, and growth stages: final transplant height was reduced by up to 20% in bell pepper (*Capsicum annuum* L.), whereas the benefit of height control was limited by overall growth suppression in jalapeño and watermelon [*Citrullus lanatus* (Thunb.) Matsum & Nakai]. Overall growth suppression, however, may be of value as a growth holding strategy. When ABA was applied immediately before the maturity stage, all tested cultivars of bell pepper, jalapeño, and watermelon reduced excessive shoot growth (up to 29% 4 days after treatment) and prolonged the transplant marketability. One of the negative side effects observed across these experiments was leaf chlorosis, although it was concentration-dependent and mostly reversible within 7 days. These results suggest that, with optimal concentration and application timing, ABA can be developed as a new management tool for vegetable transplants.

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11:15–11:30 AM

Low-level Nitrogen Fertilization Improved Root Growth Components and Quality of Containerized Artichoke Transplants

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Stand establishment of artichoke transplants during late summer or early fall is challenging in hot and semi-arid growing regions of the southern United States. A repeated greenhouse experiment evaluated artichoke [*Cynara cardunculus* L. var. *scolymus* (L.) Fiori cv. Green Globe Improved] transplants at two nitrogen (N) levels (75 and 150 mg·L^{-1}) and with two irrigation systems (flotation and overhead). Transplants were grown for 8 weeks, with fertigation applied once a week. Roots and shoot morpho-physiological measurements were taken at 4 and 7 weeks after seeding. Transplants grown with 75 mg·L^{-1} had greater root surface area, root length, root branching, and thinner root diameter than those fertigated with 150 mg·L^{-1}. Conversely, transplants grown with 150 mg·L^{-1} significantly increased total N content in roots and shoots, chlorophyll content (SPAD), and leaf photosynthesis. As a result, these transplants exhibited greater shoot length and leaf area than those grown with 75 mg·L^{-1}, these responses were more pronounced 7 weeks after seeding. Root and shoot length and surface area from overhead and flotation irrigation systems were statistically similar. However, 7 weeks after seeding, transplants under overhead irrigation had slightly greater stem diameter (~10%), shoot and root total N (~10%), and photosynthesis (~10%) than those grown with the flotation system. Overall, applying low level of N (75 mg·L^{-1} ppm) with either flotation or overhead irrigation systems can improve the transplant root system and produce shorter and more rigid seedlings, improving the ability to withstand pulling from the trays and potentially the tolerance to withstand transplant shock in the field.

Specified Source(s) of Funding: Texas Department of Agriculture–Specialty Crop Block Grant

Friday, August 7, 2015

Consumer Horticulture and Master Gardeners

Moderator: Ellen Bauske
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10:15–10:30 AM

Transforming the North Carolina State EMGV Manual from a Static Three-ring Binder with Limited Distribution into a Dynamic Digital Tool Available to the Public

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With input of 90 Extension Specialists, Agents, and Master Gardener Volunteers, the North Carolina Extension Master Gardener Manual—historically a 674 page black and white document with line drawings in a three ring binder—has been transformed into a dynamic, digital tool with integrated databases and color images. Previously restricted to students in the

Extension Master Gardener Class, the new manual is available on-line to the public. This new tool is functional in a variety of new ways. The manual is instantly searchable and Extension Master Gardener Volunteers can now refer clients directly to information in the manual. The QR codes in the database can be provided on tags on shrubs in demonstration gardens and plant sales to direct customers to specific information. Agents may use all or parts of the manual to teach a variety of courses to consumers and professionals. The transformation was accomplished over a year-long focused effort and is changing the way consumer horticulture is managed in North Carolina. For example, instead of the traditional strategy of recruiting and training Extension Master Gardeners, which in some cases resulted in very small classes and in others resulted in turning away many interested applicants, agents are now offering an Extension Gardener Course (with most of the content previously taught only to Extension Master Gardener Volunteers) and then allowing graduates to apply to become volunteers. Class sizes are increasing, resulting in broader impact as well as a more effective selection process for volunteers.

10:30–10:45 AM

Evaluating Long Distance Delivery of the North Dakota Master Gardener Core Course

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Delivering Master Gardener core course training in North Dakota is complicated by distance and geographic location. North Dakota State University faculty and personnel are primarily located in Fargo on the eastern edge of the state. Therefore, distance-learning methods were adopted to deliver the Fall 2013 core course to Master Gardener interns throughout the state. In addition to in-person training in Fargo, the Master Gardener Program used videoconferencing classrooms in county Extension offices to link to the Fargo training site. Also, Master Gardener interns had the option to take the class independently by watching recorded class videos that were posted to a content management website. The effectiveness of the three 2013 class delivery methods were assessed by comparing the number of hours each Master Gardener intern volunteered in 2014. Master Gardener interns who took the class in person or in videoconferencing classrooms on average volunteered 23.7 and 26.1 hours, respectively, during the first year of a two-year internship. In contrast, Master Gardener interns who took the online class only volunteered 15.2 hours during 2014. This pilot study appears to show that in-person training and videoconferencing classrooms in Extension offices were comparable. However, Master Gardener interns who took the class online were less likely to volunteer during the first year of the 48-hour internship. Class evaluations helped explain the difference in volunteer hours. Gathering to attend class in person or in a videoconferencing classroom helped build a sense of community and reinforced the connection to the supervising Extension agent. In contrast, online Master Gardener interns felt isolated and were less likely to volunteer.

10:45–11:00 AM

Volunteer and Coordinator Perspectives on the Extension Master Gardener Program in Tennessee

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The Extension Master Gardener (EMG) program is a vital contributor to Tennessee Extension Residential and Consumer Horticulture education and outreach. In 2014, 2480 volunteers in 37 county or multi-county associations across the state completed volunteer service and continuing education to achieve certified EMG status. These volunteers, led by Tennessee Extension agent county coordinators, contributed over 178,800 hours of service while recording over 30,300 hours of continuing education over the course of 2014. These totals illustrate the contributions of EMG volunteers across Tennessee to education and community service but also their desire for educational programming to enhance their own knowledge and skill. What is not well known currently is the relative importance of different areas of horticultural training to support programs or the areas of knowledge that are most personally valuable for volunteers. Gaining a better understanding of the most needed areas of training for EMG volunteers as they educate the public is critical to the growth and impact of the program. Retention and recruitment is contingent upon volunteers enjoying their service and the opportunities provided by the TEMG program. Therefore, a study was undertaken to survey both EMG volunteers and coordinators to determine educational needs for volunteers were as well as the preferred training delivery methods. Open-ended questions were also included to provide EMGs an opportunity to suggest changes to the current program and their opinion on the long-term needs of the TEMG program. This was a needs assessment that included aspects of retention, so both inactive and active EMGs were included. Researchers selected 25 EMGs using a random number generator, and sent them an explanatory letter and a link to the online Qualtrics survey. This pre-test was conducted to determine if any issues were present with the survey. No concerns arose from the pre-test, so a random sample of 417 EMG volunteers (16%) along with all 38 coordinators were sent the main email survey. Over the three-week survey period, 181 responses were received (34 agent and 147 volunteer). On a scale of 0–5, respondents consistently rated horticultural training in edible (4.67) and ornamental crops (4.61) as well as pest and disease management (4.64) as high priorities. Similarly, hands-on and in-person presentations (4.80) and printed materials (4.65) were rated as highly important training methods. Results indicate potential training priorities for the future but also suggest opportunities to strengthen training consistency and policies moving forward.

11:00–11:15 AM

Navigating the Extension Master Gardener Rescreening Process

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Since 2001, the state of Ohio has required fingerprint background checks for all volunteers working with vulnerable populations. Ohio State University adopted that policy that staff and all OSU volunteers would be required to undergo the background check process prior to serving in a volunteer capacity. This initial screening was implemented for Extension Master Gardeners (EMG) with little fanfare. Current volunteers were granted grandfather status. New classes that came on board accepted the requirement as status quo. In 2014, the University established Policy 1.50, whereby all volunteers as well as employees would undergo the rescreening (fingerprint background check) process every four years. This policy was met with a little resistance from the volunteers and resulted in the loss of a few EMGs statewide. In addition to the rescreening, Policy 1.50 required that staff and volunteers undergo yearly training on signs of Child Abuse Recognition and Reporting (ARR). This policy was also implemented in 2014. This presentation will walk through the process of working through the logistics of the fingerprinting and rescreening procedure as well as working with the Extension Master Gardeners on implementation. We will also discuss the ARR training program and implementation as well as suggestions on how to make this transition a little easier in other states. These processes have been established to protect our staff and volunteers as well as the reputation of the University. In addition, our clientele have the satisfaction of knowing that our volunteers are screened.

11:15–11:30 AM

Webinars Teach IPM to National Audience

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Six webinars have been held by the North Central Consumer Horticulture IPM Working Group to teach IPM practices on tomatoes, cucurbits, raspberries, shade trees, conifers, and apples for home gardeners. The webinars have reached Extension Master Gardeners and Extension Educators in many states, with attendance ranging from 472–1447 in 5–29 states. An attempt to gauge the change in IPM knowledge level resulted in self-reported gains of 13% (tomatoes) to 54% (apples) of respondents who indicated a medium knowledge level (as opposed to low or high) after the webinars. Answers to 60 specific IPM questions improved as well, for example before the cucurbits webinar 58% of participants knew that the squash vine borer could be avoided by planting in July after the borer has laid eggs for the summer, but after the webinar 80% knew this management practice. Sixty-six percent of participants knew that soil borne diseases that infect solanaceous crops also infect raspberries but after the webinar 90% of the participants knew this information. Specific pests, such as the two-lined chestnut borer on oaks were known by only 14% of participants before the webinar, however afterward 57% answered that this was a common pest for transplanted oaks. Participants liked (74% to 90%) the 90-minute length of the webinars; the majority (68% to 92%) felt there was a good mix of content and questions. Technical problems were reported by 30% to 79% of participants using UMN Adobe Connect technology and 20% to 35% using UMNWebex. Challenges for future webinars are obtaining accurate participant attendance numbers, especially when using host sites; consistent participant pre- and post-webinar assessments; and problem free technology.

11:30–11:45 AM

The Urban Double Crop: Fall Vegetables and Summer Lawn

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Though interest in gardening is high, 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, 4 m^2 gardens consisting of four plants each of broccoli (*Brassica oleracea* 'Packman'), lettuce, (*Lactuca sativa* 'Simpson Elite'), and Swiss chard (*Beta vulgaris subsp. Cicla* 'Bright Lights') were planted into a hybrid bermudagrass (*Cynodon dactylon*) lawn in late September in a split plot, randomized complete-block design. Gardens (whole plots) were established by: direct planting into the lawn (DP); glyphosate (0.09 lb a.i. per gal) treatment of turfgrass followed by direct planting (GDP); tilling with a Mantis tiller (Schiller Grounds Care, Southampton, PA) (T); and application of glyphosate followed by tilling (GT). Glyphosate was applied one week prior to planting in 20.2 cm x 15.2 cm rectangles centered on transplants. The DP was achieved by using a 5-cm drill bit on a portable drill to dig holes 7.6 cm deep into which transplants

were placed. Plants were fertilized individually at the rate of 50 g/m^2 at planting and again at four weeks. Combined yields were 828.3, 646.8, 469.4, and 446.8 g/garden in the GT, T, DP, and GDP treatments. Though vegetable yields were higher in tilled gardens, all planting techniques produced edible vegetables in the fall lawn. Previous observation suggests that the lawn will recover satisfactorily from DP treatments.

Friday, 7 August 2015

Fruit Breeding 2

Moderator: Nahla Bassil
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10:15–10:30 AM

Comparative Analysis and Genetic Study of Aroma Volatiles from Different Citrus Selections and Hybrids

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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. This study investigated aroma volatiles in citrus selections and hybrids using gas chromatography-mass spectrometry (GC-MS) from 2012 to 2014, compared juice aroma profile among different citrus genotypes, identified QTL regions controlling aroma volatiles and validated molecular markers in relevant citrus germplasm accessions. The objective was to develop markers for aroma-oriented citrus breeding. The citrus selections and hybrids included six mandarins ('Fortune', 'King', 'Murcott', 'Pimpled', 'Ponkan', and 'Sunki'), one satsuma ('Owari'), one Clementine ('Nules'), one blood orange ('Moro'), three sour orange types ('Goutou', 'Zhuluan', and one unknown), one complex mandarin hybrid ('Rangpur' lime), and a population of 116 'Fortune' × 'Murcott' F_1 hybrids. The aroma volatile composition varied among the citrus selections from 35 volatiles identified in 'Ponkan' mandarin to 123 in 'Guotou' sour orange. The aroma volatile profile was able to differentiate the 13 citrus selections and revealed complex interactions between them. The phylogenetic analysis results for the citrus selections based on aroma volatile compositions were matched well with that based on the genotypic data of 1536 SNPs. The volatile compounds in 'Fortune' and 'Murcott' behaved differently during the fruit maturation period. In 'Murcott', the total aroma volatiles obtained from samples were very similar at each developmental stage, however, the aroma constituents changed as fruit maturity progressed to a tree ripe stage. The concentration of valencene, the most abundant sesquiterpene accumulated during the last two development stages in 'Fortune', but in 'Murcott', it was present only in the first development stage and then disappeared. A total of 183 QTLs were identified on a previous generated mandarin genetic map for 84 volatile compounds, with 79 of them being consistent over two or more sampling times. A QTL interval on LG2 controlling monoterpenes and sesquiterpenes corresponded to a genomic region that contains terpenoid biosynthetic pathway genes GPS1, TPS3, TPS4, and TPS14. The QTLs were validated in the 13 citrus selections, and some QTL linked markers showed significant association with aroma volatile content.

Specified Source(s) of Funding: Citrus Research & Development Foundation

10:30–10:45 AM

Pedigree-based QTL Detection for Disease Resistance and Fruit Quality Traits: An Overview of the University of Florida Strawberry Breeding Program

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The University of Florida (UF) strawberry breeding program develops cultivars for the Florida industry, the second largest producer of fresh strawberries in the United States. There is a need for new strawberry cultivars with both improved disease resistance and superior fruit quality. This need is being addressed through the USDA–NIFA–SCRI project entitled "RosBREED: Combining disease resistance and horticultural quality in new rosaceous cultivars." The creation of the Affymetrix IStraw90® Axiom® SNP array revolutionized genetic research in octoploid strawberry. A dataset of 3624 genetically mapped SNP markers spanning 28 linkage groups was obtained for 795 pedigree-connected individuals in the UF strawberry breeding

population. Phenotypic data from one year of inoculated field trials for three disease resistance traits and non-inoculated trials for four fruit quality traits were obtained and analyzed using FlexQTL™ software. A single major locus controlling resistance to *Xanthomonas fragariae* (causal agent of angular leaf spot) was discovered on linkage group (LG) 6D explaining ~96% of phenotypic variation (PVE) and Bayes Factor (BF) >10 (BF 0–2 = nonsignificant; 2–5 = positive; 5–10 = strong; > 10 = decisive evidence). Large-effect quantitative trait loci (QTL) were also discovered for resistance to *Phytophthora cactorum* (causal agent of Phytophthora crown rot) on LGs 7D (BF=29) and 4B (BF=28) together accounting for 48% PVE and for *Colletotrichum gloeosporioides* (causal agent of Colletotrichum crown rot) on LGs 6B (BF=29) and 5C (BF=5) with 39% PVE. For the fruit quality traits, QTL for soluble solids content were detected on LGs 1A (BF=8), 3A (BF=9), 5B (BF=6) with 41% PVE; for average fruit weight on 4B (BF=6) and 6C (BF=16) with 36% PVE; for fruit number on LGs 1C (BF=6), 3D (BF=9), 5C (BF=6) and 6D (BF=6) with 31% PVE; and for total culled fruit on LGs 1B (BF=8), 2A (BF=5) and 3D (BF=29) with 54% PVE. In general disease traits appear to be conferred by 1–2 major loci while most of the fruit quality traits appear to be controlled by a larger number of small-effect QTL, with an occasional large-effect QTL. QTL-allele mining is underway for these regions, and a second year of phenotypic data on new individuals is being collected for QTL validation. Ultimately, high-throughput DNA-based markers will be developed for major loci for use in marker-assisted breeding applications.

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10:45– 11:00 AM

Usefulness of *FaPFRU*-Associated Perpetual Flowering Markers in the Cultivated Octoploid Strawberry

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The objective of this study was to evaluate four simple sequence repeat (SSR) markers linked to the *FaPFRU* Perpetual Flowering (PF) locus for ability to predict this trait in populations with different sources of PF such as: *F. virginiana* subsp. *glauca* Wasatch clone represented by 'Capitola', 'Tribute', and 'Seascape'; 'Pan American' source represented by two genetically different individuals of 'Fort Laramie' we refer to as 'Fort Laramie1', and Fort Laramie2'; and an unknown source represented by 'Sarian', 'Seascape'. Flowering phenotypic data was collected in Michigan and Oregon from 2011 to 2013. Plants were considered PF if they flowered in the spring and after July 17 (the evaluation date over 21 days past the longest day of the year). In 2013, the number of flower trusses and the number of flowers per truss were counted, cut and counted again after four weeks. The allele associated with PF in Bx089 was shared among three of the four strawberry subgenomes and was not effective in predicting PF. Markers Bx215, Bx056, and Bx063 were equally predictive in 'Capitola'-derived germplasm where association with PF phenotype ranged from 50% in Oregon (2012) to 89% in Michigan (2013). Bx215 was more predictive of PF than the other two markers in 'Tribute' (42% to 94%) and 'Seascape'-derived (50% to 94%) germplasm. Bx215 and Bx063 were equally effective in 'Fort Laramie2'-derived germplasm but none of the three markers were predictive in 'Fort Laramie1'- or 'Sarian'-derived individuals. In general, while Bx215 was most effective in predicting PF in 425 to 94% of individuals that descended from the Wasatch source and 'Fort Laramie2', the absence of the markers predicted absence of PF in > 90% of this germplasm and could be used to eliminate once flowering seedlings. This study illustrates the need to test markers in diverse germplasm to establish their usefulness in marker-assisted breeding.

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An asterisk (*) following a name indicates the presenting author.

11:00–11:15 AM

FaRXf1: A Locus Conferring Resistance to *Xanthomonas fragariae* in Octoploid Strawberry

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Xanthomonas fragariae, causal agent of bacterial angular leaf spot, is the primary bacterial pathogen of cultivated strawberry (*Fragaria ×ananassa* Duch.) and is responsible for marketable yield losses of up to 8% in Florida. As there are no publicly available resistant cultivars, and chemical control methods have unwanted side effects, the development of resistance in elite germplasm could be the most effective means to prevent outbreaks. While high levels of resistance have not been found in cultivated strawberry, the octoploid accessions US4808 (*F. virginiana*) and US4809 [*F. virginiana* × (*F. ×ananassa* 'Earliglow')] are known to be resistant. The objectives of this work were to introgress resistance from these wild sources into Florida-adapted germplasm, determine the genetic architecture of resistance, and develop a protocol for marker-assisted selection, as outlined by the RosBREED consortium of Rosaceous crop researchers. In previous efforts, the two resistant accessions were crossed to germplasm adapted to high latitudes in a series of modified backcrosses. Two individuals derived from this effort, resistant parents K12-10 and K08-17, were crossed to 'Strawberry Festival' to generate two full-sib families named 13.77 (n = 137) and 13.78 (n = 134), respectively. Progeny were inoculated and phenotyped in the field for resistance to *X. fragariae* with scores determined as percentage leaf area covered by lesions. Phenotypes segregated in a strongly bimodal fashion, suggesting control of resistance by a dominant allele at a single locus. From the tails of the phenotypic distributions of families 13.77 and 13.78, 36, and 38 individuals, respectively, were genotyped with the Affymetrix IStraw90® Axiom® SNP array. Quantitative trait locus analysis was performed with FlexQTL™ software using a novel map of 3624 SNP markers covering 28 linkage groups. A major locus was detected between 110cM and 118cM spanning an area of 400kb on chromosome 6D in family13.77 and a larger but wholly overlapping region in family 13.78. This novel locus was named *FaRXf1*, for "*Fragaria ×ananassa* Resistant to *Xanthomonas fragariae* 1." Closely linked molecular markers were developed for use in marker-assisted selection and will accelerate resistance breeding efforts.

Specified Source(s) of Funding: USDA–NIFA–SCRI Award number 2014-51181-22378

11:15–11:30 AM

QTL Detection and Allele Mining for *Phytophthora cactorum* Resistance in University of Florida Strawberry Breeding Germplasm

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Developing strawberry cultivars with both disease resistance and desirable fruit quality is a challenging but important objective of the RosBREED consortium and of the University of Florida strawberry breeding program. Plant collapse and resultant yield loss from Phytophthora crown rot caused by *Phytophthora cactorum* results in economic losses in Florida each season. An inoculated field trial was conducted during the 2013–14 season using clonally replicated seedlings from a circular diallel mating design, representing 62 full-sib families and 566 progeny from the elite breeding population. Plant mortality was recorded weekly and the area under the disease progress curve (AUDPC) was calculated for each individual. A wide variation from 0 to 132 was observed in AUDPC scores. Pedigree-based QTL analysis was performed using 3,624 genetically mapped SNP markers spanning 28 linkage groups (LG) using FlexQTL™ software. Three large-effect QTL were detected, one on LG 4B, *Pc*1 (Bayes Factor = 28), and two others on LG 7D, *Pc*2 (BF = 15) and *Pc*3 (BF = 14), together accounting for ~ 48% of phenotypic variation. Breeding values and genotype probabilities associated with each individual associated with the three loci were used to predict allele effects of the segregating QTL. Most of the families were segregating for *Pc*2 and *Pc*3, but very few for *Pc*1. Individuals inheriting *pc* / *pc* alleles (*pc*= associated with low mortality; *Pc* = associated with high mortality) at all the three loci (*pc*1*pc*1 | *pc*2*pc*2 | *pc*3*pc*3) were associated with low AUDPC scores ranging from 0 to 37. As the proportion of the *Pc* allele at any of the three loci increased, mortality also increased. Interestingly, none of the individuals were homozygous for susceptible allele at *Pc*1. The presence of a single *Pc* allele at *Pc*1 was consistently associated with plant mortality very early in the season, resulting in AUDPC scores ranging from 84 to 132. Other allelic combinations that fell in this range were either *Pc*1*pc*1 | *Pc*2*Pc*2 | *Pc*3*Pc*3 or *Pc*1*pc*1 | *Pc*2*pc*2 | *Pc*3*Pc*3 or *Pc*1*pc*1 | *pc*2*pc*2 | *Pc*3*Pc*3 indicating stronger effect of *Pc*1 & *Pc*3 than *Pc*2. Because of the complex pedigree structure, it may be possible that more than two alleles may be segregating at each of the loci. Haplotype analyses for the three loci are

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underway toward validation of allele effects in a separate set of populations.

Specified Source(s) of Funding: RosBREED is funded by the USDA–NIFA–SCRI Award number 2014-51181-22378

Friday, 7 August 2015

Ornamentals/Landscape and Turf 2

Moderator: Michelle Atkinson
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11:00–11:15 AM

Consumer Preference for Turfgrass Attributes in the United States

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Most previous studies focused on consumers/consumers' preference for low-input turfgrasses on a state level or regional level and none of them studied consumer preferences on a national or international level. Our study differs from previous studies because we investigate and compare U.S. consumers' preferences and willingness to pay for turfgrass attributes. Our specific objectives include: 1) estimating U.S. consumers' willingness to pay for various turfgrass attributes; and 2) identifying the possible consumer preference heterogeneity and market segmentations. We find the ability to withstand foot traffic attribute is one of the most influential turfgrass attributes for U.S. consumers. We also find consumers' preferences are greatly affected by the maintenance attributes. Generally speaking, many consumers are willing to pay large premiums for turfgrasses with lower maintenance requirements. Among three maintenance attributes, mowing requirement is the most predominant attribute affecting consumers' purchasing decision. Water usage, is also considered as one of the most influential attributes for consumers. Fertility requirements are found to affect consumers' choices to some extent. Three consumer segments are identified based on participants' heterogeneity in their preferences for turfgrass attributes: Balanced Consumers, Low-input Conscious Consumers, and Appearance Conscious Consumers.

11:15–11:30 AM

Lawn Renovation Using Alternatives to Glyphosate

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Total lawn renovation (eradication/removal of existing vegetation) may be desirable or necessary when perennial weedy grasses have become the major component of a lawn, or when converting the lawn from one turf species to another. In most cases, the non-selective, systemic herbicide glyphosate is the herbicide of choice for lawn renovation. Because of a desire to use natural organic or non-synthetic products, there is increasing interest in finding alternatives to glyphosate for the renovation of lawns. Specifically, the uses of both culinary (5% acetic acid) and horticultural (20%) vinegar are often touted as effective for lawn renovation, but there is nothing in the scientific literature to support or recommend their use for turf renovation. We compared the effectiveness of glyphosate and vinegar (5% and 20% concentrations) for the eradication of a mixed stand of cool-season grasses (Kentucky bluegrass, Poa pratensis L.; perennial ryegrass, Lolium perenne L.) in preparation for conversion to turf-type tall fescue (*Festuca arundinacea*). In 2014, only glyphosate (two applications at a 7-day interval) was effective for eradication of the cool-season grasses. In 2015 this experiment will be replicated, and another experiment examining different reapplication intervals of all products will be conducted. The cost of product and labor for a simulated lawn renovation will be presented, along with efficacy results.

11:30–11:45 AM

Potential for Injury to Container Tomatoes when Mulched with Grass Clippings from Herbicide-treated Turf

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Grass clippings are recommended as a mulching option for home vegetable production. To avoid the potential for herbicide injury, most labels for lawn weed control products (and many Extension home gardening publications) warn that clippings collected from herbicide-treated lawns should be used with caution in vegetable gardens. The required waiting period on some product labels, from time of herbicide application until clippings are considered safe for use in the garden, varies from a few weeks to the entire growing season. A review of Extension gardening publications suggests waiting periods of anywhere from two weeks to several months. There appears to be no published research on which these waiting periods are based, and there is little consistency for suggested waiting periods for safe clipping use in Extension literature written for the home gardener. Our research examined the effects of grass clippings collected from Kentucky bluegrass (*Poa pratensis* L.) turf that had been treated with broadcast applications of highest label use rates of 2,4-D or quinclorac. Clippings were collected 1, 3, 5, 10, 15, 20, 30, and 40 days following application of each herbicide and were applied as mulch to tomatoes (*Solanum lycopersicum* 'Celebrity') planted in #5 black plastic containers. Plant growth (height, final shoot, and root weight) and fruit yield were measured.

11:45–12:00 PM

Using Smart Irrigation Apps to Show the Value of Extension to Local Government

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Extension needs to show that they have value to local county government who funds much of local extension services. One way that the UF/IFAS Manatee County Extension Service is showing its value is by helping Manatee County save irrigation water on county owned properties. Using the Urban Lawn SmartIrrigation App, property site managers with the help of Extension are setting up the SmartIrrigation App on smart phones and tablets. By programing the soil type and unique zone characteristics, such as sprinkler type and number of sprinklers in the zone, an irrigation schedule is generated. Extension provides detailed zone information to the site managers for app set up as well as completing a full irrigation evaluation on the site to correct inefficiencies in the system. The app then provides site managers with an estimate of irrigation run times needed to meet current turf water demand using a simplified approach for automated irrigation systems. The model to determine if they are above the minimum temperature required for growth to occur will also monitor temperatures. App users receive notifications if more than 0.4 inches of rain occurs 24 hours prior to irrigation, rain is expected, or temperatures are too low for growth. Using the app instead of a set time-based schedule for irrigation, county site managers can provide irrigation amounts to turf that more closely match water needs. The Smartirrigation Turf app provides an easy way to determine your irrigation schedule for better management of turf. The irrigation schedule it generates is based on real-time ET_o data at a weather station near the system location. Using this app for irrigation is expected to reduce irrigation amounts annually by 25% to 30% if the app-suggested schedules are followed. More information can be found on the Smartirrigation Apps website at http://smartirrigationapps.org.

12:00 PM - 12:15 PM

Performance of *Zoysia* and *Axonopus compressus* Turf on Turf-paver Complex under Simulated Traffic

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Vehicular traffic on turf results in loss of green cover due to direct tearing damages to shoots and indirect long-term soil compaction. Protection of turfgrass crowns from wear injuries by physical or cultural measures could increase the ability of turf to recuperate from heavily trafficked areas. Interlocking plastic turf-pavers have been installed in heavily trafficked areas to support turf establishment. Each paver comprising lattice of cells and spaces is designed to reduce soil compaction and to protect turfgrass crowns from wear damages. The objectives of this study were to evaluate performance of turfgrasses (*Zoysia matrella* and *Axonopus compressus*) and soil (high, medium, and low sand-clay mixtures) combinations on turf-paver complex under simulated traffic. The performance of turf under traffic and recovery was evaluated based on percent green cover determined by digital image analysis and spectral reflectance responses by FieldScout® NDVI-meter. Two consecutive field trials were conducted in 2014 at CUGE Research Station, Singapore. The soil/grass combinations were subjected to 40 passes of wear and compaction treatments by a studded-roller machine for 4 weeks. Bulk density cores obtained from the cells (4 cm depth) indicated significant increase in soil compaction from medium and low sand-clay mixtures. No significant increase in soil compaction was observed from high sand-clay mixture. Higher percent loss of green cover was observed from *A. compressus* (30% to 40%) than *Z. matrella* (10% to 20%). Spectral reflectance 850nm and NDVI ratio showed high correlation ($r > 0.80$) with percent green cover in both grasses. All the spectral indices at 7 DAT (days after treatment) and 28 DAT showed higher sensitivity in detecting traffic wear damages than percent green cover data. Both turfgrasses perform relatively better on high sand-clay than low sand-clay mixture as inferred by spectral response data. 5% to 10% increase in percent green cover was observed from *Z. matrella* and *A. compressus* turf after three weeks of rest (recovery). Turf recuperation was also supported by positive spectral responses. Effective establishment of turf on turf-paver complex entails a wea-tolerant grass, *Zoysia matrella* on high sand-clay soil mixture.

Specified Source(s) of Funding: National Parks Board; Spring Singapore; Elmich Pte Ltd.

Friday, 7 August 2015

Weed Control/Pest Management and Waste Utilization in Horticulture

Moderator: John Montoya
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1:45–2:00 PM

Efficacy of a 1,3-Dichloropropene and Chloropicrin Mixture Used with Totally Impermeable Film for Nutsedge Control

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Methyl bromide (MBr) was a widely used fumigant in plasticulture due to its effectiveness against soil-borne pests and weeds

An asterisk (*) following a name indicates the presenting author.

in high value crops such as tomato, watermelon, and strawberry. However, it was found to be a class 1 ozone-depleting substance and was phased out under the Montreal Protocol in 2005 and only small amounts are available under a critical use exemption process. Alternatives to MBr must be implemented, but finding a comparable substitute to MBr has been challenging. A mixture of 1,3-dichloropropene and chloropicrin (1,3-D:Pic) is an alternative that has been used to control soil-borne pathogens and nematodes but has marginal efficacy on weeds. Virtually impermeable film (VIF) and totally impermeable film (TIF) retain fumigants in the soil longer than the low and high-density polyethylene films typically used in plasticulture production systems. The reduced rates of fumigant emission may results in greater control of recalcitrant weeds such as nutsedge. Four rates of 1,3-D:Pic (112, 168, 224, and 280 kg/ha) used with TIF, 280 kg/ha of 1,3-D:Pic used with VIF, and one non-treated control with VIF were evaluated during Fall 2014 for control of yellow nutsedge (*Cyperus esculentus*) and purple nutsedge (*Cyperus rotundus*). Initial results show that using TIF increases the retention of fumigant compared to VIF. Implementing TIF with 224 kg/ha of 1,3-D:Pic significantly improved nutsedge control compared to a higher rate of 280 kg/ha with VIF.

2:00–2:15 PM

The Relationship of Compost Knowledge, Compost Attitudes, and Environmental Attitudes of College Students

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Food waste is the number one material taking up landfill space in the United States. The Environmental Protection Agency estimates 96% of uneaten food ends up in landfills. Food and other organic wastes generate greenhouse gases in the atmosphere. College campus cafeterias generate a large amount of food waste and some universities are making efforts to capture and compost food waste. The purpose of the study was to measure the impact of a college composting program on students' environmental attitudes, compost knowledge and perceptions of composting. Undergraduate, graduate, and doctoral students were given a survey that included an environmental attitude scale as well as a compost knowledge survey asking college students to rate their composting habits, knowledge of the composting process, and how composting may make them feel. A total of 660 surveys were collected from two institutions, one in the south and one in the north. The results indicated a need and desire for compost implementation on college campuses.

2:15–2:30 PM

The Willingness to Pay for a Specialty Blend Compost Product Developed from *Sargassum* sp., Brown Seaweed, Harvested from Coastal Regions in Texas

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Composting is the natural breaking down of carbon and nitrogen-containing materials such as recycled plant parts, food scraps, paper, animal fodder, and wood chips. The end product, compost, becomes a beneficial soil amendment because it contains a full spectrum of essential plant nutrients that improve soil productivity. Coastal regions of Texas have a proliferation of brown seaweed, *Sargassum* sp., drifting onshore in all major beach areas. The biomass harvested exceeds natural decomposition rates when it is piled on the beaches and threatens them economically and environmentally. The purpose of this study is to conduct a market test to determine the potential value of seaweed-based compost to consumers in Texas. A marketing survey was developed and distributed to over 150 gardeners in the Central and South Texas regions. The questionnaire included Likert scale, Contingent Valuation, and demographic questions. Likert scale questions measured the participants' opinions on buying habits. Contingent Valuation questions measured participants' willingness to pay for compost-related products. While filling out the questionnaire, the participants were able to see, smell and touch a sample of the compost so as to better answer the survey. Results indicate that there is potential for a specialty Sargassum-based compost to be introduced to the market, as long as the price is competitive.

Friday, 7 August 2015

Crop Physiology

Moderator: Diane Beckles
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1:45–2:00 PM

Investigating the Genetic Basis of Leaf Economic Traits in Cultivated Sunflower (*Helianthus annuus* L.)

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Cultivated sunflower is an important crop species, grown worldwide for its high seed oil content, as well as for confectionery and

decorative purposes. Despite strong selection during domestication and cultivation for fast growth and high yield, cultivated sunflower retains a considerable amount of genetic diversity correlating with breeding history type and agronomic use. Genetic associations have been found for important traits such as flowering time and whole-plant branching patterns. However, little is known regarding the genetic architecture of important physiological traits involved in plant growth and carbon allocation. In this study, we used an association mapping population of cultivated sunflower, Helianthus annuus L., to assess variation in multiple leaf traits, including photosynthetic rate, stomatal conductance and water-use efficiency. Plants were grown in a common garden growth chamber environment and traits were measured at the juvenile stage. Though no significant genetic associations were detected, a considerable amount of leaf trait variation exists among cultivars, with significant correlations among multiple traits. Future studies investigating trait diversification during the domestication process of crop species can provide insight into responses to long-term selection pressures, and inform breeding efforts for sunflower.

Specified Source(s) of Funding: National Science Foundation

2:00–2:15 PM

The Effects of Salinity and Nutrient Deficiency on Spinach Growth, Physiology, and Nutrition Value

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Salinity is a major constraint to crop production in all important spinach districts of the United States and nutrient-depleted soil is an increasing concern for farmers, especially vegetable growers. The effects of salinity and nutrient deficiency on spinach were evaluated in sand cultures under greenhouse conditions. Plants were watered every day with Hoagland nutrition solution, deprived of nitrogen (N), phosphorous (P) or potassium (K) for nutrient deficiency, either with or without 20/10 mM $NaCl/CaCl_2$ for salinity treatment. Salinity itself decreased shoot fresh and dry weight (FW and DW), leaf relative water content, and specific leaf area (SLA), and increased chlorophyll and carotenoid contents, photochemical yield [Y(II)] and maximum photochemical efficiency (Fv/Fm). The N deficiency greatly reduced shoot FW and DW, SLA, and the contents of chlorophyll and carotenoids. However, the reductions in shoot FW and DW was much smaller under salt stress than under control (68% versus 85% for FW and 61% versus 79% DW). Also N deficiency decreased Y(II) and Fv/Fm under salinity treatment. Both P and K deficiency similarly reduced shoot FW and DW under both control and salt stress, and increased chlorophyll content under control condition. The P deficiency increased Fv/Fm under both control and salt stress, and Y(II) under control condition. Salinity and nutrient deficiency also affected spinach nutrition value.

2:30 PM - 2:45 PM

Using Leaf Starch to Identify Transgenic Tomatoes with Improved Greenhouse Performance

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The allocation of leaf assimilate to fruit is a major determinant of tomato yield and fitness. This process is highly regulated to ensure that carbon acquisition in source leaves is balanced with plant growth, developmental and long-term storage needs. We hypothesize that Transcription Factors (TF) as supra-regulatory proteins could partially provide the overarching control that would coordinate source-sink relations in plants and influence yield. We were able to test this using a large proprietary collection of transgenic tomato lines (8500), each ectopically expressing one of the ~1700 TFs cloned from Arabidopsis under 1 of 5 different promoters. We screened this vast population for lines with alterations in leaf starch. While source-sink interactions are complex, leaf starch may act as an indicator of changes in whole plant carbon allocation. Starch accumulates in leaves during periods of carbon sufficiency, but is degraded to sugars for export to the sinks during episodes of carbon starvation. Altered levels in the transgenic lines compared with the transgenic and non-transformed controls, may indicate changes in the carbon status of the plant due to the presence of the ectopically expressed TF. After extensive field and greenhouse screening of these lines, we selected three genotypes for further study. The TF1 and TF2 had a high starch-to-sugar ratio, and a TF3 had double the sugar and starch levels in source leaves. These lines were subjected to careful eco-physiological measurements to evaluate any changes in important agronomic traits under greenhouse conditions. The TF1 line had altered carbon distribution: identical yield but a higher number (28%; $P < 0.05$) of smaller fruit; TF2 had higher (25%; $P < 0.05$) yield and TF3 had a higher (15%; $P < 0.05$) harvest index. Metabolomic and ^{14}C-flux studies of leaf and fruit provided clues on how the presence of the respective TFs altered plant response. The results of this study will be presented.

Specified Source(s) of Funding: NSF-MCB-0620001

2:45– 3:00 PM

Antagonistic Effects of Auxins and Abscisic Acid on Floret Closure of Rice (*Oryza sativa*)

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Rice flowering refers to the opening and closing of the floret and takes 6–10 days for the numerous florets within the same panicle to complete flowering. Rice flowering time occurs at a

certain time of the day and varies among varieties and weather conditions. The regulation of rice floret opening and closing is very important for hybrid rice seed production. However, little is known about the effects of plant hormones on rice flowering. Our previous studies have shown that jasmonate (JA) and its methyl ester, methyl jasmonate (MeJA) play remarkable roles in promoting rice floret opening. In this study, we investigated the effects of auxins including indole-3-acidic acid (IAA), indole-3-butyric acid (IBA), 1-naphthalene-acetic acid (NAA), 2,4-dichlorophenoxy acetic acid (2,4-D) and 3,6-dichloro-2-methoxybenzoic acid (Dicamba, or DIC) and abscisic acid (ABA) on floret closure of fertile rice (Jia-zao-211, Huang-yue-zhan, Jin-you-gui-9, Ping-hui-141) and sterile rice (Wu-feng-A, Zhong-9A, Bo-you-A). The results showed that the percentages of closed florets were significantly lower in plants treated with IAA, IBA, 2,4-D, DIC, and NAA and that the durations of floret opening were significantly longer in plants treated with the same auxins. The auxins on floret closure exhibited time- and concentration-dependant effects. The higher concentrations of auxins resulted in higher percentages of closed florets and longer time of floret opening. ABA displayed opposite effects of auxins because it increased the percentages of floret closure and decreased the length of floret opening of rice varieties. Similarly, higher concentrations of ABA resulted in lower percentages of closed florets and shorter time of floret opening. The effective concentrations of auxins and ABA on floret closure of rice were 100–200 mg/mL. The effects of auxins and ABA on floret closure were varied somewhat with different rice varieties. Our results showed that auxins delayed but ABA promoted the closure of rice floret regardless of the varieties. This study suggests that auxins and ABA are antagonists on floret closure of rice.

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Friday, 7 August 2015

Growth Chambers and Controlled Environments 3

Moderator: Joshua K. Craver
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1:45–2:00 PM

A Biofeedback System for Plant-driven Photosynthetic Lighting

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Plant factories produce crops in closed growing environments with only artificial light. The electrical energy required for photosynthetic lighting is a significant expense, accounting for up to 60% of the overall of production costs. To reduce energy expenses, we have developed a biofeedback system that can automatically, and in real-time, adjust light levels based on the efficiency with which plants use the photosynthetic light provided by light emitting diodes (LEDs). Chlorophyll fluorescence measurements are used to determine the quantum yield of photosystem II (the fraction of absorbed light that is used to drive the light reactions of photosynthesis) and electron transport rate (ETR; the rate of the light reactions). The light output of the LEDs is adjusted by changing their duty cycle. To maintain a specific ETR over time, the biofeedback system automatically adjusts the light intensity whenever the measured ETR is different from a specified rate. We tested this approach with pothos, lettuce, and sweet potato. The biofeedback system was able to maintain a wide range of ETRs (up to about 70 to 100 $\mu mol \cdot m^{-2} \cdot s^{-1}$, depending on the species), even though quantum yield decreased with increasing light levels. Electron transport rates could be controlled more precisely at lower rates. Attempts to control the light level based on quantum yield were not very successful: the system gradually decreased the light level more and more to maintain steady quantum yields. Although quantum yields were maintained close to specified values, the lights were dimmed so much that ETRs were very low, resulting in very low photosynthetic rates. Our trials show that chlorophyll fluorescence can be used as a tool for automating the biofeedback control of LED lights. An important next step will be to determine how this approach can be used to optimize the light environment in plant factories, balancing the need for high ETRs with efficient light use.

Specified Source(s) of Funding: Georgia Research Alliance

2:00–2:15 PM

End-of-day Far-red Lighting to Mitigate Intumescences on Tomato Seedlings Grown under LEDs

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Light emitting diodes (LEDs) have attracted commercial interest as a light source for transplant production under closed-type conditions. However, intumescences, a physiological disorder characterized by tumors on leaves and stems, are observed in some cultivars of tomatoes grown under LEDs. When damage is severe, leaf necrosis and leaf abscission occur, resulting in growth reduction. Exposing plants to ultraviolet (UV) light (especially

UV-B) can inhibit intumescences, however availability of UV-B LEDs is still limited. Morrow and Tibbitts (1988) demonstrated that far-red lighting following red lighting inhibited intumescences in tomato leaf disks. End-of-day far-red (EOD-FR) lighting using LEDs could be a cost effective alternative to inhibit intumescences. The objective of this study was to examine the effect of EOD-FR lighting on intumescences on tomato seedlings grown under LEDs. Tomato rootstock seedlings (cv. 'Beaufort') were grown in a growth chamber under 100 μmol·m^{-2}·s^{-1} photosynthetic photon flux (PPF) using blue (B) and red (R) LEDs with 10B-90R% or 75B-25R% photon flux, 18-h photoperiod, 25 °C air temperature, and ambient CO_2. Varied doses (1, 2, 4, 9, or 74 mmol·m^{-2}·d^{-1}) of EOD-FR lighting were applied to the seedlings grown under the LED treatments and intumescence development was compared to a control treatment (no EOD-FR lighting). The seedlings were evaluated for incidence of intumescence 16 days after seeding. In the seedlings grown under the 10B-90R% treatment, the 1 mmol·m^{-2}·d^{-1} EOD-FR lighting (5.2 μmol·m^{-2}·s^{-1} for 3.3 minutes) reduced the incidence of stem intumescence and leaf abscission from 62.5% to 0.0% and from 54.2% to 0.0%, respectively compared to the control (no EOD-FR lighting). The 1 mmol·m-2·d-1 EOD-FR lighting reduced the percentage of leaves that exhibited intumescences from 62.0% to 42.3% compared to the control (no EOD-FR lighting). The efficacy of EOD-FR lighting was the same regardless of doses (1–74 mmol·m^{-2}·d^{-1}). The seedlings grown under the 75B-25R% treatment with EOD-FR lighting had 5.0 % of leaves exhibiting intumescences, compared to 38.6% in the control (75B-25R% treatment without EOD-FR lighting) or 39.4% observed in the 10B-90R% treatment with the same dose of EOD-FR lighting. This study showed that intumescences in tomato seedlings grown under LEDs can be mitigated by combining relatively high blue photon flux ratio during the photoperiod and EOD-FR lighting at 1 mmol·m^{-2}·d^{-1}.

Specified Source(s) of Funding: USDA–NIFA SCRI

2:15–2:30 PM

Effects of Diffused Cover Materials on Greenhouse Microclimate, Plant Growth, Fruit Yield and Quality, and Energy Use in Greenhouse Cucumber and Sweet Pepper Production

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Greenhouse cover materials affect not only the light quantity and quality entering the greenhouse but also heat loss to the outside, which in turn have a large influence on greenhouse microclimate, plant growth, fruit yield and quality, and heating energy use. Diffused cover materials have the potential to improve the light distribution within crop canopy, and reduce high temperature stress and increase fruit yield and quality in the summer. In this study, two greenhouse trials (one on long English cucumbers, Oct. to Dec. 2013; and one on sweet peppers, Feb. to Aug. 2014) were conducted using six greenhouses covered with standard (STD) and newly developed diffused polyethylene film (DPE) and polycarbonate sheet (DPC), two greenhouses for each cover material. It was found that the diffused cover materials (DPE and DPC) improved the vertical temperature and light distribution within crop canopy, increased light use efficiency, and reduced fruit disorders in the summer. The improvement in light use efficiency could compensate for a small/few percentage of decrease in total light transmission. Therefore, DPE greenhouses had similar marketable fruit yield as STD in fall/winter production even if its light transmission was 3% to 5% lower than STD. DPE achieved higher marketable fruit yield than STD in summer production because of its lower incidence of fruit orders. DPE greenhouses used similar amount of energy as STD greenhouses in both trials. Therefore, DPE may be a better greenhouse cover material than STD for year-round greenhouse vegetable production. DPC greenhouses saved over 10% energy in comparison to STD and DPE greenhouses. However, its fruit yield was not as high as STD and DPE because of its much lower light transmission, especially at lower solar angles during fall/winter production. Therefore, when plastic cover material manufacturers/developers try to increase the proportion of diffused light with their cover materials, the total light transmission should not be compromised.

2:30–2:45 PM

Daily Light Integral and Light Quality from Sole-source Light-emitting Diodes Affect Seedling Quality and Subsequent Flowering of Long-day Bedding Plant Species

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Light-emitting diodes (LEDs) have become an increasingly popular alternative to traditional lighting sources due to their energy efficiency, low output of radiant heat, and ability to target specific wavelengths of light. Previous research has shown that annual bedding plant seedlings can be produced using sole-source (SS) lighting provided by LEDs. However, a delay in flowering for some long-day (LD) species during finishing has been observed when LED SS lighting provided only red and

blue wavelengths of light. Thus, the objectives of this research were to: 1) further evaluate the effects of various light qualities and quantities on young bedding plant production; and 2) determine whether far-red wavelengths included in SS light quality would promote earlier flowering of LD plants at finish. Seeds of coreopsis (*Coreopsis grandiflora* 'Sunfire'), pansy (*Viola* ×*wittrockiana* 'Matrix™ Yellow'), and petunia (*Petunia* ×*hybrida* 'Purple Wave') were sown in 288-trays and placed on multi-layer shelves in a walk-in growth chamber. A daily light integral (DLI) of 6, 12, or 18 mol·m^{-2}·d^{-1} was achieved from SS LED arrays under a 16-h photoperiod with light ratios (%) of red:green:blue 74:18:8 (R_{74}:G_{18}:B_8), red:blue 87:13 (R_{87}:B_{13}), or red:far-red:blue 84:7:9 (R_{84}:FR_7:B_9). Seedlings were evaluated for transplant quality two, three, and four weeks after treatment initiation. Additionally, seedlings were transplanted and grown under a target DLI of 10 to 12 mol·m^{-2}·d^{-1} in the greenhouse. Regardless of light quality, as the DLI increased from 6 to 12 mol·m^{-2}·d^{-1}, stem caliper, shoot, and root dry mass of seedlings increased for all three species. Similarly, stem length of pansy and petunia seedlings decreased as the DLI increased. Pansy seedlings transplanted after three weeks under a DLI of 18 mol·m^{-2}·d^{-1} from LEDs providing R_{84}:FR_7:B_9 flowered an average of 3 and 5 days earlier than those from the R_{87}:B_{13} and R_{74}:G_{18}:B_8 treatments, respectively; while those seedlings under R_{84}:FR_7:B_9 for 4 weeks flowered an average of 13 and 8 days earlier. These results provide information regarding the specific light parameters from commercially available LEDs necessary to optimally produce high-quality seedlings under SS lighting. Furthermore, the addition of far-red wavelengths could significantly reduce time to flower after transplant and allow for a faster greenhouse turnover of some LD crops.

2:45–3:00 PM

The Search of an Optimized Supplemental Lighting Spectrum for Greenhouse Tomato Production

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With ongoing, anticipated energy-efficiency improvements, as well as ever-improving light-distribution architectures, light-emitting diodes (LEDs) are a promising alternative to current supplemental lighting (SL) technologies for greenhouse crop production. Yet, significant opportunities remain to optimize spectral-quality effects on plant growth and development using LEDs to supplement sunlight in the greenhouse. The objective of this study was to compare different spectra of intracanopy (IC) SL using LEDs for high-wire greenhouse tomato (*Solanum lycopersicum* cv. Merlice) production in a mid-northern climate (lat. 40° N). Double-headed plants were grown in a glass-glazed greenhouse during a winter-to-summer production cycle in 2015. Five lighting treatments were evaluated in the study: natural solar light only (control); natural + SL from IC-LED towers using either 25% blue + 60% red + 15% far-red (25B-60R-15FR); 80% red + 20% far-red (80R-20FR); 10% blue + 90% red (10B-90R); or 30% blue + 70% red (30B-70R). An increasing solar daily light integral (DLI) occurred naturally for all treatments, and a constant DLI of 10.4 mol·m^{-2}·d^{-1} (180 μmol·m^{-2}·s^{-1} for 16 h d^{-1}) was provided to all plants grown with SL. Plant productivity, leaf gas-exchange responses, and stomatal density and index were measured for plants grown in each treatment. Preliminary results from this experiment will be presented.

Specified Source(s) of Funding: NIFA SCRI grant 2010-51181-21369

Friday, 7 August 2015

Organic Horticulture 2

Moderator: Amjad A. Ahmad
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1:45–2:00 PM

Biodegradable Mulch Film for Organic Production Systems

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Biodegradable mulch film is considered to be a sustainable technology with several potential advantages as compared to traditional plastic mulch, such as: reduced labor costs (biodegradable mulch does not need to be removed from the field), cost savings for disposal, and reduced landfill waste. Effective 30 Oct. 2014, the USDA–AMS National Organic Program (NOP) added biodegradable biobased mulch film to their list of allowed substances for organic crop production. Biodegradation of biobased mulch film is considered to be a form of removal at the end of a growing season. To be considered biodegradable and biobased, a mulch film must: 1) reach at least 90% degradation in the soil within two years or less in accordance with ISO 17556 or ASTM D5988; 2) be biobased in accordance with ASTM D6866; and 3) must meet compostability specifications of one of the following standards: ASTM D6400, ASTM D6868, EN 13432, EN 14995, or ISO 17088. In addition, a biodegradable biobased mulch film may not be produced with organisms or feedstock derived from excluded methods, and it may not be produced with non-biobased synthetic polymers; minor additives such as colorants and processing aids are not required to be biobased. Field research results show variability in degradation of biodegradable biobased mulch film in soil across diverse sites such that some products may not achieve 90% degradation within two years. Factors that affect degradation include climate, soil type, pH, microbes, irrigation, and other production practices. If more than 10% of the mulch remains in the soil after two years, the grower will be in non-compliance with organic certification standards. Organic certifying agencies are responsible for verifying that adequate degradation of biodegradable biobased mulch film has occurred in the soil, however there is no established, verified protocol for this measurement. If biodegradable biobased

mulch film is used on the same field for consecutive years, it is not clear how the grower or inspector will differentiate between mulch that remains after two years and mulch that has been in the soil for less than two years. There is an assumption that the remaining 10% of the biodegradable biobased mulch film will degrade in the soil after two years but this is not specified in the rule. At this time, no biodegradable mulch films available in the United States are allowable for use in certified organic production systems primarily because they do not meet the standards regarding non-biobased content.

Specified Source(s) of Funding: SCRI Biodegradable Mulch Project

2:00–2:15 PM

Cover Crops and Conservation Tillage in Organic Jalapeno Pepper (*Capsicum annum* L. 'Tormenta')

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In 2012, teams from the Universities of Virgin Islands, Puerto Rico, and Florida initiated field trails to facilitate the adoption of cover crops and soil conservation practices among farmers in the tropics and subtropics. At the University of Florida/IFAS Suwannee Valley Agricultural Education Center in Live Oak, the first year of a two-year trial was conducted on certified organic land to evaluate the weed suppressive ability of cover crop residue compared to plastic mulch. A cover crop of sunn hemp (*Crotalaria juncea* L.) was seeded 85 days prior to pepper on the entire experimental area and terminated 12 July 2013. Treatments were arranged in a randomized complete-block design split with two weed removal frequencies, and replicated four times. Treatments included: sunn hemp terminated with a roller-crimper (RC), sunn hemp mowed and incorporated followed by an application of rye straw residue (MI+straw), sunn hemp MI followed by the application of white on black plastic mulch (MI+plastic) and sunn hemp MI and left without mulch to serve as a check plot (MI+none). Dry granular fertilizer (3-2-2) was applied by hand at a rate of 125 lb/acre (63.5 kg/ha) nitrogen (7.25 lb per bed) in two bands, and except for RC plots, was lightly incorporated with a roto tiller. The balance of recommended nitrogen was applied weekly via fertigation using an organic-compliant fertilizer (4-1-1) following transplant establishment. Drip tape was installed in all plots. Peppers were transplanted July 27. Weed frequency split (every week or every third week) was initiated six weeks after transplanting so that sufficient data could be obtained on the weed suppressive capabilities of the treatments during the critical weed-free period.

Specified Source(s) of Funding: Southern Region SARE, Project #LS12-252

2:15–2:30 PM

Use of Biochar and Compost Improves the Productivity of Nutrient-poor Tropical Soils

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Amendments are usually needed to support crop growth in highly weathered soils. Two biochars (0, and 2%) and composts (0, and 2%), were applied to two tropical soils of Hawaii (Leilehua series, Ultisol and Wahiawa series, Oxisol). Chinese cabbage (*Brassica rapa cv*. Bonsai) was used as the test plant in two greenhouse trials. The experimental design was a factorial in a completely randomized design with three replicates. Plant fresh and dry weights, soil pH, EC, total N, and other nutrients in soil and plant tissue were measured. The results showed that the interaction between biochar and compost additions significantly affected the pH in both soils. Cabbage growth was almost double in the acid Ultisol when amended with 2% lac tree (*Schleichera oleosa*) biochar and 2% vermicompost compared with either the lime or the vermicompost treatment alone. Soil pH was increased by one unit on average, and EC (in 1:10 soil-to-water ratio) was increased from 0.35 to 0.47 dS/m and 0.30 to 0.37 dS/m in the Ultisol and Oxisol, respectively. Exchangeable aluminum was decreased from 2.6 cmolc/kg to virtually zero in the high-Al Ultiso. Mehlich-3 extractable Mn and Fe in the high-Mn Oxisol decreased from 806 and 64 to 360 and 37 mg/kg, respectively. The enhanced cabbage growth in these nutrient-poor soils was likely due to the improvement of nutrient retention/availability, increasing soil pH, and decreasing Al/Mn toxicity by the additions of biochar and compost.

Specified Source(s) of Funding: Western SARE

2:30–2:45 PM

Enhancing Nitrogen Availability in Liquid Fertilizers Derived from Solid Organic Sources for Fertigation

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The need for solution fertilizers from local resources is important, especially for growers of long-term food crops from taro and fruit trees. Locally derived nutrient fertilizers for fertigation would help local farmers remain competitive and sustainable. With this goal in mind, we used tankage (meat and bone meal by products) containing about 10% total nitrogen (N) as a N source. Three main factors were manipulated to enhance the release of

inorganic N [Nitrate (NO_3-N) and ammonium (NH_4-N)] into solution: 1) time (0 to 48 hours) and temperature (75 °F and 95 °F; 2) cover and aeration; and 3) chemical and biological agents (soil, sugar, baking soda, and vermicompost). Time up to 48 hours and 95 °F significantly increased the NO_3-N concentration in the liquid fertilizer by 65% and 25%, respectively. Cover and brewing the solution increased significantly NO_3-N concentration in the liquid by 20% and 40%, respectively. The addition of a small amount (0.1 gram or less) of vermicompost significantly increased the NO_3-N release by 60, 55, and 35% compared with soil, sugar, and baking soda, respectively. Individual and combined factors were tested in a series of lab trials. Greenhouse and on-farm trials are ongoing to evaluate the quality of the produced liquid fertilizers.

Specified Source(s) of Funding: WESTERN SARE

2:45–3:00 PM

Assessing Plant Growth, Water Quality, and Economic Effects from Application of a Plant-based Aquafeed in a Recirculating Aquaponic System

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Aquaponics, the integrated production of fish and hydroponic crops in a recirculating system, is an intensive cultivation method in which metabolic fish wastes fertilize plants. This study compares the effects of two aquafeeds on Red amaranth (*Amaranthus tricolor*) productivity and on water quality parameters under cultivation of Blue tilapia (*Oreochromis aureus*), in three aquaponic replicate units per treatment over a 60-day experimental trial. The fishmeal-based control feed contains higher crude protein (40%) and phosphorus (1.12%) than the plant-based alternative feed (32% and 0.40%, respectively). The alternative feed resulted in a significantly higher amaranth crop yield ($P < 0.05$), with significantly lower concentrations of nitrate-N (NO_3-N) and total dissolved solids (TDS) in the aquaponic culture water over the course of the experiment. Orthophosphate (PO_4-P), total ammonia nitrogen (TAN), pH and dissolved oxygen (DO) levels were not significantly different between the control and alternative aquafeed treatments. Economic analysis revealed that improved plant productivity from the plant-based, lower-protein aquafeed might potentially increase total aquaponic farm revenue despite reduced fish production.

Specified Source(s) of Funding: USDA–NIFA

Friday, 7 August 2015

Plant Biotechnology 2

Moderator: Thomas A. Colquhoun
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1:45–2:00 PM

Exploration of Plant–Animal Interactions via Multiple Modalities

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The University of Florida/IFAS (UF/IFAS) maintains extensive plant breeding programs for certain fruits like tomato, strawberry, and blueberry that provide an opportunity to grow and sample large populations of diverse fruit season after season. Gainesville (home to the university) consists of a varied and ever changing population, which creates an ideal scenario for human sensory and hedonic evaluations of these fruits over multiple seasons. Understanding how consumers perceive taste and flavor of these fruits, and what specific aspects of the fruits drive overall liking will enable UF/IFAS plant breeders to select and produce more flavorful and healthy fruits through a methodology called consumer-assisted-selection (CAS). We are numerous seasons and three fruit crops into this CAS methodology, and speculate that we will need many more to discover the complete story of fruit flavor and human sensory/hedonic perception. However, our initial attempts to deconstruct tomato, strawberry, and blueberry fruits into measureable biochemical profiles and compare these profiles to sensory and hedonic ratings has illuminated many different parts of the flavor story. Numerous cultivars of tomato, strawberry, and blueberry fruits from multiple harvest seasons were assayed for taste and flavor qualities like (and among others) simple sugars, simple acids, and volatile molecules using conventional qualitative and quantitative methods (biochemical assays, spectrophotometric, titration, GC-MS, LC-MS). These biochemical data were then statistically related to psychophysical data gained from human taste panels conducted in parallel to the biochemical inventorying using sophisticated hedonic and sensory scales (hedonic) general labeled magnitude scale [(h)gLMS] to identify biochemicals with direct association to desirable taste and flavor aspects of each fruit. Analysis of the individual fruit systems (i.e. tomato or strawberry or blueberry) has resulted in three separate publications highlighting the diversity of biochemical composition through cultivars, identification of specific volatiles that positively influence perceived sweetness without the contribution of sugar, and any genetic by environmental influence on taste and flavor. The ability to compare these fruits over a harvesting season and/or between seasons is given by the psychophysical methods utilized. The (h)gLMS scales are designed to enable cross modality matching, which simply stated is a valid across group comparison. The statistical power to compare within fruit type (or an intra-fruit comparison) or time has generated many impactful observations about tomato, strawberry, and blueberry taste and flavor. The same statistical reasoning allows the inter-fruit comparison, which has opened broader concepts of taste and flavor.

An asterisk (*) following a name indicates the presenting author.

Specified Source(s) of Funding: NIH, USDA–ARS–FNRI, USDA–FDACS

2:00–2:15 PM

Reduction of *MLO* Expression in Petunia Increases Resistance to Powdery Mildew

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Susceptibility genes are plant genes used by pathogens to establish infection. We examined whether resistance to powdery mildew (*Podosphaera xanthii*) could be obtained in *Petunia hybrida* by knocking out the susceptibility gene *MLO*. A petunia gene, *PhMLO*, was identified that had 85% amino acid similarity to *SlMLO1* from tomato. Based on the *PhMLO* sequence, an RNAi construct was developed. The *PhMLO* RNAi construct was introduced into leaf discs of *P. hybrida* 'Mitchell' by Agrobacterium-mediated transformation. Ten independently transformed shoots were rooted and the regenerated T0 plants were vegetatively propagated. RT-PCR analysis found that four RNAi lines (2, 3, 8, 11) had reduced levels of *PhMLO* expression compared to transgenic controls. The RNAi line with the lowest *PhMLO* expression (line 11) did not survive. In two experiments with whole plants, leaves of RNAi lines and controls were inoculated with a 10-μl suspension of *P. xanthii* conidia (1 10^5 conidia/ml). The time course of infection and the infected leaf area were examined over a 16-day incubation in an growth chamber. The RNAi lines 2, 3, and 8 showed delayed infection and a reduced area of infection compared to transgenic controls. The transgenic lines were self-pollinated and T1 progeny were produced that will be examined for powdery mildew resistance and pleiotropic effects on growth.

Specified Source(s) of Funding: USDA Hatch project GEO00641

2:15–2:30 PM

A Basic Helix-Loop-Helix Transcriptional Factor Regulates Flower Senescence by Mediating Ethylene Biosynthesis in Petunia

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The bHLH transcription factors play important roles in plant growth and development. However, there was no report about the function of bHLH in flower senescence. In this study, a bHLH transcriptional factor, *PhFBH4*, was found to be dramatically up-regulated during flower senescence. Transcriptional level of *PhFBH4* is induced by plant hormones and abiotic stress treatments. Ectopic expression of *PhFBH4* influenced flower longevity in petunia. Silencing of *PhFBH4* using virus-induced gene silencing and antisense approach extended flower longevity while transgenic petunia flowers with an over-expression construct showed a reduction in lifespan. Abundance of transcripts of senescence-related genes (*SAG12*, *SAG29*) was significantly changed in petunia *PhFBH4* transgenic flowers. However, the overexpression or silencing *PhFBH4* increased or reduced, respectively, transcript abundances of important ethylene biosynthesis-related genes *ACO1* and *ACS1*, therefore influencing ethylene production. We also found that PhFBH4 protein physically interacted with the G-box cis-element in the promoter of *ACS1,* suggesting that *ACS1* was a direct target of PhFBH4 protein. In addition, ectopic expression of this gene altered plant development including plant height, internode length, and size of leaves and flowers, accompanying with alterations of transcript abundances in GA biosynthesis-related gene *GA2OX3*. Our results indicate *PhFBH4* plays an important role in regulating plant development through modulating ethylene biosynthesis pathway.

Specified Source(s) of Funding: USDA–ARS

2:30–2:45 PM

Petunia Plants Transformed with an ABA Biosynthesis Gene under Control of a Stress-inducible Promoter Improve Water Use Efficiency under Limited Irrigation

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Limited water availability and the long-term effects of global warming makes drought resistant crops an attractive approach for geneticists and plant breeders. Previously, we reported that petunia plants transformed with a key abscisic acid (ABA) biosynthesis gene, 9-cis-epoxycarotenoid dioxygenase (NCED), using the stress inducible promoter rd29A resulted in mild increase in ABA accumulation, accompanied by stomatal closure and significant increase in drought resistance under drought stress. Here, we conducted a greenhouse study using the transgenic plants to evaluate the effect of three different irrigation regimes on plant growth, physiological parameters, relative water content, and water use efficiency. The irrigation treatments consisted of full irrigation-100% (I_{-100}) at field capacity, irrigation-75% (I_{-75}) and irrigation-50% (I_{-50}). The results showed that under well irrigated conditions (I_{-100} treatment), P_{rd29A}::NCED plants exhibited a similar growth pattern

An asterisk (*) following a name indicates the presenting author.

and no significant differences were detected for all the physiological measurements when compared to the control plants. Under restrictive water supply (I_{-75} and I_{-50} treatments), transgenic plants overexpressing LeNCED maintained relatively higher water content, a higher gas exchange and higher photosynthetic activity, produced more biomass, and much better water use efficiency than the non-transformed control plants.

Specified Source(s) of Funding: USDA–ARS

2:45–3:00 PM

Phenylalanine and Abiotic Regulation of Early Defense

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Ultraviolet (UV) radiation and visible light are required for appropriate photomorphogenic and other developmental processes in seedlings. Stress responses early postgermination have received little attention in many intensively bred plants of economic interest, particularly how carbon and nitrogen may be utilized under different yet expected pressures. We have examined germination, seedling growth, and subcellular responses to ROS-inducing abiotic stress in germinating and young seedlings in response to UV and cold abiotic signals. We have investigated how phenylalanine, a key substrate in the phenylpropanoid pathway, may be involved in these responses in young seedlings of broccoli and soybean. We observed that signs of stress (failure to germinate or delayed germination, cessation of elongation, ROS et al.) were reduced if phenylalanine were provided before germination, during imbibition in seeds germinated in darkness. Moreover, seedling vigor in white light growth was improved with provision of phenylalanine, but only at specific points in development. Phenylalanine provision impacted both subcellular pools of phenylpropanoids, and also cuticular attributes of photosynthesizing leaves. Overall, these data indicate that breeding efforts can target management of nutrient delivery in the seed-to-seedling transition to reduce seedling loss due to stress, and minimizing later loss of yield.

3:00–3:15 PM

Applying Genotyping by Sequencing Technology on *Rosa* spp

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Black spot disease [*Diplocarpon rosae* (Lib.) Wolf] of rose is the most important leaf disease of garden roses in warm humid areas. Although the partial (horizontal) resistance to black spot has been shown to be moderately heritable, the responsible quantitative trait loci (QTLs) remain unidentified. Because of the interspecific nature and high heterozygosity in commercial roses the genetic information available on rose is limited. To effectively identify markers associated with the QTL(s) controlling black spot resistance, one needs abundant markers along the genome and careful phenotyping. The objective of this study is to utilize genotyping by sequencing technology to generate abundant single nucleotide polymorphism (SNP) markers for genetic linkage and QTL mapping. Thus far, rose seedlings and parents have been phenotyped for partial black spot resistance in the lab and the field, and an efficient protocol to extract high quality DNA for sequencing from rose leaves has been developed. Four diploid rose populations created from the crosses of black spot resistant breeding lines derived from *R. wichuriana* 'Basye's Thornless' with susceptible commercial cultivars ('Vineyard Song', 'Red Fairy', and 'Little Chief') were used for SNP detection. Their genomic DNA was digested using methylation sensitive enzymes and the resulting fragments were sequenced using the Illumina Hiseq 2500 platform. Based on preliminary data, about 89% to 91% of the sequencing reads were aligned to the rose contigs and around 50% of the reads were mapped to the strawberry genome, respectively. This SNP data along with SSR (simple sequence repeat) data will be further utilized to create a diploid consensus map and identify markers associated with the partial black spot resistance trait.

Friday, 7 August 2015

Pomology 3

Moderator: Emily K. Lavely
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1:45–2:00 PM

Measuring Fine Roots in Fruit Crops: Finding Order in Functional Variation

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Sustained production in horticultural crops depends on fine roots to supply water and nutrients over the life of a planting. However the linkages of root measurements to root function are often arbitrary. Commonly experiments that investigated root processes used traditional methods that characterize fine roots as those with diameters of ≤ 2 mm; however, these methods do not account for variation in fine-root diameter across species or fine-root specialization for absorption or transport. Therefore, the objective of this research was to examine the efficacy of using a more functional approach based on root branching order to predict root function in economically important fruit crops. Fine roots of apple (*Malus domestica*), peach (*Prunus persica*), grape (*Vitus vinifera*), and sour orange (*Citrus aurantium*) were sampled in the United States, and Asian pear (*Pyrus pyrifolia*) and jujube (*Ziziphus jujuba*) roots were sampled in China. Fine-root branches were sorted into orders one through five, and morphological and anatomical traits such as root diameter, specific root length (SRL), mycorrhizal colonization, C:N ratio, and the presence of cork periderm and secondary vascular tissue were assessed. Across all species, lower order roots (1 through 3) had no development of secondary vascular tissue or cork periderm, low C:N ratios, and presence of mycorrhizal fungal colonization, which suggests that these roots are specialized for absorption of water and nutrients. In contrast, fourth and fifth order roots that were often less than 2 mm in diameter typically had development of cork periderm and secondary vascular tissue, high C:N ratios, and little or no mycorrhizal colonization, which suggests that these roots are specialized for transport of water and nutrients. These results suggest that the use of root order is an effective predictor of fine root function and is useful to group fine roots into two distinct classes: absorptive and transport. Classifying root function based on root order can be used to draw meaningful conclusions about root foraging efficiency, production, and turnover, which have implications for whole-plant carbon allocation and root system responses to common horticultural practices such as fertilizer application and irrigation.

2:00–2:15 PM

Mechanically Pruning Apple and Sweet Cherry Increases Efficiency

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Pruning is a labor- and time-demanding operation that generally represents the second greatest annual expense for tree fruit growers worldwide. Previous research into mechanized pruning in traditional orchard architectures yielded negative results. As orchardists adopt new two-dimensional, planar systems there is improved potential for the adoption of automation and mechanization technologies, including pruning. To date, there are few studies on the effectiveness of mechanical pruning in the top two tree fruit crops in the Pacific Northwest (PNW)—apple (*Malus domestica* Borkh.) and sweet cherry (*Prunus avium* L.). The goal of this project was to determine best management practices for pruning PNW apples and sweet cherry with a commercial sickle bar mechanical pruner. Trials were initiated in 2014 in a commercial 'Tieton'/'Gisela®5' sweet cherry orchard trained to the Upright Fruiting Offshoot (UFO) system. Mechanical pruning (hedging and topping) was 23 times more efficient compared to standard manual pruning practices; however, hand pruning removed twice as much wood as mechanical pruning. Additionally, experiments comparing hand pruning (dormant only) with mechanized pruning at 3 stages (dormant, or summer at 15 or 20 leaves) were established in commercial 'Fuji'/'Nic 29' and 'Pink Lady'/'M9-337' orchards trained to the slender spindle system. Dormant mechanical pruning in 'Pink Lady' reduced yield 13% compared to hand pruning. Neither timing of mechanical summer pruning affected yield. Dormant mechanical pruning on 'Fuji' was twice as fast as hand pruning (9 s/tree versus 21 s/tree); however, the latter removed three times more wood. Manual pruning was more selective than the hedger, and most of the cuts performed by hand were thinning cuts—a key reason that more wood was removed by hand pruning. After mechanical summer pruning, up to 6.5% of fruit were damaged, though these were removed during green fruit thinning. The results of this first year of research suggest that mechanization can improve pruning efficiency with minimum effects on yield and fruit damage.

Specified Source(s) of Funding: Washington Tree Fruit Research Commission

2:15–2:30 PM

Accumulation of Total Phenolics and Antioxidant Activity in Different Tissues of Peach Fruit

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Nutritional composition and content in peach fruit is often measured using flesh tissue, based on the assumption that consumers usually remove skin (peel) prior to consuming the flesh, and that the flesh tissue accounts for most of the peach fruit. To determine if there are differences in the total phenolic content between different tissues of peach fruit, we evaluated ten peach cultivars and two advanced selections with different flesh color

(white, yellow, and red) and blush level (low, medium, and high) for the total phenolic content and antioxidant activity in different fruit tissues (peel and flesh, separately and together) across two years. Total phenolics showed no significant differences between fruit tissues regardless of the flesh color. In contrast, antioxidant activity exhibited significant differences among different tissues regardless of the flesh color. The lowest antioxidant activity was observed in the flesh (836.5 μg Trolox/ g FW), and the highest in the peel (1,610.5). Total phenolics also showed no significant differences among different flesh colors regardless of fruit tissues. However, individual phenolic compounds, such as flavonoids and anthocyanins exhibited significant differences in different flesh colors and tissues. Interestingly, individuals with yellow flesh color, the most popular peach flesh color in the U.S fresh market, showed no significant differences in accumulation of total phenolics among peel and flesh, suggesting that similar levels of total phenolics are consumed regardless of peel presence. Our present study also revealed the highest antioxidant and total phenolics accumulation in low blush yellow and white-fleshed peaches compared to other blush levels. As expected, anthocyanin accumulation was the highest in the high blushed fruit and red flesh. The relative antioxidant capacity (RAC) was positively correlated with total phenolics in the flesh plus skin tissue among the different flesh colors, with the highest correlation observed in red flesh ($r = 0.965$, $P < 0.01$). The pros and cons of analysis of total nutritional content in peach fruit and the differences in individual compound accumulation between different tissues will be discussed.

Specified Source(s) of Funding: USDA

2:30–2:45 PM

Effects of Deficit Irrigation Strategies on Peach Trees Grown in the Desert of Western Nile Delta of Egypt

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Field experiments were conducted in 2011 and 2012 to evaluate the responses of two-year-old peach trees *Prunus persica* (L.) Batsch cv. early swelling to regulated deficit irrigation (RDI) and partial root-zone drying (PRD) strategies. Trees were trained to a Y-shaped high-density system and drip irrigated. Six irrigation treatments were imposed: Irrigation control treatment (C = full irrigation) that was scheduled based on climatic data according to the crop water balance technique. The RDI treatments consisted of two percentage levels of RDI-75 and RDI-50, which received 75% and 50% of the irrigation control treatment, respectively. The PRD treatments consisted of three percentage levels of PRD-100, PRD-75, and PRD-50 that received 100%, 75%, and 50% of the irrigation control treatment, respectively. The dripper lines of PRD treatments were worked alternately every seven days. Replicates were assigned for each treatment using a completely randomised block design. Treatments were initiated at the pit hardening stage and continued until harvesting. The effects of the irrigation treatments on tree water use efficiency, physiological responses of leaves and fruits using the electron microscope imaging, fruit growth, yield, and fruit quality will be presented.

2:45–3:00 PM

Sequencing Analysis of Wood-decay Fungi Associated with Peach Scaffold Breakage

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Breakage of healthy-looking scaffold limbs is commonly seen in peach orchards in central Georgia, in the United States, and may have impact on the health and longevity of peach trees. White fungal mycelia were observed on the broken surface of some newly snapped, but otherwise healthy-looking peach scaffold limbs. Crosscut limb sections from apparently healthy scion cultivars were collected and incubated under high humidity for two weeks. Fungal growth was observed on the crosscut surface in two repeated experiments. In this study, genomic DNAs were extracted from the fungus growing on surface of the crosscut sections. Using next-generation sequencing technology and metagenomic analysis, two white-rot fungi, *Trametes versicolor* and *Schizophyllum commune*, were deemed to be the most likely fungi colonizing the heartwood in these specimens. The former likely was predominant over the latter partly because there was a much greater number of read alignments onto the sequences from the *T. versicolor* genome than that from the *S. commune* genome. The co-existence of the two fungi were confirmed by Sanger sequencing of an internal transcribed spacer (ITS) amplicon and amplicons from new primers designed from selected contigs, as two different fragments of similar sizes were amplified by the ITS and most selected primers from the DNA extracted from the specimens. Possible reasons for the white-rot fungi colonizing and growing within the peach limbs of apparently healthy, living trees are discussed, as are the likely impact of the colonization on the peach tree health. Further research needs are considered.

3:00–3:15 PM

Investigating the Role of Near-harvest Deficit Irrigation on Sweet Cherry Fruit Quality

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Water management plays an important role in fruit quality, particularly for fleshy drupes such as sweet cherry (*Prunus avium* L.). Approximately half of the nation's sweet cherries are produced in Washington State where growers are divided on the role of near-harvest irrigation (i.e., water applied within a few weeks of harvest) on key fruit quality attributes like firmness, soluble solids, size as well as the fruits' susceptibility to rain-induced splitting. The objective of this research was to elucidate the role of near-harvest irrigation on sweet cherry fruit quality traits and cracking susceptibility. Two trials were conducted in a commercial 'Lapins'/Mazzard orchard near Brewster, Washington. We established a trial with three irrigation treatments in a completely randomized design with three reps of three trees. The control treatment was irrigated regularly up to harvest (T1) and compared to trees that had irrigation cutoff 11 (T2) or 21 (T3) days before harvest. Soil water content, shoot and fruit growth, midday leaf gas exchange, and stem water potential were measured at two- to three-day intervals beginning at the onset of treatments. In addition, fruit susceptibility to splitting was assessed with a lab test on fruit harvested every three days. At harvest, yield per tree was evaluated and fruit quality traits were assessed. Both deficit treatments increased fruit soluble solids by 14% compare to control. At harvest, soil moisture in control treatments was 2.14 inches/foot greater than in deficit treatments. The stem water potential at harvest was reduced by 0.3 and 0.4 MPa in treatments T2 and T3, respectively, when compared to control (–0.75 MPa). Fruit susceptibility to splitting was reduced by 27% and 32% for T3 and T2 respectively, compared to control. In the same orchard we established a larger scale trial, with ca. 4 acres plots, one receiving regular irrigation (control) and a deficit plot in which irrigation was withheld 15 days before harvest (T2). Fruit quality and packout were assessed at commercial harvest by trained warehouse staff. At harvest, fruit from the deficit treatment were 7% lighter, 13% softer and had 11% higher titratable acidity compared to fruit from the control plot. Results from this first year of research suggest that manipulating near-harvest irrigation has variable effects on sweet cherry fruit quality.

Specified Source(s) of Funding: Washington Tree Fruit Research Commission

Friday, 7 August 2015

Teaching Methods

Moderator: Brian W. Trader
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1:45–2:00 PM

A Study and Development of an Initiative to Increase Undergraduate Student Enrollment in the Plant Science Major and Specializations

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There has been a decline in students enrolled in horticulture at many four-year universities. This study focused on examining enrollment trends; identifying important prospective student target groups; understanding critical avenues and issues for communication with key target groups; and identifying high impact and effective messaging for prospective University of Florida (UF) students and key people influencing their academic decisions. Research, planning and implementation were conducted to increase enrollment of students into the Plant Science major at UF. Information and data was gathered from university records; faculty, staff, and administrator interviews; student focus group studies; from industry leaders; and surveys. Survey work was an online human interface, a modified conjoint six level with a six variable design, and multiple regression analyses. Recruitment into the environmental horticulture area received some focus as this segment has had the slowest recent growth. The greatest opportunity for recruitment was found to be transfers from two-year colleges. Two other pools are science students in other majors and freshman. Identifying the diversity of jobs for four-year horticulture graduates is a key factor. Students and parents must understand post-graduation career pathways, salaries and salary growth potential. Identifying coursework character and sequencing that leads to various professional positions is important. Terminology and semantics, including key words and phrases must be concise, contemporary, and compelling in order to appeal to prospective students. Information must be comprehensible and meaningful to those who have little knowledge of the horticulture and plant science profession. Information should be formatted for rapid comprehension and viewing on hand-held smartphones. Websites, social media, and short videos are important avenues for communication. Contact with faculty, graduates, industry stakeholders, and current students are beneficial, as are visits to horticulture educational facilities during campus tours. A clear and concise description of the pathway for the application of freshman and transfer students is needed. For external transfer students, providing early, advance knowledge of required coursework is the most critical issue. Preparing concise and accurate information for parents and individuals who communicate with prospective students is needed. Information for prospective students should project professors as "cool professionals", rather than intensely academic. Printed collateral material is needed for personal contact. Effective student recruitment efforts must include leadership, a comprehensive commitment of all parties associated with the program and annual funding. Increased student enrollment provides opportunities to sustain or strengthen department support and fill the current and growing industry need for four-year horticulture graduates.

An asterisk (*) following a name indicates the presenting author.

2:00–2:15 PM

Building Community and Engagement among Public Gardens through Regional Intern Field Days and Service Learning Projects

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Internships in a public garden allow the unique opportunity for our future leaders to learn in an immersive environment while gaining hands-on practical work experience. Many institutions compliment learning outcomes through field trips, lectures, workshops, projects, or classes. The Philadelphia region has been designated as America's Garden Capital, with over thirty gardens within thirty miles. Gardens of this region have transformed their respective interns' experience by partnering together and with community organizations to offer an innovative day-long collaborative intern experience. For many years the gardens of the Philadelphia region have gathered to host interns from as many as 15 institutions for a picnic and most recently, a community outreach project. This program has proven successful in building relationships across interns from regional gardens, celebrating the public horticulture profession and creating awareness of the importance of public gardens in our communities.

2:15–2:30 PM

Developing a New Multidisciplinary Course that Incorporates Videoconferencing as a Tool to Connect Classrooms at Two Locations

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Recently, Kansas State University opened a new campus in Olathe, KS (KSU-O), which is in the Kansas City metropolitan area. One of the primary goals of the new campus is to bring together faculty and industry from different food systems-related disciplines to address the needs of our rapidly changing world, particularly in regards to food safety and security. The Department of Horticulture, Forestry and Recreation Resources (HFRR), together with the Department of Animal Sciences and Industry (ASI), were the first two departments to offer Master of Science programs through K-State Olathe. In order to address the need of more face-to-face classes at the new campus, as well as the industry needs regarding fresh produce safety issues, we developed a multidisciplinary course entitled: "Farm to fork produce safety." The course covers the various aspects of food safety for fresh produce grown in urban and rural environments. Pre and postmodule survey was created to assess students perception about the way that the course was delivered and to evaluate the students learning. At the end of the semester, the students developed a food safety plan for a variety of fresh produce operations. In order to reach students from both disciplines, the course is cross-listed in both departments, which enhances the curriculum of the Urban Food Systems and Food Science programs by covering this important topic. Additionally, this course was offered to both Manhattan and Olathe campuses by employing "state of the art" videoconferencing technology as the main content delivery method for both sites. Videoconferencing is a helpful tool giving the ability to connect two or more locations using audio and video equipment to engage all parties. This method of course delivery was beneficial for the faculty in Olathe who desire and need to serve as instructors to Manhattan-based students. Also, with web-based sessions, students can access the course anywhere that there is an internet connection. This delivery enhances the curriculum of the course by including elements of the different locations or by having guest speakers. However, challenges exist, such as technology limitations, effort to engage students, and others. This presentation will illustrate course development procedure, as well as the effectiveness of co-teaching and videoconferencing at two locations. It will also address the challenges and opportunities of this approach to education. Finally, the results of the surveys will be discussed. These data will be used to demonstrate the effectiveness of a technology-centric classroom.

Specified Source(s) of Funding: Scholarship of Teaching and Learning mini-grant, College of Agriculture, Kansas State University

2:30–2:45 PM

Field-On-The-Move: Producing Live, Field-based Educational Workshops via a Mobile, Outdoor Video Production Studio

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In addition to conventional Extension and outreach approaches (workshops, fact sheets and field days), we aim to advance our bilingual social media Extension and outreach campaign to remote users on a national scale by streaming live video directly from agricultural fields to web-based audiences across the United States and beyond. In its simplest terms, a webinar is a web seminar transmitted using the internet through video conferencing software. A key feature of webinar delivery lies within its interactive elements—the ability to give, receive and discuss information. However, due in part to issues of technological connectivity, the current method of webinar delivery can be considered archaic, uninteresting, and at times, not utilizing the complete potential of webinar based delivery systems to their full capabilities. Essentially, our team is one of the first to use a mobile video platform to reach growers, industry liaisons, and agricultural representatives using an interactive, high quality, outdoor production studio. For Field-on-the-Move to stream

live to viewers, we provide Internet access through the use of a high speed portable Wi-Fi and/or connected USB modem. A production switchboard transmits a live video stream through this internet connection to viewers using tablets, cell phones, or computers. For easy access to the Field on the Move live stream, we share an external connection link through our social media websites featuring the capacity to receive and view live interactive viewer comments and questions via a Twitter account embedded within the system (#FieldontheMove). This approach to managing questions and answers during live Field-on-the-Move events via Twitter enables us to connect with viewers within remote field environments as experienced in a classroom setting.

2:45–3:00 PM

Impact of School Garden-based Education on Dry Bean Knowledge and Preference

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Currently in the United States, heart disease is the leading cause of death and diabetes is seventh—both are primarily diet-related diseases. Despite the evidence that pulses in the diet may reduce the risks of these diseases, pulses are an underutilized food in the United States. Garden-based education can be an effective tool for teaching students healthy eating habits at a young age, and school gardens are currently in 32% of K-12 school districts nationwide. The goal of this study was to determine if a three-week school garden-based pulse nutrition and biology education program could have a positive impact on knowledge of and preference for dry beans among fourth grade students. In Spring 2014, a STEM-focused curriculum was developed and implemented in six fourth grade classes in Skagit and Whatcom Counties (n = 120). In the school garden, lessons included planting dry beans and calculating the percentage of emergence and average plant height. In the classroom, lessons included nutrition (with a focus on high fiber content) and biology (plant parts and their function, and plant life cycle). Results from a pre- and posteducation student survey indicated that the education program had a positive impact on the students' knowledge regarding dry bean nutrition and biology. After the education program, 38% of the students learned that beans are an excellent source of dietary fiber ($P < 0.0001$), and 17% learned that beans are found in pods on the plant ($P = 0.0001$). After the education program, students also indicated increased preferences toward eating dry beans, where 52% reported a positive change in their attitude toward more dry beans being served in the school cafeteria ($P < 0.0001$); 31% reported eating more beans ($P < 0.0001$); 35% indicated they would like to increase their frequency of eating dry beans ($P < 0.0001$); and 43% indicated that dry beans are a healthy food choice ($P < 0.0001$). The overall increase in preference for dry beans suggests that students may increase their demand for this food crop after participating in a school-garden based education program where dry beans are the target crop. As students become more familiar with dry beans through school garden-based lessons, their consumption of dry beans and other pulse crops will likely increase, and this should contribute to their overall better health.

3:00–3:15 PM

Student Directed Organic Farms as a Teaching Tool for Sustainable Farming

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The number of university or college student farms has increased dramatically during the last 20 years with about one-third of the 300 leading universities/colleges in the United States having some type of student-operated farm. Due to overwhelming student interest, these farms have grown and flourished with new BS, MS, and PhD programs quickly being developed in disciplines such as agroecology, sustainable farming, organic agriculture, and local food systems to meet the demand for a curriculum that addresses modern local agriculture-based food systems. The benefits of these farms are enormous and provide not only a hands-on agricultural education to students, but also provide locally grown produce to campus dining facilities, the community, and local food kitchens, and a place for food waste recycling, farm tours, sustainable/organic research, and outreach to farmers and local gardeners. At the Southern Illinois University Center for Sustainable Farming, we are in the fifth year of managing a student-organic farm. The farm has grown to almost a hectare with student involvement increasing from less than five students to about 20 in either paid, class credit, or volunteer positions. These students come from several university departments, across many different disciplines and are united in their desire to grow healthy, nutritious food. As the worlds' population increases and farming is further consolidated into the hands of a few, sustainability must involve the teaching of others to grow food for themselves, their neighborhoods, and their communities. Student directed and operated farms offer a place for learning and gaining food production skills, enhancing concepts from classrooms, gaining problem solving skills, and building work ethic, and hopefully, the knowledge to help feed our future.

An asterisk (*) following a name indicates the presenting author.

Tuesday, 4 August 2015

Bioenergy

(154) Advanced Breeding, Development, and Release of High Biomass-energy Cane Cultivars in Florida

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Research into alternative energy sources has been on the rise since the 1970s. Novel sources of carbon-neutral energy are currently in high demand, but can pose different challenges in their development. Energy cane is a relatively new generation crop being bred as a source for biofuel feedstock and ethanol production. Though originating from the sugarcane (*Saccharum* spp.) family, energy cane breeding strategies have diverged from the tradition goal of increasing sugars to maintaining a focus on selecting high biomass hybrids. These hybrids are derived from wide crosses between commercial sugarcane cultivars and *S. spontaneum*, a species within the *Saccharum* genus, which is characterized by high stalk counts and fiber content, excellent ratooning ability, and tolerances to abiotic and biotic pressures. A cooperative energy cane cultivar development program was established in 2007 between the USDA–ARS Sugarcane Field Station (Canal Point, Florida), and the University of Florida-EREC (Belle Glade, Florida) to produce high yielding, and disease-resistant energy cane clones. After completing four years of multi-location field trials, disease screening, and fiber component analyses, the first-ever five energy cane cultivars developed in Florida were released in October 2014 (i.e., UFCP74-1010, UFCP78-1013, UFCP-82-1655, UFCP84-1047, and UFCP87-0053). Yields of the new cultivars are comparable to, or exceed the commercial check, L79-1002 (released in 2008). Disease data, derived from both field trials and artificial inoculation, indicate very low smut susceptibility when compared to the check; with no significant differences between the new releases. Fiber composition was comparable between the five energy cane clones and L79-1002. UFCP74-1010, UFCP78-1013, UFCP-82-1655, UFCP84-1047, and UFCP87-0053 have been released publically, and are intended for cultivation on the mineral soils within Florida. Improved strategic matings incorporating a wide range of germplasm, rigid disease screening protocols, and well-designed field trials have let to rapid improvement in clone cultivar development; with several cultivars currently in Stage II far exceeding the yields and disease ratings of both L79-1002 and some of the 2014 releases. Florida provides the most desirable location in the Unites States to breed sugarcane, and thereby energy cane as a specialized derivative product. Current cultivar development foci include: increasing genetic diversity by optimizing matings with related genera; incorporation of abiotic stress tolerances; continuing the trend in yield increases and disease tolerances; and evaluating cultivars in diverse environments across the county to help target alternate locations where energy cane is desired and can be grown as a biofuel feedstock.

(155) Development of SSR Markers in Oilseed Crop *Camelina sativa*

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Camelina sativa has been recognized to adapt well to a wide range of environment conditions including drought and low nutrient soils. The annual oilseed crop has advantage of higher oil content up to 45%, of which unsaturated α-linolenic acid (18:3) comprises about 35% to 45% of total fatty acid. It is important to understand the genome of the crop to improve its agricultural values, especially yield, oil content and lodging tolerance. Total RNA was extracted from tissues grown at well watered (2.2 kPa) soil, 10 kPa (3 days after drought treatment; DADT), 100 kPa (20 DADT), and rehydrated soil By using next generation sequencing technology, we obtained more than 275 K transcripts which are responsible for about 60,171 loci, corresponding to 4.58 transcripts per locus in the *Camelina* genic regions. Read mapping was conducted by using a Bowtie 2 software and an average mapping of those reads was found to be 93%. Simple sequence repeats were explored from the assembled transcripts and more than 37,000 microsatellites were identified. Among them, a majority (58%) is a di-nucleotide motif, followed by tri-nucleotide repeats (41%), and others (1%). Some amplification primers from the SSR motifs were designed and found to be successfully applied to identify hybrids from the mapping populations so that the polymorphic SSR loci will be used for QTL mapping to identify yield, oil content and lodging traits.

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(156) Planting Method Affects Stalk Size in Sweet Sorghum

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Current efforts to grow *Sorghum bicolor* (L.) Moench for biofuels in Arizona have focused on maximizing biomass, sugar yields, and harvest windows in order to supply optimum feedstock to processing facilities. Varieties tested have been either bred for the southeastern United States (harvested at 140 to 160 days after planting) or bred in Texas to be harvested sooner, around 110 days after planting. Our previous work has shown that as intra-row plant density decreases, stalk diameter and weight increase. Thicker stalks contain more juice and sugar and are sturdier, but the greater biomass can be a challenge to transport and process. This experiment was designed to further explore the relationship between planting density and stalk diameter. Seeds of eight varieties were sown on June 6, 2014, mechanically ("normal") and manually in "hills." Normal rows were planted with a tractor-driven grain drill at 18 seeds/m. Hills were planted as a cluster of three to five seeds every 0.5 m. In this split-plot design, planting arrangement was the main plot and variety the sub-plot, with five replications. Each variety was harvested 30 days after half of the plants were flowering, which ranged from 110 to 169 days after planting. A 3.05-m section from each of two harvest rows (four-row plots) was cut manually and field weight was recorded. A subsample of 15 plants was weighed with and without leaves and panicles. Stem diameters were recorded before the stalks were passed through a roller mill and juice collected and weighed. Juice samples were analyzed by HPLC with a differential refractometer. Theoretical yields of biomass, sugar, juice, and ethanol were calculated. For all varieties, stem diameters in the hills were significantly greater than those in the normal rows. Weights of the 15-stalk subsamples and juice were also significantly higher for the hill arrangements. However, results of ANOVA for field weight show no significant difference ($P = 0.4305$) between planting treatments. Plants in normal rows were smaller but there were more of them per area. Leaves and panicles of plants in the hills were also heavier, suggesting greater leaf area and potential seed yield. While not used as human food in Arizona, it is the fifth leading cereal crop for subsistence farmers in arid environments in Asia and Africa. One crop that produces sugar, grain, and biomass would be an economical use of finite resources.

Consumer Horticulture and Master Gardeners

(140) Funding Kansas Community Gardens: Lessons From a Mini-grant Project

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Many Kansans want to grow their own fresh produce, but often lack a place to have a garden. K-State Research & Extension (KSRE) partnered with the Kansas Health Foundation to establish the Kansas Community Garden Grants project in 2011. The objective of this project was to increase Kansans' access to fresh, healthy produce by expanding the number of community gardens in Kansas. The goal was to establish 60 new gardens over a three-year period. Seed money was made available for groups to receive mini-grants of up to $5,000 to establish new community gardens. In addition to seed funding, the grant provided the opportunity to educate stakeholders via conferences in 2013 and 2014. Community gardeners could learn more about both horticulture and garden management topics. Sessions on garden management, sustainability, and how to develop the garden team gave participants insight on how to cultivate their garden organization into a cohesive group. A website (www.KansasCommunityGardens.org) was developed to provide access to the grant application and educational resources for community gardens. Videos answered "Frequently Asked Questions" about community gardening. Links were provided to KSRE horticulture websites and other community gardening publications and resources. A garden directory tells site visitors where the gardens are located throughout the state. One section includes a listing of all the gardens that have received grants with a short bio and links to any websites or Facebook sites associated with the gardens. An archive of previous conference presentations and handouts allows visitors to access information presented at the conferences. Through the 3-year period 85 gardens (25 over the original goal) received grants worth more than $394,000. The gardens were located in rural, suburban and urban areas of all parts of the state. Both allotment gardens and communal gardens were funded. The wide range of gardens involved in this project put us in contact with a diverse audience. Prior to this project some of the garden participants have had little or no connection with the Cooperative Extension Service. At the end of the third year we were able to report: 1) 85 gardens funded (82 still operating); 2) 875,632 ft^2 in communal gardens has

been added; 3) 1,500,805 ft^2 in total community garden space is now available; 4) 1,551 allotment garden plots added; 5) 5,253 gardeners/volunteers involved in community garden projects. The gardens have made a significant impact in providing more Kansans with access to fresh, healthy foods.

Specified Source(s) of Funding: Kansas Health Foundation

(141) Identifying Master Gardener Training Priorities for Volunteering with Youth

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(State) Master Gardeners are Extension volunteers that maintain their certification through required education and volunteer hours [University of (State) Extension, (State) Master Gardeners, n.d.a]. Volunteering with youth is one way (State) Master Gardeners fulfill their required hours [University of (State) Extension, (State) Master Gardeners, n.d.c; University of (State), (State) Master Gardener Program, 2010]. The purpose of this research was to identify the skills with the highest training priorities needed by (State) Master Gardeners to volunteer with youth. In Fall 2014, a stratified random sample (n = 360) of (State) Master Gardeners were sent a questionnaire constructed using the National 4-H Program's Volunteer Research, Knowledge, and Competency Taxonomy which lists the skills adults need to volunteer with youth (Culp, McKee, & Nestor, 2004). The reliability coefficient for the instrument was .972 on 86 items (Cronbach, 1971). Master Gardeners were asked to rate the importance of and their ability level in these skills using a five-point Likert-type scale. Data was analyzed by calculating frequencies, mean scale scores, standard deviations, standard error, and mean weighted discrepancy scores. The response rate was 64%. The most frequent way Master Gardeners volunteered with youth was in community gardens (22%) followed by none (14%) and in school gardens (13%). All 43 skills in the survey were deemed by (State) Master Gardeners to be either *important* or *very important*. All 43 skills had ability levels of either *below average*, *average*, or *above average*. There were six skills that had mean weighted discrepancy scores of 4.04-5.42, and they were "upholding the mission of 4-H," "knowledge of subject matter," "knowledge of 4-H organization and structure," "motivate and encourage youth," "youth club management skills," and "use of age-appropriate activities." These six skills had the highest training priority for (State) Master Gardeners. As a result of this research, it is recommended that the (State) Master Gardener Program implement training for all of their volunteers on the competencies needed to volunteer with youth. Training should include the skills with the highest mean weighted discrepancy scores, and should also focus on the main activities that Master Gardeners participate in with youth, which were in community and school gardens and in 4-H activities. Further research should be conducted to determine the main reasons Master Gardeners are not volunteering with youth.

(142) Iowa Master Gardeners' Preferred Continuing Education Topics and Delivery Methods

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Iowa Master Gardener volunteers receive 40 hours of initial classroom training. Upon completion of this training and the required volunteer service hours. Master Gardeners are responsible for completing a minimum of 10 hours of continuing education and 20 hours of volunteer service each year to remain active. The objective of this study was to identify popular continuing education topics and preferred delivery methods of Iowa Master Gardeners. Continuing education themes vary from state to state but focus on regionally relevant horticultural topics. As part of a larger survey, several questions were asked investigating the appeal of prospective topics and delivery methods. Approximately 3700 current and past Iowa Master Gardeners received the electronic survey and more than 1200 responses were recorded. Responses were ranked on a 4-point Likert scale from not at all interested to very interested. The data indicate that Iowa Master Gardeners have a strong interest in gardening with native plant material and sustainable horticultural practices. More than 85% were moderately or very interested in more training and education related to gardening with native plants. Sustainable horticultural practices were also popular with more than 80% moderately or very interested. Interestingly, youth garden education was the least preferred topic with nearly 50% of respondents slightly or not at all interested in further training. Live presentations and workshops are preferred by more than 90% of Iowa Master Gardeners. Video presentations and webinars were generally less preferred. Respondents were moderately or very interested in video presentations (75%) and webinars (65%). Certain social media sites are also popular with Iowa Master Gardeners. Nearly 60% of respondents use Facebook some or a lot and more than 30% use Pinterest some or a lot. Therefore, while they are comfortable with these technologies, they prefer live presentations and workshops over webinars and videos to receive training on these new garden topics.

(143) What Motivates Iowa Master Gardeners?

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The Master Gardener program is a nationwide volunteer program providing community service as an extension of Land Grant University's outreach mission. Although the mission of the

program is to disseminate research-based garden education to their communities, this group has been shown to have altruistic as well as personal motivations. Individuals volunteer time for a variety of broad categories including values, understanding, social, career, protective, and enhancement (Clary et al., 1998). Previous work by Schrock et al. (2000) found Master Gardeners to have a strong tendency for the values and understanding categories, meaning they like to help others and want education for personal use. The objective of this study was to determine Iowa Master Gardener's motivations for volunteering in the program. An anonymous survey was sent electronically to more than 3700 active and former Iowa Master Gardeners with more than 1200 responses recorded. The survey remained open for nearly two months with two follow-up reminders. Questions were divided into two broad categories, personal gain and community engagement. Responses were ranked on a 5-point Likert scale from strongly disagree to strongly agree. Results show that questions relating to individual rewards ranked higher than those relating to strengthening community. Specifically, more than 98% of respondents agree or strongly agree that the program provides opportunity to learn about plants, soils, and horticultural topics. Also 93% agree or strongly agree that the program provides classroom instruction and hands-on experience in horticulture. Master Gardeners are less likely to agree or strongly agree that the Master Gardener program will alleviate some societal problems (30%) and that influential people in their community are Master Gardeners (24%). Master Gardener volunteers show greater contribution when they become more experienced and familiar with the program (Ruppert et al., 1997). These data provide rationale for expanding the curriculum in order to keep the interest, and therefore retention, of this educationally driven group.

(144) County Master Gardener Coordinator Perceptions and Utilization of Training Resources

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The Iowa Master Gardner program has more than 2400 active volunteers who participate in local community service and continuing education. They reported more than 105,000 volunteer hours in 2013 valued at greater than $2.2 million (Independent Sector, 2014). Of Iowa's 99 counties, 90 have active Master Gardener programs with a total of 96 individuals who serve in this capacity. Currently, no organized orientation is available for coordinators, which becomes a challenge given the variety of tasks and skills expected of them. The objective for this study was to investigate coordinators' use of resources and training materials currently available with the intent of making recommendations for increased effectiveness. An electronic survey was distributed to all 96 county Master Gardener coordinators in Iowa with a response rate of 49%. The survey was available for one month with a follow-up note sent to non-respondents after 2 weeks. The variety of job titles held by Iowa Master Gardener coordinators is telling. While 27% report to be active Master Gardener volunteers, only 13% are horticulture specialists. Coordinators are equally as likely to be an office assistant as they are to be a horticulture specialist; yet they are the primary contact for Master Gardener volunteers. Clearly, the availability of horticultural resources is important to all coordinators, but especially to those not familiar or comfortable with questions or topics that may arise from their volunteers. More than 90% of coordinators were sometimes or often interested in learning more about motivating volunteers. Training in topics pertaining to recruiting volunteers (89%), volunteer recognition (89%), and effective communication (89%) were also considered important. These are integral components to maintaining successful volunteer groups (Stouse & Marr, 1992). The preferred method of receiving instruction varied widely among coordinators. Distance education delivery methods were generally preferred over face-to-face training options. For example, 80% of respondents were probably or definitely interested in utilizing coordinator newsletters for delivery while only 60% were probably or definitely interested in live classes on campus. A required orientation of new county coordinators would also be beneficial. This session could provide background on the program, acquaint them with the available resources and partner agencies, as well as develop relationships with their peers.

(145) MG SPROUTS: Project-in-a-Box Approach to Youth Gardening without a Garden

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Extension education and outreach makes for a busy, often hectic, day. Demand for horticultural answers and instruction often outpaces staff time available to address it. Training individuals as Master Gardener Extension Volunteers (MGEVs) offers a way to expand Extension's outreach to the community. By developing the MGEV role, defining outcomes, and providing tools for project delivery, Agents can increase the return on their investment in volunteers. MG SPROUTS is a youth horticulture project-in-a-box approach to outreach for horticulture education for children in grades K-3. The project-in-a-box approach includes role descriptions for leaders and volunteers, planning timetables for Agents and volunteers, supplemental training to prepare volunteers for the project, evaluation pieces to create statewide impact, and take-home newsletters that reach out to the parent. MG SPROUTS uses popular children's literature and gardening activities to "get hands dirty" and provide all the joy and wonder of gardening without MGEV commitment to a physical garden and its maintenance. The complete package approach and simple projects enable MGEVs to successfully

introduce gardening and horticulture to youth audiences in many community settings, such as at libraries, in after-school programs, and with homeschool groups. MG SPROUTS demonstrates how role descriptions positively set expectations and enhance the volunteer and agent experience as well as project results.

Tuesday, 4 August 2015

Crop Physiology

(170) Plant Growth Regulator and Temperature Affect *Echeveria* and *Andromischus* Leaf Cutting Rooting and Axillary Shoot Formation

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Fourteen *Echeveria* cultivars and *Andromischus critatus* stem cuttings were received on 5 November. Forty to sixty leaf cuttings of each species/cultivar were harvested from stem cuttings and allowed to air dry one day. Ten to 15 leaf cuttings of each species/cultivar were dipped (base only) in 1000 ppm 1-naphthaleneacetic acid (NAA), 1000 ppm indole-3-butyric acid (IBA), 500 ppm 2-Chloroethylphosphonic acid (ethephon), or water. Leaf cuttings were then placed in petri dishes (air only) and placed in growth chambers adjusted to maintain a 10 °C, 16 °C, 22 °C or 28 °C leaf temperature until cuttings rooted (roots length > 1 cm) or until 60 d had passed. Data were collected on time to root, un-rooted cutting number, and shoot number per cutting when rooted. Percent rooted cuttings was calculated from this data. The first nine rooted leaf cuttings were planted in soilless media in a greenhouse (22 °C/18 °C day/night temperature) on the day those leaf cuttings were considered "rooted," and survival percentage of those rooted cuttings was collected 90 d later. Leaf cutting rooting varied from 0% to 100% rooting and varied with *Echeveria* cultivars and species, plant growth regulator treatment and rooting temperature. *E. agavoides,* and *A. critatus*, and *E.* 'Black Night' and *E.* 'Black Prince' had the lowest and highest percentage rooting, respectively. Ethephon promoted rooting of species/cultivars with the lowest percent rooting on cuttings dipped in water and increased the percent survival of rooted cuttings. IBA and NAA showed little or no promotion of rooting, or rooted cutting survival. Cultivars/species differed in the optimal temperatures for leaf cutting rooting; some had an optimal temperature from 10 °C to 16 °C, others from 16 °C to 22 °C (most), and still others from 22 °C to 28 °C. Plant growth regulator application and rooting temperature also affected survival percentage of rooted cuttings.

Specified Source(s) of Funding: Minnesota Agriculture Experiment Station and USDA–ARS FNRI

(171) Development of Pistachios with Saline Irrigation Water and Regional Salt Tolerance in Pistachio Production Fields

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The published and currently accepted root zone salinity threshold for California pistachios of 9.4 dS/m ECe with an 8.4% relative yield decline above that level was developed from a small plot study for 8th through 13th leaf yields in northwestern Kern County from 1997–2002. A second large-scale study applied fresh and saline irrigation treatments (0.5 to 5.2 dS/m EC) from planting through 10th leaf yields. Average 2011–14 root zone salinity ranged from 2.5 to 13.2 dS/m and caused a significant edible in shell yield reduction of 108 to 264 kg/ha (~3/1% decline) depending on rootstock in the combined 4 year yield for every unit EC (dS/m) increase over 5 to 6 ds/m. A greatly expanded salinity survey including nine commercial fields (9th–13th leaf) in western Kern County with more than 130 individual tree data points ranging from an average root zone salinity of 1.4 to 22.3 dS/m resulted in a similar yield reduction of 48 kg/ha edible in shell for one season for every unit EC above 5 to 6 dS/m.

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(172) Embryo Abortion in *Pistacia vera* 'Pete I'

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California's 300,000-acre pistachio industry is over 90% the Pistacia vera cultivar. Cultivars with an earlier or later harvest timing would relieve the pressure on processing facilities. A recently identified cultivar, 'Pete 1' harvests earlier but is producing unacceptably high percentages of early season aborted nuts, which abscise early or produce partially filled and blank nuts. Both overload the hullers and float tanks. Initial field observations suggested insect pressure and/or fungal infestation. In an insect exclusion study flower buds were both covered by insect-impermeable mesh and left uncovered on the 'Pete 1' trees to mature throughout the season. The resulting clusters showed no significant difference in the final percentage of aborted nuts between the bagged and unbagged samples. Laboratory plating of early- and mid-nuts season nuts for fungal pathogens, detected none beyond background levels. Therefore the high

percentage of blanking and partially filled nuts in the 'Pete 1' pistachio cultivar is not due to either insect or fungal pressures. Other possibilities are pollen or ovule incompatibility, or self-thinning through embryo abortion.

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(173) Modelling Fruitlet Growth of *Pistacia vera* as a Function of Temperature

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The production of *Pistacia vera* spp. would benefit greatly from the ability to predict growth stages as a function of thermal units. In this two-year study, we determined the thermal unit requirement (TU) for the three stages of pistachio (*Pistacia vera*) fruit growth. The first stage is exocarp growth. The second stage is hardening of the endocarp through thickening. The third stage is embryo growth. Five *Pistacia* cultivars, 'Kerman', 'Golden Hills', 'Lost Hills', 'Kalehghouchi' and 'Pete 1' were compared. HOBO data loggers logged air temperature at eight California Central Valley locations. Weekly samplings of the developing fruits combined with the hourly temperature data were analyzed in a non-linear model for each growth stage. The data was also analyzed using the software DJPheno (Degree-days estimator to predict phenological stages) developed by Agriculture and Agri-Food Canada. Results from the two methods were compared. Using volume as an indicator of stage one, the thermal units to 95% of the asymptote differed between the two models. The DJPheno model required 563 TU, a value between the TU requirement for 95% of the volume (680 TU) and of 95% (440 TU) of the length of the developing fruit in the non-linear model. Stage two and three were similar between the two models. Stage two required approximately 1900 TU and stage three required approximately 1750 TU. With both methods, the cultivar 'Golden Hills' reached full embryo length before the other four cultivars. With the DJPheno method the model efficiency for cultivar 'Kalehghouchi' was weakened by the lack of sample size due to its small presence in the California industry.

Specified Source(s) of Funding: California Pistachio Research Board

(174) Adaptability and Functionality of Peruvian Origin of Quinoa (*Chenopodium quinoa* Willd.) in South Korea

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The purpose of this study was to assess the growth characteristic, yield and functional properties Peruvian origin quinoa (*Chenopodium quinoa* Willd.) 24 strains by different cultivation areas in South Korea. Collected quinoa lines were grown in three growing areas (Gangneung, Jinbu, Dargwallyeong). These areas are 40 m, 600 m, and 800 m above sea level and in 2013 and 2014 were sown mid-April, late April, and mid-May, respectively. Days of growing season from seeding to heading stage were 14~39 days in Gangneung, 34~45 days in Jinbu, and 52~73 days in Daegwallyeong depending on the cultivar. Days of growing season from seeding to flowering stage were 26~85 days in Gangneung, 36~73 days in Jinbu, 110~120 days in Daegwallyeong. Plant height and stem width were the longest and thickest in Gangneung followed by Jinbu, and Daegwallyeong, respectively. Yields were very low in Gangneung. System that can be harvested more than 1 ton per ha is Q24, Q28, Q30, Q31, Q34, Q40 were all six strains. The Q34 strain showed best yield in Jinbu and Daegwallyeong. And this study was carried out in order to determine the functional properties such as total phenolic compound (TPC) and antioxidant activities in seven cultivars of Italian millet. Their antioxidant activities were measured using DPPH free radical scavenging activities. The content of TPC was showed various values by strains. TPC value in the range 60~688mg/L, the highest value (688mg/L) was in Q22 strain. The free radical scavenging activity using DPPH method was highest in the Q22 (88%) strain as well. Antioxidant activities showed different values by seed color.

(175) Clove Seed Sprouting and Bulb Growth in Garlic (*Allium sativum* L.) in Response to Varying Temperature

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Garlic (*Allium sativum* L), one of the oldest cultivated crops, is the most widely used Allium species belonging to the family Amaryllidaceae. It is consumed in both fresh and dried forms as an important ingredient for flavouring various vegetarian and non-vegetarian dishes. In addition, garlic has several medicinal values such as anticancer, antibacterial, and antifungal agents, etc. In this study, the effects of varying temperature on clove seed sprouting, vegetative growth, and bulb development of garlic were investigated. High temperature above 23 °C enhanced vegetative growth (shoot height, pseudo stem diameter, and number of leaves) during the initial growth of garlic plants, suggesting that the high temperature affects positively on the growth of the aerial part of garlic. However, bulb development and growth during the intermediate or final growth of garlic plants was best in the temperature ranges of 17 °C to 23 °C. Furthermore, the bulb quality at harvest was significantly high in temperature below 20 °C, whereas generally low in high temperature, especially at temperatures over 30 °C. Cross section of garlic bulbs showed that cloves were formed normally in the temperature ranges of 14 °C to 17 °C, while, in the temperature below 14 °C or above 17 °C, secondary growth of cloves was induced.

Tuesday, 4 August 2015

Growth Chambers and Controlled Environments 1

(190) Greenhouse Production of Basil: Effects of Hydroponic Systems and Cultivar Selection

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Basil (*Ocimum* L. spp.) is the most popular fresh culinary herb. However, there is a lack of data characterizing the effect of hydroponic production systems and cultivars on the yield of hydroponically produced basil. Our objectives were to quantify productivity and characterize growth of basil cultivars grown in two different hydroponic production systems. Seeds of 35 basil cultivars, including selections of *O. basilicum* L. (sweet basil), *O. tenuiflorum* L. (holy basil), and *O. citriodorum* Vis. (lemon basil), were chosen. Seeds were sown into phenolic foam propagation cubes, placed in a growth chamber with a target air temperature of 24 °C, and irrigated with deionized water or a nutrient solution. Two weeks after sowing, seedlings were transplanted into nutrient-film technique (NFT) or deep-flow technique (DFT) systems in a greenhouse with a mean temperature of 23.8 °C. Nutrient solutions were maintained at a target pH of 6.0 and electrical conductivity of 1.6 $mS \cdot cm^{-1}$. Three weeks after transplanting, fresh mass was recorded. Shoots were then placed in a forced air drier maintained at 67 °C for 3 days then weighed and dry mass was recorded. There was no interaction between basil cultivars and hydroponic production system. Fresh and dry mass of plants grown in DFT systems was 2.6 and 0.2 g greater, respectively, compared to plants grown in NFT systems. Basil cultivar differed greatly in fresh mass. Fresh mass varied among sweet basil cultivars, with the highest-producing cultivars, Italian Large Leaf and Nufar, yielding 50.6 g and 43.7 g, respectively; alternatively, fresh mass of 'Emily' was 15.0 g. Purple basil generally yielded less than sweet basil cultivars, with fresh mass ranging from 31.5 g ('Aromatto') to 4.2 g ('Amethyst Improved'). Fresh mass of Thai basil [*O. basilicum* var. *thyrisiflorum* (L.) Benth.] and bush basil [O. *basilicum* var. *minimum* (L.) Alef.] was 19.4 g to 26.9 g, while holy basil was 50.6 g. Lemon cultivars varied in fresh mass, from 26.5 g ('Lemon') to 39.7 g ('Lime'). The yield of basil seems to be affected more by the cultivar selection than hydroponic production system. Therefore, hydroponic basil producers should select basil cultivars based on flavor and yield, while hydroponic systems should be selected based on operational preferences.

(191) Effect of Different Electrical Conductivities and pH on Growth and Biomass Accumulation of Dandelion (*Taraxacum officinale*) Grown in Nutrient Film and Deep Flow Hydroponic Systems

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Dandelion (*Taraxacum officinale*) is an undesirable plant that grows in backyards and fields, and is commonly categorized as a weed. However, in the past, this species was used as an important component of the human diet in some parts of the world due to its excellent medicinal and nutritional benefits. To date, not much is known about production of dandelions in hydroponic systems. The study noted herein was conducted to determine the growth and biomass accumulation of dandelion grown in two different hydroponic systems namely, nutrient film technique (NFT) and deep flow technique (DFT) using different electrical conductivity (EC) and pH treatments. In the first experiment, five treatments for EC 1.0, 1.2, 1.4, 1.6, 1.8 dS/m at a pH of 5.8 were tested in each system. In the second experiment, five treatments for pH 5.2, 5.5, 5.8, 6.1, 6.4, at an EC of 1.4 dS/m were evaluated in each system. Twelve dande-

lion seedlings per EC/pH treatment were transplanted to each system. Both experiments were replicated three times. The data for parameters—shoot height, shoot fresh weight, root length, root fresh weight, root/shoot, and number of leaves per plant—were collected four weeks after transplanting. The EC 1.0 and 1.8 produced significantly lesser biomass for the NFT system while in the DFT system, EC 1.0 and 1.6 showed significantly lesser biomass. No significant distinctions were found in the pH results. These findings will be discussed in the poster. Additional studies should be carried out to determine the optimal EC and pH for producing dandelion in hydroponics.

(192) Light Quality Impacts on Growth, Morphology, and Flowering of Grafted Tomato Seedlings

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Greenhouse tomato growers in northern climates often start seedling propagation during the winter months to initiate production in early spring and take advantage of increasing natural light. Grafting is growing in popularity because of improved disease resistance, stress tolerance, and increased yields. Since natural winter light integrals are low and supplemental lighting is needed, this study was aimed at determining the impact of light quality on grafted seedlings for grafting success, plant growth, morphology, and timing of flower development. Seedlings of 'Komeett' and 'Amsterdam' were grafted onto the rootstock 'Maxifort', 20 d from seeding using the splice/tube grafting technique. Grafted seedlings were placed into the light quality treatments of red LEDs (peak emission at 630 and 665 nm), blue LEDs (peak at 455 nm), red/blue LEDs (80:20, peak at 665 and 455 nm), or white LEDs (3700 K). In addition, T5 fluorescent tubes (4100 K) and natural greenhouse light supplemented with high-pressure sodium (HPS) irradiance were included as treatments. The study was completed in a greenhouse covered with the acrylic material DEGLAS® and conducted from Dec. 24 to Mar. 3. The growing areas of LEDs and fluorescent tubes were separated and shielded from natural and greenhouse light using an opaque blackout material. Plants were grown at a constant 19 ± 2 °C (66 °F) with a 16-h photoperiod at a photosynthetic photon flux of approximately 150 μmol·m^{-2}s^{-1}. Success of grafting was 100% in all treatments. First open flower occurred on average 62 d from seeding with no differences among treatments or cultivars. The tallest seedlings (media to apical point) after 30 d were those grown under red LEDs at 27.8 ± 1.3 cm (Komeett) and 33.6 ± 1.2 cm (Amsterdam). The shortest heights were recorded in the red/blue LED environment (15.2 ± 1.1 cm for Komeett, 16.8 ± 1.4 cm for Amsterdam). Both cultivars under red LEDs had one additional leaf (larger than 3 cm) compared to fluorescent or white LEDs, and two additional leaves compared to HPS, blue or red/blue LEDs. The caliper of the scion was larger than the rootstock independent of light quality. The smallest stem diameters were recorded for red LED grown Amsterdam seedlings at 5.0 ± 0.3 mm scion caliper and 4.6 ± 0.3 mm rootstock caliper. Although all growing environments supported development of quality transplants, the more compact plants under red/blue LEDs are expected to be preferred for greenhouse crop applications.

(193) Quantifying Growth Responses of High-value Ornamental Seedlings to Red and Far-red Light

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Light-emitting diodes (LEDs) are a developing technology that has promising potential for use as sole-source plant-growth lighting in enclosed environments. Far-red light (FR, 700 to 800 nm), associated with the red (R; 600 to 700 nm) to FR ratio, can regulate photomorphogenesis in plants, including stem elongation and leaf expansion, but little research has been published on how FR LEDs can be used to improve plant growth and quality attributes during seedling production. We grew seedlings of geranium (*Pelargonium ×hortorum*), petunia (*Petunia ×hybrida*), snapdragon (*Antirrhinum majus*), and impatiens (*Impatiens walleriana*) at 20 °C under six sole-source LED lighting treatments with an 18-h photoperiod. The following light quality treatments all included 32 μmol·m^{-2}·s^{-1} blue light (peak = 451 nm) with R (peak = 660 nm) and/or FR (peak = 729 nm) light (values after each waveband indicate intensity, in μmol·m^{-2}·s^{-1}): R_{128}+FR_0, R_{128}+FR_{16}, R_{128}+FR_{32}, R_{128}+FR_{64}, R_{96}+FR_{32}, and R_{64}+FR_{64}. Preliminary results indicate that plant height generally increased as the R:FR of each FR treatment decreased. Leaf area of geranium and petunia under an R:FR ≤ 3 was 6% to 47 % greater than plants under an R:FR ≥ 4, whereas impatiens and snapdragon under an R:FR =1 had 13 to 51% greater leaf area than plants under an R:FR ≥ 2. Shoot dry weight was similar to, or slightly increased, under an R:FR ≤ 8 compared to plants grown under less FR light. The calculated yield photon flux was not an accurate predictor of shoot biomass; in some instances, additional FR light (considered non-photosynthetic) increased growth. Photosynthetic efficiency (PE), which is calculated as shoot dry weight per unit leaf area, was generally similar among treatments. We conclude that FR light can increase biomass accumulation by increasing light interception (from greater leaf area) without reducing PE or excessive stem elongation.

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(194) Analysis of Arabidopsis Light-sensitive Mutants Grown under Different Ratios of LED and Compared to Florescent Lighting

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Energy efficiency and increased light spectrum control have begun to drive many plant growth facilities to switch from fluorescent light bulbs to light-emitting diodes (LEDs). We were interested to learn whether seemingly equivalent conditions between fluorescent lights and LEDs were functionally equivalent for plant growth. To test this, we fitted half of a walk-in chamber with LumiGrow Lumibar LED lamps (red, blue, and white lights) and maintained the other half of the chamber with the traditional fluorescent lighting (cool-white bulbs). Using Arabidopsis as a model system we measured plant growth traits in six genotypes selected for their light-sensitive phenotypes: the wild-type Columbia-0, and two natural accessions, Kondara and Knox18, with extreme and mild shade response phenotypes, respectively. Additionally, the light-signaling mutants phyB, cry1/2, and hy5 were selected for their sensitivity to varying light conditions. Plants were grown under four different light conditions at a PAR of approximately 150 $\mu mol \cdot m^{-2} \cdot s^{-1}$ where the light conditions were adjusted for different light ratios: Red (R) 143 red, 0 blue, 7 white; High Blue (HB) 73 red, 80 blue, 7 white, Mid Red Blue (MRB) 113 red, 30 blue, 7 white, and fluorescent light (F). In addition, plants were grown with the Maximum PAR (MP) output for the LED light, approximately 350 $\mu mol \cdot m^{-2} \cdot s^{-1}$ PAR where the light ratio was 75% red: 20% blue: 5% white. Our analysis of leaf size, shape, and number, as well as days to flowering, indicated differences in growth patterns between light conditions. PAR-matched and maximum PAR LEDs also showed some phenotypic growth differences compared to fluorescent lighting. However, the LED lighting did not cause the same temperature increase as fluorescent lights (~5 degrees Celsius cooler); many of the major growth differences might therefore be due to differences in temperature, rather than light. Overall, our findings suggest no reason to delay a transition to LEDs, even for studies involving light signaling.

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Tuesday, 4 August 2015

Postharvest 1

(099) Maturation Date and Postharvest Fruit and Juice Parameters of Pomegranate (*Punica granatum*) Accessions from the USDA–ARS National Clonal Germplasm Repository

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Pomegranate (*Punica granatum*) fruit from the USDA–ARS National Clonal Germplasm Repository, Davis, CA, were accessed for determination of postharvest fruit and juice quality; evaluations consisted of 10 cultivars: 'Ambrosia', 'Desertnyi', 'Eversweet', 'Golden Globe', 'Green Globe', 'Haku Botan', 'Loffani', 'Parfianka', 'Phoenicia', and 'Wonderful'. Fruit were harvested in Autumn 2014 from mature trees monthly from September through November to determine maturity and changes in juice and aril composition over time. A randomized sample of 10 fresh market quality pomegranates were selected monthly to quantify fruit mass, diameter, and length; and of those fruit, arils were removed from five and juiced to determine differences among cultivars for aril mass and juice composition. 'Desertnyi' and 'Phoenicia' had the highest total soluble solids of all cultivars. 'Haku Botan' had the highest levels of titratable acidity (TA) and 'Ambrosia', 'Green Globe', 'Loffani', 'Eversweet', and 'Golden Globe' had the least TA. 'Wonderful' had the highest level of total phenolics (in gallic acid equivalents) compared to other cultivars and 'Haku Botan' had the highest level of antioxidant activity, as quantified by the DPPH method. There were also significant differences among cultivars for aril and fruit mass, diameter and length parameters. The results of this study indicate that pomegranate cultivars vary significantly regarding maturation date and many postharvest quality parameters.

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(100) Aromatic Impact of Fresh Blackberries Identified by a Descriptive Sensory Panel

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The flavor of a product includes aromatics, basic tastes and chemical feeling factors. Aromatics are olfactory perceptions of volatile substances released by a product in the mouth. There is limited information on the aromatics of fresh blackberries (*Rubus* subgenus *Rubus*), particularly those derived from eastern United States germplasm. This study aimed to use descriptive sensory analysis to identify and evaluate the aromatic attributes of fresh blackberry genotypes (cultivars and selections) harvested from the University of Arkansas Fruit Research Station, Clarksville. A trained descriptive sensory panel (n=9) evaluated sensory attributes of 11 fresh blackberry genotypes including five cultivars (Natchez, Osage, Ouachita, Prime-Ark® 45, and Prime-Ark® Traveler) and six selections. The genotypes had commercially acceptable soluble solids levels of 8% to 11%. Each panelist evaluated four berries for each genotype in duplicate, served monadically and randomized. The descriptive panelists identi-

fied and evaluated the aromatics of fresh blackberries using a 15-point scale (0 = less of the attribute and 15 = more of the attribute). The panel evaluated the overall aromatics and individual aromatics described as blackberry, earthy/dirty, green/unripe, overripe/fermented, chemical, mold/mildew, and metallic. The genotypes evaluated had high overall aromatic impact, with values ranging from 7.6 (A-2434) to 8.2 ('Natchez') on a 15-point scale, indicating positive potential for fresh market. Although the panelists identified high levels for the blackberry flavor attribute (6.7–7.2), there were no differences identified among the genotypes. The panelists observed differences for the earthy/dirty aromatic attribute, with values from 1.2 (A-2416 and A-2491) to 2.4 (A-2434). 'Natchez' and A-2491 had the lowest green/unripe attribute (1.5 and 1.6, respectively), indicating more perceived ripeness, as opposed to A-2416 that had the highest value (3.0). The overripe/fermented, chemical, mold/mildew and metallic attributes ranged from 0.0 to 1.1 on a 15-point scale. The panelists did not find differences among genotypes for metallic or mold/mildew attributes. Aromatics play a critical role in the perception of fresh blackberry flavor and can be used to determine commercial potential.

(101) Planting Densities Affect Nitrate Concentration in Spinach (*Spinacia oleracea* L.) Cultivated in Root Floating Hydroponic System

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Light is one of the main factors involved in the accumulation of nitrate in plants especially under low light intensity. The aim of this work was to evaluate concentration of nitrates in baby spinach leaves, growing at different densities in a floating hydroponic system root expressed as dry mass. Also others parameters such leaf area index and nitrate reductase activity were measured. The planting densities were 862, 1296, and 1728 plants/m^2. Three harvest periods were performed when the leaves reached 8–12 cm of length (day 28, 32, and 38 after transplants). The density 862 plants/m^2showed a significant high dry mass compared to the highest density. Nevertheless, the leaf area index was bigger at higher density (4.61 cm^2) compared to other treatments (2.96 and 3.61 cm^2). A higher concentration of nitrates and low nitrate reductase activity were found in the highest density. The nitrate reductase activity was 0.47 μmol/g FM per hour for low density compared to 0.22 μmol/g FM per hour obtained in high density. It was concluded that high concentration of nitrate in baby spinach leafs was affected by the planting densities. Accumulated nitrates were higher in petiole than leaf.

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(102) Physiology of Postharvest Needle Abscission as Influenced by Mechanical Stress

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While postharvest processes of Christmas trees—including shaking, baling, and transportation—are critical and integral components of tree processing, these factors may affect postharvest needle abscission as they cause mechanical stress. It is hypothesized that, baling of balsam fir trees causes mechanical stress, triggering changes in ethylene and VTCs, promoting postharvest needle abscission. Thus, the purpose of this study was to uncover the detrimental physiological effect of baling balsam fir trees on ethylene, VTCs and postharvest needle abscission. Thirty, six-year-old trees, 90 cm in height and similar in girth were randomly harvested and immediately subjected to various baling treatments such as bale of one, two, three, four, and five trees with 5 replicates for each treatment. Treated trees were then transported to the laboratory and set up in 3 L of water in 4-L glass jars until a tree lost 60% of its weight and considered non-marketable. Needle loss (NL), needle retention duration (NRD), average water usage (AWU), ethylene and VTC evolution were measured. The study showed that non-baled trees lost the lowest, 11.26% of total needles compared to 24.45%, 19.91%, 16.65%, 14.28%, and 13.44% for bale of one, two three, four, and five trees, respectively. The non-baled trees also lasted one and six days longer than the bale of two and four trees, respectively. The results on VTCs also supported the argument of VTCs role in postharvest needle abscission, showing that non-baled trees evolved significantly lower concentration (0.67 mM/g) of VTCs compared to 0.94, 0.79, 0.87, 0.83 and 0.69 mM/g for bale of one, two, three, four, and five trees, respectively. However, similar concentrations of ethylene were detected in all trees ranging between 0.48 and 0.5 $\mu L \cdot g^{-1} \cdot h^{-1}$, except in the bale of five trees that was as high as 0.59 $\mu L \cdot g^{-1} \cdot h^{-1}$. This study suggests that postharvest needle abscission is induced by baling, perhaps triggered by VTCs pathway not through ethylene pathway.

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(103) Effect of Xylem-fed Maple Sap on Balsam Fir Needle Abscission and Water Loss in Spring and Autumn

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Postharvest trees are detached from their root system, which may deprive the trees of certain yet unknown root-derived factors normally translocated through xylem (e.g. minerals, ABA, cytokinins, and retranslocated sugars). Resupplying certain root-derived factors may delay needle abscission. The objective of this experiment is to take sap from a root intact tree species (i.e. maple trees) and add it to the water supplied to balsam fir branches. Further, the effect of reverse osmosis and autoclaving the maple sap will be explored. The experiment was conducted once in spring and again in autumn to examine seasonal changes in needle abscission. The only hormones found in the maple sap were ABA and its metabolites, with PA (163.0 $ng \cdot g^{-1}$) being the primary metabolite present. Needle retention was higher in branches harvested in autumn, as long as they were with maple sap that did not undergo RO. If the maple sap had undergone RO processes, then needle retention was slightly decreased in autumn. Needle retention generally decreased as the concentration of maple sap in the supplied water increased and this trend was accelerated if the sap was subjected to RO process. Autoclaving the sap successfully delayed the length of time for water consumption to decrease, but this unexpectedly did not translate into improved needle retention. These results suggest that factors other than ABA or its precursor may be regulating needle abscission in a root detached balsam fir.

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(104) Weather Conditions during Specific Apple Phenological Stages Influence Fruit Quality at Harvest and in Storage

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Interannual variability in apple fruit quality at harvest and in storage is often associated with weather conditions during specific phenological stages prior to harvest. A number of bioclimatic models have been developed and implemented in a computer weather system to help apple producers of Eastern Canada in their storage and marketing strategies. Previous studies showed that apple fruit firmness is one of the main attributes indicating fruit quality at harvest. Rainfall from 61 to 90 days from bloom (DFB) and air temperature from 31 to 60 DFB explained 39% and 12%, respectively, of 'McIntosh' apple firmness variation at harvest time. Weather conditions prior to harvest also influence the incidence of many storage disorders. Low temperatures and high rainfall from 0 to 30 DFB explained 20% and 13%, respectively, of the variation in soft scald incidence in 'Honeycrisp' apples. Low temperatures and low solar radiations from 31 to 90 DFB were associated with higher vascular browning incidence in 'McIntosh' and 'Ariane' apples. Low temperatures and high rainfall from 91 DFB to harvest explained 36% and 13%, respectively, of the variation in soggy breakdown incidence in 'Honeycrisp' apples, while high temperatures during this period were associated with superficial scald incidence in 'Cortland' apples. Recent evaluations of internal browning and core browning incidences in 'Empire' and 'McIntosh' apples revealed that 'Empire' apples are more sensitive to these disorders than 'McIntosh'. Even though many of these storage disorders are part of a group called "Low temperature disorders (LTD)", characterized by browning of internal apple flesh and/or vascular bundles, each of them seems not only to be cultivar specific but also to respond differently to weather conditions at specific phenological periods prior to harvest. Weather based predictions of apple firmness at harvest and risks of physiological disorders before storage are quite useful tools for apple producers in their marketing and storage strategies in order to provide high quality apples to their consumers.

(105) Optimizing Preharvest Calcium Application Frequency, Timing, Rate, and Sources to Increase Tissue Calcium Content and Shipping Quality of Sweet Cherry

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Northwestern U.S. sweet cherries that are shipped to distant markets are subject to various arrival issues including fruit softening, flavor loss, skin darkening, pitting, splitting, pedi-

cel browning, and decay. The objectives of this study were to develop preharvest Ca spray protocols to improve cherry shipping quality and determine the response of fruit growth, fruit size, yield, and return bloom to Ca. Fruit firmness and pitting susceptibility of 'Lapins' and 'Sweetheart' were related to fruit tissue Ca concentration, but not N concentration, in fruit sampled from different orchards. Six weekly applications of Ca were required between pit hardening and 1-week before harvest (WBH) to increase fruit tissue Ca concentration of 'Lapins'. Nine weekly applications applied from full bloom to 1 WBH did not improve tissue Ca concentration compared to the 6-application regime. The optimum Ca application rate was 0.1% to 0.15%. Leaf burning was observed at rates exceeding 0.15% for several different Ca sources. Two applications (one at pit hardening + one at 1 WBH, or one at 2 WBH + one at 1 WBH) did not increase tissue Ca concentration compared to control. Frequent applications are more important than exact spray timing. The efficacy of Ca was not dependent on fruit development. When applied six times on a weekly basis, "Cal-8" at 0.2% Ca and "Chelate Ca" at 0.05% Ca were more efficient than $CaCl_2$ at 0.07% to 0.15% Ca, $Ca(NO_3)_2$ at 0.1% to 0.15% Ca, and Ca citrate at 0.07% Ca for improving fruit firmness. Soluble solid (SSC), titratable acidity (TA), and skin color at harvest were not affected by the Ca applications. Beginning 2–3 WBH, fruit growth was negatively affected by $CaCl_2$ and Ca citrate, but not by other Ca treatments. Enhanced fruit tissue Ca concentration improved shipping quality by reducing pitting, decay, pedicel browning, skin darkening, and loss of firmness and TA after three weeks of cold storage.

(106) Preharvest AVG Applications Improve Storability of Summer Pears Depending on Application Rate, Timing, and Harvest Maturity

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'Bartlett' and 'Starkrimson' summer pears (*Pyrus communis* L.) have a characteristically short storage life due to increased ethylene production induced by cold storage. A recent trend toward greater fresh market utilization of 'Bartlett' and an increased export demand for 'Starkrimson' necessitate extended storage life due to a prolonged packing and marketing season. The effects of preharvest aminoethoxyvinylglycine (AVG) spray rate and timing on storability of 'Bartlett' fruit at three harvest maturities [H1: when control fruit firmness (CFF) ≈ 83.6 N; H2: 12 days after H1 when CFF ≈ 74.8 N; and H3: 17 days after H1 when CFF ≈ 72.6 N] and 'Starkrimson' harvested once [CFF ≈ 60 N] were evaluated with respect to ethylene production, storage quality, and ripening capacity during 5 and 4 months of storage at –1.1 °C, respectively. For 'Bartlett', AVG at 60 mg·L^{-1} applied 1 week before H1 (WBH1) suppressed ethylene production and respiration rate, retarded fruit firmness and green color loss, and reduced senescence disorders while maintaining ripening capacity of H1 and H2 fruit. Compared to 60 mg·L^{-1}, AVG at 120 mg·L^{-1} applied 1WBH1 did not improve storage quality but did delay ripening capacity by one month. AVG at 30 mg·L^{-1} applied 1 WBH1 and 120 mg·L^{-1} applied 2 WBH1 had little effect on any of the storage responses measured. Ethylene production and storage quality of H3 fruit were not affected by AVG, irrespective of rate. AVG at 60 and 120 mg·L^{-1} applied 1 WBH1 and 120 mg·L^{-1} applied 2 WBH1 did not affect initial harvest maturity (H1) but did delay pre-harvest fruit maturation of H2 and H3 fruit by about 5–7 days. The response of 'Starkrimson' to AVG was similar to 'Bartlett' (i.e., inhibited ethylene production, maintenance of fruit firmness, and reduced senescence disorders during 4 months of storage at –1.1 °C). These results suggest that appropriate preharvest AVG applications extend the harvest window of 'Bartlett' and 'Starkrimson' and reduce storage losses during extended packing and marketing.

(107) Differences in 1-Methylcyclopropene Sorption Processes in Fresh-cut Apple, Tomato, and Avocado Fruits

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Our earlier studies demonstrated that fresh-cut apple slices consumed 1-methylcyclopropene (1-MCP) rapidly when incubated in static system with 20 μL·L^{-1} 1-MCP. Sorption/consumption was strongly suppressed in slices exposed to ascorbate (360 mol·m^{-3}) prior to 1-MCP exposure. In the present study, fresh-cut tomato, avocado and apple fruits were examined to determine whether sorption patterns noted for fresh-cut apple reflected characteristics of other fruits. Slices of fruit tissue (total 25 to 30 g) were placed in 495 mL jars and 1-MCP injected at 20 μL·L^{-1}. Fresh-cut apple ('Delicious') consumed headspace 1-MCP at high rates, approximately 64.0 ng·kg^{-1}·s^{-1}, and depleted headspace 1-MCP in 1.5 hours. Apple slices pretreated with ascorbate showed 80% reduction in sorption rate (12.84 ng·kg^{-1}·s^{-1}), depleting 60% of system 1-MCP in 6 hours. Fresh-cut avocado ('Hass') tissue showed moderately high sorption at 35.2 ng·kg^{-1} s^{-1} that was unaffected in tissue pretreated with ascorbate (35.0 ng kg^{-1}·s^{-1}). Avocado slices depleted about 95% of system 1-MCP over 6 hours. By sharp contrast with apple and avocado fruits, fresh-cut tomato ('Tasti-Lee') showed very low sorption of 1-MCP, with control and ascorbate-treated tissue consuming 1-MCP at around 1.3 to 1.9 ng·kg^{-1}·s^{-1} and depleting only about 6% of headspace 1-MCP (relative to controls—empty jars) over 6 hours. In experiments with apple and avocado fruits, fresh-cut slices were heated to 90 °C, returned to room temperature, and monitored for 1-MCP sorption. Non-heated apple tissue consumed headspace 1-MCP at 61.4 ng·kg^{-1}·s^{-1}. Heated apple slices exhibited an 80% reduction

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in 1-MCP sorption (12.3 $ng \cdot kg^{-1} \cdot s^{-1}$). The non-heated and heated apple tissue consumed around 100% and 50% of headspace 1-MCP in 1 h and 6 h, respectively. Avocado tissue was far less affected by heating. Non-heated avocado consumed 1-MCP at 54.9 $ng \cdot kg^{-1} \cdot s^{-1}$ compared with 44.0 $ng \cdot kg^{-1} \cdot s^{-1}$ in heated tissue, a reduction of 19.8%. It is evident that fresh-cut fruit tissues exhibit significant differences in 1-MCP sorption/consumption capacity, and in their responses to heat and antioxidants. These differences likely represent proportional differences in thermotolerant, physical binding processes vs. oxidative metabolism. The extent to which the processes contributing to sorption of 1-MCP in fresh-cut fruit tissue are operative in intact fruits is unknown.

(108) Visual Assessment of Gas-exchange Sites in Harvested Tomato Fruit

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Gas exchange in fruits generally occurs at sites located over the entire epidermal surface. By contrast, atmospheric exchange in tomato fruit is largely restricted to the stem-scar region. Application of gas-impermeable substances to the stem-scar area of mature-green fruit prevents gas transfer and strongly suppresses ripening. In spite of the importance of the stem-scar region to postharvest attributes including ripening and pathogen proliferation, no information is available regarding the nature or location of the structures that facilitate this exchange. The purpose of the present study was to determine the nature of the gas egress sites. Specifically, the interest was to determine whether gas exchange occurs uniformly over the scar region or is localized to specific areas. Gas egress was visualized by immersing fruit in water at temperatures generating pressure differences of approximately 5 kPa between the fruit atmosphere and external atmosphere (fruit > external). Within seconds of immersion, gas egress was observed at a small number of sites situated in the corky ring and at the outer rim of the stem scar. These egress sites were consistently located over the radial pericarp walls and have been termed "radial apertures." Egress was rarely noted in tissue of the central stem-scar. Egress patterns were unaffected when fruit were subjected to greater pressure differentials (16.9 kPa). When predicted egress sites were blocked with epoxy resin, gas egress was observed at alternative sites within the interaperture corky ring and to a lesser extent the stem scar (secondary egress sites). Fruit with primary egress sites blocked with epoxy resin showed a reduced rate of ripening, indicating that these sites represent the preferential gas ingress/egress in tomato fruit. In addition to serving as gas-exchange portals, these egress points can be breached by aqueous suspensions of soft rot bacteria, leading to development of internal lesions. Speculation can be drawn that these sites, being peripheral to the stem attachment region, may serve as pathogen-ingress sites under preharvest as well as postharvest conditions.

Tuesday, 4 August 2015

Root Growth & Rhizosphere Dynamics

(220) Characterization of Root Systems in Tomato and Tomato Rootstocks Through the Use of Mini-Horhizotron Technology

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Roots are the critical sites of water and nutrient uptake in agronomic crops. Certain root characteristics, such as branching, rate of horizontal growth, and root tip density affect a plants ability to utilize soil resources. Nowhere is the importance of root systems seen than in the use of specific rootstocks for grafted plants. Grafting of tomatoes to manage biotic and abiotic stress is a potential strategy to maintain or increase production during environmental stress. Very little research has been conducted to quantify root growth and architecture in tomato rootstocks. Furthermore, no research has focused on the non-destructive analysis of roots of grafted plants. However, with the recent development of the mini-Horhizotron chamber, root systems can be viewed and non-destructively analyzed over time in diverse soil substrates. Utilizing these mini-Horhizotrons, a greenhouse study was conducted twice in 2014 to compare root systems of a commercial determinant tomato (*Solanum lycopersicum* 'Tribute') and two commercially available tomato rootstocks ('Maxifort' and 'RST-106'). These three varieties were self-grafted and also left non-grafted. Additionally, two grafting combinations were made with 'Tribute' as the scion on either 'Maxifort' or 'RST-106'. Data collected throughout the trials included total number of root tips, horizontal root tip density, rate of horizontal root growth, and total root length. In general, 'Maxifort', regardless of grafting, had a faster rate of horizontal root growth, increase in horizontal root tip density, faster rate of root tip development, and significantly longer root length compared to 'Tribute' root systems. This study demonstrates that differences in root system growth and development rate do exist in tomato rootstock varieties. These differences may explain some of the increased vigor observed

when utilizing specific rootstocks, however further research is warranted to correlate root system characteristics to yield performance in tomatoes.

(221) Evolution and Potential of the Mini-Horhizotron as an Apparatus for Teaching and Research Investigations in the Plant Sciences

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The mini-Horhizotron was developed at North Carolina State University to study root growth of seeds, liners, and plugs planted into common greenhouse containers during their production cycle. The design of the mini-Horhizotron is comprised of a clear three-chamber configuration suitable for observing and measuring root growth by utilizing the clear walls. The mini-Horhizotrons have a substrate volume similar to a standard greenhouse container, and the height of the mini-Horhizotron (10.2 cm) is also similar to a 16.5 cm diameter container (11.8 cm), providing similar air and water profiles comparatively. However, the surface area of the mini-Horhizotron is almost three times larger than a container, allowing for an increase in potential viewing of roots as they explored the substrate. Possible root measurements in situ include; root length, speed of root growth, presence and quantity of root hairs, and root branching/architecture. Shade panels slide directly against the concave-shaped clear walls to block sunlight from the rhizosphere,. In this original design, the shade panels had to be removed by pulling them up vertically which often was obstructed by (or damaged) the foliage of the plant growing in the apparatus. To prevent damage to the plants when removing the shade panels, a design modification was made to change the configuration of the shade panels such that they were set back away from the center (concave sides) of the apparatus, thus not interfering with the plant foliage when removed vertically. A second modification was made to the mini-Horhizotron to decrease the glare on the clear sides, which previously caused problems when trying to photograph the roots. This was a big concern that potentially limited the usefulness of the mini-Horhizotron, as it is believed that advancements in digital imagery data collection will be the future of research and teaching activities. An anti-glare reflective coating sprayed on the clear sides was added to reduce the glare and improve the effectiveness and quality of digital images. These modifications have improved the utility of the mini-Horhizotron in ways that should increase their utilization as research and teaching tools.

(222) Using the Rhizometer and Root Analyzing Software to Measure Root Growth of Seedlings

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The use of digital imaging and computer software programs to analyze plant root growth has increased in recent years due to advances in quality and resolution of digital imaging, as well as advancing technology creating objective software to allow for greater measurement capabilities. The rhizometer was developed at North Carolina State University to observe plant root growth and measure the effect of root growth on substrate physical properties over time. The clear cylinder design of the rhizometer allows for visible observations of the rhizosphere so that root data collection, such as root count, root length, and root hairs can be quantified without disturbance. The objective of this study was to measure several root system parameters with plants grown in the rhizometer using image software. Three substrates were compared in this study: peat amended with 20% (v/v) of perlite (PL); pine-wood-chips (PWC); or shredded-pine-wood (SW). Both PWC and SW were produced by hammer milling freshly chipped or shredded loblolly pine trees (*Pinus taeda*) through a 6.35 mm screen. Twenty rhizometers were filled with each individual substrate and four species of seeds were planted directly into the rhizometers; bean (*Phaseolus vugaris* 'Gold Rush'), corn (*Zea mays* 'Jubilee'), tomato (*Solanum lycopersicum* L. 'Better Boy'), and marigolds (*Tagetes erecta* 'Inca Orange') resulting in 60 rhizometers used. Three root measurements were taken once root tips were visible along the rhizometer cylinder; number of root tips (RT), number of roots with visible root hairs (RH), and cumulative root length (RL). Root length was measured by tracing the roots on a transparency sheet, taking a digital photograph, and using RootReader 2D software to select the traced roots and calculate total root length of the picture. Number of root tips, RH, and RL measurements had linear responses over time for all four species. At 12 days after emergence (DE), corn had the largest total RL in the SW substrate, and tomato had a higher total RL in PWC substrate at 12 DE. The higher total RL observed with these two species with SW and PWC substrates at 12 DE could be attributed to the physical properties of the substrates, such as increased air space. However, as the roots of these plants grew into the substrates and likely altered the substrates' physical properties over time, there were no observable differences in RT, RH, or RL among the substrates for each species at measurement dates after 12 DE.

(223) Toward a Better Irrigation Management in Soilless Culture by Considering the Influence of Root Development on the Evolution of Hydraulic Properties of Substrates

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Irrigation management in soilless culture is classically based on three main physical parameters of substrates (total porosity, air filled porosity, and water holding capacity), previously estimated in the laboratory by standardized methods. More than water and air contents in the media, their flows are of vital importance because water, air, and solute availability highly fluctuate over a short period of time in this growing system. Furthermore, the limited volume of substrate for plants growing in containers, and the rapid root colonization cause frequent cycles of watering and drying during cultivation, which can affect the physical properties during the growth period, and then lead to inaccurate irrigation timing. So, the evolutions of the physical and hydraulic properties of the substrate-root system have to be considered for better irrigation management and water efficiency for plants. A culture of *Rosa* ×*hybrida* 'Radrazz' was carried out with four organic growing media (peat, pine bark, coir, and wood fiber) during six months in a greenhouse, with the most common irrigation management between –1 and –10 kPa. Root volume, total volume, air and water retention properties, saturated hydraulic conductivity, relative gas diffusivity, and wettability of each growing medium were measured at the beginning and the end of the experiment. The study showed different physical behaviors for the growing media in terms of air and water retention, but mainly highlighted decreases in total volume, pore tortuosity, wettability and an increase in gas diffusion, as the common and most relevant parameters influencing their evolution in time. Results indicated that successive drying/wetting cycles generated 1) physical consolidation, and then decreases in total porosity and in air filled porosity, and 2) a decrease in wettability that limited the increase in water retention properties caused by root development. Despite effects caused by drying/wetting cycles, and especially decreases in total porosity and air filled porosity, gas diffusion was increased with time, due to better pore connections by root effects.

(224) Demonstration for Non-destructive Root Growth Measurement at Hydroponic Culture by Using a Root Imager

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We demonstrate a nondestructive root growth measurement technique under hydroponic culture conditions. Recently, a root imager that can measure the root length, root surface area, and root volume in the field has been developed. We applied this instrument to hydroponic culture conditions and demonstrated successful nondestructive tomato root growth measurement during a course of growth. First we manufactured suitable hydroponic systems for root imager measurement. We transplanted tomato seedlings into this system and took root images by using a root imager every three days, and then analyzed those images by using a root scanner. We demonstrate that it was possible to detect root growth continuously and the measurements were correlated with that of root dry weights. Then we measured tomato root growth under the salt and metal stresses treatment. We used a concentrated hydroponic culture solution or applied aluminum chloride into culture solution for tomato culture. We detected decreased root growth at these conditions. As a result, this measurement technique is applicable for in situ root analysis in hydroponic culture. Further research needs to have more physiological and morphological experiments.

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Tropical Horticultural Crops

(294) Yield and Quality of Leafy Vegetables Grown in Soilless Culture: A Comparison of Hydroponics and Aquaponics Culture Systems

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Leafy vegetables are good/inexpensive sources of essential plant-based minerals and secondary metabolites that promote human health and wellbeing; high-value vegetables can also be a source of income supplementation among low-income, small-holder farmers, however, the seasonality of these crops severely limit their utility in combating mineral malnutrition and alleviating poverty. Soilless culture production systems such as hydroponics are well suited for year-round production of such nutrient-rich foods. Combining hydroponic culture with fish production (aquaponic systems) further enhances input resource use efficiency, making it an ideal system for addressing many health problems associated with malnutrition and poverty. Aquaponics is a biologically integrated system that combines fish production (aquaculture) with hydroponic vegetable production in a recirculating setup. Waste products from the aquaculture component serve as inputs for the hydroponic component, which in turn serves a biofiltration function. The interaction of fish and vegetables in aquaponics results in a production system that is more productive than either component alone. The goal of this study was to evaluate the productivity and quality of vegetables grown under two soilless culture systems: hydroponics versus aquaponics. Two greenhouse-based recirculating systems served as a source of fertigation solution for vegetable crops grown on floating rafts. One system was stocked with Koi fish (*Cyprinus carpio*) while the other was operated as a hydroponics system. In each system, two cultivars of mustard green (*Brassica juncea*; 'Florida Broadleaf' and 'Red Giant') and Amaranth (*Amaranthus* spp. 'Red Garnet' and 'Green Leaf') were grown. Leaf yield, leaf area, leaf chlorophyll (CHLL), and mineral contents were measured during, or at the end of the crop growth cycle. Fresh mass yields of both mustard varieties were 60% to 65% higher in aquaponic culture compared to hydroponics. Total leaf area

and *CHLL* were also significantly higher (60% to 56% and 47% to 69%, respectively) in mustards grown in aquaponic culture. Yields differed between the two varieties of amaranth evaluated. Fresh weight, leaf area and *CHLL* of 'Red Garnet' were significantly higher (14%, 8%, and 7%, respectively) in aquaponic culture. Measured parameters were similar in both production systems for the 'Green Leaf' amaranthus cultivar. In addition to high resource use efficiency (space, water, nutrients), aquaponic systems are ideal for off-season production of nutrient-rich indigenous vegetables to promote food security. Careful selection of suitable cultivars would further maximize the benefits of production under this system.

(295) Performance of Organically Grown Mango Cultivars in a Rainy Tropical Region

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Research was conducted in 2014 to determine the performance of adult mango trees of 'Osteen', 'Keitt', 'Edward', and 'Palmer' with organic management in Mayaguez, a rainy region in Puerto Rico (averaging 1750 mm of annual rainfall, with 19.8 °C minimum and 31.5 °C maximum temperatures). Data was collected on flowering and harvesting dates, marketable fruit yield and quality, as well as pest and disease occurrence. Keitt, the cultivar of reference, was the latest in flowering (late March) and in harvesting (33 weeks after flowering), while 'Osteen', 'Palmer', and 'Edward' flowered in mid-March, early-March and early-February, respectively, taking 31, 25, and 27 weeks, in that order, from flowering to last marketable harvesting. As compared to 'Keitt', total marketable fruit weight was 14% lower in 'Edward', 23% higher in 'Palmer' and 86% larger in 'Osteen'. Individual 'Keitt' and 'Osteen' marketable fruits were about 30% heavier than those of 'Palmer', and about 44% heavier than those of 'Edward'. Soluble solid content in the juice of ripe fruit was greater in 'Edward' than in the other cultivars, while titratable acidity values were larger in fruits of 'Keitt' than in fruits of the other cultivars. Fruit anthracnose was more prevalent in 'Edward' than in 'Osteen', but was not detected in 'Keitt' and 'Palmer'. The main pest found in the orchard was the fruit fly *Anastrepha obliqua*, affecting about 3 times as many fruits in the late-harvest cultivars 'Palmer', 'Osteen', and 'Keitt' than in the early cultivar 'Edward'. These results indicate that while anthracnose may be an important concern with some cultivars in a rainy location, in the conditions of this study the fruit fly was a more important challenge to marketable fruit yield, and it should be addressed in future experiments in this location. Economic analyses must be conducted to determine if commercial production of these cultivars is profitable under the conditions of this research.

(296) Cultivar Trial of Olives (*Olea europa*) in Hawaii

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Hawaii has the advantage of diverse ecological zones with 11 of the world's 13 climate zones. Many crop species can be grown in Hawaii, including olives (*Olea europa*) that are adapted to Mediterranean growing conditions with mild, rainy winters and long, warm, dry summers. Ten olive cultivars were selected for oil production; six cultivars were transplanted on 24 Feb. 2011, and four cultivars were transplanted at 13 July 2011, at the Lalamilo Research Station in Kamuela, HI, (760 m elevation; latitude and longitude, 20.0188°N, 155.6765°W). The soil series was the Waimea series (medial, amorphic, isothermic, humic Haplustands). Trees were planted in a randomized complete-block design with 1-tree plots replicated seven times at a spacing of 3 m in single row windbreaks. Maximum/minimum air temperatures were recorded at the Lalamilo station, and the lowest minimum temperature recorded was 8.3 °C, which is above that reported to be required for breaking the dormancy of buds. Yet, during April 2013, trees of three varieties (Arbequina, Arbosana, and Koroneiki) were observed to flower. On 16 October 2013, five trees each of 'Arbequina' and 'Arbosana' were harvested, and six trees of 'Koroneiki' were harvested in a one-time harvest. Average yields per tree were 1.89, 4.89, and 2.04 kg (fresh weight) and total yields were 8.8, 14.2, and 11.0 kg fresh weight, respectively for 'Arbequina', 'Arbosana', and 'Koroneiki'. The average color of fruit was 3.5, 2.1, and 3.3, respectively. Oil was milled from these fruit (in two presses), resulting in 2.0, 3.0, and 2.6 kg of oil (assuming a specific gravity of 0.91) or a yield of 22%, 21%, and 24%, respectively. Oil was sent to the University of California, Davis, Analytical Lab and extra virgin olive oil quality was determined. Apparently, the agro-environment of Kamuela, HI, is suitable for the flowering and fruit set of these three olive varieties. Further research is needed to determine whether olive oil production is economically profitable in Hawaii.

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(297) Seed Piece Size and Cost Affect Yield and Economics of "Green" Ginger Production in Temperate-climate High Tunnels

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Immature ("green") ginger can be grown successfully in high tunnels in temperate climates. Seed pieces (rhizomes), sourced from tropical production areas, are typically larger than required to produce a successful crop. We examined the effect of growing ginger in Minnesota using 4 sizes of seed pieces (30, 60,

90, or 120 g) created from dividing larger pieces before transplant. Plants were grown in Rosemount, MN, in 2013 and in Waseca, MN, in 2014, using raised beds in high tunnels. Equal numbers of seed pieces (23) were planted in each 1.8-m plot in four replicates each year. Rhizome yield was 1.9 $kg \cdot m^{-2}$ in 2013 and 1.2 in 2014. Average yield was 0.9 $kg \cdot m^{-2}$ using 30-g seed pieces (3.8-fold increase per kg planted), and 2.3 kg using 120-g seed pieces (2.4-fold increase per kg planted). Assuming relative seed costs of $8.80 or $2/kg, and production and labor costs of $13.99/$m^2$ regardless of seed costs, the break-even market price for green ginger ranged from $18.42 to $22.14/kg, respectively, if 30-g seed pieces were used, and $10.02 to $15.78/kg, respectively, if 120-g seed pieces were used. Net profit was less than $0 at a retail price of $11 per kg for green ginger unless 120-g seed pieces were used and seed costs were $8.80/kg. Returns at these prices ($2.23/$m^2$) were less than estimates for high tunnel-grown cucumbers ($4.09/$m^2$). At a retail price of $33/kg[1] for green ginger, net profit ranged from $9.15/m (30 g per seed piece, $22 per kg seed) to $53.79/$m^2$ 120 g per seed piece, $8.80 per kg seed). This is comparable to estimated profit of > $30/$m^2$ for tomatoes.

Specified Source(s) of Funding: Minnesota Agricultural Experiment Station

(298) Yield and Fruit Quality Traits of Atemoya Cultivars Grown in Puerto Rico

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The demand for tropical fruits has increased more than 33% during the last decade as consumers seek healthy and more diverse food products. There is a lack of formal experimentation to determine yield performance and fruit quality traits of atemoya (*Annona squamosal A. cherimola*) cultivars. Six atemoya cultivars (Bradley, Geffner, Lisa, Priestly, 47-18, and 75-9) grown on an Oxisol soil were evaluated for three years at Isabela, Puerto Rico. Preliminary data indicates that there are no significant differences in marketable fruit production between 'Geffner' and 'Lisa', which averaged 8,628 fruit/ha. A significantly higher yield of marketable fruit was obtained by 'Lisa', averaging 1,814 kg/ha. Individual weight of marketable fruit was significantly higher in 'Priestly' and '75-9', which averaged 266.9 g. Significantly higher soluble solids concentration values were obtained from fruit of '75-9', 'Bradley' and 'Geffner', which averaged 24.7%.

(299) Effects of Biostimulants and Fertilizers on Specialty Bell Pepper

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An experiment was conducted in July–November 2014 in Mayaguez, Puerto Rico, to determine the effects of biostimulants and fertilization on growth, yield, and quality of 'Chocolate Beauty' bell pepper grown in containers in a high tunnel protective structure. The plants were grown in a 3:1 mixture of alluvial soil and sphagnum + perlite mix (Promix® BX), fertilized with either: 1) 22.67 kg of N-P-K per 0.40 hectares pre-plant and 45.35 kg of N per 0.40 hectares 10 weeks later using granular urea (= field fertilization recommendation by Ag Experiment Station, UPRM); 2) 22.67 kg of N-P-K per 0.40 hectares pre-plant and 45.35 kg of N per 0.40 hectares divided in 10 applications every seven days using an urea solution (= greenhouse fertilization); and 3) 22.67 kg N-P-K/0.40 ha from organic 6-6-5-8Ca + 0-0-15-1Ca pre-plant and 45.35 kg N/0.40 ha from organic 6-0-0-8Ca (Bioflora®). Every 14 days the crop leaves were sprayed to run-off with different biostimulant solutions. The biostimulants tried were: 1) a blend of amino acids formulated for crops (AA) (Aminoquelant Ca®), at 4 mL/L of water; 2) an extract of the marine alga*Ascophyllum nodosum* formulated for crops (Stimplex®), at 5 mL/L; 3) a mixture of natural ingredients containing brassinosteroids, vitamins, and enzymes (Vitazyme®), at 10 ml/L of water; and 4) water (control). Fruits were harvested at maturity (color turning from green to chocolate), weighted, quantified, and graded into categories according to their diameter and quality. Only fertilizers affected the total fruit number and weight per plant, with the soluble treatment resulting in more fruits per plant than the other treatments. Marketable fruit number was significantly lower in plants treated with granular fertilizer. There was a significant interaction between biostimulants and fertilizers on total marketable fruit weight and weight of medium size fruits, with the highest yields resulting from the combination of the alga extract and organic fertilizer. The treatments did not affect the number of non-marketable fruit, but plants treated with granular fertilizer resulted in a larger weight of non-commercial fruits. These results indicate that the yield of this specialty pepper may be regulated with fertilizers and/or combinations of fertilizers and biostimulants. Disclaimer: Mentioning brand names does not imply an endorsement from the authors or from the University, and is done solely to specify the materials used in this research.

Tuesday, 4 August 2015

Viticulture and Small Fruits 1

(336) Cultivar Evaluations for Organic Strawberry Production in High Tunnels

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Strawberry production in high tunnels has great economical potential for small farmers. However, limited information is available on cultivars suitable for a high tunnel microclimate. This study was a continuation of our 2013–14 cultivar trials with the objective to investigate cultivars that would produce during the fall and following spring in organically managed high tunnels. Strawberry plugs of 10 cultivars (eight June-bearing and two day-neutral) were planted on September 30, 2014, in 30' x 96' high tunnels in Greensboro (zone 7) and Goldsboro (zone 8), North Carolina. The experiment was conducted as a completely randomized block design with three replications, 18 plants per replication. Plugs were planted 14'' apart in two rows of a 3-foot wide raised bed covered with black plastic mulch. Irrigation and fertigation were provided through a drip tape buried under the plastic. Row covers were applied when field temperatures below 0 °C were forecasted. Cultivars performed similarly between the two locations. Day-neutral varieties 'Abion' and 'San Andreas' were the first to produce berries and had significantly higher yield than June-bearing cultivars by the end of 2014, which reflects fall yield. By the end of February 2015, the accumulated marketable yield ranged from 17 grams/plant for 'Camino Real' to 110 for 'San Andreas', and the total yield was from 20 for 'Camino Real' to 131 'San Andreas'. The top three producers were 'San Andreas', 'Radiance', and 'Abion', which yielded more than other cultivars. 'Camino Real' had the largest number of runners (2.4/plant) by the end of 2014, while 'Camarosa', 'Sweet Charlie', 'San Andreas', and 'Radiance' had almost no runners. The canopy size remained similar from December through February with average diameter of 21.5 cm, although harvests continued during that period. The average marketable berry weight ranged from 16.6 grams for 'San Andreas' to 32.7 grams for 'Benicia'. The °Brix value was fairly constant during the winter, with an average reading of 10.1 for February 12 and 9.7 for March 5, although 'Benicia', 'Festival', 'Radiance', 'San Andreas', and 'Winterstar' had slightly higher °Brix. Through March 2015, the results from the current year's study were similar to that of the previous year; therefore, a conclusion on recommended strawberry cultivars for organic high tunnel production can be drawn once the trial is completed in June.

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(337) Impacts of Biofumigation and Anaerobic Soil Disinfestation on Strawberry Plant Nutrition and Fruit Quality

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Anaerobic soil disinfestation and biofumigation are two non-chemical methods for controlling soilborne plant pathogens of strawberry. Due to their high mineral contents, both treatments could potentially increase mineral content in strawberry plants and thus impact fruit quality, but research in this area is limited. A trial was conducted with 11 pre-plant soil-incorporated treatments arranged in a randomized complete-block design with six rows (blocks). Biofumigation treatments consisted of deactivated mustard meal, deoiled mustard meal, mustard pellets, and Biofence mustard seed meal. Other treatments included dried molasses as a carbon source for an anaerobic treatment and a Basamid® chemical treatment. Additional combination treatments of deactivated mustard meal combined with molasses, deoiled mustard meal combined with molasses, and molasses combined with soybean meal (to lower amendment C:N ratio) were also applied, as well as an untreated control. Harvested strawberry fruit were analyzed for sugars (fructose, glucose, sucrose), organic acids (malic and citric), and mineral content (B, Na, Mg, P, S, K, Ca, Fe, Cu, Mn, and Zn). Harvested leaves were analyzed for mineral content. Data were analyzed using mixed model analysis of variance (Glimmix procedure, SAS Institute, Cary, NC) and least squares means were compared with ten orthogonal contrasts of scientific interest. There were no differences among treatments for glucose and fructose. However, fruit from the plots treated with the combination treatment of molasses with deoiled mustard meal did have significantly more sucrose than the control ($P < 0.05$). Fruit citric and malic acid contents were greater in the anaerobic disinfestation plots treated with the combination of molasses and soybean meal than in the plot treated with Basamid® ($P < 0.05$). However, fruit sugar and organic acid content did not consistently differ among most treatments. Likewise, there were no consistent patterns of differences among treatments in mineral content of either fruit or leaf tissues ($P < 0.05$). However, plants in Basamid® treated plots had a greater concentration of Ca than those treated with molasses and soybean meal ($P < 0.05$). In general, the alternative methods of biofumigation and soil anaerobic disinfestation produced fruit of equal quality to that produced using the Basamid® chemical treatment.

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(338) Evaluation of Chilling Injury to Strawberry Plants Following Application of an Organic Fungicide

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Fragaria ananassa 'Camarosa' (strawberry) plants were grown in a single hoop style high tunnel with straight, raisable sidewalls for vernalization at Mississippi State University's R.R. Foil Plant Science Research Facility. In late February 2011, plants started flowering and on 5 March 2011, plants were exposed to a 15-h chilling event following a foliar application of an extract of *Reynoutria sachalinensis* [giant knotweed (Regalia®)] at 1 (10 $mL \cdot L^{-1}$). Application was made 24 hours before the chilling event to strawberry plants with open flowers. Chilling event was simulated in an environmental growth chamber with initial temperature set at 16 °C and decreased by 4 °C per hour until reaching 0 °C and held for 8 hours. In addition to the spray treatment, there were two non-sprayed controls: one with plants left in the high tunnel (9.7 °C) and one with plants exposed to the chilling treatment. To assess chilling injury, total growth, yield, marketable grade, and antioxidant enzymes were determined. There were no significant differences in total growth, yield, or marketable grade regardless of spray or chilling exposure; however, there was an increase in glutathione-S-transferase in plants sprayed with Regalia® compared with non-sprayed plants. While Regalia® may not cause a quick response to protect 'Camarosa' strawberry plants from chilling temperatures, it does appear to enhance antioxidant activity in strawberry plants under moderate chilling conditions.

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(339) The National Strawberry Sustainability Initiative Phase II: A Public–Private Partnership Moving Technology from Demonstration to Practice

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The National Strawberry Sustainability Initiative (NSSI) is a public–private partnership between the Walmart Foundation and the University of Arkansas System Division of Agriculture Center for Agricultural and Rural Sustainability. This grants program encourages innovation and outreach programs at public and land grant universities to support the U.S. strawberry production system. The goal of the NSSI is to improve sustainability of the system from production throughout the supply chain to consumers. Phase I of the program emphasized moving science and innovative technology from the laboratory to the field. The current Phase II of the program emphasizes extending technology from demonstration to practice in partnership with growers and other private sector participants throughout the supply chain. In 2014, six projects were funded through universities collaborating with more than 30 growers. Projects included the expanded testing of new and potential strawberry cultivars, addressing grower-specific needs for organic production, expanding marketing for locally and regionally produced berries, production of berries in protected systems, sustainable soil management, and remote sensing of irrigation needs for frost protection and water management. Accomplishments of the NSSI will be highlighted and the opportunities for public-private partnerships will be presented.

Specified Source(s) of Funding: Walmart Foundation

(340) Soilborne Pathogen and Nematode Management through Removal of Root Inoculum in Continuous Red Raspberry Systems

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Soil borne pathogens and nematodes limit production of red raspberries (*Rubus ideaus*) in the Pacific Northwest of the United States and have been attributed to increasing reports of "replant disease." Newly implemented Reregistration Eligibility Decisions by the U.S. Environmental Protection Agency limit fumigation practices and current methods of disease and pest control are ineffective, leading to a decreased lifespan of crop productivity, an increased frequency of fumigation and replanting, and increased grower costs. Growers need new and alternative techniques for effective management of soil borne pathogens and nematodes. This project addresses this need by investigating the effects of root removal in continuous raspberry

production systems. Infested root and crown material remaining from the previous raspberry production fields likely serves as a reservoir of inoculum for subsequent plantings. This project will evaluate the impacts of raspberry root removal on residual inoculum levels through two field experiments. The first experiment began in August 2014, and compared three root removal devices, including a Lundeby plant lifter, a potato harvester, and a beach cleaner. All pieces of equipment lifted approximately 98% of the root material to the surface for removal. The potato harvester was the fastest to remove roots per linear distance, followed by the plant lifter and beach cleaner. In a second experiment, efficacy of root removal to reduce soil borne pathogens and root lesion nematodes (*Pratylenchus penetrans*) was compared with and without fumigation using a split plot design, with fumigation as the main plot and root removal as the split plot. This experiment was established in August 2014 and measurements are ongoing. Comparison of pre- and post-root removal/fumigation treatments on *P. penetrans* revealed root removal reduced population densities by 99.8%. Additional evaluations revealed *Fusarium* and *Pythium* populations were reduced through root removal (16% and 21%, respectively), but fumigation had a greater effect at reducing their numbers (41% and 64%, respectively). The combined effect of root removal with fumigation was the most effective, and reduced *Fusarium* and *Pythium* by 64% and 69%, respectively. Large roots remaining in control plots (without root removal) were colonized by both pathogens regardless of fumigation treatment, indicating that these roots serve as residual sources of inoculum. These data suggest root removal may have a role in an integrated pest management approach for the management of soil borne pathogens and nematodes in red raspberry.

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(341) Blackberry Cultivar Evaluation Both in High Tunnel and Field in Northern New Mexico

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Fruit growers in northern New Mexico are frustrated with erratic and severe late spring frosts. Most growers would like to diversify their operation to other alternative fruit species to reduce the risks. Blackberries bloom later and late frosts present less chance of flower damage, but their winter hardiness and adaption to high pH soils are not clear in northern New Mexico. Two semi-trailing, three free-standing and one primocane blackberry cultivars were tested both in high tunnels and in the field from 2011–14 at New Mexico State University Sustainable Agriculture Sciences Center at Alcalde, NM. Two semi-trailing cultivars-Triple Crown and Chester were planted at 1.5 2.6 m in a 5.2 12.2 m high tunnel with an identical field planting and all free standing cultivars (Ouachita, Natchez and Navajo, and primocane cultivar-Prime–Ark 45) were planted at 0.6 1.7 m in another 5.2 12.2 m high tunnel with an identical field planting. Comparing all cultivars together, yield of floricane cultivars was correlated to winter damage while primocane cultivar Prime-Ark 45 had reliable crops in high tunnel each year in northern New Mexico. Comparing the winter of 2012–13 to 2013–14, 2013–14 was milder with minimal temperature of –15.6 °C and 2012–13 was colder with minimal temperature of –21.6 °C. In 2013, all floricane cultivars lost their crop in the field and had minimal yield in high tunnels. 'Chester' was hardier than 'Triple Crown' and 'Ouachita' was hardier than 'Natchez' and 'Navajo'. When temperature dropped to –21.6 °C, High tunnels could protect the cane from winter damage, but not the flower buds. In 2014, there was light winter damage in the field but a full crop in high tunnels for both semi-trailing and free standing cultivars. 'Triple Crown' had higher yield than 'Chester' both in the high tunnel (21,800 kg/ha vs.11,239 kg/ha) and in the field (7252 kg/ha versus 3843 kg/ha). 'Ouachita' had higher yield than 'Natchez' and 'Navajo' in both 2013 and 2014. 'Prime-Ark 45' had similar yield to 'Ouachita' in the high tunnel in 2014 but twice the yield of 'Ouachita' in 2013. 'Navajo' did not grow well either in the field or in the high tunnel, presumably because of high pH soils. Growers can grow blackberries and expect a good yield in mild winters but floricane blackberries are marginal and winter damage is expected in severe winters; and 'Prime-Ark 45' had reliable crops in high tunnels in northern New Mexico.

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(342) Yield Performance and Cold Hardiness of Advanced Thorny and Thornless Primocane-fruiting Blackberry Selections at Kentucky State University

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Kentucky growers are interested in primocane fruiting blackberries because they can be grown organically and are able to

produce a niche-market crop from late summer until frost. Locally produced fruit from primocane fruiting blackberry selections can be harvested from July until October, providing an extended season for fruit sales 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-fruiting cultivar 'Prime-Ark® 45' (thorny erect, primocane-fruiting) and the Arkansas Primocane-fruiting (APF) selections of thorny or thornless (T) advanced selections (Prime-Ark® Freedom, APF-156 T, APF-158, APF-172 T, APF-185 T, APF-190 T, and APF-205 T) from the University of Arkansas 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 five 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 five plants. Rows were spaced 14 feet apart. This trial was planted on the certified organic land and managed with organic practices following the National Organic Program standards. Weed control was achieved by placing a 6- to 8-inch deep layer of straw around plants, adding straw when necessary and hand weeding. Plants were irrigated weekly with t-tape laid in the rows. Primocane fruit production began in late July or early August for most selections. APF-158 had the highest yield in 2013–14 at 7147 and 3458 lbs/acre, and Prime-Ark® Freedom had the lowest at 760 and 648 lbs/acre. Prime-Ark® Freedom had the largest average berry size at 6.3 and 6.7 g. All selections experienced severe die back during Winter 2013–14; however, APF-190 T had the lowest cane death at 64%. Year to year yield and fruit quality characteristics will need to be further evaluated.

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Floriculture 1

(352) Engineering Pine Wood Chip Aggregates for Greenhouse Substrates

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Since 2010, researchers in the Horticultural Substrates Laboratory at North Carolina State University have been investigating the engineering and processing variables that influence the consistency and reproducibility of traditional and alternative organic substrate components. The most researched material/component has been processed pine trees. These pine wood/tree components have been proven to be successful when used in greenhouse and nursery mixes, mainly as a peat/bark-extender. It has also been shown that the use of wood components specifically processed into uniform wood chips could replace perlite in peat-based greenhouse substrates. To specifically engineer wood to yield a uniform and consistently shaped/sized particle requires many specific processing steps. The engineering of pine wood chip aggregates requires different processing equipment and methodology compared to pine wood fiber (or similar) components used as peat/bark extenders. Pine wood chip aggregates are manufactured from pine logs that are initially chipped to yield coarse wood chips (1.0 L x 0.2 W x 1.0 H –cm). These coarse wood chips are then hammer-milled through a 6.35-mm screen to yield the final aggregate material that is 0.11 L x 0.4 W x 0.2 H –cm. In addition to the specific machine types needed to produce these fiber-less uniform particles, other variables play a major role in the consistency of the end product. Moisture content of freshly harvested and chipped trees can range from 42% to 55% depending on the time of the year when the trees were harvested. Before hammer milling, it is important to adjust (reduce) the moisture content of the wood chips to between 35% and 40%. Moisture is the single most important factor in the manufacturing and engineering of organic materials. Wood chips with too little moisture (below 30%) will often shatter and splitter more when milled due to the brittleness of the wood at that low level of moisture. Since different aggregate sizes are needed for different substrate mixes (propagation, plugs, bedding plant flats, one-gallon pots, etc.) the screen size used to process the wood chips can be changed to produce smaller wood chips. So, like perlite, different grades/sizes of PWC can be constructed. Despite the traditional uses (pulp, paper, timber, fuel, etc.) and more recent uses (wood pellets, biofuels, etc.) of pine trees in the United States, it is still believed that pine wood is a reliable source of sustainable greenhouse substrate components in the foreseeable future.

(353) Postharvest Handling Methods for Fresh-cut Peonies

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Two peony cultivars, 'Sarah Bernhardt' and 'Duchess de Nemours', were treated to a series of cold treatments (0–168 hours in 2013 and 0–336 hours in 2014; 24- and 48-hour intervals, respectively) at 1.5 + 2 °C to establish the minimum time necessary for chilling prior to shipping for maximum consumer vase life. Preliminary research found that chilling for 1 week, doubled the vase life, and data from 2013 season corroborated those findings. However, vase life for cut flowers in 2014 decreased significantly and did not improve with chilling. Vase life for 'Sarah Bernhardt' and 'Duchess de Nemours' peonies averaged 6.1 days and 5.9

days, respectively, for the entire treatment period and did not differ from the unchilled control. This research did not clearly identify minimum chilling requirements for Alaska peonies. In contrast, cut stems in 2013 showed a linear increase in vase life with chilling (8.2–14.2 days for 'Sarah Bernhardt' and 6.9–13 days for 'Duchess de Nemours'. Vase life and bud diameter did not differ among early- mid- and late-season cutting dates for both cultivars. Cut stems from two commercial farms showed the same short vase life, and there was no statistical difference in vase life among farms. Environmental factors during spring growth or postharvest handling differences play a more significant role in defining vase life than simply hours of chilling. Vase life for 68 cultivars (7 days, 1.5 + 2 °C) in 2014 ranged from 4–9 days (mean 6.0 + 1.0 days). In 2013, vase life averaged nearly three days longer, 8.6 + 2.7 days (range 4–14 days). Vase life for 2014 was significantly lower for most cultivars than 2013. In 2013, more than 70% of the cultivars showed an average vase life of 7 days or more, while in 2014, only 24% reached that standard. The four main classifications of peonies, semi-double, Japanese, bomb, and full double, had an average vase life ranging from 5 to 17 days. One class had a vase life of less than 7 days for both 2013 and 2014, the Intersectional hybrids.

(354) Morphological Characteristics and Its Related Gene Expression in Cut Roses with Bent Peduncle Phenomenon

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The bent peduncle phenomenon (BPP) causes low production of cut flowers in rose greenhouse cultivation. It is still not easy to avoid the BPP in the field because of unknown mechanisms. To address this challenge, this study was conducted to investigate the morphorogical characteristics including the form of floral organs and floral organ identity-related gene expression of BPP shoots in cut rose plants 'Beast'. Morphological observation confirmed the fact that BPP was accompanied by the early formation and being phyllody of a specific sepal among five sepals, which gave rise to peduncle bending in the upper part of the phyllody with fasciation. Year-round BPP frequency in 'Beast' was in the range of 5% to 20% with seasonal change, increasing rapidly with an average temperature rise in summer. Except bent peduncle, the BPP shoots appeared to grow normally in terms of speed and size of floral development in comparison with normal. However, carbohydrate distribution to the floral part in BPP shoots was significantly reduced. Expression of floral organ identity-related genes was relatively higher at BPP flowering shoots more than normal shoots, which means BPP might be linked with flowering process in the level of its related gene translation. In summary, BPP may be considered by two distinct processes: First a special sepal's illegal start for cell division in SAM and affected by environmental factors, esp. heat stress. Second, a special sepal's phyllody development accompanying with continuous auxin supply to the peduncle, resulted in BPP induction.

(355) Evaluating Light-emitting Diodes for Use in Supplemental Greenhouse Lighting for Seedling Plug Production

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In temperate climates, seedlings are often grown in commercial greenhouses under supplemental lighting (SL) during the winter to increase plant quality. To increase the photosynthetic daily light integral, SL is typically delivered by high-pressure sodium (HPS) lamps. Light-emitting diodes (LEDs) have potential to be used in SL applications because of their increasing energy efficiency and ability to emit specific wavebands of light, which can increase photosynthesis and regulate plant morphology. We evaluated seedling growth under four fixture types that included red (R, peak = 660 nm), blue (B, peak = 453 nm), and/or white (W, peak = 560 nm) LEDs or HPS lamps, all of which delivered a *PPF* of 90 $\mu mol \cdot m^{-2} \cdot s^{-1}$ (high SL); a sixth treatment delivered 10 $\mu mol \cdot m^{-2} \cdot s^{-1}$ from HPS lamps (low SL). Seedlings of seven ornamental and vegetable varieties were grown at 20 °C under ambient solar light and SL treatments under a 16-h photoperiod and for 21 to 40 days. At transplant, seedling height, leaf area, leaf number, and fresh root and shoot weight were measured and then plants were transplanted and grown in a common environment under a 16-h photoperiod until flowering. Preliminary responses were variable among varieties studied and characteristics measured, and no consistent treatment effects were apparent. However, plants under low SL were usually shorter, and smaller leaves, and had lower fresh shoot weight than the five high SL treatments. Seedlings under the LED treatments were usually at least as tall as those under HPS lamps. In four varieties, shoot weight was greater under some of the LED treatments than the high HPS treatment while the opposite was true for two varieties. Our initial conclusion is that the spectrum of SL has inconsistent effects on plant growth attributes and that both SL types are effective at producing high-quality seedlings.

(356) The Effect of Salinity on the Growth and Nutrient Status of Zinnia Grown Under Regulated Deficit Irrigation

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As fresh water resources become more limited agricultural producers will have to consider alternative, often poor quality, water sources for irrigation. Impurities such as salinity in water can impact irrigation management practices and adversely af-

fect crop yield. To test the effects of salinity on plant growth and nutrient composition, *Zinnia elegans* was produced under two different sub-irrigation management regimes and exposed to various concentrations of NaCl to simulate the crop production challenges associated with poor water quality. Plants were irrigated for a short- or long-cycle of exposure in sub-irrigation to achieve differing levels of potting medium saturation at each irrigation event. Plants under these two irrigation management regimes were challenged with NaCl at concentrations up to 1.5 g/L. Zinnia plants accumulated more Na in shoot tissues as the NaCl concentration in the irrigation water increased. The electrical conductivity in the potting medium also increased over time as the NaCl concentration in the irrigation water increased and the rate of leaf area expansion decreased with increasing levels of salinity. Fertilizer and water use efficiency have both been reported to increase under regulated deficit irrigation practices such as short-cycle irrigation management. In our study, plants under short-cycle sub-irrigation management maintained lower gravimetric water content throughout the production cycle compared to plants under long-cycle sub-irrigation but the drier medium conditions did not increase susceptible to salt injury. Further, plants grown under short-cycle irrigation management for 4 to 6 weeks accumulated less Na in shoot tissue than plants grown under long-cycle irrigation management. Sodium accumulation in the shoot tissues was a product of both the amount of sodium in the irrigation solution and the amount of water used by the plant over time. Therefore short-cycle irrigation can be used as an effective water management technique even when raw water quality is poor as represented by elevated salinity. Our research indicates that zinnia can be irrigated with saline water up to 0.5 g/L in a 4- to 6-week production cycle without adverse effects on growth.

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(357) Screening of Ornamental Sweetpotato (*Ipomoea batatas*) Cultivars for Intumescence Development

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Ornamental sweetpotato (*Ipomoea batatas*) is an herbaceous ornamental crop commonly produced in greenhouses. The species has been increasingly popular, with several new cultivar introductions in recent years because of its trailing growth habit and striking foliage colors and shapes. However, the species is susceptible to developing intumescences—a physiological disorder characterized by abnormal, translucent outgrowths on the leaf surface with a gall or wart-like appearance. Ultimately, this disorder results in the death of the affected cells. With many recent introductions, we conducted a screening trial with 36 ornamental sweetpotato cultivars to 1) describe and characterize foliage type and plant growth; and 2) document intumescence development and severity of each cultivar. Each leaf on each plant was rated for intumescence development on a scale from 0 to 5 (0 = no intumescence and 5 = severe) after six weeks of production in a glass greenhouse. Nearly half (47%, n=17) of the cultivars exhibited some level of intumescence development. The cultivar 'Blackie' had the highest average rating of 2.27, while most cultivars that developed intumescences had an average rating of 1.5 or less. Cultivars 'Blackie' (67%), 'Sweet Caroline Bronze' (35%) and 'South of the Border Chipotle' (34%) had the highest percentage of their total number of leaves exhibiting intumescences. Nineteen cultivars were non-symptomatic for intumescence occurrence, including 'Sidekick Black Heart', a compact substitute for 'Blackie' and 'Black Heart.' No relationship was observed between leaf color, shape, or plant habit and intumescence occurrence. This practical information may aid greenhouse growers in selecting ornamental sweetpotato cultivars for production in an effort to avoid this disorder.

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(358) Effects of Different Irrigation Strategies on the Evolution of Peat Hydraulic Properties during Cultivation

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Evolution of physical and hydraulic properties of substrates during plant cultivation is mainly due to root development, but also to the multiple alternations of drying (evapotranspiration) and watering (irrigation) periods, and, more precisely, to the intensity of drying. Indeed, most organic materials used as substrates are known to become more or less hydrophobic during desiccation, which can amplify degradations in physical and hydraulic properties, and consequently lead to poor irrigation management and plant development. *Rosa* ×*hybrida* 'Radrazz' were grown in 1.5-L pots filled with peat substrate during five months in a greenhouse, on different culture tablets managed with three different irrigation thresholds, i.e. intensity of drying before rewetting: A) water potential always maintained at container capacity, i.e. –1 kPa; B) irrigation triggered when water potential reached –10 kPa; C) irrigation triggered when water potential reached –30 kPa. Controls (pots without plant) were also managed with these three different irrigation thresholds, in order to identify the respective effects of root system versus

irrigation regimes. Root volume, total volume of the substrate, air and water retention properties, saturated hydraulic conductivity, relative gas diffusivity, and wettability of peat were measured at the beginning and the end of the experiment. The study showed different physical behaviors for the growing media in terms of air and water retention, but mainly highlighted decreases in total volume, pore tortuosity, and in wettability and an increase in gas diffusion as the common and most relevant parameters influencing their evolution in time. Results indicated significant effects of irrigation strategies as well as root development, mainly in terms of hydraulic properties and wettability of the substrate. Although the root system contributed to improve all properties (air and water flows, wettability) in comparison to the controls (without plant), peat wettability decreased with the intensity of drying (i.e. irrigation thresholds) and then led to a higher degradation of water flow properties and of its ability to rewet.

(359) Utilizing the Mini-Horhizotron as a Tool for Assessing Plant Root Disease Severity in Floriculture Crops

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Two experiments were conducted to assess the use of the mini-Horhizotron in measuring disease severity of *Pythium aphanidermatum* on the roots of bedding snapdragons and poinsettias grown in three different horticultural substrates. Plugs of *Antirrhinum majus* 'Snapshot Red' (bedding snapdragon) and *Euphorbia pulcherrima* 'Angelica White' (poinsettia) were planted in mini-Horhizotrons containing either a commercial potting mix, a substrate containing 70% peat moss and 30% pine wood chips (PWC), or a substrate containing 80% peat moss and 20% PWC. The plants were allowed to grow until healthy, white roots could be seen through the clear sides of the mini-Horhizotron. Tracings of the root system were taken using clear transparencies at the time of inoculation with *Pythium aphanidermatum*, and one month later at the termination of the experiments. The tracings were photographed, calibrated and converted to high contrast black and white images in Adobe Photoshop and uploaded into Cornell University's RootReader2D software for total root length measurements. Results showed that snapdragons grown in the 80:20 PWC substrate had a total root loss of 6%, as compared to 48% for the 70:30 PWC substrate and 81% for the commercial mix. *Pythium* infection was more severe for poinsettias, with total root losses of 71%, 87%, and 91% in the commercial, 80:20 PWC, and 70:30 PWC substrates, respectively. Visual observations that were noted weekly during the experiment for both snapdragon and poinsettia provided evidence of the timing and severity of root disease symptoms. The ability to observe the root system in situ allowed for mycelium growth/presence to be documented as it occurred after inoculation, which is difficult to do when plants are grown in traditional containers. Other observations included fungal gnat (*Bradysia* spp.) larva, water-soaked and necrotic roots, and loss of root hairs. The results of this study illustrate how the mini-Horhizotron, when used in addition to other disease assessment techniques, can help provide a non-destructive assessment of root disease severity over time. The ability to view the rhizosphere and the accuracy with which root length can be measured suggests that the mini-Horhizotron could have broad applications in plant pathology research.

(360) Vase Life Evaluation of Field-grown *Lilium* Hybrids under Shade Cloth

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Vase life performance of *Lilium* hybrids was evaluated from a field study 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. Twelve flower stems from each cultivar were harvested prior to anthesis and randomly placed in four solutions: 1) 12 $mg \cdot L^{-1}$ sodium hypochlorite; 2) 12 $mg \cdot L^{-1}$ sodium hypochlorite and 9 $mg \cdot L^{-1}$ gibberellic acid; 3) 20 $g \cdot L^{-1}$ sucrose and 12 $mg \cdot L^{-1}$ sodium hypochlorite; and 4) 20 $g \cdot L^{-1}$ sucrose, 12 $mg \cdot L^{-1}$ sodium hypochlorite and 9 $mg \cdot L^{-1}$ gibberellic acid, with 3 replicates. There were no consistent vase life trends related to planting month. Only the Oriental hybrid lilies grown under NFS had a significant reduction in vase life. For Oriental and OT hybrid lilies the sodium hypochlorite and gibberellic acid solution significantly increased vase life. However, for the Asiatic and LA hybrid lilies the sucrose, sodium hypochlorite, and gibberellic acid solution significantly increased vase life.

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(361) Testing the Utility of Intergenic Spacer Regions to Identify Distinct *Plumeria* Taxa

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In Hawaii, *Plumeria* cultivars contribute to the floriculture, landscape, and tourist industries. However, many of the cultivars suffer from insect, fungal, and viral afflictions, thereby diminishing flower yields and rendering plants unmarketable or unfit for export. A *Plumeria* breeding program will help to overcome these problems, while simultaneously creating novel *Plumeria* cultivars. Information about genetic relationships from

molecular studies can allow us to develop better breeding strategies to introduce horticulturally important traits from *Plumeria* spp. into cultivated *Plumeria*. Recent studies have employed the use of intergenic spacer (IGS) regions to distinguish species and assess genetic similarity. In this preliminary experiment, five morphologically distinct *Plumeria* species were chosen to test the utility of six IGS regions for separating putative *Plumeria* species. Molecular data sets for IGS regions—trnQ-rps16, ndhF-rpl32, psbD-trnT, psbJ-petA, rpl32-trnL, and trnV-ndhC—were analyzed separately and in combination by means of Neighbor-Joining (NJ) and Maximum Parsimony (MP) methods to test for congruence. Intergenic regions psbD-trnT and trnQ-rps16 were the most successful single regions at identifying genetic relatedness among *Plumeria* spp., while recovering outgroup taxa. Both regions yielded similar tree topologies between NJ and MP analyses. The combination of these two regions yielded similar tree topologies to trees generated from analyses of individual regions, but with higher branch support. In conclusion, these two regions can now be used to further assess the genetic relatedness among *Plumeria* spp. and cultivars to develop better breeding strategies.

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Fruit Breeding 1

(023) Development of the Simple Sequence Repeat Marker PruG4RS for the Differentiation of Cherry Rootstocks

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The use of clonally propagated *Prunus sp*. rootstocks in sweet cherry production is increasing as these rootstocks provide reduced tree size and precocity. Numerous clonally propagated cherry rootstocks are in commercial production, such as the GiSelA series, or under test, such as the Michigan State University (MSU) series. Many of these dwarfing cherry rootstocks are difficult to differentiate based on morphology alone, therefore DNA markers that differentiate rootstocks are an important tool to verify identity and prevent mix-ups among these rootstocks during the vegetative propagation stage. The simple sequence repeat (SSR) marker PceGA59 was determined to uniquely distinguish the commercially available GiSelA rootstocks; however it did not distinguish all five of the MSU rootstock selections. In an attempt to meet this need a new SSR marker, PruG4RS, was developed based on an analysis of genome-wide genetic data for these rootstocks obtained using the RosBREED (www.rosbreed.org) Illumina Infinium® cherry SNP array. Two SNP markers were identified which were unique for each rootstock and sequence from the peach genome v1.0, available at the Genome Database for Rosaceae (www.rosaceae.org), was used to search for SSRs within the region surrounding the chosen SNPs. After identifying several potential SSR markers, those with the most specificity to the sequence of interest and least colinearity with additional scaffolds were selected and primer pairs designed for each. The most informative and highest quality SSR marker, PruG4RS, was developed from peach sequence upstream of the SNP marker ss490553174 on linkage group 4. The development of PruG4RS and its combined use with PceGA59 has successfully circumvented the limitations of each individual marker and proven effective for use as a "quality control" DNA diagnostic tool for the commercial GiSelA rootstocks as well as the MSU breeding program rootstock selections.

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(024) Resistance of New Sweet Cherry Cultivars to Fruit Pitting

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Pitting is a serious postharvest problem in sweet cherries, consisting of sunken areas in the flesh that reduce product value and may result in shipment rejection. Pitting is believed to be caused by mechanical damage during harvest and packing, but symptoms may not appear for many days after the injury. Cultivars differ in pitting susceptibility. The pitting resistance of four new cherry cultivars ['SPC136' (Suite Note™), '13S2009' (Staccato™), '13S2101' (Sovereign™), and 'SPC103' (Sentennial™)] was compared with three commercial standards ['Bing', 'Lapins', and 'Sumtare' (Sweetheart™)]. Pitting was induced using a handheld instrument that drops a metal rod having the mass of an average cherry from a constant height onto the cheek of the fruit. Each cultivar was harvested at two different stages of maturity based on the CTIFL cherry color chart. Fruit were cooled to 4 °C before inflicting the artificial pitting injury. Severity of pitting was assessed after 2 weeks of 1 °C storage. Suite Note™ cherries

were similar to 'Bing' in susceptibility at color Stage 4, but more susceptible than 'Bing' at Stage 6. The late-maturing cherries (Staccato™ , Sovereign™ , and Sentennial™) were all similar to Sweetheart™ in susceptibility at Stage 6, but Sovereign™ was more susceptible to pitting than Sweetheart™ at Stage 4.

Specified Source(s) of Funding: Growing Forward 2, Agriculture and Agri-Food Canada

(025) Genetic Analyses of Root-knot Nematode (*Meloidogyne floridensis*) Resistance in 'Flordaguard' Peach Rootstock

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The peach (*Prunus persica*) cultivar 'Flordaguard' is the predominant rootstock for peach production in Florida. It is effective as a rootstock due to its low-chill requirement and ability to withstand infection by the endemic peach root-knot nematode (RKN), *Meloidogyne floridensis* (*Mf*). The *RMia* gene present in the rootstocks 'Nemared,' 'Nemaguard,' and 'Okinawa' rootstocks does not confer resistance to *M. floridensis*. A source of broad spectrum and dominant resistance against the major RKN including *Mf* was found in Myrobalan plum P.2175 (*Prunus cerasifera*) and Japanese plum J.222 (*Prunus salicina*) carrying the *Ma* and *Rjap* genes, respectively. However, these resistances cannot be readily incorporated into southeastern U.S. breeding programs due to these plums' susceptiblity to peach tree short life, Armillaria root rot, and plum leaf scald. In this study, we examine the genetic basis of resistance in 'Flordaguard' with the goal of identifying markers associated with nematode resistance. We hypothesize that the resistance in 'Flordaguard' may be controlled by a recessive allele and that the wild peach, *Prunus kansuensis*, may have a resistance gene allelic to that found in 'Flordaguard.' To infer the allelic composition in 'Flordaguard,' F_2 and BC_1F_1 populations were generated from crosses made between the resistant ('Flordaguard' or *P. kansuensis*) and susceptible ('Okinawa,' 'UFSharp,' and 'Tardy Nonpareil') cultivars. Parental polymorphism was measured using an initial set of 30 SSR markers evenly distributed throughout the eight linkage groups based on the *Prunus* (interspecific 'Texas' almond × 'Early gold' peach) reference map available from the Genome Database for Rosaceae. The populations were genotyped using the polymorphic SSR markers. The segregating progenies are being evaluated for *Mf* resistance to identify associations between the polymorphic SSR markers and the resistance phenotype. The information obtained in this study will clarify the inheritance of the nematode resistance phenotype of 'Flordaguard' and will indicate if it is allelic to nematode resistance genes in other *Prunus* rootstocks.

Specified Source(s) of Funding: USDA–ARS Specialty Crops Block Grant Program

(026) Smooth Delight and Smooth Zest Nectarines: Four New Low-chill Stone Fruit Cultivars

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In the late 1990s, the *Prunus* Breeding and Genetics Program began to develop a series of early ripening nectarine cultivars adapted to the low chill zone (200–400 chill units) of the southern United States. This work has resulted in two pairs of nectarines that ripen in early to mid May in the low to medium chill zone of Texas. The Smooth Delight nectarines ('Smooth Delight One' and 'Smooth Delight Two') have low acid flesh and bloom about five days before 'Flordaking' and ripen between 'Flordaking' and 'TexKing'. Thus their chilling requirement is estimated to be about 350–400 chill units. The Smooth Zest nectarines ('Smooth Zest One' and 'Smooth Zest Two') have acid sweet flesh and bloom 4–5 days after the low chill peach 'TexFirst', about seven days before the nectarines 'Smooth Delight One', Smooth Delight Two', and 'Suncoast', and 12–14 days before the medium chill (450 chilling hour requirement) peaches 'Flordaking' and 'TexKing'. Thus, their chilling requirement is estimated to be about 200–250 chill units. 'Smooth Delight One' and 'Smooth Zest One' have white flesh whereas the 'Smooth Delight Two' and 'Smooth Zest Two' have yellow flesh. 'Smooth Delight One' and 'Smooth Delight Two' are sister seedlings from a cross between 'Sunmist' and 'Arctic Star'. 'Smooth Zest One' was selected from a cross between a white-fleshed semi-freestone peach selection, TX3D75W, and the low chill peach, 'TexFirst'. 'Smooth Zest Two' was chosen from a cross between two nectarine selections, both which were derived from the Florida nectarine germplasm. These four firm attractive nectarines are being released for home garden and commercial use in the low to medium chill adaptation zone.

(027) Zest Peaches and Smooth Texan Nectarines: New Medium Chill Stone Fruit Cultivars

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In the late 1990s, the *Prunus* Breeding and Genetics Program at Texas A&M University in College Station, TX, began to develop a series of early ripening, yellow peach and nectarine cultivars adapted to the medium chill zone (500–600 CU) of the southern United States. This work has resulted in five new peach and three new nectarine cultivars. The new peach cultivars

ripen consecutively from mid May to late June in the medium chill zone of Texas. These Zest peach cultivars have similar size but better color, fruit shape, and firmness as compared to 'June Gold'. All the 'Royal Zest' releases resulted from crosses made between adapted breeding materials and a high colored California cultivar. 'Golden Zest' is derived from a cross between a Californian and a Brazilian peach cultivar. The Smooth Texan nectarine cultivars ripen starting about two weeks before and finish a little after 'June Gold' in the medium chill zone of Texas. 'Smooth Texan One' and 'Smooth Texan Two' share 'Crimson Baby' as a mother but have different pollen parents whereas 'Smooth Texan Three' is a cross between the California nectarine 'Diamond Ray' and the Chinese nectarine 'Danmo'.

(028) Progress in the Development of Moderate-chill Peach Cultivars for the Southeastern United States

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The Southeastern U.S. peach industry is spread over four production areas, i.e., central Georgia/South Carolina (high chill, main season), the Lower Coastal Plain along the Gulf coast (moderate chill, early season), north Florida (low chill, very early season) and, most recently, central Florida (ultra-low chill, ultra-early season). These areas have distinctly different climates and, consequently, require markedly different priorities for the breeding of new peach cultivars. The main season production areas in central Georgia and South Carolina have been supported for many years by the breeding programs at the USDA-Byron location in central Georgia and Clemson University South Carolina (recently restarted after a lengthy hiatus). The north Florida production area has been supported by the breeding program at the University of Florida since 1952. The University of Florida has recently turned its attention to the needs of the "upstart" central Florida production area as well. However, for many years the lower coastal plain production area lacked any focused breeding support and, instead, had to rely on the occasional "spin-off" from other peach breeding programs, many of which are now shuttered. In 1991, a cooperative, moderate chill peach breeding program was established by the University of Georgia, the University of Florida and the USDA–Agricultural Research Service (Byron, GA) to address the unique needs of this industry. A novel aspect of this program has been its utilization of nonmelting (i.e. "canning") flesh germplasm for the fresh market where melting flesh cultivars have traditionally dominated. Non-melting flesh germplasm offers a considerably slower rate of softening as fruit approaches maturity compared to melting types. This makes possible the breeding of peaches that can be harvested at a more mature stage, allowing the development of significantly improved eating quality, larger size and improved red blush without sacrificing the firmness needed for long distance shipping. To date, this program has released eight cultivars including six non-melting peaches, several of which have been extensively planted by commercial growers in southern Georgia.

(029) Fruit Biochemical Content of Wild *Aronia* Germplasm

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Dark-colored fruits of the genus *Aronia* (chokeberry) are high in antioxidants and have been recognized for their potential as a new nutraceutical fruit crop. *Aronia* species which produce dark-colored fruits include *mitschurinii*, *prunifolia,* and *melanocarpa*, in both diploid and tetraploid forms. A replicated planting of wild *Aronia* accessions was used to determine how the fruit from wild germplasm compared biochemically to fruit from cultivated forms of chokeberry. Over two years, we quantified percent water content, total phenolics by Folin-Ciocalteu assay, total anthocyanins by HPLC and spectrophotometer, individual anthocyanins by HPLC and oxygen radical adsorption capacity (ORAC) by assay. *Aronia* genotypes analyzed included seven *mitschurinii*, 17 diploid *melanocarpa*, 13 tetraploid *melanocarpa*, and 11 *prunifolia* for a total of 48 accessions. There were considerable differences in total anthocyanins, total phenolics and ORAC values between accessions of *Aronia*. Accessions with the highest total phenolics content and ORAC values were twice those of the lowest values for accessions. For total anthocyanin content, the highest accessions were nine times higher than the lowest accessions. In both years, fruits of *mitschurinii* accessions had the highest average water content, while fruits of *prunifolia* accessions had the lowest water content. Diploid *melanocarpa* fruits had the highest levels of total anthocyanins, while *prunifolia* fruits had the lowest concentrations. *Prunifolia* fruits contained the greatest concentrations of total phenolics, while either *mitschurinii* or diploid *melanocarpa* had the lowest concentrations, depending on the year. The ORAC levels were highest for diploid*melanocarpa* fruits in both years, while *mitschurinii* fruits had the lowest ORAC values. In comparing *Aronia* fruit from 2010 to 2011, values for water content, total anthocyanins, total phenolics and ORAC decreased for all taxonomic groups. Over all accessions, water content decreased 4%, anthocyanin content decreased by 29%, total phenolics content decreased by 17% and ORAC decreased by 13%. Maximum differences observed between years for individual accessions were 12% for water content, 66% for anthocyanin content, 44% for total phenolics content and 45% for ORAC. Significant differences in fruit biochemical composition among wild *Aronia* accessions make this germplasm useful in a breeding program to develop new nutraceutical cultivars. Significant year-to-year variation in fruit biochemical composition can be expected and

significant variation between genotypes of the same taxonomic group can exist.

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(030) YouTube Videos Provide Expansion of Information of Fruit Cultivars

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The dissemination of information on fruit cultivars has gone through many changes in recent times. For many years, the primary means of sharing information on new cultivars were limited to grower meetings, factsheets, meeting proceedings, nursery catalogs, and other print sources. As internet resources developed, the internet became a primary source of information about new cultivars, their primary traits, and recommendations for use. Universities have also included internet sources of information. The University of Arkansas Division of Agriculture has a long history in fruit breeding, the program having begun in 1964. More than 60 cultivars have been released, including blackberries, grapes, peaches, nectarines, and blueberries. The University first began using the internet to provide new cultivar information in the early 2000s on its Cooperative Extension Service website. The presentation used short written descriptions of cultivars and pictures. In 2013, the University first utilized YouTube videos to provide additional exposure for the fruit cultivar releases. The video and audio for five blackberry, three nectarine, four peach, and six table grape cultivars were recorded at the University's Fruit Research Station, Clarksville, in the breeding program's advanced selection plots. The videos ranged from 1.5 to 2.5 minutes in length, and included views of the fruit and plants of each cultivar along with narration highlighting the major attributes of each. Final production including editing of the videos and adding music to each were done at the University Campus. Portions of the songs "Blackberry Freedom", "Table Grape Getalong", and "Peach Blues" were used to introduce and end the videos, all original compositions provided for these productions. The videos were posted between 3 July and 15 Oct. 2013. Overall, the videos proved to be the most popular of the video series of the University's Agricultural Experiment Station, far out-numbering other crops and topics in numbers of views. Among the fruits, blackberry views were much higher than those for table grapes, peaches and nectarines. As of early March 2015, the most popular of the blackberries was 'Prime-Ark® Freedom' with almost 5,000 views. Of the table grapes, 'Faith' had the most views, 935. The peaches and nectarines were viewed the least, the most popular was 'Bowden' having 400 views. Total views for all cultivars were just over 25,000 by this same date. This method of communication has increased exposure for the cultivars and added a new dimension to information sharing from the breeding program.

Genetics & Germplasm 1

(001) International Cultivar Registration for Ornamental Crabapple

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The Beijing Botanical Garden (with Dr. Guo Ling serving as the official registrar), was selected as the International Cultivar Registration Authority for *Malus* by the International Society for Horticultural Science, Commission for Nomenclature and Cultivar Registration in 2014. The crabapple garden in Beijing Botanical garden was awarded the Garden of Excellence of China 2012–13 by the Chinese Association of Parks. Eighty-two species and cultivars in the *Malus* genus were introduced. The tree's formal characteristics, cold hardness, drought and flood tolerance, and resistance to pest and disease have been investigated. Genetic relationships among the species and cultivars have been elucidated by gathered molecular data. A system for evaluation has been developed. 'Radiant' and other crabapple cultivars have been planted in Northern China. New cultivars were bred.

(003) Effectiveness of Molecular Markers for Detecting the Non-astringent Trait of Chinese Persimmon and a Trial to Identify the Gene Conferring Chinese PCNA Trait in 'Luo Tian Tian Shi'

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The hexaploid persimmons (*Diospyros kaki*. Thumb. 2n = 6x = 90) are classified into four types depending on its nature of astringency-loss of the fruit. Among these four types, pollination-constant and non-astringent (PCNA) is most desirable for fresh consumption since it stably loses their astringency on the tree. The trait of natural astringency-loss in Japanese PCNA cultivars is recessive, while that in a Chinese PCNA cultivar, Luo Tian Tian Shi, is dominant. The locus controlling the trait of natural astringency-loss is different between Japanese and Chinese PCNA cultivars. Until now, we constructed seven molecular markers (RO-1 to RO-7) to detect Chinese PCNA trait by AFLP analysis using segregated F_1 offspring of 'Luo Tian Tian Shi' Japanese PCNA 'Okugosho', and the most preferable marker was RO-6. However, we do not analyze efficiency of this marker (RO-6) to F_1 offspring from different combinations of paternal

parent. So, we have investigated the efficiency of this marker to 74 or 109 F_1 individuals from 'Luo Tian Tian Shi' Japanese PCA 'Iwasedo' or 'Yotsumizo', respectively. Consequently, we confirmed a good fitness of this marker, in which all PCNA individuals of 30 among L-I offspring ('Luo Tian Tian Shi' 'Iwasedo') and 54 individuals of 55 PCNA individuals in L-Y offspring ('Luo Tian Tian Shi' 'Yotsumizo') had this marker. In addition, to identify the gene (*CPCNA*) conferring Chinese PCNA trait using BAC library of *D. lotus*, a close diploid relative of *D. kaki*, we have initiated the trial to confirm whether the linearity exists in genome of *D. lotus* for the molecular markers detected in 'Luo Tian Tian Shi'. Since *CPCNA* locus seemed to exist between RO-6 and RO-5 markers in 'Luo Tian Tian Shi' due to our previous experiment, we screened several clones using the sequences of each marker and obtained several clones of BAC library of *D. lotus*. And then, we detected SNPs in the end sequences of clones obtained from RO-5 and RO-6 marker, both of which only exist in female plant of dioecious *D. lotus*. Currently, we are analyzing F_1 generation derived from the cross between male and female plant of *D. lotus* for examining the linearity of the markers in *D. lotus*.

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(004) Horticultural Traits Associated with Cacao Accessions Recommended for Puerto Rico

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Cacao (*Theobroma cacao* L.) is an important agricultural product from which the international chocolate industry is based upon. Increasing demand for chocolate, especially in emerging markets in Asia, coupled with reduced worldwide production has led to shortfalls in cacao "bean" supplies. Deficits have also been associated with increases in demand for cacao supplying "specialty" or niche market, high-chocolate content bars. The increase demand in cacao for specialty markets, the availability of land, and ideal growing conditions has sparked interest in this agricultural crop in Puerto Rico. The USDA–ARS Tropical Agriculture Research Station in Mayaguez, Puerto Rico, is responsible for management of the National Plant Germplasm System's cacao germplasm collection. Research on cacao at this site dates back to the 1930s and a number of highly productive accessions with associated good quality chocolate are being recommended for planting on the island. The recommended accessions have been evaluated in multi-site trials and phenotypic data (e.g., flower and pod morphology and color) as well as data for number of pods produced in a year, number of seed per pod, seed/pod index values, and quality of chocolate from micro-fermented beans have been determined. Accessions are also being tested for pollen incompatibility and cross-compatibility by carrying out a large number of controlled pollinations. Summarized data for the recommended cacao accessions for the Puerto Rican cacao/chocolate industry is presented. Limited amounts of scionwood for clonal propagation could be supplied for research and educational purposes by contacting the presenting author (Brian.Irish@ars.usda.gov) or by requesting the material online via the USDA–ARS Germplasm Resources Information Network http://www.ars-grin.gov/.

(005) Collection and Evaluation of Breadfruit in Puerto Rico

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Breadfruit (*Artocarpus altilis*) is an emerging crop in Puerto Rico, although it has been appreciated as a backyard tree in the island for centuries. There is interest in establishing organized commercial orchards of breadfruit in Puerto Rico, but little has been done in the island to characterize and evaluate breadfruit germplasm to be found locally. The College of Agriculture of the University of Puerto Rico has initiated a long-term project to collect, characterize, and evaluate breadfruit germplasm to develop cultivars for potential growers and to expand the body of knowledge on the management of this crop. We have collected germplasm from various parts of the island with different ecological environments, and established collections and comparison experiments. In replicated experiments, we have found differences between accessions in transplanting survival, plant growth rates, shoot height gain, stem branching patterns, leaf area, leaf chlorophyll concentration, that may result in differences in adaptation to contrasting regions of the island and their yield.

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(006) Fruit Quality and Nutrient Dynamics during Fruit Maturation of Jujube (*Ziziphus jujube* Mill.) in New Mexico

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Jujube (*Ziziphus jujuba* Mill.) originated in China, and plays an important role in traditional Chinese medicine. Jujube is considered a functional food, and is believed to help improve sleep quality and regulate the digestive system. Jujube cultivars were imported to the United States in 1908, and are currently distributed widely across the country. Jujube is predicted to have a high potential as a crop in the southwestern United States because of this plant's good environmental adaptation and drought tolerance. Interest in jujube is growing, and farmers are requesting more information on cultivar selections for different uses, vitamin C content, flavor (sweetness), and antioxidant capacity. Our objective is to study the nutrient dynamics during fruit maturation, including vitamin C content, titratable acid, soluble solids, moisture content, sugar composition, and total phenolic content. Fruits of 10 cultivars grown at New Mexico State University (NMSU) Sustainable Agriculture Science Center at Alcalde, NM, and 5 cultivars grown at Los Lunas were harvested on 25 Aug., 10 Sept., 25 Sept., and 7 Oct. 2014. Vitamin C content and moisture content decreased significantly during the ripening process. The vitamin C content of fully matured fruits ranged from 248–374 mg/100g fresh weight in this study, which is 5 times higher than in orange. Vitamin C content varied among cultivars. 'Lang', 'So', 'Sugarcane', and 'Sherwood' had higher vitamin C content. Titratable acid and soluble solids increased significantly during maturation. In fully mature jujubes among cultivars studied, the range for titratable acid was from 0.27% to 0.46%, and 19.9% to 33.7% for soluble solids. Glucose, fructose, and sucrose content increased during ripening. Matured fruits in this study contained 31–82 mg/g FW glucose, 32–101 mg/g FW fructose and 53–159 mg/g FW sucrose. Sucrose content increased rapidly during fruit development. Cultivars could be divided into two groups: "high-sucrose" group (more sucrose than glucose and fructose), which included 'Dagua', 'Honeyjar', 'Lang', 'Li', 'Maya', 'Sugarcane' and 'Sherwood' and "low-sucrose" group (less sucrose than glucose or fructose). Total phenolic content in fruit decreased during maturation. Mature fruits in this study contained 12–16 mg GAE/g DW total phenolic content.

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(007) Comparison of Three Genotyping by Sequencing Pipelines for Variant Identification and Linkage Mapping in the Cultivated Octoploid Strawberry

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Genotyping By Sequencing (GBS) is believed to provide a rapid and economical method of single nucleotide polymorphism (SNP) discovery. The objective of this study was to evaluate the usefulness of GBS in the allo-octoploid cultivated strawberry, *Fragaria ×ananassa*. Five GBS libraries were constructed, each containing DNA from 66 to 96 individuals. Each library was sequenced in one lane (single end) with the Illumina HiSeq 2000 platform. Sequences were trimmed to 64 bp and analyzed after alignment to the strawberry *F. vesca* Fvb genome reference. Three analyses pipelines, POLiMAPS, Stacks and TASSEL, were used to identify SNPs in five bi-parental populations ranging in size from 10 to 63 progeny. We compared the number of markers generated by each pipeline, and placed markers on linkage groups representing the 56 (= 2N = 8) chromosomes for each of the five populations. Our results compare the performance of the three bioinformatic pipelines in resolving GBS data from polyploid species.

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(008) Developing Black Raspberry Genetic and Genomic Resources

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This study incorporates field and laboratory components to advance and streamline identification of a variety of traits of economic interest and to develop molecular markers for marker assisted breeding of black raspberry (*Rubus occidentalis* L.). A lack of adapted, disease resistant cultivars has led to the steady decline of the black raspberry (BR) industry in the United States. Interest in production and breeding new cultivars has been fueled by news regarding the potential health benefits of black raspberry bioactive compounds. To accomplish our goals, we used two related full-sibling populations that were replicated and planted at five production sites (Oregon, Washington, Ohio, North Carolina, and New York). Detailed trait measurements included primocane vigor, flowering and fruiting, disease and aphid tolerance, and plant architecture to assess the influence of environment on genotype (GxE). Initial analysis of GxE on primocane vigor indicated that individual genotypes showed significant variation among sites. We are also developing, and making available, genomic tools including molecular markers for construction of linkage and physical maps, and a draft genome assembly. Markers are being developed by sequencing and analyzing libraries generated by genotyping by sequencing (GBS). Initial analysis through a custom data pipeline identified over 23,000 single nucleotide polymorphic/insertion-deletion (SNP/indel) loci. Preliminary results indicate that GBS is appropriate for SNP detection in this highly-homozygous species. A densely populated genetic linkage map will be used to improve the draft genome assembly, for quantitative trait locus (QTL) mapping, and comparative genomic studies with other Rosaceae species.

(009) Morphological Characterization in Germplasm of *Genipa americana* L.

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The Genipap tree is a tropical fruit tree common in Brazil. The tree is indigenous to South America and grows in the wild and also in small orchards. With the desire to preserve the genetic resources of the species, germplasm was collected in 2009 and is maintained at the Germplasm Bank of Genipap (BG Genipap) in the Embrapa Coastal Tablelands. The BG is located in Nossa Senhora das Dores, Sergipe, Brazil (10°29'30"S, 37°11'36"W, altitude 204 m). The plants were collected randomly from natural populations in several Brazilian states. There are 227 individuals representing represent 24 accessions, which were evaluated by survival rate, total height, and circumference; diameter at branch height and branch girth; shape and edges of leaves; bristle and the color of the leaves; length and width of leaves; and length and edge type of the the peciolate. In 13 of the 24 accessions, the survival rate was 100%, and varied between 80% to 100% of the remaining accessions. The average height was 2.10 m. The medium of the diameter of the plants varied from 1.94 to 5.96 cm. The average of the girth diameter was 2.85 cm. The majority of the leaves are lanceolate (48%) or oblong (35%). However, at BA accession, the leaves are all lobed because they are from the species G. infundibuliformis Zappir & Semir. The color of the leaves of this species is dark green when mature, and average 29.69 cm in length and 11.10 cm in width. The morphologic characterization indicates variability between and inside the accessions. Evaluations will continue every six months, with the ultimate goal of selecting individuals with interesting characteristics, such as survival and height, to ensure the conservation, maintenance, and development of the species.

(010) Genetic Diversity of Persian Walnut Revealed by a Set of Microsatellite Markers in Indiana

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Fourteen microsatellite markers of black walnut were developed and evaluated in a Persian walnut genotypes and cultivars. Those primers were used for studying diversity in 48 Persian walnut genotypes/cultivars belonging to four different geographical groups, such as Indiana, California, Eastern Europe, and a few samples from Russia. All of the markers were polymorphic and revealed a total of 50 alleles ranging from 4 to 8 alleles per locus with a mean value of 6 alleles per locus. No relation could have been observed between any loci and cold hardy resistant genotype. Cold hardy resistant cultivars and genotypes did not separate on the dendrogram obtained by cluster analysis. Indiana and California cultivars formed separate groups while other genotypes formed smaller sub-groups or scattered among different groups. The size of allele was presented for each sample that allowed the easy observation of allele frequencies in each geographical group at each locus. Using this information, dissimilarities and similarities between cultivar groups can be easily estimated. The analysis revealed the links between the American and European walnut genotypes and confirmed that the Russian and Eastern European genotypes are related.

(011) Microsatellite Development and Characterization in Hazelnut

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The genome sequences of 'Jefferson' and seven other hazelnut (*Corylus avellana* L.) cultivars allowed efficient in silico comparisons and identification of polymorphic SSRs. The 'Jefferson' genome was searched using MISA and 17,588 SSRs >15bp were identified. Removal of duplicates, short fragments, repeats at ends, and repeats containing only A's and T's reduced the number of unique fragments to 2069. The 'Jefferson' sequences were aligned with reads from the seven other cultivars using MAQ and the results visualized in Tablet. The 489 SSRs showed variation in repeat number and primers were designed for them. The PCR amplification and separation on agarose gels confirmed that 360 were polymorphic. Fluorescent forward primers were ordered and were used to amplify 48 diverse accessions plus the parents of the mapping population. After post-PCR multiplexing, samples were submitted for sizing using capillary electrophoresis. Allele sizes were determined using GeneMapper software, entered in a spreadsheet and analyzed using PowerMarker and Cervus software. A total of 1906 alleles were present at the 360 loci. The number of alleles per locus ranged from 2 to 15 with an average of 5.29. The mean observed heterozygosity, expected heterozygosity, polymorphism information content, and the frequency of null alleles were 0.52, 0.54, 0.49, and 0.03, respectively. These newly developed polymorphic microsatellite markers will be mapped and used for diversity studies, cultivar fingerprinting, and MAS.

(012) Detection of QTLs for Yield in Globe Artichoke

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The genetics basis of yield-related traits in *Cynara cardunculus* L. were studied in 115 F_1 progeny derived from an interbotanical varietal cross between wild cardoon globe artichoke (Estrella del Sur FCA). The aim of this work was to identify QTLs controlling yield-related traits as a first step to marker assisted selection. Both progenitors and their F_1 were grown at the Experimental Field Station of the Universidad Nacional of Rosario in 2014. Seven agronomic traits were evaluated:number of head per plant (NHP); fresh weight, diameter and length of the main head (WMH, DMH, and LMH, respectively); and fresh weight, diameter and length of the second heads (W2H, D2H, and L2H, respectively). The normal distribution of the traits in the F_1 was verified by a Shapiro-Wilks test. The *t*-Student test was performed to compare the means values between parents. The correlation between traits was determined by the Pearson coefficient. A total of 247 SSRs (Single Sequence Repeats) were used to evaluate the genotypes. The markers were tested for an expected Mendelian segregation in the F_1 population by a $\chi 2$ (chi-square) test. Only SSRs showing a fully consistent with monogenic segregation ($\chi 2 \leq \chi 2\alpha = 0.1$) were used for QTLs association. Association between SSR locus and traits was determined by a one-way ANOVA ($P \leq 0.05$). The proportion of total phenotypic variance explained by each QTL was estimated by R^2 values. All the morphological traits showed normal distribution (Sh-W > 0.94) and the parental genotypes were significantly different for one to another for all traits analyzed. The correlation analysis revealed that diameter and length of the main or secondary heads were the most important factors influencing fresh weigh. A total of 70 SSRs showed Mendelian segregation and were used for QTLs association. Eleven SSR markers were linked to 22 QTLs and six of them showed association with more than one trait. Three SSRs were associated with WMH, three with DMH, five with W2H, eight with D2H, and three with L2H. The percentage of total phenotypic variation explained by each QTLs ranged from 6% to 18%. This

work provides evidence that there are several loci controlling globe artichoke yield and the SSR linked to yield-related traits should be used for marker-assisted improvement of the species.

Tuesday, 4 August 2015

Herbs, Spices, & Medicinal Plants

(300) Black Cohosh and Goldenseal Field Establishment in a Marginal Woodland

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Black cohosh and goldenseal are highly market-demanded and shade-loving medicinal plants. Heavy collection of these plants from the wild has caused significant decline or disappearing in plant population. Cultivation of such medicinal plants in woodlands instead of collecting them from the wild is an attractive and alternative way to meet the market demand and to conserve natural resources. Such cultivation or forest farming practice could significantly enhance and diversify income opportunities for small-scale farmers and woodland owners. Black cohosh and goldenseal rhizomes were planted and established in a wooded research field on the farm of North Carolina A&T State University. The overall goal was to help small-scale farms to find alternate ways to increase their productivity and profitability by developing an efficient propagation protocol for medicinal plants and using forest farming on marginal woodland. Woodland was slightly tilled after cleaning up of weeds and bushes in areas where raised beds were made later with added composts. Drip irrigation was established on the raised beds, with beds without drip lines served as controls (drip irrigation was applied initially to all beds until plants established). Hardwood mulch was added on top of and between the raised beds after planting to hold moisture. Each species was planted in the raised beds using a split plot, randomized complete-block design (RCBD) with six treatments of irrigation and spacing. The irrigation treatment (with- and without drip irrigation) was applied in main plots, while spacing (three levels) was applied in split plots. The bed size was 4 x 76 ft. and the split plot size was 4 x 24 ft.

(301) Influence of Biochar Amendments on Green Roof Media Physical Characteristics and on the Growth of Basil and Peppermint

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There are few research papers relating to the incorporation of biochar into green roof media and the subsequent effects of these additions on herb growth. Nonetheless, there is an interest in biochar incorporations into green roof media as well as an interest in growing agronomic crops on green roofs. The objectives of this research were: (1) to determine differences in media physical characteristics of biochar (Biochar Now, Loveland, CO) at 5%, 10%, or 15% (by volume) incorporations into heat-expanded clay (HEC; Garick, Cleveland, OH) and (2) to assess the growth effect of biochar incorporation on the growth of 'Genovese Compact, Improved' basil (*Ocimum basilicum* L.) and peppermint (*Mentha piperita* L.). A commercially available green roof substrate, Rooflite® Intensive Ag Media (RIA; Laurel Valley Soils, Landenberg, PA), was included for comparison. All media were supplemented with 14.0:6.1:11.6 slow-release fertilizer. Cylinders (17-cm 17-cm; depth diameter) were used for physical characteristic determinations. The RIA media had the highest total porosity (TP), water retention or container capacity (CC), aeration porosity (AP) and AP after an applied suction of 6.3 kPa. In the HEC media, there was a linear increase in TP and CC with increasing amounts of biochar. The HEC containing 15% biochar increased CC to 24% compared to HEC alone (18%). The RIA media had the highest water retention (CC = 28%). Particle size distribution was similar for media except that RIA media had a greater proportion of particles larger than 4.0 mm and a smaller proportion of particles between 1.0 to 2.0 mm and of particles < 0.053 mm size. There was significant shoot dry weight (g/shoot) response to biochar additions ($P \leq 0.01$) and significant shoot dry weight and plant area coverage (cm^2) difference between the two species ($P \leq 0.001$). Peppermint benefited more than basil from biochar incorporations. Following the plant growth study, media containing biochar additions had similar final potential of hydrogen (pH) and electrical conductivity (EC) values as the 100% HEC control. Stomatal conductance was significantly different between the two species following irrigation and successive drying of media over several days; peppermint typically having much greater stomatal conductance following initial irrigation and during the drying period of several days. In conclusion, biochar additions to HEC media increased total porosity and container capacity, which contributed to increased shoot dry weight of peppermint.

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(302) Mulching, Closer Spacing, and Double Harvesting Increased Stevia Biomass Yield in Western North Carolina

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Stevia (*Stevia rebaudiana*) is an increasingly popular natural sweetener that has been embraced by health conscious consumers around the world. Presently, most stevia is grown in China, India, and Vietnam. Now, however, several large corporations are producing stevia in the United States, including eastern North Carolina. Stevia as a commercial specialty crop may also present a unique economic opportunity for farmers in the mountains of western North Carolina (WNC) but it has not been evaluated in this region for commercial production. In this pilot study we used a randomized split-split plot design to investigate mulch types (black plastic, white plastic, and bare ground), in-row spacings (15, 30, and 46 cm in double rows with 30 cm between rows on the bed), and harvest times (single cutting and two cuttings) on yields of plant biomass and steviosides. The trial site was at the Mountain Research Station in Waynesville, NC. Rooted stevia plant plugs from cuttings of a commercially grown variety were transplanted in the field on 6 June 2014, on raised beds with drip-irrigation. For the two harvest treatment, the first cutting was on 22 July and the second was on 4 September. The single optimal harvest was done on different dates based on the plant development (30% bud stage) in each plot. Results indicated that applying plastic mulch and using the closest plant spacing significantly increased biomass yields when compared to bare ground and the two wider plant spacings. No difference was detected between the two plastic types or between the two wider plant spacings. The double cutting produced almost twice the biomass yield of the single harvest. The findings from this investigation indicate that plant spacing, mulching, and harvest times can significantly affect stevia biomass yield in WNC.

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(303) Hawaii Farmers Find a Niche Market in Exporting Ginger Seed

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In 2012, researchers from the University of Hawaii received a Western Sustainable Agriculture Research and Education (WSARE) grant to promote farming practices that would help to control bacterial wilt caused by *Ralstonia solancearum* in edible ginger (*Zingiber officionale*). Bacterial wilt disease is the greatest limiting factor in the production of edible ginger with crop losses upward of 60%. A major objective for this grant was to provide growers with bacterial wilt free planting material. Through the process of tissue culture, plantlets free of bacterial wilt were multiplied. These plantlets were then grown hydroponically in pots filled with clean media atop benches in order to maintain a bacterial wilt free environment. After harvest, DNA tests were performed on batch samples to assure no contamination had occurred. Distribution of this bacterial wilt free planting material went out to growers who agreed to follow the recommended cultural practices. This program has led to a group of new ginger growers on Hawaii Island that identified an emerging market for bacterial wilt free ginger seed rather than ginger for direct consumption. Mainland states including Alabama, California, Minnesota, Virginia, New York, and Oregon have found a demand for edible baby ginger as their shorter growing seasons preclude them from growing fully matured ginger for seed. Hawaii has now become a source for edible ginger seed production in the United States.

(304) Identification of Biological Effective Constituents from the *Potentilla supina*

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Potentilla supina (PS) is a member of the Rosaceae family that is native to China, Japan, Korea, India, and Malaysia. It produces one or more erect stems from a branching caudex and system of rhizomes. It grows 20 to 60 cm tall, and is slightly hairy to nearly hairless. The leaves are ternate, divided into three leaflets. The basal leaves are largest, borne on long petioles. Each has oval leaflets up to 3-cm long that are deeply cut into blunt teeth. Smaller leaves occur higher on the stem. The inflorescence is a cyme of one or more flowers. The flower has usually five yellow petals up to 1-cm long on a calyx of pointed sepals and narrower pointed bractlets. *Potentilla supina* is often used in Korean traditional systems of medicine as a remedy for hemostasis, dysentery cough, pertussis, sore throat, and external bleeding. Generally, drugs that are used for arthritis have antinociceptive and anti-inflammatory properties. The purpose of this study was to determine whether the total polyphenol content, antioxidative, and antiinflammatory activities were examined on the extract

from PS and their biologically active constituents were identified. The total polyphenol contents appeared to be highest in EtOAc fraction (316.4 ± 11.8 mg/g) of PS. The DPPH radical scavenging activity was highest in an EtOAc fraction of PS of 95.4 ± 0.3% at a concentration of 250 μg/mL ($P < 0.05$). The anti-inflammatory activities of EtOAc fraction of PS was evaluated for inhibitory activities against lipopolysacchride(LPS) induced nitric oxide(NO) and prostaglandin E_2(PGE_2) production in RAW264.7 celllines. The EtOAc fraction of PS was high inhibitory activity for both tests with IC_{50} values showed in the ranges of 29.34 ~ 50.75 μg/mL. The biological effective compounds in the whole parts of PS were isolated by a bioassay-guided purification using the antioxidative and antiinflammatory activities. The repeated column chromatography of ethyl acetate-soluble layer in this ethanol extract led to isolation two constituents such as caffeic acid (1) and quercitrin (2). The structures of these compounds were identified by spectroscopic methods and by comparing their data to those in the literature. As far as we know, two compounds were isolated for the first time from this plant. Both compounds were already reported ingredients but the two compounds are considered to exhibit a high physiological activity. This result revealed that EtOAc fraction of PS is expected to be good candidate for development into source of prophylactic agent.

(305) Winter Greenhouse Production of Basil (*Ocimum* spp.) for Essential Oils

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Basil is one of the few medicinal herbs that is an annual. The purpose of our research was to test eight different cultivars for growth and performance under controlled environment agricultural conditions: that is, basic fertigation supplied with a capillary mat, heat under the benches and natural winter light greenhouse conditions. Seeds of eight cultivars were sown in October and allowed to germinate and grow for five weeks. Multiple plants were then transplanted into 6-inch pots filled with soilless mix and received one of three fertilizer treatments; either just 100 ppm N from 20N–4.4P–16.6K water soluble fertilizer; 100 ppm N from 20N–4.4P–16.6K plus 6 g of 12N–3.1P–14.9K slow release fertilizer or 100 ppm N from 20N–4.4P–16.6K plus 9 g of 12N–3.1P–14.9K slow release fertilizer. At eight weeks after sowing, plants were pricked out to only three per pot. Fifteen weeks after sowing, one plant from each pot was harvested, dried, weighed, and set aside for essential oil analysis. The experiment design was a RCBD across two north-south running benches with six replications. All cultivars germinated within seven days. Italian Large Leaf, Genovese, and Nufar cultivars had larger leaves than plants of 'Mrs. Burn's Lemon' and 'Spicy Globe'. 'Holy' basil, which was the only cultivar with obvious pubescence, took the longest to grow (pricked out at 19 weeks after sowing) and to flower. All other cultivars started to flower between week 12 and 13 after sowing. All plants receiving only 100 ppm N were slower to develop, but eventually flowered. There did not appear to be any growth differences between the other two nutrient treatments. Cultivars Mrs. Burn's Lemon and Spicy Globe had a bushy habit as compared to the more single-stemmed structure of the other cultivars. At weeks 19–20, plants of all cultivars except 'Holy' and 'Spicy Globe' were at least three feet tall. Production timelines for all cultivars will also be presented.

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(306) Performance of Three Fennel (*Foeniculum vulgare*) Cultivars Produced in a Protected Agricultural Greenhouse System

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Fennel (*Foeniculum vulgare)* is a perennial, herbaceous horticultural crop native to the Mediterranean region. All parts of the plant, including the seeds, roots, and stems, are conventional culinary ingredients. Recent interest in nutraceutical compounds has resulted in an increased demand for fennel extracts. Two primary bioactive compounds, fenchone and anethole, are extracted to produce essential oils of fennel. Although fennel has traditionally been produced in soil in a cold environment, soilless cultivation in the southern United States within protected agricultural systems has been limited. This study investigated cultivar performance in a protected production environment. Seeds of three fennel cultivars (Grosfruchtiger, Bronze and Green, and Bronze) purchased from Johnny's Selected Seeds (Winslow, MA) were germinated in a greenhouse at the Mid-Florida Research and Education Center located in Apopka, FL. Four weeks after germination, seedlings were transplanted into 7.6-L containers filled with soilless substrate (Fafard 4 Mix, Sun Gro Horticulture, Agawam, MA) and irrigated through a drip system. Plant growth indices (width1 x width2 x height) were recorded weekly. Eight weeks after transplant, plants were destructively harvested and dried in an oven at 65 °C until a

constant dry weight was obtained to quantify shoot biomass. Differences in plant growth indices and biomass among cultivar will be discussed. Results from this work will assist in selection of fennel cultivar for production within protected agricultural production.

(307) Wyoming Fresh Herb Production

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This project studied culinary herbs that can be grown in Wyoming for sale at local venues such as restaurants and farmers' markets. Results of this research could encourage the expansion of specialty crop production in Wyoming. Four species of culinary herbs were grown in two 12' × 16' high tunnels oriented perpendicular to one another, one north/south, the other east/west. The same species were also grown in a greenhouse on the campus of the University of Wyoming. Herbs grown were oregano (*Origanum vulgare*), basil (*Ocimum basilicum* 'Sweet Dani'), garlic chives (*Allium tuberosum*), and sweet marjoram (*Origanum majorana*). Herb seedlings were planted 30 May 2013, into 1.1-L containers in the greenhouse and directly in the ground in high tunnels. Final 2013 data were taken 26 November 2013. The study was repeated in 2014, with the same herbs planted in the high tunnels and greenhouse 24 May 2014, and grown until 27 October 2014. Data collected included days from sowing to germination, days from sowing to transplant, and fresh weight of harvested herbs on a per-plant basis. Each herb species was organized in in each location in a completely randomized experimental design, each with 16 single-plant replicates. Plant tissue analyses were conducted on a portion of the herbs. All data were analyzed using analysis of variance and mean separations. Results indicated differences in yields of herbs depending on whether located in the high tunnels or in the greenhouse. Yields were higher in the high tunnels than in the greenhouse for all four species in 2013 and for chives in 2014. There were also differences in herb yields among locations within the high tunnels. Anticipated impacts of this research include increased utilization of high tunnels and greenhouses in Wyoming to produce specialty herb crops for local sales and estimates of fresh weight yields of herbs grown in a greenhouse and high tunnels.

Tuesday, 4 August 2015

Produce Quality, Safety, and Health Properties 1

(083) Comparison of Free Citrulline and Arginine in Watermelon Seeds and Flesh

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Citrulline, a non-essential amino acid found in watermelon, helps promote vasodilation in humans by stimulating the nitric oxide system. Arginine is a primary amino acid used in the nitric oxide system of mammals. Citrulline has been reported in both flesh and rind of watermelon, and reports vary widely regarding relative content in fruit grafted or seeded or seedless watermelon cultivars. Little is known about watermelon seeds. In this study, watermelon seeds (embryos) of various types and cultivars were analyzed for free citrulline and arginine and compared to amounts found in grafted and not grafted seedless watermelons. Samples were extracted with 0.03M phosphoric acid and supernatant injected onto a Hitachi HPLC equipped with DAD detector (195 nm), a Gemini 3u C18 110A 250x4.6 mm column, and using a mobile phase of 0.015 M phosphoric acid with flow rate of 0.5 ml/min at 25 °C for 30 min. A subset of samples was run by amino analyzer to verify results. Free amino analysis was done using 0.5 ml supernatant diluted with 0.02N HCl to a final volume of 1 mL and analyzed using a Hitachi Model L-8900 Analyzer, 570 and 440 nm and an analytical column (model 2622SC PF; 40-mm length, 6.0-mm ID). Separation was done by using a borate buffers and a 30 to 70°C gradient buffer. Ninhydrin was used for instrumental postcolumn derivatization. Amino acid standard curves of 1 to 5 nM were made with serial dilutions of an amino acid standard mixture containing 2.5 pmol of 18 amino acids in 0.02 N HCl. Non-treated watermelon seeds of heirloom, hybrid seeded, or seedless types were purchased from seed companies. Grafted and not grafted seedless watermelons ('Fascination' with 'Carnivor' rootstock) were obtained from field plantings in SC. The citrulline and arginine contents of watermelon flesh were much higher than that of seeds (2–2.5 vs. 0.03 to 0.1 mg/g fresh weight), and 7–9 vs. 0.3 to 1 mg/g fwt, respectively. The ratio of citrulline to arginine was much less in seeds (0.04 to 0.33) compared to flesh (2 to 4). The different citrulline and arginine ratios between seeds and placental tissue most likely reflect the very different roles these tissues play in the reproduction system of watermelon. Citrulline can act as a storage mechanism for nitrogen while arginine is a nitrogen storage form in seeds. Citrulline content of flesh was less from grafted watermelons than from fruit of ungrafted plants.

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(084) Combinations of Rootstocks and Scions to Increase the Fruit Quality in Watermelon

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Grafted plants have been a useful tool in the control of soil-borne diseases. However, some studies indicate that the combination of some rootstock-scion could change the quality of the fruits, and therefore the selection of the rootstock and the scion is fundamental. The aim of this study was to evaluate the variability of quality parameters, such as firmness, soluble solid content and lycopene concentration in fruits of two types of seedless watermelon scions (cv Mielheart and Ocelott) grafted onto four commercial rootstock (*Cucurbita maxima* x *Cucurbita moschata* cv. "TZ-148" and "RS-841", *Cucurbita maxima* cv. "53004" and *Cucurbita moschata* cv. "Super Shintoza"). Non-grafted "Mielheart" and "Ocelott" were used as control. Plants were growing in open field conditions under commercial system production in Colima, Mexico. The field was arranged in a split-plot design with three repetitions. Lycopene concentration ranged up to 50% depending on the watermelon scions. Lycopene concentration could increase in grafted plant fruits by 19% to 28% compared with the non-grafted fruits. There was a difference of more than 10% in the Total Soluble Solid content between the two watermelon scions used, however, there was no difference between the grafted and non-grafted fruits. Grafted fruits had superior firmness compared to non-grafted fruits; in this case there was no difference between the two watermelon scions. Lycopene, Total Soluble Solid and firmness may vary depending on the combination of scion and rootstock used. The use of grafted plants could be a useful tool to increase the fruit quality.

Specified Source(s) of Funding: Universidad de Guadalajara

(085) Strawberry Cultivar and Tissue Chemotypes

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Strawberries are a model system for fleshy fruit in the Rosaceae family. True strawberry fruit are the achenes or "seeds" that cover the surface of a modified receptacle. Strawberries are regularly consumed for their unique flavor and nutritional value. Fruit nutritional quality has been attributed to phytochemicals including micronutrients, antioxidants and specialized polyphenolic compounds present in the fruit. Organoleptic properties, including flavor, aroma, texture, and appearance, are important characteristics for consumers. Fruit nutritional value and organoleptic quality are based on the metabolites present at the ripe harvest stage. Different germplasm and the physiological changes that occur throughout fruit growth and ripening influence the metabolic profile that is important for quality fruit. Despite the importance of phytochemical content, variation in the germplasm and through development of the berry is not well understood. The aim of this work was to screen fruit for desirable chemotype traits that support quality fruit to enhance health benefits, flavor, and post-harvest longevity. The relative contents of metabolites in four different cultivars of strawberry were characterized by measuring detectable vitamins, amino acids, and polyphenols using ultra-performance liquid chromatography quadruple time-of-flight mass spectrometry profiling in achene and receptacle tissues. Differences in cultivars support the idea that breeding for quality enhancing metabolite content is possible because much variation can be explained by genetic differences. The majority of health-promoting phytochemicals are present in receptacle strawberry tissue. Polyphenols including flavonoids and ellagitannins were abundant in the 'Strawberry Festival' receptacle and Winterstar™ cultivar achenes, while vitamins were present primarily in 'Florida Radiance', Sensation™, and Winterstar™ receptacle. The presence of procyanidin pentamer in only 'Strawberry Festival' highlights the uniqueness of the varietal, despite relatedness to other cultivars. Breeders can use these findings to select germplasm for traits like high vitamin content or anthocyanidin content compared to other popular cultivars. Consumers prefer a sweet, flavorful strawberry that lasts. Selective breeding can deliver the ideal berry incorporating Winterstar™ germplasm, which has high polyphenolic content, to promote increased postharvest shelf life.

(086) Evaluation of Consumer Acceptance of West Coast versus East Coast-produced Broccoli through Sensory Analysis of Quality Rating Factors and Nutritionally Important Metabolites

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Production trials and germplasm evaluation of broccoli (*Brassica oleracea* var. italica) developed for eastern U.S. production conditions have identified lines and cultivars that are better adapted to more stressful, variable East Coast environments. As a part of this work sponsored by the USDA–SCIR grant program we conducted sensory analysis of broccoli grown in California vs. South Carolina. The project objective was to evaluate potential consumer acceptance of broccoli grown in the eastern United States relative to broccoli grown and shipped from the traditional West Coast production areas. A sensory panel was established to determine consumer acceptance of broccoli grown and shipped from California (CA) vs. broccoli grown in South Carolina

(SC). All samples were cooked before evaluation. One of the SC (SC1) lines was similar in head shape (domed) and color to the CA sample. The other SC line (SC2) was lighter green in color and had a less domed shape head. The sensory panel (n = 100) evaluated all samples for appearance, color, overall liking, overall liking of flavor, sweetness intensity, and bitterness. The evaluation was based on hedonic and intensity scores. The CA and the SC1 samples were liked equally overall and both were liked more than the SC2 samples. The overall flavor of all three CA, SC1 and SC2 was liked equally. CA samples were sweeter than SC2 samples but equally sweet as SC1 samples. CA and SC1 samples were less bitter than SC2 samples. Panelist were asked to indicate if the color of the broccoli samples was too light, just about right or too dark. The majority of panelist thought that the color of CA and SC1 was just about right. However, they thought that SC2 was too light. Those who thought that the color was too light gave lower overall liking scores (4.9) to the sample than did those who thought that the sample color was just about right (7.1). Thus, the color was likely a major contributing factor to it being liked less than the other two samples. We extracted four replications of each of these samples and measured, carotenoid and chlorophyll pigments (impact on color and taste); glucosinolate compounds (impact on taste/bitterness); mineral content (impact on quality in general); and sugar and organic acids (impact on flavor). The relationship between the content of the metabolites measured and the panelist ratings will be discussed.

Specified Source(s) of Funding: USDA–SCRI

(087) Effect of the Application of Edible Coatings on the Quality of Minimally Processed Mangoes (*Mangifera Indica* L.)

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Worldwide, Mexico is the seventh largest producer of mango and the first exporter of this fruit to the United States. However the lack of appropriate technology in food preservation, which would allow maintaining the quality of the fresh-cut mango through its storage (15 days at 5 °C), mango producers have not been able to take advantage of new markets such as minimally processed products (MMP). Drained intracellular fluid and loss of firmness are the main problems for fresh-cut mango; these problems diminish the visual quality and promote the microbial growth, which cause the rejection of the product. Combining low temperatures of conservation with the use of edible coatings (EC) in submicron systems, would extend the shelf life of MPP. Therefore, the aim of this work was to compare the behavior of 'Ataulfo' and 'Kent' mangoes as a fresh-cut product when to compare the applied, sodium alginate (2 g/L) with citric acid (0.5 g/L) (SA-CA) and a nanoemulsion based on xanthan gum (0.3 g/L) with α-tocopherol (2 g/L) (XG-T). Mango cubes were dipped in the coatings and packaged in polystyrene plastic containers that were stored for 16 days at 5 °C. Physicochemical, microbiological and sensory analyses were performed periodically during storage. There were no statistical difference between EC for total soluble solids and citric acid content. At the end of storage the mangoes treated with XG-T were firmer than SA-CA (49.63% and 67.27% of firmness, for 'Ataulfo' and 'Kent' mangoes respectively). The count of lactic acid bacteria (LAB) increased in all treatments; fresh-cut mango at 8 days reached a microbial growth population by ~4 log UFC g and ~5 log UFC g for 'Ataulfo' mango and 'Kent' mango respectively. Sensorial analysis indicates that acceptability falls within the first 12 days for 'Ataulfo' mango and the eight days for 'Kent' mango. We suggest that 'Ataulfo' mango can be used for minimal processing due to maintained better quality standards than cultivar 'Kent'. This study is a step forward for the commercialization of mango products with added value that would represent more revenues for the mango producer in Mexico.

(088) Effectiveness of Acidic Electrolyzed Water in Reducing Microbial Load on Lettuce Produced in a High Tunnel

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High tunnel extends the production season for vegetables. Collection of rainwater provides an alternative source of irrigation water during the growing season. However, rainwater is prone to contamination by animal feces and environmental dusts and debris. Preliminary studies showed that the collected rainwater was high in bacteria incluing E. Coli. This lead to high microbial load on the vegetables produced. The objective of this study was to determine the effects of acidic electrolyzed water on microbial load of black seed lettuce produced under this condition. Black seed lettuce was grown in a high tunnel. They were irrigated with rainwater collected in black plastic tanks and tranferred with a solar powered pump. Lettuce leaves were harvested manually and transported to the lab in a cooler for analysis. The leaves

(100 g) were cut into 1-cm lengths and mixed well before samples of 10 g each were taken. The samples were treated with no rinsing, rinsing with tap water or acidic electrolyzed water. For the rinsing treatment, black seed lettuce were rinsed with 500 mL of tap water or 500 mL acidic electrolyzed water in a plastic container placed on a shaker at 20 rpm for five minutes. The leaves were mixed with 90 mL of Peptone water, homogenized in a stomacher for two minutes before the solution was inoculated onto petrifilm plates for total aerobic count after proper dilution. The total aerobic bacteria counts were 2425, 1485, or 25 CFU/g for lettuce with no rinse, rinsed with tap water or acidic electrolyzed water, respectively. Rinsing with tap water reduced the microbial load by 40%, whereas rinsing with acidic electrolyzed water reduced the micorbial load of lettuce leaves by 99%. These results indicate that acidic electrolyzed water can be an effective decontaminating treatment for vegetables irrigated with rainwater during production.

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(089) Testing the Frying Performance of *Camellia oleifera* Oil

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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 has been commonly referred to as the "eastern olive oil" due to health benefits associated with its consumption. Camellia oil has certain physiochemical properties that are beneficial to human health and these properties also contribute to the heat stability of the oil. Although it has many industrial uses, *Camellia* oil is most commonly consumed as a cooking oil with roughly one seventh of the Chinese population using it for this purpose. This study examined how Camellia oil and oils with similar chemical characteristics, peanut and soybean, respond to high heat stress during frying and what degradation products were produced. Over five consecutive days, each oil was subjected to high temperatures through the frying of potatoes. A series of analysis were conducted on an oil sample taken from each day to determine the fatty acid profile, peroxide value, acid value and total polymeric materials in the waste oil. These tests are important to determine how the beneficial and potentially negative nutritional aspects of the oil change during heating as this could have effects on human health. Overall, peanut oil was most stable under high heat and frying conditions followed by *Camellia* and soybean oils, respectively. Even though the physiochemistry of peanut oil remained most unchanged, there are still potentially greater health benefits with using *Camellia* oil for the purpose of frying under high heat. The fatty acid profile for peanut oil changed the least during frying, peroxide values peaked at 2.1 mg peroxide/kg oil, acid values at 0.4 mg KOH/g oil, and total polymeric material values topping 11 units. Further research is being conducted to determine the biodiesel potential of tea-seed oil. The remaining waste oil from the final day of the frying portion of the project will be transesterified into biodiesel and each oil will then be subjected to a number of tests to determine the quality of product that can be produced from a highly oxidized feedstock.

Specified Source(s) of Funding: The University of Georgia

(090) Analysis of Effect on Harmful Microorganism Death Rate According to Ultraviolet Irradiation and Sterilization Condition of Substrate for Cultivation of Oyster Mushroom

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Mycelial growth of oyster mushroom is very important. Careless management of mycelial growth can cause contamination and low yield of the mushroom. To reduce contamination, it is necessary to maintain clean cooling rooms, inoculation rooms, and cultivation rooms. We first investigate the death rate of microorganisms from ultraviolet (UV) irradiation in the cooling and inoculation rooms and the contamination rate according to the sterilization condition of substrate. Though contamination rates based on sterilization conditions did not show large differences, the amount of electricity used was the lowest at 121 °C for 90 min. As a result, UV irradiation time killed the microorganisms and bacteria was not detected after UV irradiation for 6 hours using 40-W UV lamps in a 56-m^3 room. The death rate of fungi is not substantial in the same UV irradiation conditions.

Tuesday, 4 August 2015

Propagation 1

(176) Propagation of Several New England Shrubs by Softwood or Semi-hardwood Stem Cuttings

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Many shrubs indigenous to New England remain absent from the horticulture industry despite traits that make them attractive for cultivation. As part of a project to evaluate indigenous plants for horticultural potential, we evaluated adventitious root development on softwood stem cuttings of *Myrica gale* and semi-hardwood stem cuttings of *Rhododendron canadense, Lonicera villosa,* and *Ilex mucronata* treated with auxin in the form of K-IBA dissolved in water or IBA dissolved in 50% ethanol. Cuttings of each taxon were evaluated for rooting percentage after a minimum of five weeks under mist. Ninety-five percent of *M. gale* cuttings rooted when auxin was not applied, and auxin concentrations higher than 1000 ppm reduced root formation. Rooting percentages ranged from 20% to 50% among cuttings treated with 3000–10,000 ppm IBA or K-IBA. Nearly all cuttings of *R. canadense* rooted, whether auxin was applied or not. Cuttings produced dense profusions of adventitious roots that were thinner and shorter than adventitious roots produced by many other taxa. One hundred percent of *L. villosa* cuttings rooted without auxin treatment, as well as when IBA or K-IBA was applied at 1000, 3000, or 5000 ppm. Cuttings of *I. mucronata* rooted poorly, although auxin concentrations of 1000–10,000 ppm produced rooting in 20% to 30% of cuttings, whereas no rooting occurred without exogenous auxin. Our results demonstrate that *L. villosa, R. canadense,* and *M. gale* are readily propagated from stem cuttings, and that higher auxin concentrations or factors other than auxin need to be evaluated for commercial propagation of *I. mucronata*.

(177) The Effect of 6-Benzylaminopurine (BAP) on Bud-forcing of Twelve *Quercus* L. Species

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Oaks (*Quercus* L.) are globally iconic trees, prized economically for their strong, rot-resistant wood, ecologically for their contributions as a keystone species, and aesthetically for their ornamental landscape value. One method of propagating oak species is micropropagation—using young, newly flushed shoots collected immediately after emergence in the spring. This is a narrow and somewhat unpredictable time window for obtaining explants. However, forcing bud break of cuttings can increase the time range to collect young shoot explants and allow for shoot development in a controlled, clean environment. The objective of this experiment was to determine the effectiveness of 6-benzylaminopurine (BAP), a cytokinin, on bud break in twelve *Quercus* species. Dormant cuttings of one- and two-year-old wood were collected from 12 different species of *Quercus*: *alba, bicolor, cerris, falcata, imbricaria, macrocarpa, macrocarpa* var. *macrocarpa, pagoda, palustris, rubra, texana,* and *variabalis*. Cuttings of 10–33 cm in length with 5–25 buds each (depending on species) were collected in Kennett Square, PA, in mid-February. The experiment was a factorial design with 12 species, 3 BAP treatments (0, 100, and 500 ppm) and 3 replications, giving a total of 108 cuttings. Each of the 3 repetitions were placed into Erlenmeyer flasks with distilled water and placed in a greenhouse with a heat set point of 20 °C and a cooling set point of 26.5 °C. Cuttings were evaluated weekly and rated on a scale of 0–4 with 0 = no development, 1 = slight bud swelling, 2 = moderate bud swelling and elongation with visible green coloration, 3 = bud break with partially visible leaf and inflorescence tips, 4 = newly emerged leaf fully visible (target stage for shoot tip micropropagation). Results indicate that the BAP treatment at 100 or 500 ppm significantly increased the rate of bud break and shoot elongation by 1–2 weeks for four of the *Quercus* species: *imbricaria, macrocarpa, pagoda,* and*variabilis*. There was no significant effect from BAP application on the remaining eight species. All *Quercus* species except *alba, bicolor*, and *pagoda* reached stage 4 with all treatments indicating that forcing bud break without BAP application is a viable option, but the rate may be enhanced with some species with the application of BAP.

(178) Propagation Methods and Distribution Potential of Eastern Hemlock, an Endangered Minnesota Conifer

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Eastern hemlock (*Tsuga canadensis*) is a common native conifer in the eastern United States and is propagated and grown as an ornamental tree in the landscape. In Minnesota, however, it exists at the northwestern edge of its range and is listed as an endangered species with fewer than 50 trees and scattered seedlings found throughout the northeastern portion of the state. The Minnesota Landscape Arboretum has trees in its collection that were grown from seed produced by an extirpated eastern hemlock population near Mille Lacs Lake, MN. Through collaborations with the Minnesota Landscape Arboretum and the Minnesota Department of Natural Resources, we have potential to seed-propagate existing trees to preserve genetic diversity and integrity by introducing Minnesota-sourced seed into the

landscape industry. This regionally adapted seed should lead to landscape plants that are better adapted to Minnesota's climate. Our research combines genetic diversity information and clonal and seed propagation of native and cultivated populations to identify best practices for handling and distributing Minnesota-sourced Eastern hemlock seed and cuttings. We measured the effect of four different auxin concentrations (0 ppm (control), 5,000 ppm IBA, 10,000 ppm IBA, and a 5,000 ppm IBA/5,000 ppm NAA combination) on winter hardwood cuttings taken in January 2015 from native-sourced Minnesota Landscape Arboretum accessions and will report these results. Additionally, in September 2014, cones were collected from two native remnant populations near Duluth, MN and four native-sourced accessions from the Minnesota Landscape Arboretum. Estimated germination rates ranged from as low as 2% and 3% in seeds grown from native remnant populations to up to 28% in seeds grown from cultivated trees at the arboretum. Ultimately, establishment of best practices for propagation will inform both conservation and nursery industry distribution decisions.

Specified Source(s) of Funding: Minnesota Agricultural Experiment Station

(179) Propagation of *Amelanchier spicata* by Softwood Stem Cuttings

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The *Amelanchier spicata* complex (dwarf serviceberry or shadbush) comprises North American shrubs in the Rosaceae with aesthetic value and edible fruits for humans and wildlife. Our objective was to evaluate the effects of auxin concentration and method of auxin delivery (K-IBA in water vs. IBA in 50% ethanol) on adventitious root development of softwood stem cuttings from phenotypically distinct plants from two provenances in Maine. Cuttings were treated with a quick-dip in IBA or K-IBA, at concentrations of 3000, 5000, and 8000 ppm. Cuttings serving as controls were treated with distilled water or 50% ethanol. After 52 days under mist, we recorded the percentage of cuttings that rooted, as well as a subjective assessment of rooting quality. Provenance had a modest influence on rooting success, but data were pooled because there was no interaction between provenance and treatment. Auxin treatment enhanced rooting percentage (75% with auxin and 50% without) and quality of roots on cuttings that rooted (mean scores of 3.1 with auxin and 2.1 without), but we found no differences in outcomes among auxin concentrations evaluated. *A. spicata* was likewise insensitive to method of auxin delivery, as treatment with IBA or K-IBA produced similar results. Since ~25% of cuttings failed to root despite auxin treatment, and root systems that developed were not consistently robust, factors other than auxin should be investigated to improve propagation of *A. spicata* as a commercial crop for horticulture in North America.

(180) In Vitro Seed Germination and Rootstock Establishing for Micrografting of *Theobroma cacao* L.

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Micrografting has been successfully implemented in several plant species of *Citrus, Eucalyptus, Havea, Malus, Olea, Prunus*, and other genera. This technique is employed for plant rejuvenation, true-to-type propagation, recovery of virus-free plants, testing of post cryopreservation viability and for regeneration of plants. The procedure involves grafting of a meristematic shoot or of an embryo onto epicotyl or hypocotyl cambium layer of a young seedling grown aseptically. This study tested the possibility of establishing cacao (*T. cacao* L.) seedlings in vitro with the purpose of using them as rootstocks. Seeds from cacao pods (accession TARS 16542) provided by TARS in Mayaguez, PR, were shipped overnight to Fort Collins, CO. The cacao seeds were extracted, cleaned of mucilage, sterilized and cultured aseptically. The highest germination was observed when seeds were sterilized in isopropyl alcohol (70%; 10 min.) followed by sodium hypochlorite (1%; 20 min), rinsed with sterile water and placed on a solid, half strength MS medium supplemented with cysteine (100 mg/L), at 30 °C, in dark conditions. The seed germination varied from 60% to 100%. The main impediments for the in vitro germination and seedling development were excretion of phenolic compounds as well as contamination that occurred at various stages of plant development. These factors decreased the number of usable rootstocks. Increasing the concentration of sodium hypochlorite and sterilization time (5%; 40 min.) lowered contamination but drastically inhibited the seed germination. After 4–5 days, the seedlings were transferred to double stacked Magenta boxes and placed in a growth chamber (26 °C) with an 18-h photoperiod. After 5–6 weeks of cultivation under light conditions, seedlings (ca. 10–12 cm long) were ready for grafting. Shoots 4–6 mm long were grafted into the hypocotyl cambium layer of the rootstocks. After 5–7 day cultivation period under dimed light, the grafted plants were transferred to light conditions (18 h) and 8 weeks later to pots. Over 50% of micrografts developed canopies. Future studies will focus on evaluating factors that might increase the percentage of plants developed from grafts. The feasibility of using micrografting for plant regeneration from cryopreserved meristematic cacao shoots will be tested.

(181) In Vitro Comparison of Benzyladenine and Meta-Topolin on Shoot Proliferation of River Cane (*Arundinaria gigantea*), a Candidate for Wetlands Restoration

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River cane *(Arundinaria gigantea)* is an endangered species of temperate woody bamboo native only to the southeastern United States. This fast-growing but noninvasive species forms dense stands, called canebrakes, along waterways, where it can effectively control erosion, absorb agricultural runoff, and provide a habitat for diverse animal species. These qualities make River cane an excellent candidate for wetlands restoration in the Southeast. Unfortunately, since European settlement of North America, River cane has suffered a devastating 98% habitat loss, making it critically endangered. Therefore, an efficient and large-scale propagation method is needed both to expand existing populations and to undertake viable wetlands restoration projects. Vegetative macropropagation has low proliferation rates, and seedset in River cane is extremely infrequent and unpredictable, but in vitro micropropagation could supply consistent material with higher proliferation rates. Although previous studies have achieved shoot proliferation in vitro, to date there is no report of successful rooting and acclimatization of River cane. Benzyladenine (BA) is the most widely used cytokinin for in vitro shoot proliferation, but BA can negatively impact the subsequent rooting and acclimatization steps in micropropagation for many species. Substitution of BA with meta-topolin (mT), a rapidly degrading natural analog of BA, often improves response in these steps. Here the effects of both mT and BA were compared *in vitro* using River cane nodal explants, and studies optimizing shoot proliferation will be reported.

(182) Effect of Time of Fertilization and Electrical Conductivity of the Nutrient Solution on Transplantable Stage of Dandelion (*Taraxacum officinale*)

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The ideal transplanting stage for most of the plants grown hydroponically is 4-leaf stage and it generally takes 4 weeks for the seedlings to reach this stage. Dandelion (*Taraxacum officinale*), however, requires five weeks to reach this stage. It would be beneficial to be able to shorten this phase by a few days since it would reduce the time required to complete one production cycle. One approach to achieve this could be manipulation of the nutrient strategy of the seedlings in the nursery phase with an objective to reach an early transplanting stage. This study was conducted to determine the effect of time of fertilization and electrical conductivity (EC) of the nutrient solution on transplanting stage of dandelion. Forty-five seeds of dandelion were sown to conduct this study. There were six treatments for "days to start nutrition" namely: D0 (nutrition started on day of sowing), D3 (nutrition started three days after sowing), D6, D9, D12, and D15; and two treatments 0.5 and 1.0 dS/m for the EC of the nutrient solution. The data were collected on shoot height, number of days required to reach 2-leaf and 4-leaf stage, number of push-outs, and number of leaves after 4 and 5 weeks. The entire experiment was replicated three times. Both the treatments "EC" and "day to start nutrition" had significant effects on the measured plant growth parameters of dandelion. The seedlings grown with treatment combinations D0 x 1.0, D3 x 1.0, D6 x 1.0, and D9 x 1.0 reached the 4-leaf stage in less than five weeks and were significantly different from the other treatments. Therefore, the time of fertilization and EC of the solution may hold application in shortening the transplanting phase of dandelion.

Tuesday, 4 August 2015

Teaching Methods 1

(265) Evaluation of a Collaborative Writing Project: Student Development of a Literature Review in Inter-institutional Teams

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Written and oral communication, conflict resolution, problem solving, planning, and project management are all important skills that students need for success in the 21st century. A course project was designed to augment development of these skill sets and strengthen student learning through their inter-institutional collaboration on a shared, semester-long writing assignment. Undergraduate and graduate students from Oklahoma State University and Kansas State University taking HORT 5422 (Flowering and Fruiting in Horticultural Crops) and HORT 625 (Floral Crops Production and Handling), respectively, collaborated in teams of two or three, with students from both universities on a team, to produce a literature review of crop growth and development in high tunnels. To facilitate project completion, five sequential instructional documents were developed. The first document required students to join Dropbox and add articles related to a crop category (fruits, vegetables, flowers, or miscellaneous/other) assigned to their group. The second document had students pursue more detailed literature related to their crop category and add at least 10 more papers to their group folder. In the third document, students were to

provide an introduction and summarize via bullet point statements relevant findings from the literature under the major topics of light, temperature, nutrition, and miscellaneous/other. The fourth document called for students to synthesize and integrate across crop categories within each of the environmental areas. Each group was only responsible for integrating all crop statements for one major topic. The final document required all students to read through and edit a final combined version of the manuscript. Student assessment via pre- and postsurvey instruments revealed that though students sometimes found the experience frustrating, their perceptions of group work and knowledge gain were positively influenced by the project.

Specified Source(s) of Funding: Association of Public and Land Grant Universities Innovative Teaching Awards Program

(266) Virtual Nursery Field Trip (VNFT) Use by Horticulture Instructors in Nursery Production and Related Courses

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Teaching nursery production requires not only classroom lectures or hands on lab exercises but also viewing actual production systems and operations. Funding, logistics, and geography often limit the scope of field trips available to students in nursery production courses. The Virtual Nursery Field Trip (VNFT) was developed to supplement in-class and field trip portions of a nursery production course. Digital HD video footage was captured at 42 nursery locations in 22 states. Videos were arranged by topic for a total of nine "chapters." Individual video segments range from a few seconds to several minutes. Videos were compiled onto a single USB drive containing 444 individual videos (total time about 10.75 hours) and 28 company profiles for a finished project size of 29 GB. USB drives containing videos and company profiles were provided free of charge in Spring 2013 to instructors of Horticulture at land grant institutions (1862, 1890, and 1994) who submitted a request form. Educators receiving the videos were surveyed in Spring 2014 to determine the effectiveness of VNFT. Of those completing the survey (55) 34 indicated they used the VNFT in nursery production or other courses. Of those using the VNFT, 82% indicated that the VNFT objective of supplementing in-class and field trip portions of nursery production course was achieved. Approximately 220 students had viewed videos by the completion of the survey. Of those instructors who used the VNFT, 56% indicated that the videos were much better than other horticulture educational videos. Almost all instructors who used the VNFT (97%) indicated they plan to use VNFT in the future. When asked to evaluate quality, organization, thoroughness, and ease of use, 80% to 90% of users rated the VNFT videos highly. If videos were made available online, instructors indicated they would be "very likely" (61%) or "somewhat likely" (24%) to access them online. Videos are now available to educators online at http://vnft.ag.auburn.edu.

Specified Source(s) of Funding: NIFA Higher Education Challenge Grant

(267) Characterizing Student Use of Virtual Plant Maps as a Study Tool in Plant Identification Courses

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Virtual plant maps were developed using the Google Maps web-application for the Landscape Plant Identification Courses at Kansas State University. The maps were provided as an additional study resource for students in the courses to review and revisit plants covered in lecture and laboratory sections at their convenience. We obtained student feedback administered through a survey at the end of the fall semesters (2013 and 2014; n = 87) and spring semester (2014; n = 20) in order to assess the student use of the study tool. We found that 63% (n = 55) and 75% (n = 15) of the students in the fall courses and spring course, respectively, used the virtual maps as a study tool. Of the students that used the virtual maps, 47% used them for studying the most recent plant list, and 47% used them to review all previous plant lists including the most recent list, in the fall semesters. In the spring semester, of students that used the maps, most students (67%) used them for reviewing all previous plant lists, including the most recent list. When asked how the students used the maps, 67% of the fall and 87% of the spring students reported using the virtual maps mainly for visual review (online only), while 21% of fall and 13% of the spring students used the maps for both visual, online review and physically re-walking the path covered in lab. Of those students who did not use the virtual maps, 63% (fall) and 80% (spring) indicated other study methods were more useful for them; while 34% and 20%, fall and spring, respectively, cited that they forgot about the map as a resource, as the two main reasons for not using the maps as a study tool.

(268) The Global Resource Systems Major at Iowa State University

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The Global Resource Systems (GRS) major at Iowa State University (ISU) was established in 2009, and is a college-wide undergraduate major within the College of Agriculture and Life Sciences (CALS) at ISU. The program's mission is to address the world's greatest challenges in food and agriculture including those related to health, poverty, and the environment. GRS does this by developing outstanding talent to fulfill employment needs of the future. It is the first and only GRS program in the United States, and combines technical, cultural, and leadership competencies with a global perspective and systematic approach. The curriculum is learner-centered and designed to allow students to apply technical specialties in different situations with a global perspective. Degree requirements include completion of core GRS courses, a minor or second major within CALS, and proficiency in a single world language. GRS includes a number of high impact educational practices, most significantly a learning community, service-learning, global internship, and a senior capstone research and poster presentation. The global internship is designed for students to apply systematic thinking and problem solving skills. Ninety-three students have interned in 30 countries, on five continents. Students complete internships with non-governmental organizations (NGO), universities, and global corporations in one of six areas, 1) food issues, 2) human health, 3) sociology and education, 4) technology and innovation, 5) business/global workforce, and 6) environment. One measure of success of GRS at ISU is the increase in student enrollment. The number of students has risen from 25 (2009) to 120 (2015). The number of graduates per academic year has risen from 0 to 22. Of 53 graduates, 25 (47%) have enrolled in graduate or professional schools, and 3 graduates have volunteered with the Peace Corps. The number of faculty and staff has grown to accommodate this increase in students, and includes seven faculty, two staff, and one postdoctoral research associate with GRS responsibilities listed as part of their position responsibility statement. Program assessments includes: 1) alignment between course and program student learning outcomes, 2) changes in students' knowledge, attitudes, behaviors, and world view, 3) students' perceptions and satisfaction, 4) the teaching and learning process, 5) students' learning transfer, 6) students' performance, and 7) impact of service learning. By measuring these characteristics we are able to further refine and continuously improve this unique, interdisciplinary major.

(269) Advancing Your Scholarly Teaching into the Scholarship of Teaching and Learning (SoTL)

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Scholarly teaching focuses on student learning and is grounded in the subject matter being taught, and in the implementation of effective pedagogies. The scholarship of teaching and learning (SoTL) on the other hand is research focused on teaching and learning. The scholarship of teaching and learning involves framing a research question related to student learning and systematically investigating it. The research methodology may include qualitative and quantitative data collection as well as direct and indirect measures. Data analysis may take multiple forms as well. The final step is to make the research public through peer-review and critique. Similar to disciplinary focused research, an important end goal of SoTL is to communicate research findings with members of the professional community so they in turn can build on the work and advance the practice of teaching beyond an individual classroom. Many faculty members with teaching appointments are interested in completing and publishing SoTL projects. And although faculty are well versed in conducting and publishing horticulture based research, many are unfamiliar with how to effectively conduct SoTL. The objective of this session is to outline a framework and provide a stepwise process to guide faculty in developing a publishable scholarship of teaching project related to horticulture.

(270) Hawaiian Lei—A Floriculture Design Lab

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Hawaiian lei have become a popular congratulatory token during graduation ceremonies at universities across the Mainland. While the most common style features flowers strung through the flower center or crosswise through the calyx, there are also other lei making methods which utilizes tying, braiding, twisting or sewing the plant materials together. These latter styles are reminiscent of the old wrist corsages with tightly bunched foliage and flowers. In Hawaii, lei are common adornments given to honor a person during special occasions such as anniversaries, graduations, weddings, and welcome/send-off parties; or used in celebrations such as Aloha Fridays, hula competitions, and other events. Design competitions are held every first of May to choose the best lei; in these, all flowers and foliage must be identified. Different styles such as haku (arranged in a braid), hili (tight braid or plait), kui (strung; kui poepoe—strung crosswise), kipu'u (knotted loosely), wili (twisted, wound, wrapped), and humu-papa (sewn to a backing) are featured with perhaps up to twenty different flowers, flower parts, foliage, seeds, and seed pods. Since lei components are not limited to tropicals, many temperate plants can also be used in lei-making in a floral design class. This poster shows examples of the different lei styles, the portions of lei identifying methods as well as the typical plant materials used in lei making. It also provides a video link to an actual laboratory class that incorporated lei making in an introductory ornamental horticulture course.

(271) Using a Pen Pal Program to Assess Student Learning in Science and Communications

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Youth at two schools (St. John, USVI and West Liberty, IA) participated in the *I Grow Culture* Pen Pal program. The purpose of the 8-week program was to evaluate how well middle school students communicate about local gardening and science. The collaborating schools were specifically chosen because they meet the criteria of having a garden for middle school students to integrate English and science into their agriculture curriculum. Specific objectives of this study were to 1) increase understanding of local gardening, 2) establish a garden-based distance cultural relationship, 3) practice communication technologies to improve writing and science communication, and 4) increase awareness of sustainability in both environments. The program supported expository writing skills, understanding of traditional learning systems, and improved knowledge of garden diversity and practices. Pre and post questionnaires with multiple choice and open-ended responses were administered to evaluate knowledge gain with the pen pal program. Additional documents such as suitcase of artifacts, brochures and videos were developed by the students and collected to evaluate students' perspectives on culture, agriculture and sustainability. Preliminary results showed that Caribbean students are more confident to explain their school garden while the Iowa students have a better understanding of sustainable gardening. Both schools have identified the need to keep their garden growing for years to come.

(272) Perceptions of the Audubon Cooperative Sanctuary Program: A Survey of Superintendents of United States University-affiliated Golf Courses

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The Audubon Cooperative Sanctuary Program (ACSP) recognizes sustainable golf course management practices and is administered by Audubon International, Troy, NY, in partnership with the United States Golf Association There are six categories of the ACSP certification; 1) Environmental Planning; 2) Wildlife and Habitat Management; 3) Chemical Use Reduction and Safety; 4) Water Conservation; 5) Water Quality Management; and 6) Outreach & Education. Currently, only 13% of the estimated 17,000 golf courses in the U.S. have achieved some level of ACSP certification. A survey was conducted to determine the level of ASCP certification of U.S. university-affiliated golf courses and the interest of having students involved in the application process. A cross-sectional, self-administered online questionnaire was administered to a population of 120 U.S. university-affiliated golf course superintendents. Data was analyzed using Chi-square, Spearman's rank correlation, and Cox multiple regression analysis. The survey response rate was 31.9%. A majority of respondents (75%) were familiar with the ACSP and 25% identified their university-affiliated golf course as having some level of certification. Fifty-four percent of superintendents reported that their college or university affiliate has a turfgrass or horticulture program, and those with these programs were more likely to be ACSP certified. Nearly 60% of superintendents reported academic courses from nearby colleges or universities visit their golf course for tours or laboratory exercises, and 85% of respondents report employing full- or part-time students on their course. Of those superintendents who were not ACSP certified, 73% reported being interested in becoming certified if students were to assist in the application process. Superintendents at non-ACSP certified courses ranked "cost" as their main reason for not being certified, while those superintendents at ACSP certified courses ranked "labor" and "time" as the most challenging factors for completing the certification process. The most reported benefit of being ACSP certified was "enhanced public perception". Student assistance was identified as a viable option for superintendents who want to become certified or want to further their certification status and this may create valuable service-learning activities for students and instructors.

(273) TPSS 300—Evolving to Become a Flipped Class/BYOD Course

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Although lecturing can be an effective teaching method, it is sometimes boring for the students and the instructor and does not engage the students. The traditional classroom typically uses lecturing with the students doing homework outside of class. The flipped classroom approach provides content to students through videos and other online methods outside of class. Then, in class, students have the opportunity to do more hands-on, active learning through discussions and solving problems. The objective is to describe how TPSS 300 Tropical Production Systems has become a more flipped classroom course. Rather than listening to so many lectures, students were assigned to view YouTube videos, websites, handouts, popular works publications, and scientific articles. Students did this outside of class. Students brought their laptop, tablet, or smartphone to class (BYOD, bring your own device). They broke up into groups of two to four students and discussed questions and points about the day's topics. Some of these questions and points dealt with the content they viewed outside of class. Some were new. Each group then went in front of the class and

presented their answers with each student in a group speaking. Students also used their laptops or mobile devices to help answer questions and look up additional relevant information in class. Students used most of the class time for small group discussion. Small groups promoted each student talking and contributing. This helped in peer teaching and sharing of personal experiences, a process that benefitted both the advanced and less advanced learners. Oral presentation skills improved because each student in a group had the opportunity to speak in front of the class rather than the spokesperson of a group speaking. Laptops and mobile devices furthered Internet search skills. The instructor used minimal lecturing, now being in the new position of guiding students in their activities. TPSS 300 has been evolving from a lecture course to a flipped classroom course, enhancing student learning, small group discussion skills, and speaking competence.

Wednesday, 5 August 2015

Undergraduate Student Poster Competition

Moderator: Kimberly Moore
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(254) Evaluating Shade Effects on Primocane Blackberry Flowering and Fruiting

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High temperatures limit primocane blackberry production in the upper south during the bloom and early fruiting period, resulting in poor fruit set and poor fruit quality. Shade may have the potential to delay bloom and flowering to a more favorable season by reducing temperatures that cause poor fruit set and quality. A greenhouse study was established to evaluate the effects of shade on primocane blackberry growth, physiology, and fruiting. Canes of 'PrimeArk® 45' were planted in 11.3-L pots. At approximately 0.25 m in height, one of the four following treatments was imposed with eleven replications: 1) an untreated control [CK], 2) unshaded for 30 days then shaded for 30 days [US], 3) shaded for 30 days then shaded for 30 days [SS], and 4) shaded for 30 days and unshaded for 30 days [SU]. After treatments ended, plants were grown without shade for 30 days. Plants in the SU treatment were significantly taller than the US while the control and SS treatments were intermediate. A similar trend was seen between the height and cane diameter with the SU treatment as the largest and US as the smallest. The SU had the largest total leaf area of all treatments and CK was the lowest. Dry weight of leaves was consistent for all treatments except for SS, which was significantly lower than the others. Shading reduced net photosynthesis measured, but plants readjusted to unshaded conditions. At the conclusion of the greenhouse study the US had the most flower formations of all the treatments with nearly four times as many as the SS. The CK treatment recorded the highest number of fruits when potted plants were harvested and the SU had the least amount. There was a direct correlation between shade and increased water use efficiency, which improves the sustainability of blackberry production. First bloom dates for each treatment were recorded. The CK bloomed first followed by US and SS. The last to bloom was the SU, 26 days after the CK. At the conclusion of the experiment the CK had the largest number of fruits and SU the least. The US displayed nearly four times as many flowers as the SS, CK and SU when all potted plants were harvested. In conclusion, there was significant delay of flower and fruiting when 50% shade cloth was implemented and removed in the SU treatment.

Specified Source(s) of Funding: Southern SARE Young Scholar Internship

(255) In Vitro Microtuberization in 30 Potato Varieties

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Potatoes, *Solanum tuberosum*, when grown in the Caribbean, are planted in October. Freshly harvested potatoes require 2–3 months of cool storage (vernalization) to break dormancy to sprout and grow. Obtaining seed potatoes, normally harvested in the fall in the continental United States, do not have the vernalization for October planting in the Caribbean. The objective was to study the influence of MS medium with 10% sucrose on induction of microtubers in tissue culture for 30 varieties. Potato microtubers could then be harvested and vernalized year-round for planting in the Virgin Islands. Virus-free potato germplasm was obtained from the USDA as in vitro plants. The tissue culture medium contained MS salts and Gamborg vitamins, 8% agar and 10% sucrose. Single nodal sections were placed in 8-dram shell vials and grown under 16-h photoperiod at 25 °C. Data was collected weekly on microtuber formation. After four weeks ten varieties started to form microtubers, but at a low percentage per variety. Within eight weeks, 18 varieties had formed microtubers and 28 varieties by 12 weeks. 'Red Pontiac' and 'Tasty' produced no microtubers while 'Cruza 148' had 100% microtuberization. The microtuberization rate varied between the other varieties. Microtubers can be induced from potato cuttings for 60% of the varieties tested after eight weeks in vitro on 10% sucrose. Further studies will be developed to enhance microtuberization efficiency incorporating reduced light and plant growth regulators.

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An asterisk (*) following a name indicates the presenting author.

(256) Predicting Harvest Date from Sorrel Bud and Calyx Measurements

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Sorrel (*Hibiscus sabdariffa*) is an important Caribbean crop during the holiday season for the red calyx used to make a flavorful juice. Breeding work at the University of the Virgin Islands–Agricultural Experiment Station has developed sorrel varieties to extend the season normally December through January to October through May. The objective was to measure sorrel bud and calyx development and use it to predict days to harvest the calyxes. Three inbred varieties and two hybrids were used. Seeds were planted in January and data collected twice a week on developing floral buds length and width. Upon flowering, data was collected on the expanding calyx and analysed with regression analysis. Harvest time was determined when the calyx expansion ceased as seeds in the capsule matured. January planting of sorrel resulted in floral induction within a month after germination due to the short-day photoperiod. Both developing floral bud length and width can be used to predict harvest date for sorrel varieties and hybrids.

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(257) Morphological Stages of Seedling Development in Mustard (*Brassica rapa*) Microgreens

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Microgreens, have seen a tremendous increase in production in the last decade as consumers demand novel, fresh, and local products. Microgreens are currently defined as any plant harvested immaturely for the fresh and whole consumption of its early-developed leaves, cotyledons, and hypocotyl, pending the point of third true leaf emergence. At this time, there are no standards to define developmental stages of microgreens and their corresponding harvestable maturity. Counting the number of days from sowing until harvest is the most commonly used method. However, this method often results in inconsistent outcomes depending on environmental conditions. The objective of this study was to describe developmental stages of microgreens based on morphology that in turn can be used to define and establish harvestable maturity. In this experiment, *Brassica rapa* (Suehlihung No. 2 Mustard.), a commonly produced microgreen species, was grown for 14.5 days in a controlled environment with an 18-h photoperiod (23.9 °C, 10.5% RH, 77.8 $\mu mol \cdot m^{-2} \cdot s^{-1}$). Variables were measured as a function of days after radicle emergence including total height, length of the hypocotyl and epicotyl, length of individual cotyledons and true leaves, and angles between the two cotyledons and the first two true leaves. All measurements were taken twice a day (8:00am and 8:00pm) between germination and the emergence third true leaf. Germination was 57.5%, with a maximum germination rate occurring four days after sowing. The first easily defined maturity stage was measured five days after germination, and was characterized by stability in overall height and cotyledon length. Eleven days after germination, a second stage of maturity was described as the distance between the tips of the two cotyledons equaled the distance between the tips of the first two true leaves; this stage lead to the emergence of the third true leaf. Correlation between morning and afternoon measurements and the rate of cotyledon and true leaf development revealed that measuring morphological traits during the afternoon may result in more accurate morphological evaluations. For "mustard-microgreens", relationships observed between time and organ development suggest that harvestable maturity could be assessed by identifying morphological stages. The study indicated that morphological stages may be used to better define harvestable maturity of microgreens, to enhance production practices, establish product prices, and improve communication between the producers and consumers.

(258) Seaweed Extract on the Growth and Development of Marigold and Sunflower

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Seaweed Extracts, of marine brown algea, are marketed for use in agriculture and horticulture. These marine plants, rich in vitamins and minerals, are known to improve root development and increase nutrient uptake, and plant growth. Liquid organic kelp is known to increase crop yields, drought resistance, frost protection, and stress recovery. Nature's NOG is a plant stimulant that speeds germination and early growth, enhances root growth and hardiness, increases the health, strength and beauty of your plants. This study was conducted to examine the application of seaweed extract on the growth and development of marigolds and sunflowers. These two studies were conducted, during summer 2014, in the greenhouse at the University of Maryland Eastern Shore (UMES) Agricultural Experiment

Station for seventy-one (71) days using a complete randomized design. The flower studies had three fertilizers [Control (Scott's 20–20–20), Nature's Nog, and Organic Kelp] and three different applications [soil applied, foliar applied, and both (soil and foliar application were alternated)] with four replications of each. The flower seeds were soaked for one hour in the respective treatments and planted into 15.24-cm flower pots containing Promix Bx Mycorise Pro potting mix. Treatments were applied to each plant every two weeks starting at 150 ml per plant; the volume of the treatments was increased as the plants got older. Plant height and shoot and root dry weights were evaluated. There was a significant difference in shoot height and root dry weight among the treatments for the marigolds study. The soil applied organic kelp had the highest root and shoot dry weight. There was a significant difference in root dry weight and shoot dry weight among the treatments for the sunflower study. The organic kelp treatment tended to have the highest shoot height and the soil and foliar applied Nature's Nog treatment tended to have the highest root dry weight. Further studies will be conducted to evaluate the effects of seaweed extracts on marigold and sunflower.

Specified Source(s) of Funding: Evans–Allen

(259) Comparison of Biomass, Essential Oil Yield, Phenolic Content, and Antioxidant Capacities between Overwintered and Transplanted Lemongrass (*Cymbopogon citratus*)

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Lemongrass (*Cymbopogon citratus*) is a perennial herb primarily grown in tropical and subtropical regions. It has many useful characteristics, including medicinal, antibacterial, antifungal and insect repellent, but its potential to survive outside its tropical origins is uncertain. In the temperate climate of the Delmarva Peninsula, there is increasing interest in growing the plant outdoors instead of in controlled environments due to the cost. The objective of this study was to examine the potential to grow lemongrass in the moderate climate without sacrificing the phenolic and antioxidant capacity of the plant. All of the lemongrass was grown on an organic field site at the University of Maryland Eastern Shore Experiment Station during 2013. After harvest in fall some plants were overwintered in the field. The remainder were transplanted to a greenhouse in Fall 2013, and re-planted in the field in Spring 2014. Both transplanted and overwintered lemongrass were grown in the same field once more until they were harvested in early fall, before the onset of frost. The biomass, yield of essential oil, phenolic content, and antioxidant capacities in transplanted and overwintered lemongrass were evaluated. Harvested plants were freeze-dried for essential oil production using steam distillation. Freeze-dried samples were ground and extracted using 80% ethanol to determine total phenolic and flavonoid contents and antioxidant capacities including DPPH radical scavenging capacity and oxygen radical absorbance capacity. The overwintered plants were substantially larger in biomass than the transplanted ones ($P < 0.05$). Essential oil yield, amounts of phenolic compounds, and antioxidant capacities were not different between overwintered and transplanted plants. The results showed that the overwintering practice in a moderate climate might increase biomass yield, but not affect essential oil production and antioxidant capacities in lemongrass, indicating the potential of lemongrass production in moderate climates. However, a study for extended periods is needed to confirm the observations of this study.

Specified Source(s) of Funding: 1890 Teaching Capacity Grant

(261) Lettuce Development and Nutrient Runoff under Regimes with Kelp, Fish Emulsion, and Synthetic Fertilizers

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Nutrient runoffs resulting from synthetic fertilizers can contribute to pollution of watersheds through high levels of chemicals such as nitrogen. Consequently, there is a need to search for alternative sources that are more environmentally friendly. In this study, four combinations of two naturally occurring fertilizers, kelp (*Ascophyllum nodosum*) and fish emulsion were compared with a synthetic fertilizer (20:20:20) for their effects on the growth and development of two varieties of lettuce (*Lactuca sativa*), Red Sails and Black Seeded Simpson. The combinations were Kelp from GS Plant Foods (Kelp GS), Kelp from Natures Nog (Kelp NN), Kelp GS plus fish emulsion and Kelp NN plus fish emulsion. Each treatment contained 240 $mg \cdot kg^{-1}$ of nitrogen and was applied weekly for the last four weeks of the five-week trial. Data were collected weekly on nitrate-N and phosphate content of leachate from the growing medium. This presentation will discuss the weekly leachate content and other data collected at the end of the five-week study, including leaf area, leaf fresh and dry weights and leaf macronutrient and micronutrient contents.

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An asterisk (*) following a name indicates the presenting author.

(262) The Effect of Gallic Acid Treatment on *Rubus* Callus

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Gallic acid is a naturally occurring secondary plant metabolite that is believed to function in plant defense by stimulating rapid prickle development as well as activate signal transduction pathways that aid in the chemical defense pathways of the plant. Interestingly enough, due to the observation of gallic acid's involvement in prickle development, it can be hypothesized that gallic acid can play a role in the developmental regulation of plant growth. In this study, the effect of varying concentrations of gallic acid on *Rubus* callus is investigated through multiple qualitative and quantitative analysis techniques. It is predicted that a moderate dose of gallic acid will stimulate rapid tissue proliferation and cell cycle changes that mimic those induced by gallic acid in vivo as a defense mechanism, while a high dose of gallic acid will damage the tissue. After sterile blackberry leaf explants are cultured into a callus state utilizing a Murashige and Skoog media containing thidiazuron, the *Rubus* callus are exposed to varying concentrations of gallic acid. Throughout differential gallic acid exposure, the growth of the callus are quantified through area and mass measurements, while gene regulation is monitored through NGS and qPCR. Cell proliferation is quantified through cell cycle analysis and microscopy. Gallic acid is a naturally occurring secondary plant metabolite that is believed to function in plant defense by stimulating rapid prickle development as well as activate signal transduction pathways that aid in the chemical defense pathways of the plant. Interestingly enough, due to the observation of gallic acid's involvement in prickle development, it can be hypothesized that gallic acid can play a role in the developmental regulation of plant growth. In this study, the effect of varying concentrations of gallic acid on *Rubus* callus is investigated through multiple qualitative analysis techniques. It is predicted that a moderate dose of gallic acid will stimulate rapid tissue proliferation and cell cycle changes that mimic those induced by gallic acid in vivo as a defense mechanism, while a high dose of gallic acid will damage the tissue. After sterile blackberry leaf explants are cultured into a callus state utilizing a Murashige and Skoog media containing thidiazuron, the *Rubus* callus are exposed to varying concentrations of gallic acid. Throughout differential gallic acid exposure, the growth of the callus are quantified through area and mass measurements, gene regulation is monitored through NGS and qPCR, and cell proliferation is quantified through cell cycle analysis and microscopy.

Specified Source(s) of Funding: RI INBRE

(263) Photosynthetic Physiology and Kaempferol Yield Affected by Leaf Treatments in Soy Plants

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Environmentally sound plant treatments that can impose mild stress and elicit bioaccumulation of useful phytochemicals are not readily available. We treated leaves of soy plants at V4 stage by an ABA spray, a dodder spray, leaf piercing and leaf holing to investigate their effects on photosynthesis, photosystem II efficiency and kaempferol accumulation in leaves and roots. Although photosynthesis was in the order of leaf holing > dodder spray > control > leaf piercing > ABA spray, only ABA vs. any other treatment, and leaf holing vs. leaf piercing were significant. Stomatal conductance followed the same pattern. However, instantaneous water use efficiency and air-to-leaf temperature difference were the same across treatments. Although maximum photosystem II efficiency (F_v/F_m) was the same across treatments, quantum yield (F'_v/F'_m) was lower in leaf piercing than control or dodder spray. Nonphotochemical quenching (NPQ) was >100% greater in leaf piercing and ABA spray compared to control. Concentrations of all four leaf kaempferols tested were greatest in ABA spray. However root kaempferols were the same across treatments. Different types of leaf wounding—piercing vs. holing—affect photosynthetic physiology of young soy leaves differently. ABA spray provides a promising lead as a leaf treatment to elicit leaf kaempferols while leaf holing and dodder spray may boost gas exchange.

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(264) Reclaimed Wastewater as an Irrigation Alternative for Growing Coleus (*Plectranthus scutellarioides*)

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In this study, we compared the efficacy of irrigating coleus, a low salt tolerant plant, with full- and half-strength solutions of treated wastewater, salt water, and a water-soluble fertilizer. Plants were grown in greenhouse conditions for four weeks. Plants irrigated with wastewater were rated higher aesthetically than the small stunted plants irrigated with salt water and rated similarly to the plants irrigated with a water-soluble fertilizer. Final ECs of the growing substrate were similar between the groups of plants irrigated with full-strength solutions (2.0 dS) and those irrigated with the half-strength solutions (1.15 dS). Root dry weights were somewhat similar with slight variation between all groups. However, shoot dry weight was highest in the group irrigated with half-strength fertilizer and lowest in the group irrigated with the full-strength salt solution. The coleus plants grown with the half-strength fertilizer performed the best overall. Since the plants with the treated wastewater and fertilizer performed better than the plants with the salt solution, sodium is most likely the greatest issue rather than the EC of the growing substrate.

Wednesday, 5 August 2015

Environmental Stress Physiology 1

(206) Salt Tolerance of Ten Perennial Plants in Asteraceae

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Asteraceae is one of the largest plant families, and is important primarily for its many garden ornamental species. Rooted cuttings of ten perennial species (*Chrysactinia mexicana*, *Eupatorium greggii*, *Leucanthemum ×superbum*, *Melampodium leucanthum*, *Santolina chamaecyparissus*, *Symphyotrichum oblongifolium*, *Tagetes lemmonii*, *Tetraneuris scaposa*, *Viguiera stenoloba*, and *Wedelia texana*) in Asteraceae were transplanted in plastic containers with Metro-Mix 360 on 6 Oct. 2014. Two weeks later, treatments were initiated by irrigating plants with nutrient solution at electrical conductivity (EC) of 1.3 $dS \cdot m^{-1}$, saline solution at EC of 5.0 $dS \cdot m^{-1}$ (EC5), or at EC of 10.0 $dS \cdot m^{-1}$ (EC10). Four weeks after treatments, the experiment was terminated. Upon termination, visual foliar salt damage (leaf edge burn, necrosis, or discoloration) was rated on a score of 0–5, where 0 = dead; 1 = severe (over 90%); 2 = moderate (50% to 90%); 3 = slight (< 50%); 4 = good quality with minimal foliar damage; and 5 = excellent with no visible foliar damage. Above ground parts including stems, leaves and flowers were harvested and dry weight (DW) was determined. *V. stenoloba*, *San. chamaecyparissus*, and *E. greggii* at EC5 or EC10 had minimal foliar damage with their DWs decreased by 11% to 18% and 22% to 28%, respectively. *L. superbum* also had minimal foliar damage, but EC5 and EC10 reduced its DW by 40% and 59%, respectively. *M. leucanthum* and *Tag. lemmonii* at EC5 had minimal foliar damage with 33% and 42% of DW reduction, respectively, while those at EC10 had moderate foliar damage with 56% and 71% of DW reduction, respectively. *C. Mexicana* at EC5 and EC10 had slight foliar damage with 56% and 64% reductions in DW, respectively. *Sym. Oblongifolium* and *W. texana* at EC5 had slight foliar damage with 28% and 6% reductions in DW, whereas those at EC10 had moderate foliar damage with 45% and 35% reductions in DW. *Tet. scaposa* at EC5 had moderate foliar damage with 58% of DW reduction, while all *Tet. scaposa* plants at EC10 died. In summary, *V. stenoloba*, *S. chamaecyparissus*, and *E. greggii* were more salt tolerant than the other seven species.

Specified Source(s) of Funding: "Floriculture and Nursery Research Initiative" and "USDA–NIFA Hatch project"

(207) The Effects of Partial Root-zone Drying on Water Uptake Between the Drying and Wetting Zones

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Partial root-zone drying (PRD) is an irrigation method that manipulates plant chemical and hydraulic signals from the roots to the leaves to close stomata and increase water use efficiency (WUE). The roots are split into two "zones", one zone is allowed to dry and the other zone is irrigated. Roots in the drought-stressed zone may produce ABA and/or send a hydraulic pressure signal to trigger abscisic acid (ABA) production in the shoots. Accumulation of ABA in the shoots signals the stomata to close. The dynamics of water uptake between the drying and wetting zones has not been separated as to its affect on overall transpiration kA dwarf tomato variety, 'Micro-Tina' (*Lycopersicon esculentum* Mill) was grown from seed, then root systems were split and placed in two 10-cm pots. Soil moisture sensor probes were placed in each pot and connected to a data logger. Irrigation was controlled based on the average substrate water content of one plant (one sensors in each of the two pots). An irrigation valve opened when the average reading from these two sensors dropped below 40% (v/v). Each plant was watered with two 4 $L \cdot h^{-1}$ emitters. Individual pots were placed on load cells to measure water uptake and transpiration from each half of the root system. Three treatments (v/v), —40% (control), 25%, and 15%— were applied. In control plants, each pot had one emitter.

An asterisk (*) following a name indicates the presenting author.

The two drought stress treatments were implemented by placing both drip lines into one pot and allowing the "drying side" to reach the desired volumetric water content (VWC), after which the two lines were switched to the other pot. Placing both water lines in one pot ensured that all plants received equal amounts of water. Water uptake in the "irrigated side" increased, adjusting for the decreased water uptake from the "drying side" The 25% and 15% VWC treatments appeared to reduce leaf photosynthetic rate and stomatal conductance. This data suggest that 15% and 25% VWC treatments reduced transpiration rates while both root sides continued to uptake water.

Specified Source(s) of Funding: University of Georgia Horticulture Department

(208) The Responses of African Vegetable Amaranth (*Amaranthus* spp.) Varieties to Drought Stress

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Amaranth (*Amaranthus* spp.) is a drought resistant crop widely grown and consumed for its nutritious leaves in East Africa. Among the many issues facing smallholder farmers in this region is a lack of high quality germplasm and increasing climate variability that makes rain during the growing season unpredictable. Identifying germplasm that exhibits drought resistant characteristics will increase the resilience of agricultural systems in this region of the world. The goal of this research was to characterize differences in drought response between four varieties of vegetable amaranth grown in this area: AC45, AM38, ExZan, and ExZim, including their response at different stages of vegetative development. All varieties were exposed to both short term and long term stress while plant responses were evaluated. Under short-term drought stress (up to 8 days without water) one variety, ExZim, showed the least effects of water stress in terms of biomass reduction. However, all varieties exhibited a high capacity to recover from water stress in terms of stomatal conductance and relative water content, which showed that plants were able to acclimate to stressed conditions. Under long term drought stress, each variety was exposed to moderate water stress of 0.15 m^3/m^3 volumetric soil water content for an extended period of up to six weeks. ExZan was the only variety with significant reductions in both dry weight and leaf area, though it was also the variety with the greatest biomass under well-watered conditions. Drought response was assessed across vegetative development stages by maintaining soil moisture of 30% of water holding capacity during one of the following growth stages: 10–15 nodes, 15–20 nodes, or 20–25 nodes. Contrary to previous literature reports, drought during later stages of development (20–25 node growth period) had the greatest negative impact on biomass production. These results suggest that amaranths can acclimate to drought stress and survive but growers should minimize water stress to plants at later growth stages to optimize harvestable leaves. In selecting amaranth varieties, growers should bear in mind that while some varieties yield better in well-watered conditions (ExZan in our experiments) others might be more resilient under drought stress (ExZim in our experiments). These considerations can help growers budget scarce water resources and preserve yield even in times of water stress. Planting more drought resistant crops such as amaranth will help improve the sustainability of agroecosystems and their resilience to climate change.

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(209) Calcium Chloride Pretreatment Enhances Waterlogging Tolerance of Chrysanthemum under High Temperatures

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Field-grown chrysanthemum [*Dendranthema ×grandiflorum* (Ramat.) Kitam.] would not grow well or even die in summer heavy rain conditions in subtropical and tropical areas, while exogenous calcium might enhance waterlogging tolerance and alleviate plant damages. The effects of various $CaCl_2$ concentrations pretreatment were studied on growth and malondialdehyde content in two chrysanthemum cultivars, waterlogging-tolerant 'Huang Gin-Ging' and waterlogging-intolerant 'Kaa Dei-Na'. Vegetative young plants with 14–16 leaves were placed in a phytotron at 30/25 °C under natural daylengths (13–13.5 h). Apart from normal irrigation (control), plants were pretreated with 0, 60, 90, or 120 mM $CaCl_2$, respectively to the medium on 1 and 3 days before subjected to a 3-day waterlogging followed by a 9-day recovery. For both cultivars, control plants grew well. Plant growth of 'Hunag Gin-Ging' did not differ among $CaCl_2$ pretreatments, while 'Kaa Dei-Na' exhibited increased plant height, leaf number, and root dry weight as $CaCl_2$ concentration increased. The application of 120 mM $CaCl_2$ pretreatment enhanced growth of waterlogging-intolerant 'Kaa Dei-Na' through higher root dry weight and lower malondialdehyde content.

(210) Oxygen Release Compound Alleviates Injuries of Chrysanthemum under Waterlogging and High Temperature Conditions

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Heavy summer rain in subtropical and tropical areas causes soil hypoxia, which is detrimental to field-grown chrysanthemums [*Dendranthema ×grandiflorum* (Ramat.) Kitam.]. Oxygen release compound (ORC), mainly composed of magnesium peroxide,

may alleviate injuries of chrysanthemum under waterlogging as ORC can release oxygen when solved in water. The effect of ORC on growth and photosynthesis were studied in two chrysanthemum cultivars, waterlogging-tolerant 'Huang Gin-Ging' and waterlogging-intolerant 'Kaa Dei-Na'. Vegetative young plants with 14-16 leaves were placed in a growth room at 30 °C/25 °C and 12-h photoperiod with an average light intensity 220 μmol·m^{-2}·s^{-1}. Plants were subjected to three treatments: normal irrigation (control), waterlogging treatment (3-day waterlogging followed by 9-day recovery), and ORC treatment (80 mL of 1.0 g·L^{-1} ORC solution applied to the medium one day before the waterlogging treatment). Results showed that control plants of both cultivars grew well and maintained high photosynthesis rates. As compared with control, waterlogging treatment caused more root dry weight reduction in 'Kaa Dei-Na' than 'Huang Gin-Ging' (52.3% vs. 7.8%). Plants of 'Huang Gin-Ging' at waterlogging or ORC treatments did not differ in growth and exhibited a declined net photosynthesis (Pn) at Day 3 but a recovered Pn at Day 12. In contrast, 'Kaa Dei-Na' at ORC treatment had greater shoot length and root dry weight, consistently higher Pn and lower intercellular space CO_2 concentration than those at waterlogging treatment. ORC application prior to waterlogging resulted in increased growth and Pn and alleviated the injury of waterlogging-intolerant 'Kaa Dei-Na'.

(211) Flowering Response of Bougainvillea to Drought Stress

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Bougainvillea cultivars are widely used ornamentals valued for their ability to bloom profusely while tolerating poor growing conditions such as pollution, compaction, and drought stress. However, flowering is often inconsistent, with short-day photoperiod being the apparent trigger in the subtropics, and drought stress being the apparent trigger in the tropics. Established cultivation practices include subjecting them to drought stress to induce greater flowering, but little published research has been made into the mechanisms by which Bougainvillea are induced flower. This experiment seeks to show that drought stress has a significant effect in regulating the flowering response of Bougainvillea and is key to understanding how to induce and prolong the flowering period of Bougainvillea. Thirty-five rooted cuttings of *Bougainvillea glabra* 'Afterglow' were pruned to the same height and grown under long-day conditions in a growth chamber with temperature regulated at 25 degrees Celsius. Cuttings were subjected to seven levels of water stress (1 = 50 mL upon wilting, 2 = 25 mL/3 days, 3 = 25 mL/2 days, 4 = 50 mL/2 days, 5 = 50 mL/day, 6 =1 00 mL/day, 7 = permanently saturated) where 1 = very high, 2 = high, 3–4 = medium, 5 = low, 6 = very low, and 7 = saturation. Stomatal conductance was measured using a leaf porometer as a proxy of water stress. The number of flower buds on each plant was counted at the end of six weeks. Plants grown under saturation were the earliest to flower, and produced more flowers than plants grown under all the other treatments. Plants under very high and very low water stress flowered later and had fewer flowers than those under low, medium and high water stress. Plants grown under medium water stress produced more flowers than those grown under low or high water stress. These preliminary results support published findings that watering in between periods of medium water stress induces flowering in spite of long-day conditions. Additionally, these results also suggest that water stress at both high and low levels influences the initiation and number of flowers in Bougainvillea.

(212) The Interactive Effect of CO_2, Temperature, and Water on Growth and Flowering of *Petunia* ×*hybrida*

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Changes in climate, such as increases in CO_2, temperature, and variable precipitation have been observed and are expected to have a substantial impact on agriculture including the horticultural industry. Climate change could present a serious challenge to U.S. agriculture because of the sensitivity of agricultural systems to climate. Light, CO_2, temperature, nutrients, and water availability are important abiotic factors for plant growth and development. Among those factors increasing temperature due to the elevated atmospheric CO_2 concentration and the availability of water may have a direct impact on growth and flowering under the predicted future climate. The objectives of this research were to investigate the interactive effects of CO_2, temperature, and water availability on the growth and flowering of petunia (*Petunia* ×*hybrida*), and to examine the expression pattern of major genes involved in plant growth and flowering pathways. Petunias were exposed to two levels of CO_2 (400 and 800 μmol·m^{-2}·s^{-1}), two levels of temperature (21/18 and 28/25 °C), and two water regimes (0.12 and 0.43 m^3·m^{-3}). To quantify the impact of three abiotic factors, growth index, gas exchange, time to anthesis, flower size, flower longevity and the number of flowers were measured. For the gene expression study, major genes in photosynthesis, respiration, hormone biosynthetic pathways, autonomous and photoperiod flowering pathways were selected and their expression patterns were determined using semi qRT-PCR. Preliminary results showed flowering was inhibited under elevated temperature with ambient CO_2, but recovered when elevated temperature was paired with elevated CO_2. At the completion of this project, we will have a fundamental understanding of the interactive effects of CO_2, temperature, and water availability on plant growth and development.

(213) Assessing and Comparing Relationships Between Heat and Drought Tolerance: Analytical Approaches

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Drought and heat tolerance are expected to become increasingly important considerations in agriculture and plant breeding. Identifying promising sources of heat and drought tolerant genetic materials will be crucial to efforts to develop adaptable varieties that can perform when stressed. However, heat stress exacerbates drought stress, and drought affects heat tolerance with consequent effects on identification and utilization of elite germplasm in breeding programs. This is particularly important for common bean, not only because it is the most widely human consumed legume, but also because of its importance as a protein source in the developing world where heat and drought stresses are common. Accordingly, we have been testing both new as well as conventional advanced technologies to assess their applicability to identifying the separate and combined effects of heat and drought on diverse bean genotypes. Our goal is to develop a rapid and efficient phenotyping method for evaluating stress resistance in fields, greenhouses, and growth chambers. The expectation is that other researchers may then use this method in their own germplasm evaluations—while such methods can never replace field evaluations, they can act as a supplement to field data by providing information on how varieties perform in conditions that are difficult to reliably replicate in the field. A variety's field performance could be used to characterize its response to stress for the traits measured, and we could use that information to discover any trends among stress tolerant or stress susceptible varieties. For our experiments, we selected several advanced bean lines with known performance in the field. To date, our results show clear differences in the germplasm that we tested for traits measured under elevated temperatures. These traits included photosynthetic rates, stomatal conductance, leaf temperature, and plant survival, and chlorophyll fluorescence traits such as photosystem II efficiency, non-photochemical quenching, and linear electron flow. Additionally, a number of these traits showed clear correlations with each other. From these results a simple, replicable screening method for heat stress tolerance emerges that researchers can readily adapt to the equipment on hand and from which they can infer a variety's drought tolerance.

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(214) Environmental Stresses in Cranberry Production: Critical Thresholds and Physiological Effects

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Abiotic stresses are known to cause substantial yield losses in crop productions worldwide. Critical thresholds of the main environmental factors affecting plant physiological processes have been established for several plant species, yet little is known about these relationships in cranberry production. While overhead irrigation and subsurface drainage systems have been used respectively to avoid the effects of heat and water stress and to reduce the risks of hypoxic conditions in the root zone, the definition of critical thresholds based on leaf gas exchange parameters is important to improve the efficiency of such cultural operations. We investigated the effects of soil matric potential, air temperature and flooding times on cranberry physiology to determine the set points where stresses typically occur. Experiments were conducted in a growth chamber using cranberry plants collected from the field (as 0.06 m^2 mat of vines) and grown in 27-litre containers filled with sand. For experiment 1, cranberries were grown under constant matric potential conditions, with treatments varying between -1 and -9 kPa. For experiment 2, the photosynthetic and transpiration rates of current year and 1- to 2-year-old leaves were measured over a range of leaf temperature (from 21 °C to 37 °C). For experiment 3, treatments consisted of flooding time ranging from 24 to 120 hours and gas exchange measurements were performed each day during treatments. All measurements were carried out on fruiting uprights. Photosynthesis was optimal when soil matric potential ranged between –3 and –7 kPa, whereas at –9 kPa, leaf photosynthesis declined by 16%. The highest CO_2 assimilation rates were observed at a leaf temperature of 29 °C, with photosynthesis decreasing by 6 and 17% at 33 °C and 37 °C, respectively. After 24 hours of flooding conditions, the rate of photosynthesis had dropped by 20%, with an average reduction of 4.5% over each of the next four days. The responses of stomatal conductance and transpiration to soil matric potential, temperature and flooding time were similar to photosynthesis in all three experiments. Our results show that over the ranges investigated, hypoxic conditions may be more critical for cranberry production and should thus be avoided. Water stress and heat stress nevertheless resulted in an important loss of carbon assimilation. Hence, cranberry growers may achieve significant increases in yield by focusing more thoroughly on irrigation and drainage.

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Floriculture 2

(362) Lantana Cultivars Respond Differently to Plant Growth Regulator Substrate Drenches

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One of the best-performing herbaceous annual bedding plant for landscapes and containers is lantana (*Lantana camara*). Lantana cultivars provide color throughout the summer, even in hot and dry conditions. However, controlling the size of lantana produced in containers can be a challenge. Our objectives were to quantify the efficacy of substrate drenches containing plant growth retardants (PGRs) on growth of lantana cultivars varying in growth habit. 'Little Lucky Peach Glow', 'Lucky Peach', and 'Landmark Peach Sunrise' lantana cuttings were individually planted into 4.5-inch diameter round containers filled with a commercial, soilless growing substrate comprised of sphagnum peat moss and perlite. Fourteen days after planting, once the roots of lantana cuttings reached the container wall, 70-mL aliquots of solution containing 0 (control), 0.5, 1.0, 2.0, or 4.0 ppm ancymidol, flurprimidol, paclobutrazol, or uniconazole were applied to the surface of the growing substrate. Six weeks after applying PGR drenches, data were collected. The plant height from the surface of the growing substrate to the top of the plant canopy and the widths at the widest point of the plant and perpendicular from that widest point were recorded. The Growth Index (GI), an integrated measurement of plant size incorporating the height and widths of plants, was calculated. There was variation in plant height, width and GI among the cultivars used in this study. 'Little Lucky Peach Glow', 'Lucky Peach', and 'Landmark Peach Sunrise' are representative cultivars of small-, moderate- and large-growing series and the height, width, and GI of plants not treated with any active ingredient reflected this. In addition to the differences among lantana cultivars, we found variation in activity among the different PGRs applied. Ancymidol generally had the lowest activity across the four PGRs applied. For example, drenches containing 4.0 ppm ancymidol resulted in plants that were similar to plants treated with 0.5 to 1.0 ppm flurprimidol or uniconazole or 2.0 ppm paclobutrazol for 'Lucky Peach' lantana. Across all cultivars, flurprimidol and uniconazole had the greatest activity in suppressing plant height, width, and GI. Substrate drenches containing flurprimidol, paclobutrazol, or uniconazole are useful to control size of lantana produced in containers, though the recommended concentration depends on the active ingredient and the growth habit of cultivars being treated.

(363) Wetting Agent Addition for Limiting Risks of Hydrophobicity of Peat Substrate

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An important constraint of peat substrates is their hydrophobic character which appears when they undergo a high degree of desiccation. The amount of time (and irrigation events) needed to rewet hydrophobic peat-based substrates is long and the quality/properties of the substrate can be decreased as a result. To remedy this, the use of wetting agents is already common practice and is known to improve the wettability of peat-based substrates. In order to avoid these negative impacts for plant growth, and then to improve irrigation management, this work aimed to estimate the wettability (by contact angle measurements) and hydration efficiency of a peat substrate, with or without wetting agent addition and prepared at different moisture contents: 25%, 37.5%, 50% and 62.5% (by weight). Results confirmed the positive effect of wetting agent addition on the wettability and hydration efficiency of peat. In details, its incorporation into peat did not reveal significant differences in wettability and hydration efficiency at higher water contents (i.e., when the materials are wetted and then hydrophilic), but subsequently led to a progressive increase in wettability and hydration efficiency for drier peat. So, wetting agent should be considered by its ability to improve the wettability of peat with a hydrophobic character, thus improving the ability and speed of the peat to be rewetted, rather than only their ability to influence the water retention characteristics of peat.

(364) Effect of Water Content on the Hydration Efficiency of Several Organic Substrates

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Hydrophobicity of organic matter is the primary factor affecting soil physical properties after drying. In horticultural productions, the measurement of wettability is even more relevant due to the large use and the high content of organic materials in growing media, and to the large and rapid variations of water content in the media (due to the limited volumes of pot/container). Both of which can quickly create hydrophobic conditions, leading to retardation or resistance of water infiltration and creation of preferential flow paths for water and solutes and then deteriorate physical properties of growing media and plant water uptake as well. In order to avoid these negative impacts for plant growth, and then to improve irrigation management, this work aimed to

estimate the hydration efficiency of some traditional and alternative organic materials used as substrates (peat, coconut coir, aged pine bark, wood fiber) under different initial moisture contents: 25%, 37.5%, 50% and 62.5% (by weight). Results showed that hydration efficiency was influenced by initial moisture contents in all materials. Different minimum moisture content thresholds according to the substrates to overcome risks of hydrophobicity could be defined. Thus, coir, bark, and wood fiber had a high ability to rewet (hydrophilic products) in contrast with peat, which remained hydrophobic for 50% moisture content, and below.

(365) Growing Media in France and Europe: Inventory and Current Perspectives

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In France, and more largely in Europe, the main constituent of growing media used in soilless culture are peats, due to their physical qualities (water retention, aeration, physical stability). But, this fossil carbon resource is non-renewable (in our lifetime due to slow growth habit of peats) and societal demand and ecological policies are demanding a more wise use of peat and peatlands (Stategy for Responsible Peatland Management, IPS, 2010; EPAGMA Code of Practice for Responsible Peat Management, 2011). There is also increased interest in promoting renewable organic materials (bark, coir, wood, compost). Commission II (Horticultural Use of Peat) of the International Peat Society conducted a survey in order to evaluate the amounts of growing media constituents used in major growing media producer countries in the European Union (EU). This survey was continued in more detail in France for several years by the C.A.S. This survey asked for amounts of organic, composted, mineral and synthetic constituents in horticultural substrates, and a split between professional and retail markets for all constituents used. Data show that there is an increase in the use of composted organic material in some countries, in particular for the hobby sector. Synthetic materials are of no importance in EU growing media. Due to the specific properties of mineral materials, these are often applied in professional media. The availability and price of organic materials other than peat, i.e. bark or coir, often determine if a material is used as a constituent or not. Bog peat is still the overall predominant growing medium constituent in the EU. Peat-free growing media are highly esteemed by some stakeholder and user groups but still play an overall minor role in industrial production of growing media.

(366) Comparative Efficacy of Various Substrates on Growth, Flowering, and Vase Life of 'Vermeer' *Lilium*

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Effects of growing substrates were studied on production and postharvest performance of cut 'Vermeer' lily (*Lilium* hybrids). Plants grown in coco coir alone or in combination with soil produced highest plant height, plant dry weight, and flower quality; greatest leaf area, leaf chlorophyll contents, and bud and flower diameter; and longest vase life, which were similar to that of plants grown in soil, but was greater than plants grown with spent mushroom compost alone or in combination with soil or coco coir. Moreover, plants grown with coco coir alone or in combination with soil reached anthesis the earliest. Use of coco coir as substrate also improved photosynthetic and transpiration rate, and plants had highest stomatal conductance and leaf temperature. Results demonstrated that coco coir is the best alternate substrate for high quality and rapid cut *Lilium* production. Spent mushroom compost is not suitable due to poor plant growth and delayed production from high water-holding capacity.

(367) The Effect of Moisture Adjustment Procedures on Substrate Hydration and Wettability

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Similar to minerals soils, organic substrates have been shown to exhibit hysteretic behavior. Consequently, irrigation and drying cycles of substrate materials influence a given materials ability to capture and retain water. The purpose of this study was to determine the effect of drying a substrate to a specific moisture content (starting at high moisture and drying down to specific lower moisture contents) vs. hydrating (starting at low moisture contents and wetting up to specific higher moisture content) might have on the wettability of that material. Pine bark, peat moss, and coconut coir materials each attained a moisture content of 50% by weight through one of two techniques, hydration or drying. Hydrated treatments were dried to 25% moisture content allowed to equilibrate for 24 h and hydrated up to 50%. Similarly, dry down treatments were initially hydrated to 66% moisture content allowed to equilibrate for 24 h and dried to 50% moisture content. Treatments were then tested for water capture and retention. Differences in the ability to capture water

were noted between the two methods of attaining 50% moisture for all treatments. After the initial hydration event bark that was dried down to 50% moisture content retained 36.5% moisture compared to 33.5% for the sample that was hydrated up to the same moisture. At the last hydration event the dry down treatment retained 39.8% moisture compared to 35.1 % for the hydrated treatment. In a similar trend the peat, which was dried to 50%, moisture content, held 29.5% water while the hydrated treatment retained 24.4%. The values attained for peat after the last hydration event in which the dry down treatment reached 54.4% and with the hydrated treatment only reaching 34%. This is consistent with previous research showing hysteresis to be more pronounced in peat than in pine bark. Coir treatments comparing the two methods followed trends more similar to bark than peat, however, retained the most water out of the three components, which is expected since coir has been shown to be more hydrophilic. At initial hydration, coir dried down to 50% retained/captured 58.9% of the applied water and the hydrated coir retained 52.7%. Again similar to the difference observed in bark, at the last hydration event coir which was dried down to 50% attained 70.2% compared to 65.9% of the applied water for the hydrated treatment.

(368) The Effects of Parboiled Rice Hull-amended Substrates on the Growth and Water Use of *Petunia* and *Zinnia*

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Utilizing renewable and low-cost materials to create growing mixes is an important strategy for sustainable greenhouse and nursery production. Parboiled rice hulls has been suggested as a viable substitute to peat moss, because it is inexpensive, light in weight, and excellent to increase drainage and aeration. Our previous results indicated that altering the composition of commercial potting mix (CPM) by substituting 40% peat moss with ground- or whole-rice hulls provided as comparable physical properties as CPM. This research was conducted to evaluate the effects of parboiled rice hull amendment on plant growth and to compare the amount of water consumed by plants grown in different formulations of potting mixes. *Petunia* 'Easy Wave Neon Rose' and *Zinnia* 'Benary's Giant Golden Yellow' were grown in the greenhouse in 0.6-L pots filled with commercial potting mix (CPM, 70% peat moss), or amended mix either with ground rice hulls (GRH, 30% peat moss and 40% ground rice hull) or whole rice hulls (WRH, 30% peat moss and 40% whole rice hull), and were fertigated to provide two different levels (high and low) of volumetric water content (WVC) throughout production periods. The growth of *Petunia* was similar regardless of the types of growing mix used, however, shoot dry weight was slightly smaller in rice hull grown plants due to the reduced shoot growth. Meanwhile, the growth of *Zinnia* was slightly reduced by WRH as evidenced by reduced plant height, and branch and leaf numbers especially during the first four weeks of vegetative phase, however, it was recovered by the end of production period. The number of flowers was slightly decreased in rice hull grown *Petunia* due to the overall reduction in plant size, while it was not different in *Zinnia* grown in different types of mix. The daily water use increased in both plant species as plants aged. Significantly higher amount of water was required to maintain higher VWC regardless of the types of potting mix. However, plants grown in CPM consumed significantly higher amount of water to maintain target ranges of VWCs compared to the ones grown in rice hulls. In both species, GRH produced quality crops with the least amount of water. It is concluded that peat-based medium amended with 40% ground rice hulls is a sustainable option for the production of both *Petunia* and *Zinnia* as it helps reduce water use of crops without major adverse impacts on the crop quality.

Specified Source(s) of Funding: USDA–NIFA

(369) Physical and Chemical Properties of a Peat-based Substrate Amended with Parboiled Rice Hulls

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Parboiled rice hulls (PRH) have been proposed as a viable alternative growing media component for the greenhouse and nursery industry. Although PRH can be used as a substitute to peat moss, there is limited information regarding the proper mixing proportion of PRH and peat moss in producing crops. Identifying appropriate proportion of PRH and peat moss helps formulate more sustainable growing mixes to growers and reduce production cost. This research was conducted to evaluate the physical and chemical properties of PRH when amended to a peat moss-based commercial potting mix (CPM, Farfard #2, peat moss:perlite:vermiculite = 70%:20%:10%, by volume) and to determine the proper mixing ratio of the substrates as comparable as CPM. Either ground PRH (GRH, size >2 mm) or whole PRH (WRH, size >5 mm) was mixed with different portions of peat moss (0%, 20%, 30%, 40%, 50%, 60%, or 70%) to replace a total volume of up to 70% of peat moss in the potting mix, while maintaining the same proportion of perlite and vermiculite. Water holding capacity (WHC) was higher in CPM than most of the other mixes, however, WHC of GRH at mixing proportions as low as 40% was not significantly different from that of CPM. Incorporation of higher proportion of GRH or WRH increased air filled porosity by two to three times while decreasing water holding capacity by 10% to 20%. Water holding capacity and air-filled porosity were maintained high

when substrate was amended with either 40% GRH (51.0% and 24.5%) or 40% WRH (38.4% and 39.3%) as compared to CPM (55.3% and 28.7%). Most of measured physical properties of these mixes were within the recommended ranges for growing media. Meanwhile, bulk density increased with higher proportion of GRH but was little affected by higher proportion of WRH compared to CPM. Regardless of the mixing ratio, the pH and EC were significantly lower when rice hulls were incorporated in the mixes compared to CPM. Higher proportion of rice hulls slightly increased the pH, but the EC was only 20 to 50% as that of CPM even with the highest proportion of rice hulls. Our results suggested that substrate amendments with either 40% WRH or 40% GRH may be viable options to substitute peat moss in commercial potting mix. Further research needs to be done to evaluate plant performance grown with rice hull containing mixes in comparison with commercial potting mix.

Specified Source(s) of Funding: USDA–NIFA

(370) Evaluation of Conventional and OMRI-certified Organic Fertilizers, and Their Effect on Soil pH

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The rising popularity in the marketplace of certified organic plant materials has extended into the ornamental plant industry, which has created a demand for information on bedding plant production using organic fertilizers. The nitrogen formulation in organic fertilizers tends to be greater in the ammonical form than nitrate, which has the potential to raise the pH of the soil over time. Higher soil pH results in lower availability of various nutrients for a plant. This study was conducted to determine the effects of organic fertilizers on soil pH. This study utilized soil pH, soil EC, plant dry mass and SPAD measurements. This experiment used four different cultivars of petunia in a modified random block design; each cultivar set was divided into four groups for application of four different fertilizers. Two fertilizers were conventional fertilizers, and two were OMRI certified organic fertilizers. The soil pH, soil EC, and plant dry mass were the leading indicators of fertilizer performance.

(371) Evaluation of Injection-moldable PLA- and PHA-based Biocomposites for Horticultural Application: Processing, Properties, and Performance

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Replacement of petroleum-based materials with renewable materials for plant pots (containers) is a priority for the horticulture industry, and the majority of containers that are used in horticulture are injection molded. The goals of our research were to develop and characterize the processing, properties, and performance of six injection-moldable biocomposites made with base resins of polylactic acid (PLA) or polyhydroxyalkanoate (PHA) and evaluated for use in the model application of sustainable horticulture containers. Resins of PLA or PHA were combined with fillers of soy protein, distillers dry grains with solubles (DDGS), lignin, BioRes™ , or selected combinations of these fillers and were evaluated for their processability on common injection molding equipment and for their suitability to fulfill the functional requirements of the model application. We conclude that, with proper management of material moisture content and thermal processing profiles, all six biocomposites are suitable for processing on standard compounding equipment and molding on standard injection-molding machines. Results from mechanical testing and application trials indicate that all of the materials fulfill the functional requirements for horticultural production of common greenhouse crops, and two of the materials, PLA-Lignin (90/10) and PHA-DDGS (80/20), should be sufficiently durable for culture of long-cycle nursery crops.

Specified Source(s) of Funding: Iowa State University and the Specialty Crops Research Initiative

(372) Fertilizer Rate, Vesicular-Arbuscular Mycorrhizae, and Trichoderma Application Influenced Poinsettia Growth and Development

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Vesicular-Arbuscular Mycorrhizae (VAM) and *Trichoderma* fungi have been attributed to improved plant uptake of macro and micronutrients and enhanced water availability. The main objective of this study was to examine the application of VAM and a commercial product, RootShield™ containing *Trichoderma harzianum*, and various fertilizer rates on the growth and development of poinsettias. The study was conducted in the

greenhouse in a complete randomized design with four microorganism treatments (Control, VAM, RootShield™, and VAM plus RootShield™); one soil media (Promix Bx Mycorise Pro); and three fertilizer rates (recommended rate and 50% and 25% of the recommended rate), with four replications each. Poinsettia cuttings, 'Poi Cortez Burgundy' (*Euphorbia pulcherrima*), were obtained from Greenstreet Grower, Inc. Treatments were added at the time of transplanting. The poinsettias were fertilized every three weeks. Plant height, days to color change, and shoot and root dry weights were determined. Results indicate that the VAM treatment influenced plant growth and development. There was a significant difference in shoot dry weight. The VAM treatment also tended to have the highest shoot height among treatments. There was a significant difference in shoot dry weight among treatments in the recommended fertilizer rate. There was also a significant difference in root dry weight among treatments in both the 50% and 25% recommended fertilizer rates. There was no significant difference in number of days to color change between the treatments and fertilizer rates. More studies will be conducted to further assess the effects of reduced fertilizer rates and beneficial microorganisms on growth and development of poinsettias.

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Marketing and Economics

(146) Combating Rose Rosette Disease: Economics and Marketing

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In order to inform rose breeders as they develop Rose Rosette Disease (RRD) resistant roses, consumer and supply chain preferences for different rose attributes will be determined. A series of consumer experiments will be conducted to: 1) to assess the tradeoffs people make among different rose attributes; 2) predict market shares of disease resistant roses versus regular roses; 3) investigate whether disease resistant roses will expand the rose market by attracting new buyers or by replacing regular roses; 4) estimate consumer threshold levels of willingness to pay for foliage damage and shorter life expectancy due to disease; 5) determine consumer and different segment acceptance of genetically modified roses; 6) investigate different market segments based on stated rose preferences; and 7) study regional differences in rose preferences that may exist among end consumers and landscape installation firms. Beyond investigating the consumers' preference, other factors that might inhibit the increase of rose sales will be explored. Possible marketing barriers perceived by supply chain participants that might prevent them from supplying these improved rose cultivars, will be identified. This part of the project will complement the work with the breeding team to assess the cost of using the technology developed in this project versus the cost of developing RRD resistant roses without the technology to determine if the cost of the technology is an impediment to its use. The consumer experiments will be combined with eye tracking technology (www.tobii.com) and electromyographic (EMG) data to assess respondents' cognitive response to stimuli and electroencephalogram (EEG) to study brain activity while responding to the experiment stimuli.

(147) How Do Intensive Cropping Systems Impact Profitability for Pumpkin Producers?

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Pumpkin cropping systems field trials in 2011 and 2012 demonstrated that use of plastic mulch and transplants can significantly increase yield in pumpkins. However, with these increasingly intensive agriculture systems come added input costs. We conducted an economic analysis to evaluate whether the marketable yield increases seen in the different production systems improve the overall profitability of growing pumpkins. Our economic analysis was conducted by developing a production budget using data for 'Gladiator' production from four planting dates in 2011 and 2012 in differing cropping systems. An assessment of the costs and profits was done for four production systems: direct seed into bare ground, direct seed into plastic mulch, transplant into bare ground, or transplant into plastic mulch. Our results show that direct seed into plastic mulch, transplant into bare ground, and transplant into plastic mulch would increase profits by 41%, 44%, and 34% per hectare, respectively when compared to the grower standard cropping system of direct seed into bare ground. Average yields were similar for all three production systems that differ from the grower standard, but the estimated variable costs changed greatly across the systems. Direct seed into plastic mulch, transplant into bare ground, and transplant into plastic mulch were found to increase total cost of production by 20%, 16%, and 25% per hectare, respectively, when compared to the grower standard cropping system of direct seed into bare ground. However, increases in yield more than made up for these increased costs. Additional analyses were done to consider how sensitive the projected revenue stream was to small changes in expected yields and prices. For reasonable changes in yield and price, the mulch and transplant systems always increased profitability: Direct seed into plastic mulch, transplant into bare ground, and transplant into plastic mulch

were found to increase profits by 38% to 56%, 40% to 64%, and 33% to 41% per hectare, respectively, when compared to the grower standard cropping system of direct seed into bare ground. The transplant into bare ground treatment generated the greatest increase in farm profits, but all three intensive cropping systems showed large profit increases relative to the grower standard of direct seeding into bare ground.

(148) Green Growth: An Exploratory Study of Metro and Non-metro Garden Centers' Use of New Media Marketing

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The introduction of mass merchants and big-box stores has increased competition in the green industry and could negatively impact the economic viability of garden centers. In order to compete against such retail giants, small, family-owned garden centers focus on offering exceptional customer service and developing meaningful relationships, which are keenly desired by customers. New media marketing campaigns are relatively low cost and if used correctly could positively impact the reputation, image, and profits of garden centers. Social media is used by over 75% of adults (Duggan & Brenner, 2013) and excels at fostering consumer engagement, interaction, and even relationships. Garden centers that are not using social media as part of their marketing strategy could be putting their business at a disadvantage. Additionally, social media can be used to foster relationships between businesses and consumers, resulting in positive returns on investment. This qualitative study used in-depth interviews with employees and customers of four garden centers in the Great Plains region of the United States. The following research questions guided this study: 1) What are stakeholder perceptions and attitudes toward new media marketing; 2) What barriers do employees and owners encounter when using new media to market their business; 3) What new media strategies are being implemented in the marketing of metro and non-metro garden centers; 4) What are stakeholder perceptions regarding customer interaction of new media marketing content? Results of this study indicate that garden center operators continue to prefer traditional marketing channels, which include radio, television, and newspapers. They are skeptical regarding the ability of social media to generate a positive return on investment. Garden center employees identified that the primary barriers to new media marketing are with the time requirements associated with answering customer questions. Stakeholders are consciously using relationship management techniques (to various degrees), however the lack of measurement and strategy is hindering the profitability of those developed relationships. Although garden center operators don't believe that their businesses should be using social media to advertise their products, customers indicated that they did want to see some targeted and relevant advertising in addition to educational content. This study recommends that garden centers integrate a five-tier approach to developing relationship marketing strategies which includes creating measurable objectives, identifying user habits, identifying meaningful content, measuring the relationship, modifying the process and repeating.

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(149) Dates International Trade Could Be a Challenging Opportunity for Fruit Export Diversification for Chile

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Chile has become an impressive fresh fruit exporter, being first in the Southern Hemisphere and third in the world after the United States and Spain. Diversification plays an encouraging role in handling new fruits. One of the best examples is blueberry, which was non-existent in the country in 1980. Today Chile is second-largest world exporter of the crop. While Chile is not a date fruit producer, in the north climate conditions are conducive for its production, as shown in in the Esmeralda Experimental Station, in the Pica Oasis, and some other areas in the north and in areas where it is grown as an ornamental. Dates (*Phoenix dactylifera* L.) are produced and consumed in great volume around the world at attractive prices. A study was conducted for the 2009–13 to analyse volume and prices of world import/export countries. Careful consideration was given to transaction prices for each of the countries that export and import dates. The data obtained was analyzed with regard attractivness of the market, competitiveness, and attractivness to import countries. The source of data was Trademap of the International Trade Center. Both imports and exports grew during the research period (2009–13)—7.6% and 10.3%, respectively, as an annual average. We detected that the date import/export trade increased during the last five months of a year, showing higher unit value mainly due to Ramadan and New Year's festivities. The analysis conducted in this work presents a promising future for date fruit production and export from the desert areas of northern Chile.

(150) Estimating the Economic Feasibility of Producing Blackberries for Four Different Production Systems

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As health concerns are on the rise, consumer behavior regarding food, nutrition and health benefits are changing. In 2013, the three leading causes of death in the United States were heart disease, cancer, and chronic lower respiratory diseases (Kochanek et al., 2014). Numerous research studies support the blackberry potential role in helping to reduce the risk of these diseases (Manganaris et al., 2014; Seeram 2010; Seeram 2008; Seeram et al., 2006). Blackberry's health benefits had stimulated domestic consumption and consequently an increase in production in the United States (Safley, Boldea, and Fernandez, 2006). However, production of blackberries requires a high initial investment and a delay of three years in returns after planting. The goal of this poster is introduce an interactive tool that allows blackberry producers evaluating cost, returns and run breakeven, sensitivity or risk analyses for four different production systems (e.g., floricane high tunnel production, primocane high tunnel production, floricane field production, and primocane field production). This tool was developed in Microsoft Excel using VBA interfaces for simplified data entry. The user-friendly interfaces allow the producer to generate tabular and graphical information that highlights estimated costs and returns. However, the tool is flexible enough to assess the changes to cost, revenue and risk as expected costs, revenue prices and/or yields change using the tool's default data or information entered by the user. This tool is useful because it allows blackberry producers to estimate operating costs, fixed costs, total costs and expected total returns by modifying production practices or production systems, cost or return values. Estimating total costs per year, breakeven, sensitivity and risk analyses for yields and prices would assist blackberry producers to make better production, management and marketing decisions when comparing production costs and revenues of different production systems.

Specified Source(s) of Funding: Southern SARE

Nursery Crops 1

(414) Comparison of Pine Bark Substrates from Multiple Suppliers: White Wood Percentage and Volume

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Bark has been an important component in horticultural substrates for years (and is rapidly increasing in greenhouse professional mixes and in retail potting soil mixes), and in the nursery industry bark is the most common substrate component used in the United States. Bark is obtained as a byproduct of the timber industry (pulp mills, saw mills, pole peeling operations, etc.) when it is striped off logs after harvest. The objective of this work was to evaluate the differences in white wood content among different pine bark suppliers and materials. Fresh and aged pine barks from four different sources were tested. White wood is a term used to describe the actual pine wood, or xylem that accompanies the bark during the debarking process. White wood percent and volume were determined in all pine bark sources/samples. Three replications of each bark material had white wood removed my hand (sorting and picking). After removing the white wood from the pine bark the volume and mass were calculated and recorded. There were differences between sources as well as among sources when comparing fresh versus aged pine barks. Volume percentage ranged from 23% to 4.5% and mass percentage ranged from 19% to 4%. The four fresh bark materials from the different suppliers had white wood percent's that ranged from 5% to 22% and in the aged bark it ranged from 5% to 14%. The size of the white wood particles was also extremely variable between bark suppliers/sources. There is no official standard or guideline for how much white wood is allowed in pine bark, for the bark to be considered "good quality" or "acceptable". However, a general rule is that 10% white wood is acceptable in bark mixes. The variability in pine bark supplies can be likely influenced by many factors including species of pine tree, thickness of bark at time of removal, tree harvest season, method of bark removal from logs, variations in hammer milling, variations in bark handling and screening, and variations in bark pile management and aging. These variations can exist between/among different suppliers, but also it can (and very often does) vary from season to season at the same supplier.

(415) Comparison of Pine Bark from Multiple Suppliers: Variation in Substrate Physical Properties

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Bark has been an important component in horticultural substrates for years (and is rapidly increasing in greenhouse professional mixes and in retail potting soil mixes), and in the nursery industry bark is the most common substrate component used in the United States. Bark is obtained as a byproduct of the timber industry (pulp mills, saw mills, pole peeling operations, etc.) when it is striped off logs after harvest. The objective of this work was to evaluate the differences in physical properties among different pine bark suppliers and materials. To compare any differences

amongst pine bark substrates, fresh and aged pine barks from four different sources were obtained and tested. The physical properties of the substrates were tested using the porometer method. Results showed that there was great variability amongst the different sources. The bark materials tested all had total porosities around 80%. The container capacity ranged from a high of 52% to a low of 19% among the bark sources. Aged pine bark had higher container capacities and less air space than freshly processed pine bark. The air space of the materials varied greatly from 30% to 45%. The recommended BMP guidelines for nursery substrates are 20% to 30% (used to be minimum 10% but that has been discounted in recent years as it was way too low) air space and 45% to 65% water holding capacities. The variation in these properties is directly related to the particle size of the bark, which is a direct result of the processing of the materials. The range of particle sizes (and shapes) in bark fit together in a matrix and helps create the porosity (air and water) of the bark substrate. Processors can screen bark to create any particle size combination they wish, or what is requested by a grower depending on the crop to be grown or irrigation practices preferred (more or less water). The variability in pine bark supplies can be likely influenced by many factors including species of pine tree, thickness of bark at time of removal, tree harvest season, method of bark removal from logs, variations in hammer milling, variations in bark handling and screening, and variations in bark pile management and aging. These variables can exist between/among different suppliers, but also can (and very often do) vary from season to season at the same supplier.

(416) A New Automated Irrigation System Reduces Irrigation Consumption during Gardenia Production Using Overhead Irrigation

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Properly scheduling irrigation for nursery container crops can be difficult in substrates having low water-holding capacity. To produce high quality plants, nursery managers often apply excess irrigation resulting in high leaching and nutrient movement. Therefore, a simple, automated, sensor-driven irrigation system designed at Louisiana State University (LSU) to better regulate irrigation application volumes was evaluated using Gardenia jasminoides 'August Beauty' grown in one of two container sizes (1- and 3-gallon) and two pinebark substrates (fine and coarse) over a 4-month period. Gardenia grown using the new irrigation system were compared to plants grown using a traditional timed over-head irrigation system. The traditional timed system applied 2.5 cm of water per day. Over the course of the study, gardenia had similar growth between irrigation systems within substrate treatments. Gardenia growing in coarse substrate had higher growth indices and greater biomass compared to gardenia growing in the finer substrate. Within four months of planting, all gardenia had reached marketable size. However, gardenia grown using the new irrigation system reduce water application volumes > 30% compared to the traditional timed irrigation system.

(417) Growth Response of Date Palm (*Phoenix dactylifera*), Royal Palm (*Roystonea regia*), and Washington Palm (*Washingtonia robusta*) to Saline Irrigation Water

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With increasing population demands on the world's water supply, there is a greater need for water conservation. Thus, nursery producers are challenged to avoid the use of high-quality potable water for irrigation. In arid and semiarid climates where water is limited, soil salinity is major problem and palm production can be challenging. The objective of this study was to evaluate the impact of different levels of salinity on the growth of date palm, royal palm, and Mexican fan palm. Palm liners were grown in 1-gallon containers in the greenhouse located at the University of Florida, Fort Lauderdale Research and Education Center, Davie, FL. Palms were irrigated with water having five different salt concentrations: 0, 5, 10, 15, and 20 dS/m). Palms were fertilized with controlled-release fertilizer (Osmocote Plus, 15 N–9 P_2O–12 K_2O, 12–14 months at 70 °F). A supplement of calcium sulfate was added as liquid (drench) and magnesium was added as granular kieserite (surface application). Plants were watered with salt solutions by hand at a rate of 250 ml three times a week. Measurement of growth was taken monthly, height for each plant was measured to the tip of the tallest fully extended leaf, and number of new mature leaves per plant was counted. Mexican fan palms started to show mild injury symptoms in all EC levels (0, 5, 10, 15, and 20 dS/m) by week 6, then severe injury symptoms started showing after week 8. Royal palms showed severe symptoms at the highest EC level (10, 15 and 20 dS/m) after 8 weeks compared to other EC levels where the injury symptoms were moderate. Date palms showed the most tolerance to salinity up to 12 weeks under all treatments and after that these plants began to show mild symptoms (leaflet tip necrosis) at the highest two EC levels (15 and 20 dS/m). With increasing the EC levels, all three species showed reduced growth.

(418) Physiological Response to Drought Stress and Water Use in Two Redbud (*Cercis*) Ecotypes

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Drought tolerance is an important adaptation for landscape plants. Redbud is an important landscape plant with two ecotypes that respond differently to water availability. The current study was conducted at the University of Kentucky greenhouse facilities in Lexington, KY, to determine key factors impacting differences of redbud cultivars with different drought tolerances. Cultivars selected include eastern redbud (*Cercis canadensis Canadensis* 'Appalachian Red' and *Cercis canadensis texensis* 'Oklahoma'. Liners were grown in 7-gallon containers filled with 85% pine bark:15% peat (v:v) in a completely randomized experiment design. Substrate moisture content was continuously monitored using EC5 (Decagon, IL) moisture sensors inserted into three representative containers per cultivar treatment. Physiological parameters related to plant water stress were collected on a daily basis throughout the study. Photosynthetic rate was collected using a LICOR 6400 and sap flow using a Dynamax sap flow sensor to track real time plant moisture status. The relationship between volumetric water content and sensor output was determined for both ecotypes. It was found that 'Oklahoma' maintained around 35% higher net photosynthesis compared to 'Appalachian Red' over a three-day dry down experiment. Over that same time period, 'Oklahoma' lost 78.2 g of water through transpiration compared to 126 g of water per plant for 'Appalachian Red'. 'Oklahoma' maintained a photosynthetic rate at 90% or greater of the maximum rate even under substrate water content of 0.27 $m^3 \cdot m^{-3}$, whereas 'Appalachian Red' showed a significantly reduced photosynthesis rate beginning at substrate water contents of 0.31 $m^3 \cdot m^{-3}$. Sap flow showed a similar trend to direct transpiration measurements with 'Oklahoma' at 0.47 L cm/day and 0.84 L cm/day for 'Appalachian Red'. 'Oklahoma' plants had thicker, broader, heavy leaves and a higher number of stomata per unit leaf area compared to 'Appalachian Red', which may be related to the observed higher relative leaf water content, stomatal conductance, and net photosynthesis under drought stress conditions.

(419) Wettability of Fresh and Aged Pine Bark Substrates from Different Sources

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Bark has been an important component in horticultural substrates for years (and is rapidly increasing in greenhouse professional mixes and in retail potting soil mixes), and in the nursery industry bark is the most common substrate component used in the United States. Bark is obtained as a byproduct of the timber industry (pulp mills, saw mills, pole peeling operations, etc.) when it is striped off logs after harvest. The objective of this work was to determine the wettability and initial hydration of pine bark substrates from different suppliers. Aged pine bark substrates (duration of aging varied among the suppliers) from four sources/suppliers were used to conduct and compare wettability. They were compared at two different moisture contents (MC; 50% and 25%) and two different levels of wetting agent (none and standard rate according to label). Each pine bark was tested as follows: 1) 50% MC with no wetting agent; 2) 50% MC with standard wetting agent; 3) 25% moisture content with no wetting agent; and 4) 25% moisture content with standard wetting agent. Each pine bark was wet up or air-dried to obtain the desired testing moisture content before wettability was tested. Results varied across each source. Source 1 reached container capacity with the first hydration event at 50% MC regardless of the presence of wetting agent. At 25% MC, container capacity was never reached, also regardless of the presence of wetting agent. Source 2 reached container capacity with the first hydration event at 50% MC regardless of the presence of wetting agent. At 25 % MC, it took five hydration events to reach container capacity without the addition of wetting agent. With wetting agent, it took four hydration events at 25% moisture. Source 3 took two hydration events without wetting agent and 1 event with wetting agent to reach container capacity at 50% moisture. At 25% moisture, it took seven hydration events without wetting agent and four hydration events with wetting agent to achieve container capacity. Source 4 took three hydration events without wetting agent and one hydration event with wetting agent to reach container capacity at 50% moisture. Container capacity was never reached, regardless of the presence of wetting agent, at 25% moisture. Difference among suppliers is likely due to differences in aging practices and timing. Differences in bark processing and handling also are likely reasons for the variability in wettability.

Organic Horticulture 1

(062) The Effects of Alternative Media and Deficit Irrigation on Organic Vegetable Transplant Production

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In an effort to study the effectiveness of organic media and deficit irrigation in organic vegetable transplants we grew lettuce (*Lactuca sativa*) 'Green Romaine', sweet pepper (*Capsicum anuum*) 'Olympus F1', and tomato (*Solanum lycopersicum*) 'West Virginia '63' in three different organic media combined

with three irrigation regimes. Plants were grown for eight weeks in the commercial media Black Gold Natural and Organic Potting Mix as well as Johnny's 512 Mix, or an autoclaved compost sourced from the university's organic farm. Irrigation was supplied at 80%, 100%, or 120% of initial container capacity and plants were reliant on nutrients present in the media as no supplemental fertilization was supplied. Plants were evaluated bi-weekly in terms of height and leaf number and on alternate weeks leachate was collected in order to evaluate changes in pH and electrical conductivity. At the end of eight weeks, plants were evaluated visually, harvested, and fresh and dry weights were collected. Initial pH and EC was 8.4 and 270 $\mu S \cdot cm^{-1}$, 6.8 and 1400 $\mu S \cdot cm^{-1}$, and 7.4 and 160 $\mu S.cm^{-1}$, for organic farm compost, Johnny's 512 Mix, and Black Gold respectively. Significant differences were observed in height and fresh and dry weights between organic media for lettuce, sweet pepper, and tomato transplants at the end of the experiment. Within each media treatment watering regimes did not significantly affect height, fresh and dry weight, or visual rating at the end of the experiment. Despite high initial and final pH and low electrical conductivity (EC) readings, organic farm compost outperformed both Black Gold and Johnny's 512 Mix in our experiments at least as determined by final visual ratings. Deficit irrigation at 80% of container capacity does not significantly affect growth as measured by fresh and dry weight, height, or visual rating in each of the media and plant species that were investigated. We suggest that deficit irrigation can be effectively used in organic transplant production without affecting transplant quality while minimizing nutrient loss from the media. We further postulate that initial EC and pH readings may not correlate well with the production of quality transplants and that other initial measurements of fertility may be better indicators of media quality and efficacy in producing transplants.

(063) The Effect of Rowcovers and Municipal Water or Rainwater on the Growth of Vegetable Crops in Organic High Tunnels in Kentucky

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There has been an increased interest and demand in consumers' desire for organic and locally grown food. In regions where year-round outdoor production is not possible, this demand can only be met for part of the year. High tunnels provide an opportunity for extending seasons and allow the grower to meet this consumer demand for an extended period each year. However, unlike outdoor production, high tunnels are typically in a fixed and permanent location and do not allow for the rotation that is commonplace in organic as well as conventional outdoor production. In addition, while they do prolong the season, they are not immune to the effects of frost and winter as regions move into the deeper winter months. Another issue with high tunnels is that the use of municipal water in high tunnels leads to a dramatic increase of salts in the soils. The build-up of chlorine, fluorine, and sodium salts due to the use of municipal water will adversely affect the soil and ultimately decrease the profitability of the high tunnel. The objective of this research was to examine the late-winter growth of three vegetable crops (arugula, spinach, and beets), with and without rowcovers, with either municipal water or rainwater for irrigation under high tunnel production. Plants were seeded in early February in four replicated high tunnels containing the treatment combinations. Plants were destructively harvested six weeks after planting by taking four samples from each plot to determine plant fresh weight and dry weight. As expected, the three crops had different biomass production during the growth period. Water source did not significantly influence growth of any of the three plant species. Rowcovers provided about a 40% increase in growth of the plants evaluated, likely providing protection during several cold weather events in Kentucky in February and March. Potential long term influences of these production methods will be discussed.

Specified Source(s) of Funding: USDA–NIFA Funding

(064) Effects of No-till and Strip-till Systems in Organic Pepper and Broccoli Production

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Organic no-till and strip-till systems have gained attention because of their capacities to enhance soil health and suppress annual weeds. This study, conducted at the Horticulture Research Station, Ames, IA, compared no tillage (NT), strip tillage (NT), and conventional tillage (CT) in organic production of broccoli and bell pepper, with data being collected on crop yield, weed suppression, nitrate leaching, and soil growing degree days. All plots were seeded to a cereal rye/hairy vetch cover crop in Sept. 2013, and were either roller-crimped (NT and ST) or tilled-in (CT) in late spring of 2014. Each tillage treatment was split into two fertility regimes—one based entirely on preplant granular fertilizer (Preplant), and the other split between the granular fertilizer and post-planting fertigation (Split)—to test the effect of fertigation on nitrate leaching and yields under the typically

N-limited reduced tillage conditions. Yields of pepper were equal among the three tillage treatments, with Preplant treatments averaging 19.0 $Mg \cdot ha^{-1}$ and Split fertilizer treatments averaging 14.7 $Mg \cdot ha^{-1}$. Yield of broccoli were highest in CT treatments, averaging 5.4 $Mg \cdot ha^{-1}$, with no difference between ST and NT treatments. Weed measurements taken three weeks after planting showed that CT treatments had significantly more weed biomass than ST or NT treatments, demonstrating that early season weed suppression by the cover crop mulch was effective. Averaged across the whole season, nitrate concentration in leachate was 40% higher in CT than NT or ST plots. Soil growing degree days (SGDD) was greatest under CT management for both broccoli and peppers, and SGDD of ST treatments was higher than NT treatments in pepper plots, but not in broccoli plots. In summary, reduced tillage systems maintained yields of peppers, but not broccoli, while reducing nitrate leaching and providing early season weed suppression. Split application of fertilizer using drip irrigation did not increase yields.

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(065) The Effects of Cover Crops on Squash Bug (*Anasa tristis*) Populations

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Organic squash growers struggle with various diseases and insect pests that affect squash yield. One important pest, the squash bug (*Anasa tristis*), causes damage by feeding on xylem of cucurbits. The bug is also responsible for transmitting a bacterium, *Serratia marcescens*. This bacteria causes cucurbit yellow vine disease, which causes cucurbits to yellow, wilt, and decline in 5% to 100% of plantings (Bruton et al., 2003). Currently, organic growers utilize row covers, organic insecticides, and field sanitation techniques to control this pest, however, none of these methods are 100% effective. Field studies were conducted to analyze the affect of growing adjacent cover crops on squash bug populations. Sunn hemp (*Crotalaria juncea)*, cowpea (*Vigna unguiculata)*, and buckwheat (*Fagopyrum esculentum*) were planted adjacent to yellow squash during Summer 2014. Fields were scouted weekly and squash harvested every 2–3 days. Results from the first trial suggest squash bugs showed no preference for any cover crop treatment (Poisson distribution, $P = 0.066$) and squash yields were highest in control plots (one-way ANOVA, $P = 0$). Slight adjustments were made in trial two to encourage better growth of cover crops and decrease competition between squash and cover crops. In trial two, control plots had the most squash bug egg masses (Poisson distribution, $P = 0$) and buckwheat plots had fewer squash bug adults than the control (Poisson distribution, $P = 0.026$) Yields were comparable in control, buckwheat, and cowpea plots (one-way ANOVA, $P = 0.036$). The experiment will be repeated in the coming season to obtain more conclusive results.

Specified Source(s) of Funding: Southern SARE Graduate Research Grant

(066) Exploring Systems Management of Insect Pests and Diseases on an Oregon Organic Vegetable Farm

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A goal of an organic farming system is to suppress insect pests and diseases through ecological and systems management. The goal of this project is to explore the strategies and outcomes of ecological and systems management on long term organic farms. This poster describes this effort for Persephone Farm, a 30-year-old diversified organic vegetable farm in the Willamette Valley of Oregon. Data sets utilized include farm data (field maps and 20–30 years of yield, cropping history, soil analysis, pest incidence, and input records), university personnel diagnostic and scouting data, and on-farm research data. The farm's primary design and soil- and habitat-building strategies include 21 cropped acres amidst 30 additional acres of forest/riparian habitat; small farm fields bordered by native vegetation; a four-year rotation including three years of vegetable crops and one year of pasture/cover crops; spatial rotation; a diverse crop mix; farm-scaping including beetle banks, aggregated in-crop insectary plantings, and a hedgerow; soil management including cover cropping, organic amendments, mulching, and liming; and a flock of pastured laying hens. Additional strategies include resistant varieties, irrigation management, staking, and row spacing/orientation. Insect pests and diseases that have been but are no longer a problem include cabbageworms (*Pieris rapae*, *Plutella xylostella*, *Trichoplusia ni)* most aphids (many species, especially *Myzus persicae),* Zucchini Yellow Mosaic Virus, and head rot (*Pseudomonas* spp.) and downy mildew (*Peronospora parasitica*) of broccoli. Clubroot (*Plasmodiophora brassicae)* has developed but is not a significant economic problem. Insect pests that are an economic problem but not increasing in importance (and likely suppressed to some degree) include brassica (*Phyllotreta cruciferae*) and tuber (*Epitrix tuberis*) flea beetles, cabbage aphids (*Brevicoryne brassicae*), cucumber beetles (*Diabrotica undecimpunctata, Acalymma vittatum*), thrips on onions (*Thrips tabaci, Frankliniella occidentalis,* and symphylans (*Scutigerella immaculata*). Diseases that are increasing in importance include cucurbit root rot/wilt (diagnosis underway) and spinach Fusarium wilt (*Fusarium oxysporum* f. sp. *spinaciae*). Onion downy mildew (*Peronospora destructor)*, potato late blight (*Phytophthora infestans)* and winter squash storage diseases (*Botrytis cinerea, Fusarium spp., Phoma spp., and Sclerotinia sclerotiorum*) are

important but not increasing. As possible, the project uses the available data to relate ecological and systems management practices to insect pest and disease outcomes, and examples will be provided. Project publications will be available at eXtension.org/organic_agriculture and should be useful learning materials for farmers, students, and researchers.

Specified Source(s) of Funding: Western SARE

(067) CAL-Collaborative Organic Research and Extension Network: On-farm Research to Improve Strawberry/Vegetable Rotation Systems in Coastal California

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CAL-CORE is a network of researchers, farmers, extension professionals, industry and non-profit organizations dedicated to furthering research into organic strawberry and vegetable production in coastal California. Formed 9 years ago, we have worked on a variety of fertility, pest and disease management issues facing organic growers. Currently, our main effort centers on vegetable/strawberry rotations and different options for fertility and disease management. In a replicated field trial we compare treatments across a range of sustainability criteria: crop yield, nitrogen cycling and losses, greenhouse gas emissions, disease incidence, biocontrol of insect pests, soil carbon pools, and economics. Ultimately a full life cycle analysis for each rotation system will be developed to assess their overall environmental footprint. Main treatments are 2- vs. 4-year rotations with different crop combinations believed to be either suppressive of a major soil borne disease (*Verticillium* wilt), or more profitable but more conducive to disease. Superimposed on the rotations are fertility treatments (legume/cereal cover crop only, legume/cereal cover crop + compost + additional fertility amendments, cereal cover crop + mustard seed meal, or untreated control) and in the two legume/cereal cover cropped treatments Anaerobic Soil Disinfestation (ASD, a promising option for controlling a range of soil borne diseases) is used for disease management prior to planting strawberries. Six network farmers also chose a sub-set of these treatments to test on their farms and compare to their own management practices. The study is in year 4 and all treatments at all locations are now planted to strawberries. Preliminary data on system productivity, nitrogen cycling greenhouse gas emissions, soil carbon, plant disease and biocontrol of cabbage aphids will be presented. Findings to date demonstrate: good production levels in all treatments, modest control of strawberrry disease in year 2 of the 2-year rotation in the ASD treated plots; greater soil C loss in the bare fallow treatments and following strawberries; significant biological control of cabbage aphid on broccoli by syrphid fly larvae; low levels of greenhouse gaas emission in general but increased rates following cover crop incorporation. This project will provide farmers with tools to improve their production systems, meet water quality regulations, and quantify climate-related impacts of these intensive organic systems.

Specified Source(s) of Funding: OREI CALW-2011-01969

(068) The Center for Sustainability of Farms and Families: Impacts of the Small-scale Farm Grant

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Kentucky State University-College of Agriculture, Food Science, and Sustainable Systems-Center for Sustainability of Farms and Families (CSFF) is supporting new economic opportunities for limited resource farmers through demonstration projects and grants funded through support from the Kentucky Agricultural Development Board and Tobacco settlement funds. This granting program is impacting the production and sales of Kentucky-grown farm products. We have received applications from 81 of 120 counties in Kentucky, including 11 counties identified as SOAR and 15 Appalachian Regional Commission counties that have been funded through The Small Scale Grant program. Over 331 grant proposals have been reviewed with a total of over $1,700,000 in funds requested. The grant gives priority to three specific areas: Organic Agriculture, Aquaculture, and Value-added processing. Presently 46 applications for Organic Agriculture with a total over $204,000, 23 for Aquaculture totaling over $94,000, and 78 in Value-added processing with a total over $337,000 have been approved. Funded projects include mobile freezer units on trailers, aerators for ponds, equipment for canning fruits and vegetables, farm tractor implements to support the integrity of organic crops, goat cheese and soap making equipment, root cellars, and many additional items. Given the network of agricultural agencies and marketing groups in Kentucky, we have assisted numerous applicants with contacts for selling their products, educated them on production techniques, or secured funds from other sources whose mission is more aligned with their needs.

(069) The Use of Shade Cloth and Passive Venting to Delay Spring Bolting in Organic Kentucky High Tunnels

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High tunnel technology has allowed season extension and year-round vegetable production for organic producers in Kentucky. The adoption of high tunnels into current production systems has accelerated and numerous organic producers are moving to this production system due to the introduction of NRCS's Environmental Quality Incentives Program (EQUIP). However, numerous problems concerning the efficiencies and profitability of high tunnels have arisen and limited the productivity of these systems. In response to these questions Kentucky State University completed construction of four gothic-style single-bay high tunnels (30' x 96') in 2014. During April and May, heat buildup and light levels in high tunnels can limit profitability by causing lettuces and mustards to bolt. To reduce this effect and delay bolting, a low-cost and energy-efficient strategy using shade cloth and venting was introduced into the high tunnels. Initial findings during Spring 2014 revealed that the use of 50% light transmission shade cloth with passive venting delayed bolting by 14 days. This delay in bolting allowed for an additional 2 weeks of harvest that would allow producers, on average, an additional $275 in sales per week for each tunnel. Costs associated with installation of the shade cloth and setup of the venting was negligible. Total costs of shade cloth was $160 per tunnel and it is expected that the shade cloth with proper care will last four to five years. Overall, the total cost of $70 per tunnel each spring for the installation of shade cloth and setup of passive venting makes these management practices economically viable when the potential return is $550.

Specified Source(s) of Funding: USDA–NIFA Evans Allen Funding

Wednesday, 5 August 2015

Ornamentals/Landscape and Turf 1

(316) The Business License: An Effective Extension Tool and a Challenging Research Tool

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Turfgrass production, ornamental horticulture, and landscape services directly contribute $4.0 billion in output, and indirectly contribute $3.8 billion to Georgia's over $700 billion economy. Urban agriculture industries, as a group, were severely challenged by the statewide drought of 2007 and then by the national economic downturn in 2009. Many businesses closed while others consolidated. Although the economy has improved in recent years, industry associations have not noted an increase in membership. This project attempted to use business license information to 1) provide insight into the state of the industry, and 2) identify new businesses so that Extension and professional association resources can be extended to them. Gwinnett County was selected as representative of the Metro Atlanta urban and suburban area, and open record requests were filed for unincorporated Gwinnett and the cities of Duluth, Lawrenceville, Snellville, Norcross, Buford, and Lilburn, which lie within the county. Businesses were identified using the North American Industry Classification System (NAICS) number. Although data collected on business license applications was similar among the government entities, data supplied in response to the open record requests was not. Requests for data from Norcross, Lilburn, and Buford, yielded no response. Gwinnett County supplied initiation dates for each business, number of employees, and some financial information. Duluth, Lawrenceville, and Snellville provided little other than contact information. Other factors may confound compiling the data. Unincorporated Gwinnett County removes non-tax payers after three years; however, no information was available on when non-tax payers were removed from city license lists. Attention was focused on information provided regarding the tree care industry to determine if a unified database with main contact person, mailing address, phone, and, e-mail could be created. A total of 47 tree care companies were located within Gwinnett County and through use of the Internet, 21 email addresses were identified. It remains to be determined if the other businesses have failed or simply have no internet presence.

Specified Source(s) of Funding: OSHA Susan Harwood Training Grant

(317) Pine Sawyer Beetle (*Monochamus carolinensis*) Feeding Preference on Eleven Pinaceae Taxa

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Although not native to Kansas, pines (*Pinus* L.) grow and adapt quickly to various environmental conditions, which enhances their adaptability throughout the region. This resulted in an increased use of Scots (*P. sylvestris* L.) and Austrian (*P. nigra* J.F. Arnold) pines in Christmas tree plantations, windbreak plantings, and landscapes. Since first being reported in Kansas in 1979, pine trees in Kansas have experienced increased

mortality due to the spread of pine wilt disease, a complex interaction consisting of the pinewood nematode [*Bursaphelenchus xylophilus* (Steiner and Buhrer) Nickle] (PWN) and the vector, pine sawyer beetle (*Monochamus* spp. Megerle) (PSB). Choice feeding preference trials involving adult PSB (*M. carolinensis* Olivier) were conducted between 2011 and 2014 using eleven Pinaceae taxa: Austrian, eastern white (*P. strobus* L.), lacebark (*P. bungeana* Zucc. Ex Endl.), loblolly (*P. taeda* L.), loblolly-pitch hybrid (*P. taeda* × *rigida* Mill.), ponderosa (*P. ponderosa* P. Lawson & C. Lawson), Scots, and southwestern white (*P. strobiformis* Engelm.) pines and deodar cedar [*Cedrus deodara* (Roxb. ex D. Don) G. Don], concolor fir (*Abies concolor* Lindl.), and white spruce [*Picea glauca* (Moench) Voss]. One newly emerged PSB adult was placed into each feeding arena (n = 150) containing three to four shoots of current season's growth from different tree species (one shoot per species). Adults were allowed to feed for 48 (2011) or 72 (2012–14) hours, at which point plant shoots were removed and data collected on feeding occurrence and percent feeding area. Our goal was to determine if the PSB feeding preference trials would indicate non-preferred Pinaceae taxa alternatives for use in the landscape. However, augmented design analyses of feeding occurrence and percent feeding area for the eleven taxa did not indicate significant evidence for feeding preference of the PSB on most of the taxa with the exception of increased preference for both Scots and eastern white pines compared to deodar cedar. The feeding preference trials suggest that PSB may be more polyphagous thus allowing for host switching among Pinaceae taxa.

(318) Economic Injury Threshold of Chilli Thrips (*Scirtothrips dorsalis* Hood) on Knock Out Rose

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Chilli thrips has become an established pest problem for ornamental plant growers and landscape managers in Louisiana and surrounding states. Defining its economic injury levels can help better manage this pest by scheduling insecticide sprays as needed (vs. calendar-based). In this study, we used Knock Out rose 'Double Red' to quantify chilli thrips injury symptoms and their relationship with chilli thrips population levels at 0, 3, 5, 15, 30, 50, or 75 thrips per plant. Injury symptoms including brown and grey lesion on leaf surface, dark brown leaf edges, puckering and deformed growth on expanding leaves were evaluated weekly, and a visual damage rating was assigned to plants at 4 weeks after inoculation. Number of leaves, flowers, and thrips, and plant dry weight were also recorded. Results indicated that chilli thrips can injure Knock Out rose at a low initial population (i.e. 3 to 5 thrips per plant) if allowed to develop on newly transplanted plants and left untreated for 4 weeks. Plant growth and quality can be more quickly affected at higher population levels such as 15 and above thrips per plant. If infested, newly transplanted plants need to be treated within 14 days to prevent crop loss from chilli thrips injury.

Specified Source(s) of Funding: USDA–NIFA Pest Management Alternative Program

(319) Public Perception of a Sustainable Landscape Demonstration

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Degradation of water quality in urbanizing watersheds due to increased impervious surfaces and removal of natural vegetation and wetlands is well recognized. What is under-appreciated, however, is the conflict between ornamental landscaping practices in urban/suburban ecosystems and water quality management. This project was designed to demonstrate the ecosystem services attained by a change from our current lawn-based landscaping paradigm to one that encourages less-intensive management and allows for a greater abundance and diversity of native flora and fauna. A suburban landscape was designed and installed in a Delaware residential development that demonstrated sustainable landscape principles i.e. reduced lawn space, strategies for water management, a 6000 square foot meadow, a forested buffer and a predominantly native plant palette. The landscape was managed for three years, tracking installation ($31,932) and management costs ($6,921). As most labor following installation was devoted to weeding, these costs are anticipated to decline as the landscape matures. An intercept interview was conducted from 8–15 July 2013, at the two Departments of Motor Vehicles (DMV) in New Castle County, DE. The survey data show the ecosystem services changes were perceived to have a positive impact on people's quality of life. The most important impacts were found to be: undesirable wildlife (negative); flood control (positive); and water quality (positive). Tours for industry professionals and homeowners were conducted during years 2 and 3. An online survey was conducted in November 2015 of tour participants. Most visitors attended a tour because they

were curious about what a sustainable landscape would look like or because they wanted to get ideas for their own or a client's landscape. Most respondents thought the landscape looked different than their own or other landscapes in their neighborhood. While most found the sustainable components of the landscape desirable, fewer were likely to incorporate them in their own home landscapes. The three most positive attributes were greater diversity of wildlife, better water quality and better flood control. The least desirable attributes were greater initial establishment costs and initial maintenance required (represented by "takes time to establish" and "more initial weeding required"). For those who toured the site, undesirable wildlife was not an important concern.

Specified Source(s) of Funding: National Integrated Water Quality Program (NIWQP) Award

(320) Residents and Specialists Rate Residential Streamside Landscapes Differently

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Water quality specialists promote landscapes with no turf for residences along streams. Homeowners have been reluctant to install such landscapes, even when they learn that they are beneficial for water quality. To understand why, a survey of preferences for residential landscapes along streams was developed. The survey consisted of 20 digitally enhanced photos of streamside residential landscapes with no turf, some turf, or nearly all turf. A single generic home was used in each photo, so results would not be based on preferences for home styles. Surveys were completed by residents living on or near streams who were asked if they would want the landscape for their yard. Surveys were also completed by water quality professionals who rated the landscapes for effects on water quality. As expected, ratings by water quality specialists aligned inversely with the amount of turf in the landscape: those with no turf were rated the highest and those with all turf were lowest. Residents rated landscapes no turf lowest, indicating a strong negative reaction to designs promoted by water quality specialists, and likely accounts for their reluctance to install them. Contrary to predictions by water quality specialists, residents did not rate landscapes with all turf highest. In fact, residents preferred landscapes with intermediate levels of turf. These were also the only landscapes they rated above neutral, indicating that these were they only ones that residential respondents were likely to consider adopting for their own homes. To encourage the adoption of residential landscapes that will contribute to improved water quality, examples that include some turf are likely to be more successful than ones that are turf-free.

Specified Source(s) of Funding: A grant from the Washington State Department of Ecology funded this research.

(321) Golfer Perception of Trees on Golf Courses

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With the exception of true "links-style" golf courses, trees are an important component of most golf course landscapes. While trees can significantly affect speed of play, quality of the golf experience, and the health of golf course turf, they are often mismanaged or neglected by golf course management. Golfer perception of turf quality (green speed, rough grass height, tee surface quality) often drives turf management decisions made by the golf course superintendent. If golf course managers better understood golfer perception of and appreciation for golf course trees and their health, the care of golf course trees may gain greater priority in golf landscape management plans. We could find no research on golfer perception of golf course trees, so developed a survey to measure golfer attitudes about trees on the golf course. Questions about the architectural, aesthetic and environmental value of trees on the golf course, their effects on speed and quality of the golf experience, and perceptions of tree health were asked of golfers after completing golf rounds. Golfers playing on public fee and private golf courses were included in the survey. Survey results will be shared with state, regional, and national golf course superintendent and club manager associations.

(322) Landscape Evaluation of Daylily Cultivars for Daylily Rust: Association of Ploidy with Disease Severity

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Daylilies (*Hemerocallis* species and hybrids) are popular perennials for landscapes, performing well in full sun, heat, humidity, and periods of dry weather. As of early 2015, over 78,000 cultivars have been registered with the American Hemerocallis Society. Daylilies are generally considered to be pest-free; however, a rust disease (*Puccinia hemerocallidis*), which was introduced into the United States 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 surveyed a landscape planting of 575 newer cultivars (including 163 diploids and 412 tetraploids), which had not been sprayed with fungicides to prevent infection by daylily rust during Summer 2013. The warm, damp Summer 2013 was ideal for spread of daylily rust. Plants were rated at the end of the summer on a 1 to 3 scale: 1 = no or little visual sign of infection, 2 = moderate infection, or 3 = severe infection. Tetraploid cultivars were

associated with higher daylily rust severity ratings than diploid cultivars based upon our analysis using Fisher's Exact Test (Freeman-Halton Test) ($P < 0.0001$). This association was also shown in our analyses of ratings data on older daylily cultivars published by other researchers in 2002 and 2003. This association may be of interest to daylily hybridizers and as a basis for future research.

(323) Green Roofs on Guam—How Vegetation Survives Typhoons?

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Guam, a tropical island located in the "typhoon alley" of the Western Pacific is populated by 180,000 people and visited by 1.5 million tourists annually. Frequent damaging winds and occasional strong typhoons (hurricanes) discourage farmers from the production of fresh fruits and vegetables. Over the last decade, documented benefits of green roofs and their increasing popularity has convinced some home owners to establish roof vegetation on existing solid concrete roofs to conserve exceedingly expensive energy and at the same time to grow a small garden for personal enjoyment. A major challenge is the survival of these gardens during tropical storms when over 200 $km \cdot h^{-1}$ winds blow for several hours. It has been determined that only dense turf rooted to wire mesh that is attached to the concrete roof can be fully typhoon proof. Other plants need to be grown in their own soil inside flat porous rings inserted within the turf mat. In the event of wind damage and even complete soil loss, the rings can be easily filled with new soil, the green roof becomes fully functional within a few days and the garden can be reestablished. Information presenting the survivability of different types of vegetation under conditions of heavy rain and winds ranging from 142 $km \cdot h^{-1}$ to 378 $km \cdot h^{-1}$ will be presented and discussed.

(324) Evaluation of Ornamental Eudicot Species for Phytotoxic Response to Various Pesticides in the Southeastern United States for Interregional Research Project #4 (IR-4)

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The Interregional Research Project #4 (IR-4) is a national program that provides pest management solutions for specialty crop growers and was started at the Tifton GA location in 1977. In the last four years, the IR-4 Project on the U.S. southeastern coastal plain has completed 30 phytotoxicity experiments on twelve ornamental eudicot genera including *Buddleia, Buxus, Hedera, Hydrangea, Ilex, Lantana, Ligustrum, Portulaca, Rhaphiolepis, Rhododendron, Spiraea,* and *Verbena*. Three herbicides were applied at label rates as either a broadcast granular or as "over-the-top" foliar sprays. Over this same period, seven fungicides were applied to eudicots 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 eudicot species. Phytotoxicity was recorded on a 0 to 10 scale (0 = no injury; 10 = dead) at intervals required by the protocol which differed for each species and chemical combination. Plant height and width were also measured at initial and final evaluations to assess any adverse chemical impact on plant growth and marketability. Data were analyzed in ARM (Agricultural Research Manager) using ANOVA, with means separated using Fisher's Protected LSD at a level of 0.05. Results indicated no injury among any of the fungicide treatments, but significant differences in phytotoxicity between the nontreated controls and some of the herbicide treatments. IR-4 research data have contributed to the registration of Alibi Flora, Dimension, Echelon, Insimmo, Marengo, Mural, Tourney, and Trinity on these eudicot ornamental horticulture specialty crops.

(325) Temperature Affects Cacti and Succulent Development Rate

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Seventeen succulent and one cactus species (1-2 year old) grown in 5.7 cm diameter plastic pots in a soilless media were received from Altman Plants, Inc. (Vista, CA) on 5 November. Plants were unpacked and acclimated in greenhouses for 2 weeks (22 °C/18 °C day/night temperature; under natural photoperiod) in St. Paul, MN. The uppermost unfolded leaf (succulents) or tubercle (cactus) was marked, and plants were then placed in growth chambers, where leaf/tubericle temperature was maintained at constant 10 °C, 16 °C, 22 °C, or 28 °C. Irradiance was maintained at 300 $\mu mol\ m^{-2}\ s^{-1}$, the photoperiod was 12 hours, plants were watered as needed, and plants were fertilized twice a week with 400 ppm N from 15–0–15 fertilizer (Dark Weather Feed). After 10 weeks, nine species (more rapid leaf/tubericle unfolding) were removed from chambers and the number of unfolded leaves/tubercles above the previous mark was counted. A second group of nine species with a slower leaf/tubericle unfolding rate was removed after 15 weeks. Development rate for each species and at each temperature was calculated. The experiment was replicated four times over time. Leaf/tubericle unfolding rates increased as temperature increased from 10 °C to 22°C for 16 species. The leaf unfolding rate of eight of these species continued to increase as temperature increased from 22 °C to 28 °C. In contrast, with six species, leaf/tubericle unfolding rate decreased as temperature increased

from 22 °C to 28 °C. *Sempervivum calcareum* and *Sedum* hybrid 'Burrito' ('Burros Tail') died when temperatures increased from 22 °C to 28 °C. In contrast, *Andromischus critatus* 'Key Lime Pie' and *Crassula arborescens* 'Silver Dollar Jade' leaf-unfolding rate increased as plant temperature increased from 10 to 16 and then decreasing as temperature was further increased to 28 °C; *C. arborescens* died when growth at constant 28 °C.

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Wednesday, 5 August 2015

Vegetable Breeding

(038) Estimates of Genetic Variance for Drought Tolerance Traits in Tomato

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Tomato (*Solanum lycopersicum* L.) is an economically important vegetable crop worldwide and like many other crops, its productivity is severely impacted by environmental stresses such as drought. Genetic improvement through hybridization with wild relatives of the tomato is one approach of introducing important drought tolerant traits into cultivated varieties. Shoot and root morphological characteristics such as root mass/length, leaf size, root-to-shoot ratio, stomatal density, and physiological properties such as stomatal conductance are important for drought tolerance. However, heritability of some of these tolerance traits is uncertain. In the current study, genetic variability and broad-sense heritability of an F_2 population derived from a cross between a wild species *Solanum cheesmaniae* (with drought tolerance traits) and an advanced breeding line RVT1 were investigated. The F_2 population, F_1 and both parents were planted in sand media and morphological parameters: plant height, shoot fresh weight (SFW) and root length were measured after eight weeks. Significant phenotypic variation for all the traits was recorded among the F_2 generation. Broad sense heritability in plant height, SFW, and root length were 0.90, 0.74, and 0.28, respectively, indicating strong genetic effects on plant height and SFW, compared to root properties. The unexpected amount of variation for root length among the F_1 and parent plants may be an indicator of residual heterozygosity for underlying gene loci, as well as environmental effects. The occurrence of F_2 progeny with root length and area greater than either parent demonstrates the potential of this approach for genetic improvement of drought stress tolerance.

(039) Vernalization, Dormancy, and the Annualization of Onion (*Allium cepa*) for Breeding

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The biennial life cycle of onion (*Allium cepa*) provides a significant challenge for plant breeders. The lengthy vernalization period, coupled with bulb dormancy in some varieties, mandates a two year generation time from seed to seed; roughly six months of which is spent holding mature bulbs in cold storage. There is remarkably little publicly available information on the critical vernalization period for long-day storage onions, and even less on the nature of onion bulb endodormancy. The goal of this research is two-fold: 1) to characterize the requirements for vernalization, dormancy, and floral induction in cultivated onion, and 2) to develop a reliable protocol for breeders that will allow for onion seed to be produced on an annual cycle in a winter greenhouse while still offering a bulb evaluation. A time course experiment conducted over two years with F_1 hybrid onion bulbs (Cortland & Sherman, Bejo Seeds) held at 10 °C was used to determine the minimum vernalization time required for floral competency. Bulbs were removed from cold storage at two week intervals, planted in a greenhouse at 15 °C, and monitored for sprouting, scape emergence, and flowering. The date of each developmental change was recorded for individual bulbs. A great deal of bulb-to-bulb variability was observed in the critical vernalization period for floral competency. A 9-week endodormancy period was observed, which may have an impact on when vernalization is initiated. The optimum cold treatment to satisfy the vernalization requirement and overcome dormancy for Cortland and Sherman bulbs was found to be between 14 and 16 weeks at 10 °C. The average times to scape emergence in the greenhouse for these vernalization lengths were 85 and 74 days post-chilling, respectively. In the 2013–14 season, field grown onion bulbs flowered and produced viable seed in a greenhouse within approximately 13 months. This seed was planted for the 2014 field season and is the first instance of approximating an annual cycle for onions in our breeding program. The results from this experiment have established a baseline for the critical vernalization period in long-day storage onions, and will prove to be valuable in creating an annualization protocol for breeders. Furthermore, this work has laid the foundation for future experiments with RNA sequencing of the doubled haploid line CUDH 2107 to identify candidate genes responsible for vernalization, dormancy, and floral development.

(040) Comparison of Tomato Genotypes Grown Under Conventional and Organic Production System for Nutrient Composition

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There is a growing interest in the quality of fruits and vegetables produced under conventional and organic production system. While some of the reports on subjective comparison of quality of fruits and vegetables produced under conventional and organic systems are already available, we were interested to determine the genotypic differences under conventional and organic production system for nutrient composition in tomato. For that, we grew three genotypes of tomato with three replications under organic and conventional production system at Mountain Research Station, Waynesville, NC. Nutrient analysis was performed from vegetative (leaf) and reproductive (fruit) parts at three different stages. Results indicated that conventional system was significantly ($P < 0.05$) better than organic system for almost all nutrient availability except Magnesium and Sulfur. No genotypic differences was found for nutrients availability from vegetative stage to reproductive stage indicating that either the number of genotypes in the study was too small to draw the conclusion or all genotypes show the similar pattern for nutrient uptake and utilization under conventional and organic production system. This information may be useful to address the questions related to these two production systems with respect to nutrient utilization.

(041) Breeder to Seeder to Eater Synergies

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Currently many seed companies do not engage with or consider the needs and preferences of organic farmers and their fresh market customers (i.e. chefs, farmers' market consumers, CSA members, retailers and wholesalers) during the plant breeding process. Organic farmers need varieties adapted to local conditions and organic production methods. Additionally, their fresh market customers demand vegetables of superior flavor, texture, cooking quality and nutritional value and have an appreciation for uniqueness, quality and novelty. Incorporating chefs, farmers and other end users into the plant breeding process gives breeders deeper insight into preferred traits while also increasing awareness and understanding of organic plant breeding to a broader audience. Engaging with chefs through sensory evaluations to evaluate varieties and breeding populations set this work apart from standard sensory panels. In addition to a high degree of discrimination in taste and flavors, chefs may imagine novel applications of the material and may identify varieties and uses that are outside of the culinary norm. Other impacts resulting from soliciting end-user input into breeding projects include creating connection and increasing communication between plant breeders with the fresh market community of organic farmers, CSA members, chefs, farmers' market consumers, retailers and wholesalers and identifying consumer preferences that can guide breeding objectives and variety development.

Specified Source(s) of Funding: OREI

(042) Stability Estimates and Breeding for Eggplant Fruit Phenolic Acid Content

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Eggplant genetic resources are a rich source of variation for secondary metabolites that influence fruit quality. Phenolic acid conjugates are secondary metabolites that constitute the major dietary phenolics in eggplant and affect fruit culinary attributes as well. Bioactive properties of these compounds are of considerable interest for human health. Prior research indicated that these secondary metabolites are influenced by environmental stimuli that may positively or negatively influence performance of genotypes across environments. Utilizing multiple open field and greenhouse production environments and a diverse collection of *Solanum melongena* hybrid and open-pollinated cultivars, land races, plus *S. macrocarpon* and *S. aethiopicum* accessions, twenty phenolic acid conjugates were identified in fruit flesh. These compounds were assigned to six classes that included hydroxycinnamic acid amides, caffeoylquinic acid esters, hydroxycinnamoylquinic acid esters, malonylcaffeoylquinic acid esters, di-hydroxycinnamoylquinic acid esters, and other hydroxycinnamic acid conjugates. We demonstrated that environmental variance was high but not significant for individual classes or total phenolic acid conjugate content in eggplant fruit. Significant differences among genotypes and differential response of genotypes across environments were greater sources of variation relative to environment alone. Partitioning genotype environment interaction into stability statistics demonstrated a lack of stability in individual classes and total phenolic acid conjugates over environments. Since variance components for genotypes exceeded those estimated for the genotype environment interaction, our results suggested that it might be possible to develop genotypes that are uniform and stable for specific phenolic acid conjugate profiles. Stability estimates provided a useful measure for selecting individual genotypes with predictable performance for phenolic acid conjugate content across environments. Relatively high broad-sense heritability estimates (0.64–0.96) for individual classes and total phenolic acid conjugates further suggest that stability estimates may improve the efficiency of breeding new cultivars. Progress in breeding eggplant genotypes with specific phenolic acid conjugate profiles will be discussed.

An asterisk (*) following a name indicates the presenting author.

(043) ANN Modeling of HS-SPME/GC-MS and Sensory Analysis of Potato Clones as a Potential Flavor Prediction Tool during Selective Breeding

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Most plant breeding programs emphasize increased yield, size, and abiotic or biotic resistance during early selection cycles. However, these foci may inversely affect the production of metabolites that generate produce flavor. Several marketing research studies have indicated that consumers are generally dissatisfied with the flavor of fresh produce and desire increased flavor, suggesting an opportunity to boost consumer appeal through breeding for flavor improvement. Flavor is a complex term that encompasses taste, aroma, and texture. Non-volatile metabolites constitute taste and create basic flavor notes of sweet, sour, bitter, salty, and umami. Aroma consists of volatile metabolites and texture induces characteristic mouthfeel. Because volatile metabolites exhibit more diversified flavor notes than non-volatile metabolites, they are considered to have a more significant effect on the flavor of horticultural produce. Through analysis of named potato cultivars as well as advanced clones grown at Colorado State University's San Luis Valley Research Center, this study evaluates the utility of an artificial neural network (ANN) to model the relationship between quantitative data and sensory panel analysis of cooked potato tubers. A model that can predict sensory panel response to cooked potato samples based on quantitative data will enable selective breeding for improved flavor, without the arduous task of conducting resource intensive sensory analysis. In this study, the volatile compounds of cooked potato samples will be analyzed using headspace solid-phase microextraction coupled with gas chromatography-mass spectrometry (HS-SPME/GC-MS). A trained panel of 10 to 12 panelists will be used for sensory analysis. An effective ANN model for sensory analysis prediction in potatoes would demonstrate a practical method for flavor evaluation during selective breeding. Selection for flavor improvement in a breeding program will most likely increase consumer appeal of a particular horticultural product, which may effectively facilitate market expansion for that particular crop.

Specified Source(s) of Funding: USDA Specialty Crops Grant

(044) Gas Chromatography-based Myrosinase Activity and QTL Mapping in Broccoli (*Brassica oleracea* L. var. *Italica*)

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Vegetables in the *Brassica* genus have been shown to contain a number of compounds that exhibit pharmacological activity. This research elucidates genetic loci involved in the production of glucosinolate hydrolysis products, which are associated with anti-cancer bioactivity in broccoli (*Brassica oleracea* L. var. *italica*). The myrosinase (thioglucosidase EC 3.2.1.147) activities of 104 $F_{2:3}$ families from the mapping population BNC VI158, grown in 2009 and 2010, were determined by the quantification of sinigrin (exogenous glucosinolate) hydrolysis products on a gas chromatography-flame ionization detector system. QTL analysis of the data was conducted in the software package MapQTL 5 (Van Ooijen, 2004) using a dense linkage map with 590 mapped SNP marker loci, covering an estimated 96% of the *B. oleracea* genome. This map was developed by Brown et al. (2014) using a 60K Illumina SNP array of *Brassica napus*, and is anchored to the genomic sequence of the rapid cycling *Brassica oleracea* T01000. The results of this study will provide useful information for the identification of genes involved in the chemopreventative activity of broccoli and support the breeding of *Brassica* cultivars that can serve as functional foods.

Wednesday, 5 August 2015

Citrus Crops

(309) The Effects of Rootstock on 'Ray Ruby' Grapefruit Fruit Quality

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The Indian River district of Florida is the world's major production region for fresh grapefruit and Indian River grapefruit are valued for their high quality. In the past, the rootstock of choice for Indian River grapefruit was Sour Orange (*Citrus aurantium* L.). However, sour orange is susceptible to citrus tristeza virus (CTV) and when the brown citrus aphid, vector of CTV, arrived in Florida sour orange fell out of favor and 'Swingle' citrumelo [('Duncan' grapefruit (*C. paradisi* Macf.) x Trifoliate orange (*Poncirus trifoliata*)] became the rootstock of choice. Unfortunately, 'Swingle' has proven to be a poor rootstock for the acid flatwoods soils typical of the Indian River district, and alternatives are needed. We report results here on the effects of seven rootstocks on fruit quality of 'Ray Ruby', an important red grapefruit in the Indian River district. Four recent releases from the USDA rootstock breeding program, US-852, US-897, US-942 and US-812 (all C. reticulate x P. trifoliata hybrids), X639 (*C. reticulate* x P. trifoliata), along with industry standards Sour Orange and 'Swingle' were included in the trial. The trial was planted in 2005-6, in Indian River Co.,

FL. Fruit quality data were collected in 2012 (eight harvests), 2013 (six harvests) and 2014 (single harvest). In each year, rootstock effects on fruit size, total solids, and solids acid ratio were significant. Sour Orange and 'Swingle' produced the largest fruit, whereas US-897 (a semi-dwarfing rootstock) produced the smallest fruit. Peel thickness (measured only in the 2011–12 season) was greatest in Sour Orange early in the season, but not toward the end of the season. Misshapen ("sheep nosed") fruit occurred more frequently on Sour Orange than on other rootstocks, although sheep nosing was not a major problem with any rootstock. Analysis of variance for fruit quality data collected in January of each of the three years confirmed that Sour Orange and Swingle produced the largest fruit and US-897 the smallest fruit. Total solids were highest in US-897 and lowest in X639 and US-852. Total solids/acid ratio was significantly lower on X639 than all other rootstocks. Our results indicate that 'Ray Ruby' grapefruit produced on the new USDA trifoliate hybrid rootstocks for the most part produced fruit with quality equivalent to Sour Orange. Although tree performance and yield are the most important characteristics when selecting rootstocks for a particular area, our data indicate that fruit quality can also be strongly affected by rootstock.

(310) Evidence for Alternative Pathways of CLas Movement in Citrus Trees

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Inconsistencies in the description of CLas movement within a citrus tree and laboratory/field observations led us to investigate the anatomical and physiological aspects of citrus trees in response to HLB development. A series of girdling, grafting and budding experiments revealed that, despite robust anatomical barriers, CLas (or a CLas-derived signal) tested positive in tissues with no apparent direct connection to the inoculation point, and the CLas-derived signal moved laterally across the phloem tissue. In addition, phloem and xylem sap movement indicated that, at times, the CLas-derived signal moved in the opposite direction to the phloem flow, suggesting transport in the xylem sap. CLas-signal was also capable of traveling through non vascular tissues as evidenced by its presence in juice cells, albedo and flavedo in fruit from HLB-affected trees. Based on the type of symplastic/apoplastic connections between various plant parts, the presence and/or absence of CLas signal in different tissues indicate a separate form of HLB transmission throughout the tree.

Specified Source(s) of Funding: Citrus Research Development Foundation

(311) Yield, Tree Size, and Fruit Quality of Mature 'Owari' and 'Brown Select' Satsumas on *Poncirus trifoliate* 'Rubidoux' and 'Flying Dragon' Rootstocks in North Florida

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There is increasing interest in the culture of satsuma citrus in the states bordering the northern Gulf of Mexico. Yield, tree size and fruit quality of 'Owari' and 'Brown Select' satsuma (*Citrus unshiu* Marcovitch) on *Poncirus trifoliata* (L.) Raf. ('Rubidoux' and 'Flying Dragon') were evaluated for five years at the North Florida Research and Education Center, Quincy, FL. Tree size (canopy area and canopy volume), yield and fruit quality data were analyzed as a 2 x 2 factorial design with scion and rootstock as the main effects. Yield per tree averaged across all scion rootstock combinations was 16, 88, 91, 143, and 101 kg in 2010, 2011, 2012, 2013, and 2014, respectively. Yield was influenced by scion, and was higher for 'Brown Select' than for 'Owari' in three of five years, and by rootstock every year (higher for 'Rubidoux'). Yield per tree was about 2-fold higher for trees on 'Rubidoux' compared to 'Flying Dragon': the highest yield was recorded for 'Brown 'Select' on 'Rubidoux'. Yield efficiencies (yield/m^2 canopy area) were not generally different since tree canopy area was often about 2-fold greater for trees on the 'Rubidoux' rootstock. For three of the five years, fruit weight was greater for 'Brown Select' (average = 157 g) than 'Owari' (average = 146 g), with no rootstock effect. Soluble solids (°Brix) of orange juice averaged 10.0, and were higher for satsuma on 'Flying Dragon' than on 'Rubidoux' in three of five years. Juice pH averaged 3.67 and was not affected by scion or rootstock. Trees were not subjected to freeze protection and were not damaged by minimum temperatures as low as –9.4 °C, with the exception of the 2014/2015 fall and winter. A visual rating of cold injury (defoliation) after an extremely early freeze on 19 Nov. 2014 (–5.6 °C) indicated that cold hardiness varied by scion (higher for 'Brown Select') and rootstock (higher for 'Rubidoux'). Differences in cold hardiness did not persist on a final cold injury assessment (24 Feb. 2015) after several freeze events during Winter 2014–15.

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(312) The Effects of Citrus Planting Design on Soil Properties and *Phytophthora nicotianae* Propagule Counts in Flood-irrigated Soil

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The Lower Rio Grande Valley (LRGV) of South Texas is the citrus producing region of the state. Its subtropical semi-arid climate offers excellent growing conditions to produce oranges and sweet, deep red colored grapefruit. Foot rot and root rot, caused by *Phytophthora nicotanae,* are a big problem in the citrus groves of the LGRV. This oomycete infects the roots and trunk of the tree leading to tree decline and eventually it causes tree death. *P. nicotanae* infections to plant roots prosper in water saturated soils. Such conditions are readily found in the LRGV as citrus trees are typically flood irrigated in South Texas. We hypothesize trees planted on raised beds rather than flat ground will result in a lower count of *P. nicotanae* propagules in the soil as water will move laterally through the soil profile to irrigation roots without water touching the tree trunk. We compared the soil habitat of plastic mulch covered soil to bare uncovered soil on raised beds vs. to flat beds. We measured the soil gravimetric water content, bulk density, soil and ambient temperature under flat-covered, flat-uncovered, raised-covered, raised-uncovered beds, and quantified *P. nicotianae* propagules during the spring and summer trials. A comprehensive understanding of the soil environment under different planting methodologies will provide new opportunities to decrease disease incidence of *P. nicotianae*.

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(313) Inoculum Sources of *Phytophthora nicotianae*

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One of the most important diseases affecting citrus production in South Texas is *Phytophthora* root and foot rot caused primarily by *Phytophthora nicotianae*. *P. nicotianae* is a fungus-like organism that infects feeder roots and the trunk of citrus trees, which leads to poor water and nutrient uptake causing tree decline and eventually tree death. It is well established that the first step in an effective management of disease caused by biotic agents is the elimination of sources of primary inoculum of the causative agent. In order to identify potential inoculum sources of *P. nicotianae* within the citrus production system in South Texas, we conducted a survey of citrus nursery facilities and different components of citrus grove operations in the Lower Rio Grande Valley (LRGV). *P. nicotianae* propagules were isolated, quantified and compared between the different potential inoculum sources including protective sponge wrappings around mature trees, leaf litter found throughout groves as well as soil and irrigation water sources from nurseries and groves using standard practices. Observations were also taken of other fungal pathogens recovered from the same set of samples. Available data revealed the presence of *Fusarium*, *Pythium* and *P. nicotianae* in protective sponge, soil and leaves from mature groves. However, only *Fusarium* and *Pythium* were recovered from nursery materials suggesting that inoculum of *P. nicotianae* in LRGV groves perpetuate within citrus groves and were unlikely to have originated from the nursery system. By identifying, quantifying, and distinguishing sources of these fungal pathogens, growers can more effectively manage the diseases they cause through prophylactic measures such as proper field sanitation as a complement to the use of chemical treatment.

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(314) Impact of Young Citrus Shoot Flush Nutrients and Phloem Sap Composition on Asian Citrus Psyllid Populations

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Asian Citrus Psyllid (ACP) *Diaphornia citri* Kuwayama, 1908 (Hemiptera: Liviidae) is a phytophagous pest on citrus and other rutaceae host plants. Psyllids feed on phloem sap and reproduce exclusively when young expanding flush shoots are present. As they feed on young leaves theyextract phloem sap which results in a leaf deformation known as epinapsis and can lead to flush shoot death. While feeding on plant tissues they transmit the phloem inhibiting bacterium *Candidatus Liberibacter asiaticus*, putative causal pathogen of the deadly citrus greening disease or Huanglongbing (HLB). Presently there is no cure for the disease, however, vector control plays a very important role in the management of ACP and in turn reduces the spread of HLB. Understanding the nutritional ecology of a pest is very effective in controlling the pest population. In this study, flush shoots of citrus at different growth stages were analyzed

for their nutritional composition. Phloem sap was extracted from leaves of each developmental stage and different free amino acid contents were recorded. The results were then used to study the interactions of *D. citri* densities on flush shoots of different growth stages. The juvenile flush stages showed several major macro-nutrients (N, P, K) and some micro-nutrients (Na, Zn, and Cu) in higher concentrations, while mature flush shoots contained larger amounts of Ca, S, Mg, Fe, Mn, and B. Higher quantities of amino acids were also present in in younger flush stages, and their content decreased as the leaves matured. The higher concentrations nutrients and amino acids found in in juvenile flush stages were positively related to psyllid densities and development, as eggs are laid solely on newly emerged flush shoots and nymph development occurs only on younger flush stages. This indicates that the chemical composition of mature leaves and phloem sap are not conducive to oviposition and immature development.

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(315) Mature Citrus Transformation to Combat Citrus Diseases in Florida

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Citrus canker, caused by *Xanthomonas citri*, and HLB or greening, thought to be caused *by Candidatus liberibacter asiaticus*, cause serious economic losses in the Florida citrus industry. Traditional breeding programs are lengthy endeavors because the time for flowering and fruit production of new cultivars can range from 5 to 20 years. Mature tissue transformation is a relatively rapid means of genetic improvement that preserves early flowering and fruiting of the scion or rootstock. Mature rootstock and scion transgenics flower approximately 13 and 19 months after the transformation event, respectively. The transcriptional co-regulator, *non-expresser of pathogenesis-related genes*, *NPR*1, plays a central role in the activation of salicylic acid dependent defense genes, which increase systemic acquired resistance (SAR). *NPR*1 is a candidate gene for conferring disease tolerance to canker and greening. The *Arabidopsis thaliana NPR*1 gene was transformed into mature scion cultivars, Hamlin, Valencia and Pineapple, and the rootstock cultivars, Swingle and Carrizo, via *Agrobacterium*-mediated transformation. PCR amplification of *NPR*1 using gene specific primers indicated that all the transgenic lines contain the *NPR*1 transgenes. Southern blot analyses confirmed that the transgenes were primarily low copy number and integrated into the plant genomes. These transgenic lines will be challenged by the pathogens in the future and assessed for tolerance.

Wednesday, 5 August 2015

International Horticulture and Issues

(151) Current Status of Agriculture Extension in China

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Agricultural extension in China provides agriculture technology and applications related to all processes during agriculture production through experimentation, demonstration, training, and consulting. Agricultural extension is considered as a bridge between agriculture research and farmers, and between government agencies and farmers, which plays an important role in agriculture development in China. Agricultural extension system is an integral part of the national agriculture support and protection system and agriculture social service system, which support a national strategy of developing agriculture through science and technology. This study introduces the history of agricultural extension in China, the legislative background of the agricultural extension and the current five levels of agricultural extension systems. Problems within the Current Agriculture Extension are also analyzed.

(152) Improving Home Gardening Techniques for Small-scale Farmers in Bangladesh under the Farmer-to-Farmer Program

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This extension report describes expert consultation and training conducted on home gardening techniques in Bangladesh under Farmer-to-Farmer (F2F) program. The assignment was carried out in Khulna district of Bangladesh using formally structured training activities in a classroom setting with participants receiving face-to-face or hands-on technical assistance. The main objectives of the assignment was to conduct training in sustainable household vegetable gardening techniques as well as train host institute's extension agents and field assistants for replication of training thereby multiplying impact to more households. Basic concepts of home gardening techniques were delivered. Topics included seed quality, seed saving methods, transplants, organic soil preparation, integrated farming techniques, hydroponic techniques, and plant disease identification and eradication. Simple home recipes of botanical pesticides demonstrated including neem leaf extract, garlic extract, compost tea, vegetable oil, and soap. A method on making enriched compost in the field was demonstrated. Trainees prepared a compost bin (3' x 3' x 4') with bamboo sticks and used locally available materials on the farm such as dry leaves, grasses, tree branches, rice straw, farm

manure. Six farmers' groups with over 300 farmers (including male and female and eight extension agents) received classroom and hands-on training. It appeared that farmers needed further training in organic farming and sustainable cultivation of vegetables.

Specified Source(s) of Funding: Evans-Allen

(153) Improving Organic Farming Practices for Training of Trainers in Nepal under the Farmer-to-Farmer Program

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Growing interest and public perception in organic farming in Nepal is on the rise due to environmental pollution, food safety concerns, and the excessive use of farm chemicals in crop production. The practice of sustainable organic farming is not a new for the farming community, however, organic agriculture as a new movement is recent and since then, efforts to provide advance knowledge in the organic farming among the farmers by various organizations including non-governmental are continuous. This paper presents extension report from a volunteer assignment conducted under a Farmer-to-Farmer program in Napal for training of trainers in organic agriculture education. A face-to-face classroom and hands on training for faculty, research assistants and students was conducted. The aim was to integrate and strengthen organic agriculture curriculum and organic farming practices in crop production. Several training sessions delivered on organic seeds, vegetable transplants, integrated pest management, soil health, and organic certificate requirements. Field sessions conducted at the organic farms in various locations and consultation on organic composting methods, vegetable gardening and production issues discussed. The future impact of the project is that faculty who received the training would replicate the training to the farming community, improve and develop organic farming technologies, teaching tools, and assist the Government in formulating policy issues. The organic industry and market is too small in Nepal. Political commitments, improved production, marketing incentives and institutionalization of Nepalese organic movement are key factors to further enhance Nepal's organic sector.

Wednesday, 5 August 2015

Ornamental Plant Breeding 1

(045) Characterizing Crop Timing and Quality Traits of an Interspecific Hybrid *Petunia axillaris* × *P. exserta* F_7 Recombinant Inbred Line Population

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Petunia (*Petunia ×hybrida*) has consistently ranked among the top three bedding plants sold in the United States. Previous studies indicate that using wild species can improve commercial cultivars by providing new alleles for desired traits such as development rate and flower bud number. An interspecific P. axillaris × P. exserta F_7 recombinant inbred line (RIL) population was developed and 171 RILs and the parental species were phenotyped for a wide range of crop timing and quality traits at 14 °C, 17 °C, and 20 °C under a 16-h photoperiod. Additionally, days to flower was evaluated under a 9-h photoperiod at 20 °C only. The number of nodes on the main stem was counted 0, 14, and 28 days after treatments (DAT) began and used to calculate development rate. The population exhibited transgressive segregation for all crop timing and quality traits evaluated. Days to first flower ranged from 31–62, 37–70, and 46–93 DAT at 20 °C, 17 °C, and 14°C respectively. Average flower bud number at first flowering increased from 13–26, and the number of flowering branches increased from 6–9, as temperature decreased from 20 °C to 14 °C. Total flower bud number at first flowering ranged from 2 to 44, 1–65, and 8–73 for plants grown at 20 °C, 17 °C, and 14 °C, respectively. Days to first flower were positively correlated to total flower bud number, number of branches with flower buds, and node number below the first flower at all temperatures. A high-density single nucleotide polymorphism-based genetic linkage map for this population has been generated using genotyping-by-sequencing. These phenotypic data will serve as the foundation for future QTL mapping and candidate gene identification efforts for crop timing and quality traits of interest.

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(046) Combating Rose Rosette—The Information Pipeline

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Rose Rosette Disease (RRD) threatens to decimate the US rose industry and impact the use of our national flower in home and commercial landscapes. Thus, there is an immediate need to control the disease. The Specialty Crops Research Initiative is

providing funding to work to this end. A critical component of a successful research endeavor is getting the information generated into the hands of those who will use it. A logo has been developed that evokes the idea of the disease triangle, which for this disease includes the mite vector, the virus, and the host plant rose. The RRD website hosted by AmericanHort will be enhanced to serve as a repository of up-to-date information on RRD and further complemented with active Facebook page, Twitter account, and Pintrest account for ongoing updates. A newsletter is being developed for dissemination of up-to-date research results and Fact Sheets on the Best Management Practices (BMPs) will be developed and evolve based on the scientific findings of this project. Images of dozens of rose cultivars naturally infected with RRD in landscape settings are being added to Bugwood.org. A poster with RRD symptoms has been developed that can be displayed in a variety of educational and industry venues and can be seen in another poster presentation at this meeting. The goal to generate educational materials and information outlets to educate producers and consumers about symptomology in BMPs is complemented by a planned monitoring program. Contacts with Master Gardener outlets, Rose Societies, and other horticultural organizations are being made to reach major gardening consumer groups. A diversity of information outlets is viewed as the most effective way to meet the needs for dissemination of the research based knowledge that will be generated by this project to the broad clientele groups that are affected by the disease.

(047) Combating Rose Rosette Disease: Development of Rapid, Efficient, User-friendly Virus Diagnostic Tools and Studying Virus–Vector Interactions

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Over the past few decades, Rose Rosette Disease (RRD) has spread from its source in the Rockies, through the Mid-West to the East coast. It now threatens to decimate the U.S. rose industry. Garden roses, which form the cornerstone of the multi-billion dollar landscape industry, annually generate wholesale U.S. domestic bare root and container production valued at ~ $400 million. There is an urgent need to control RRD. It is caused by a novel plant virus, the *Rose rosette virus* (RRV), which is transmitted by wind-blown eriophyid mites (*Phyllocoptes fructiphilus*). Unlike other rose diseases it can kill a rose within two to three years of infection. A newly-funded USDA, NIFA, Specialty Crops Research Initiative Program Project involves 17 scientists in six states working on a range of approaches to learn more about this disease and determine how best to manage it. The long-term goal of this project is to develop roses resistant to this virus and/or mite vector. Key to this effort will be the development of efficient diagnostic tools to enable rapid, easy-to-use and accurate detection of the virus. RRV-specific primers and probes (for nucleic acid-based assays) and monoclonal and/or single-chain antibodies (for serological-based tests) will be designed and developed. Lateral flow devices (for both antibody and nucleotide based detection), for in-field detection systems, as well as ELISA, RT-LAMP (Reverse transcription-Loop mediated isothermal amplification of DNA) and self-quenched primer (SqP) technologies (for laboratory detection systems) will be developed. The most consistent assay will be tested and validated by several diagnostic labs and then moved via outreach to other plant diagnostic labs. Interactions between the mite vector and rose hosts will also be studied. Rose genotypes that are either resistant or susceptible to mite feeding, reproduction, or RRV transmission will be examined by low temperature scanning electron microscopy. We hope to identify differences in leaf surface properties that can be utilized for screening breeding lines. The breeding aspect of the project includes the field evaluation of 400 roses for RRD resistance. In the long term, this project hopes to identify additional sources of resistance and develop hybridization and genetic tools to move resistance into commercial cultivars.

(048) Combating Rose Rosette Disease: Breeding for Resistance

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In the past few decades, Rose Rosette Disease (RRD) has spread from its source in the Rockies, through the Mid-West, to the East Coast. It now threatens to decimate the U.S. rose industry. Garden roses, which form the cornerstone of the multi-billion dollar landscape industry, annually generate wholesale U.S. domestic bare root and container production valued at ~ $400 million. There is an urgent need to control RRD. It is caused by a novel plant virus, the *Rose rosette virus* (RRV), which is transmitted by windborne eriophyid mites (*Phyllocoptes fructiphilus*). Unlike other rose diseases it can kill a rose within two to three years of infection. The long-term goal of this project is to develop roses resistant to this virus and/or mite vector. The breeding aspect of the project includes the field evaluation of 400 roses for RRD resistance. This will be done in collaboration with Mark Windham at the University of Tennessee and Tom Evans at the University of Delaware. We will work with private breeders in California, Wisconsin, Pennsylvania, and Connecticut on the development of the research populations. Once developed, these populations will be propagated and planted for field assessment for RRD resistance in Tennessee and Delaware and for horticultural evaluation in Texas. The populations will be genotyped using the sequencing approach and this information will be combined with phenotype and pedigree information to identify markers associated with RRD resistance using the FlexQTL software developed by the Plant Research Institute.

(049) Induced Autotetraploidy Results in Reduced Fertility in 'Crimson Pygmy' Japanese Barberry

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Japanese barberry (*Berberis thunbergii*) is a desirable landscape shrub; however, it is identified as invasive in more than 30 eastern and central United States and Canada. Berberis thunbergii 'Crimson Pygmy' is one of the most popular cultivated varieties of Japanese barberry. Diploid (2n) 'Crimson Pygmy' were induced to autotetraploidy (4n) in vitro via treatment of nodal explants with the mitotic inhibitor, colchicine. Diploid and tetraploid plants were grown in containers and established in a field containing many other diploid and tetraploid Berberis thunbergii genotypes. Formal evaluations of fruit and seed production were conducted in 2012, 2013, and 2014 when plants were 8, 9, and 10 years old, respectively. Based on acetocarmine staining and pollen germination tests, tetraploid plants had similar male fertility to diploid controls. In 2014, tetraploid plants produced 1.3 seeds per plant in comparison to 783 seeds per plants for diploid controls of the same age. Almost all fruits on tetraploid plants contained small, black aborted embryos, and most fruits dropped from plants by my mid-July. Seeds from tetraploid plants exhibited germination percentages that were half those for seeds from diploid plants. Since tetraploid 'Crimson Pygmy' barberries produce only 0.2% of the seed produced by diploid 'Crimson Pygmy' plants, their use in the landscape should present a minimal invasive risk to the environment.

(050) 'Little Madame', a New *Vitex* Release

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Vitex negundo, cut-leaf chastetree, is a deciduous multi-stemmed shrub or small tree used in landscapes. Plants bloom in late spring. Flowers are lavender-colored and foliage is highly dissected. Height may reach 3 to 6 m with a spread of 5 to 8 meters. This drought-tolerant plant may be grown in USDA cold hardiness zones 6A through 9B. During cold winters in zones 6 and 7, 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, including sterility, as *Vitex* can be weedy. Seeds from *V. negundo* 'Heterophylla' were irradiated with 3krad gamma radiation in 2006. Seeds were germinated and a plant with potential ornamental qualities was selected. This plant was propagated and planted in replicated plots in Griffin, GA (zone 8A) in 2009. Evaluations continued for five years. This selection has been named 'Little Madame'. 'Little Madame' is smaller than 'Heterophylla' and has a denser, more compact form. Internodes are shorter in 'Little Madame' and multiple branches occur at the nodes, while 'Heterophylla' has the typical Vitex pattern of two shoots per node. Flower color is a dark violet-blue on both cultivars. 'Little Madame' sets very few viable seeds, but is readily propagated through stem cuttings.

(051) SSRs Are Useful in Characterizing Genetic Diversity in Endangered *Magnolia ashei*

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Magnolia ashei Weath., or Ashe's magnolia, is an endangered species endemic only to the Florida Panhandle. *M. ashei* is sometimes listed as a variety of the closely related bigleaf magnolia, *M. macrophylla* Michx., which has a wider and less well-documented distribution. An understanding of the genetic diversity of the native populations of *M. ashei* will enable effective conservation of the species, as well as provide insight into the relationship between this species and *M. macrophylla*. We collected leaf samples from wild-growing *M. ashei* plants in eight sites in Florida, as well as from cultivated plants from botanic gardens or nursery sources. Thirty-one SSR primer pairs from published *Magnolia* SSR studies were evaluated for amplification of polymorphic loci in *M. ashei*. While many of the primers tested were not effective in amplifying polymorphic loci, the primers did work in *M. ashei* indicate that individuals in the populations are genetically distinct. Additional sampling and polymorphic loci will be needed to determine whether each population has a distinct genetic makeup. We plan to collect and voucher more samples of *M. ashei* and *M. macrophylla* as we work to characterize and conserve this important native plant.

(052) Immature Embryo Culture of *Hydrangea quercifoia* Bartr

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Hydrangea quercifolia Bartr. is one of the most beautiful native shrubs in the United States for its great foliage color and exfoliating bark. To cross it with other *Hydrangea* species, embryo rescue is needed to avoid embryo abortion during maturation. Immature embryo was excised and sterilized at 75% alcohol for 5, 10, 15, and 20 seconds. As exposure times went up, the embryo germination rate decreased from 18.5 to 3.7%. Media were optimized within 4 formulations and the B-5 media produced highest embryo germination rate at 18.5%, which was significantly higher than that of WPM and MS (full or half strength). Sucrose concentrations had significantly affected on embryo germination rate and media with 2% sucrose yielded 18.5% germination rate. Both increasing and decreasing sucrose concentrations greatly reduced the embryo germination. The optimization of *H. querifolia* immature embryo germination system should be sterilized immature embryo at 75% alcohol in 5 seconds or less, then cultured them in B-5 media with 2% sucrose. Further studies should focus on improving immature embryo germination rate and its micropropagation.

(053) 'UMNAZ 493' and 'UMNAZ 502'; Two New Cold-hardy Deciduous Azalea Selections from the University of Minnesota

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More than 1000 species have been described in the genus *Rhododendron*, Ericaceae (heath family). While the genus has rendered some of the most beautiful flowering shrubs available for use in the landscape, relatively few species from the genus are winter hardy in USDA Zone 4 landscapes (average annual minimum temperature –30 °F to –20 °F). The deciduous azaleas (*Rhododendron* subg. *Hymenanthes* sec. *Pentanthera*), with 15 species native to North America, are the most cold hardy of the *Rhododendron* species. Since 1957, the University of Minnesota Woody Landscape Plant Breeding and Genetics program has been actively engaged in a deciduous azalea breeding effort, utilizing cold-hardy species and cultivars to develop reliably cold hardy cultivars with a wide range of flower colors. Over the years, the program has released 15 cultivars in the Lights Series of deciduous azaleas. Herein we describe the two newest Lights Series deciduous azalea cultivars to be released by the project; 'UMNAZ 493' PPAF First Editions® Electric Lights™ Double Pink Azalea and 'UMNAZ 502' PPAF First Editions® Electric Lights™ Red Azalea. 'UMNAZ 493', selected in 1994, is a hose-in-hose double-flowered type with light pink flowers. 'UMNAZ 502', selected in 1995, is the first red-flowered cultivar released by the program. Based on field observations and laboratory cold-hardiness tests, 'UMNAZ 493' and 'UMNAZ 502' are rated winter hardy to USDA Zone 4a (–25 °F to –30 °F).

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An asterisk (*) following a name indicates the presenting author.

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Pomology 1

(429) Salt Tolerance of 22 Pomegranate Cultivars

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Punica granatum (pomegranate) is an attractive fruit and ornamental shrub with orange-red flowers and colorful fruits. Interest in growing pomegranate has increased recently due to high levels of antioxidants in its fruits and well adaptation to hot and dry summer and moderately alkaline soil. A greenhouse experiment was conducted to screen 22 pomegranate cultivars for salt tolerance. Rooted hardwood cuttings were grown in CP512 treepots for three months and then pruned to 30 cm high. Pruned plants were irrigated once a week with saline solution at electrical conductivity (EC) of 10.0 $dS \cdot m^{-1}$ for four weeks and subsequently with saline solution at EC 15.0 $dS \cdot m^{-1}$ for another three weeks. Another group of pruned plants were watered with nutrient solution (no addition of salts) at EC of 1.3 $dS \cdot m^{-1}$ as control. No visually foliar salt damage (leaf edge burn, necrosis, or discoloration) was observed during the period of the experiment regardless of cultivars. However, salt treatment significantly reduced the length of new shoots by 25% and dry weight of new shoots by 32% on average for all cultivars with large variations among cultivars. These results indicated that all pomegranate cultivars are moderately tolerant to the tested salinity level. A hierarchical cluster analysis using multivariate parameters (the length of new shoots, plant height, and dry weights of new leaves, new branches, and total new shoots) was conducted and the 22 pomegranate cultivars were classified into two groups. The group consisting of 'AI', 'Deanda', 'Kazake', 'Russian 8', 'Apseronski', 'Purple Heart', 'CV', 'Chiva', 'Kunduzski', 'LC1', 'ML', 'Salavatski', 'Spanish Sweet', 'Wonderful' was more salt tolerant than the group including 'Al-sirin-nar', 'Kandahar', 'Surh Anor', 'Early Wonderful', 'Angel Red', 'Ben I', 'Utah Sweet', and 'Mollar'.

Specified Source(s) of Funding: Floriculture and Nursery Research Initiative and USDA–NIFA Hatch project

(430) Pomegranate Variety Trial in Arizona

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Pomegranate fruit have become popular in recent years for culinary use and for their potential health benefits. Thirty-two cultivars of pomegranates (*Punica granatum*) were planted in three locations in 2012 in southern Arizona to determine their growth performance and potential as fruit crop when grown at different elevations and climatic conditions. Field sites were established in Yuma, Tucson, and Bowie at elevations of 50 m, 700 m and 1124 m, respectively. Twenty-seven cultivars are grown for their fruit and five cultivars for their ornamental value. In Bowie, plants were smaller than at the other two sites. Harvest was on 9 Oct. 2014 and yields were up to 4000 g per plant. 'Azadi', 'Sosa Carrillo', and 'Palermo' had the greatest yields. The °Brix:acid ratios for the Bowie site fruit ranged from 3 to 16, and fruit interior and exterior color had the darkest red color of the three sites. In Tucson, plants were the largest of the three sites. Harvest was on 23 Oct. 2014 and yields were up to 14,000 g per plant. 'Purple Heart', 'Wonderful' and 'Josefina' had the greatest yields. The °Brix:acid ratios for the Tucson site fruit ranged from 3 to 14, and fruit interior and exterior color was not as dark red as in Bowie. In Yuma, plants were larger than those in Bowie, but smaller than those in Tucson. Harvest was on 6 Nov. 2014 and yields were up to 5000 g per plant. 'Purple Heart', 'Sosa Carrillo', and 'Cranberry' had the greatest yields. The °Brix:acid ratios for the Yuma site fruit ranged from 3 to 16 and fruit interior and exterior color was the least red of the three sites.

Specified Source(s) of Funding: Specialty Crop Block Grant–Arizona

(431) Effect of Bloom and Fruit Thinning on Quality Characteristics of 'Harvester' and 'Redglobe' Peach Fruit Varieties in Georgia

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Peach trees are traditionally fruit thinned between 30–45 days after full bloom (AFB) to maximize production efficiency and fruit size. Other thinning times and methods are available. In the last few years, peach growers in Georgia have been evaluating the possibility of using bloom thinning in certain varieties. However, the end result and the effect of weather events (i.e. freezes) have not allowed the determination of benefits and/or losses produced by both methods. Bloom thinning can be done during the pink flower and open blossom stages. This method can be more beneficial than fruit thinning resulting in a 10% to 30% increase in fruit size and yield and a reduction

of labor cost needed to thin fruit. The objective of this study was to compare bloom and fruit thinning based on labor use, fruit characteristics, and overall yield. Bloom-, fruit-, and no-thinning treatments were applied to 'Harvester' and 'Redglobe' peach varieties in 2014. The experimental design was a split-plot with a randomized complete block design (RCBD), with plots being the two varieties, seven blocks within a plot, five replicates per treatment (bloom-, fruit-, and no-thinning), and trees as replicates. Bloom thinning was done at full bloom, with a freeze occurring two days after thinning. Fruit thinning was done at 38 AFB. The use of blocks differentiated the effect of the freeze for both orchards, as the blocking corresponded to a gradient in elevation and freeze damage, with one extreme of the experiment having no damage and the other having almost 100% damage. There was a significant difference ($P < 0.05$) for blocks when considering all data together due to the freeze damage, however, the blocks could be separated based on their damage levels. The results hereafter are based on blocks with no freeze damage. Three different harvest time points were performed for 'Redglobe' and two harvest points for 'Harvester'. There were significant differences for the first, third, and total yield harvested when comparing bloom-, fruit-, and no-thinning experiments for 'Redglobe' ($P < 0.05$). Similarly, there were differences between the first harvest and total yield when comparing bloom-, fruit-, and no-thinning experiments for 'Harvester' ($P < 0.05$). Bloom thinning saved approximately 50% of time of labor per tree when compared to fruit thinning ($P < 0.05$). Differences for fruit weight were observed when comparing bloom-, fruit-, and no-thinning for 'Redglobe' ($P < 0.05$). The results of this project yielded encouraging observations; however, this experiment will be repeated due to the environmental effects.

(432) A Survey of Fruit Quality Characteristics of Georgia Peach (*Prunus persica* L.) Cultivars

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Fresh peach fruit consumption per capita in the United States has been in decline from 6.0 lb in 1990-1992 to 4.4 lb in 2010–12. This reduction has been frequently associated with consumer disapproval of peach fruit quality. On the other hand, increase in consumer acceptance has been often linked to variations in textural characteristics, soluble solid content (SSC), total titratable acidity (TTA), SSC/TTA ratio, phenolics, and aroma volatiles. The main objective of this research was to study a representative group of peach varieties grown in Georgia for fruit quality characteristics: SSC, TTA, sugar, and acid profiles. Commercially ripe peaches of various cultivars were harvested, maintained for 4–5 days at room temperature (21 °C ± 1°C), and then frozen for further analyses. Instrumental analyses of fruit were performed by the Agricultural and Environmental Services Laboratories at the University of Georgia, Athens, GA. Significant differences between varieties were found for the majority of variables being measured ($P < 0.05$). Among varieties, SSC values ranged from 8.2 to 13.0 for 'Springprince' and 'Gala', respectively. Similarly, total sugars ranged from 14.9 to 40.2 mg/g for 'Blazeprince' and 'Early August Prince', respectively. Within the sugars, sucrose levels ranged from 10.3 for 'Blazeprince' to 32.4 mg/g for 'Gala.' Several acids were measured and identified, with citric acid having the highest value of 3.4 mg/g for 'Flavorich' cultivar. Among the identified acids, succinic, tartaric, and malic acids had slightly lower concentrations than citric acid, with an average range of 0.5 to 1.3 mg/g. Total acid values ranged from 4.2 for 'Blazeprince' to 34.1 mg/g for 'Redglobe.' 'Blazeprince' cultivar had the lowest concentration for total sugars and total acids among all varieties. Inversely, the highest sucrose and total sugar concentrations were found in 'Early August Prince' and 'Gala' varieties. The results of these analyses will be used to identify fruit characteristics that are important in fresh peaches. Additionally, the peach cultivars will be compared in the future using sensory analysis (both descriptive and consumer tests) to determine the effect of these fruit quality characteristics and their relationship with consumer acceptance.

(433) The Effect of Gibberellic Acid (GA_3) and Aminoethoyxvinylglycine (AVG) on Late-season Peach [*Prunus persica* (L.) Batsch] Varieties in Middle Georgia

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The peach ripening season in middle Georgia spans five months beginning in the middle of May and concluding in the middle of September. Approximately, 60 different peach varieties are currently being grown in Georgia and ripen throughout this market season in which each variety is available for one to two weeks. Within the season, there are time points when variety ripening times may not overlap, thus producing several days in which no fruit is available. This is clearly a problem in peach production in middle Georgia for certain late-season varieties. Plant growth regulators (PGRs) are widely used in apples, cherries, and other fruits. Gibberellic acid (GA_3) and aminoethoyxvinylglycine (AVG) treatments in stone fruit have shown to increase fruit firmness, inhibit/decrease ethylene production, delay maturity and shift harvest windows, and reduce fruit drop. The objective of this research was to study the effect of GA3 and AVG on delaying maturity, increasing fruit firmness, and shifting the ripening window of two late-season ripening varieties. Plant growth regulators were applied with an airblast sprayer [333g/A of Retain® (AVG) and 20fl oz/A of ProGibb® 4% (GA_3) in a 100 gal/A spray volume, plus organosilicone surfactant] on

two late-ripening varieties: 'Ruston Red' in Lane Southern Orchards, Byron, GA; and 'Early August Prince' in Pearson Farms, Marshallville, GA, and in Lane Southern Orchards, Fort Valley, GA. Applications were made on early-mid June 2014, approximately three to four weeks before fruit harvest. Control plots were left untreated at the same locations for comparisons. A total of three replications, single-tree plots, were used for treated and untreated comparisons. Fruit was harvested from treated and untreated trees and fruit characteristics were taken at approximately two to three weeks before commercial harvest. The effect of locations (Lane Southern Orchards and Pearson Farms) and varieties ('Early August Prince' and 'Ruston Red') were found to be statistically different ($P < 0.05$). Differences in fruit firmness were seen for 'Early August Prince' and 'Ruston Red' in Lane Southern Orchards for almost all plots after the first commercial harvest. 'Early August Prince' firmness in Pearson Farms did not show significant differences among treated and untreated fruit. The fruit treated with plant growth regulators, ProGibb® and Retain®, were firmer than the untreated fruit. This trial produced important and encouraging results; however, they were not consistent across varieties and locations. Additional trials could provide support for the use of these plant growth regulators.

(434) Antioxidant and Whitening Activities of Fruit Development Stages in Several Pear Cultivars

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Pear (*Pyrus* spp.) fruit contains phenolic compounds, such as chlorogenis acid, rutin, procuanidins and arbuin. These phenolic compounds were investigated for their activity as antioxidants or as coloring factors in the fruit and their products. Asian pear (*Pyrus pyrifolia*) is a good source of arbutin, a polyphenol, which has a whitening effect on the skin. This study was carried out to investigate the biological activities, including the total phenolic contents, antioxidant activities, and melanin synthesis inhibition of several Korean pear cultivars. The total penolic contents of five pear cultivars were present in high quantities in unripe development stage. Total phenolic content of 'Chuwhangbae' extract was higher than those of other pear cultivars regardless of development stages. But total flavonoid contents did not differ between cultivars or development stage. Arbutin, a type of phenolic compounds, has an inhibitory effect of melanogenesis. The contents of arbutin in pear cultivars were declined as fruit matured. The radical scavenging activity of the extract was also decreased that fruit gets ripe. In B16F10 mouse melanoma cells, most of the cultivar extracts inhibited melanin synthesis about 50% at a 100 $\mu g \cdot mL^{-1}$ concentration of extracts (except 'Gamcheonbae') until 90 days after full bloom. From these results, we confirmed that the pear extracts have antioxidant activity and skin-whitening effects.

(435) Hi1-4: A Unique Pawpaw Selection in the Kentucky State University Repository Collection

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The North American pawpaw [*Asimina triloba* (L.) Dunal] is a native tree-fruit that is in the early stages of commercial production. Pawpaw fruit have fresh market appeal for farmer's markets, community supported agriculture, and organic markets, as well as processing potential for frozen pulp production. There are approximately 50 pawpaw cultivars available; however, many pawpaw varieties tend to be low yielding and have small fruit size of less than 120 grams. Pawpaw varieties with fruit weights over 120 g per fruit are considered to have a large enough fruit size for commercial sale and processing. 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. The selection Hi1-4 has been identified in the Repository collection with a

unique fruit type and promising characteristics as a new potential cultivar. In 2014, the fruit size of Hi1-4 (317 g) was comparable to the pawpaw cultivars Sunflower (278 g), KSU-Atwood (345 g), and the advanced selection Hi7-5 (325 g). The selection Hi1-4 has a pleasing orange flesh and large fruit size that would be excellent for processing. This selection, Hi1-4, is being propagated via chip budding onto seedling rootstocks. Yield and fruiting characteristics will be examined in additional trials.

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(436) Performance of Five North American Pawpaw Advanced Selections in Grower Trials at Three Locations

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The North American Pawpaw (*Asimina triloba*) is a tree fruit native to the Eastern U.S., and is being produced commercially in small orchards around the United States and worldwide. There are currently over 50 pawpaw cultivars available, but many older cultivars have small fruit size, low yields, and inferior flavor. Seedlings and controlled crosses contained at the National Clonal Germplasm Repository for Asimina spp. located at Kentucky State University (KSU) have been evaluated for yield, fruit size, and flavor; and several superior selections have been identified for evaluation and potential future cultivar release. To determine the performance of these advanced selections at different locations, pawpaw variety trials including one commercially available cultivar (Sunflower) and five advanced selections identified in the KSU Repository Collection (G6-120, G9-109, G9-111, Hi4-1, and H3-120) were established in plantings at three grower cooperator sites, in central Ohio (Urbana, OH; USDA Plant Hardiness Zone 5b), southern Ohio (Aberdeen, OH; USDA PHZ 6a), and southern Kentucky (Bowling Green, KY; USDA PHZ 6b). Survival at the three sites was similar, ranging from 79% to 83% overall. Survival among the selections across all sites was also not significantly different, ranging from 70% to 100%. Trunk diameters differed by selection, with G9-109 and G6-120 having smaller diameter trees compared to Hi4-1 and H3-120. Hi 4-1 also had greater vigor than the currently available cultivar Sunflower. Data will continue to be collected on precocious flowering and fruiting.

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Postharvest 2

(109) The Effect of Phytosanitary Irradiation on the Quality of 'Chandler' Pummelo [*Citrus maxima* (Burm.) Merr.]

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Phytosanitary treatments prohibit the introduction of pests such as fruit flies into pest free zones, and are often required for international trade. Irradiation is increasingly being considered as an alternative to chemical phytosanitary treatments, such as methyl bromide. While 400 Gy is the generic dose for all insects except the adults and pupae of *Lepidoptera*, 150 Gy is sufficient to control most species of *Bacterocera* and 1000 Gy is the upper limit of treatment for fresh produce. In this study, we evaluated the chemical and physiological effect of low-dose gamma irradiation on the postharvest quality of 'Chandler' pummelos [*Citrus maxima* (Burm.) Merr.], an emerging crop of interest in the United States. 'Chandler' pummelos from a local grower in California were irradiated at target doses of 150 Gy and 1000 Gy. Irradiated and untreated pummelos were stored at 12 °C for three weeks and at 20 °C for the fourth week to reflect three weeks of sea shipment at the ideal temperature for storage of pummelos and an additional week of retail under ambient conditions. Color, titratable acidity, total sugars, juice content, weight loss, and concentrations of organic acids were not different for the irradiated fruit in comparison to the untreated pummelos. Irradiation reduced hardness of the pummelo rind and firmness of the flesh. Rind hardness continued to decrease during the three weeks of storage at 12 °C, however, during storage at 20 °C for one week, hardness increased, most likely due to moisture loss from the surface of the fruit. Although, a decrease in the firmness of the pummelo flesh was observed immediately following irradiation, storage did not lead to additional softening. The external appearance of pummelos was negatively impacted by higher irradiation dose, longer storage time and higher temperatures as pitting and mold growth were evident on pummelos treated at 1000 Gy and following storage at 20 °C. When stored at ideal temperature, pummelos irradiated at 150 Gy appeared to maintain similar quality as untreated pummelos. The results suggest that 'Chandler' pummelo quality is compromised at 20 °C and 1000 Gy treatment but irradiation with 150 Gy can serve as a potential phytosanitary treatment for 'Chandler' pummelos.

(110) Hand versus Mechanical Harvest of Fresh-market Grape Tomatoes

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Grape tomato (*Solanum lycopersicum*) sales represented 22% of the U.S. fresh tomato supermarket segment in 2013, with a value in excess of $100 million. Fruit is typically hand-harvested each three to four days during the season; thus, labor constitutes a significant portion of production costs. We investigated the potential for utilizing the Model 2000 Blueberry Harvester (BEI Inc.) for mechanical harvest, given the similarity of plant architecture between blueberry bushes and staked grape tomatoes. This over-the-row harvester has two vertical shafts securing harvesting tines (10-mm diameter) with protective coating and adjustable rotation speed. Detached fruit fall onto "fish-scale" catch plates and are conveyed to field lugs at the rear of the unit. Fifty-plant plots (30.5 m) were harvested either by hand (two plots) or mechanically (two plots) from a commercial field in west-central Florida in June 2014. Over a three-week period, hand-harvests were done every three to four days (4 harvests, total), and mechanical harvests were done weekly (3 harvests, total). Harvested fruit at full orange and red maturity stages were sorted and stored in rigid clamshell containers (1 lb capacity) for 4 d at 15 °C then transferred to 20° for two days. Non-recovered fruit were considered those that either remained on the plant or fell to the ground during harvest. Hand-harvesting recovered 96% of marketable fruit from plots, whereas mechanical harvesting recovered 56%. The amount of immature fruit that was harvested mechanically was 137% higher than hand harvested (5196 kg/ha compared to 2188 kg/ha, respectively). After six days storage there were no significant differences in tomato quality due to maturity stage or harvest method. Appearance was consistently rated as field fresh; there was evidence of bruising, shrivel or decay, and firmness averaged 265 g-f/mm. Soluble solids content ranged from 6.40 to 7.07 °Brix and citric acid levels ranged from 0.38 to 0.47. Mechanical harvest shows promise for end of season, when removal of immature fruit is not an issue.

(111) Postharvest Control of Brown Rot (*Phytophthora palmivora*) of Florida Citrus Fruit Using Phosphite Salts

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Brown rot on citrus fruit in Florida is primarily caused by *Phytophthora palmivora* and is most common during the fall rainy period. Control of brown rot was evaluated on four different varieties of harvested citrus fruit inoculated with *P. palmivora* about two days before treatment. The fruit were then dipped in ambient (22 °C) or heated (49 °C) solutions of potassium phosphite (1.2% KPhos™), calcium phosphite (1.2% Calci-Phite®), and/or thiabendazole (0.025% TBZ) for 30 seconds. Control fruit were dipped in water alone. Treated fruit were then held at 29 °C with 90% RH until evaluated for brown rot and Diplodia stem-end rot (*Lasiodiplodia theobromae* from natural infections) after 7 and 14 days. 'Murcott' tangerine hybrids, 'Navel' and 'Hamlin' oranges, or 'Ruby Red' grapefruit treated with KPhos reduced brown rot incidence by 92%, 74%, 68% and 82%, respectively, compared to the control. Combination of KPhos and TBZ also significantly reduced the incidences of both brown rot and Diplodia stem-end rot. The use of Calci-Phite® with TBZ did not significantly reduce brown rot incidence, but significantly reduced Diplodia stem-end rot incidence. Use of hot water alone (49 °C) significantly reduced brown rot incidence compared to the ambient control on 'Murcott' tangerine hybrids and 'Ruby Red' grapefruit. Mycelial growth of *P. palmivora* was significantly inhibited in vitro after 30 seconds exposure to 49 Calci-Phite® water, and completely inhibited after a 20- or 30-minute exposure, even when evaluated up to 14 days after exposure. 'Ruby Red' grapefruit and 'Murcott' tangerine exposed to the 49 °C water dip treatments did not significantly differ in titratable acidity (TA), total soluble solids (TSS), TSS/TA ratio, vitamin C, or fruit weight loss and fruit respiration rate compared to those dipped in 22 Calci-Phite^{R} water. The heated dip treatment also significantly inhibited subsequent color development and resulted in significantly higher juice glucose and fructose contents compared to the control. The results suggest that a post-harvest fruit dip with KPhos™ and TBZ can effectively control both brown rot and Diplodia stem-end rot on fresh citrus, and that heated (49 °C) solutions can provide even better control.

(112) Influence of Shellac Coating, Proline Dip, and Harvest Date on Chilling Injury in 'Marsh' Grapefruit

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In order to minimize postharvest chilling injury (CI) in 'Marsh' grapefruit, freshly harvested fruit were 1) untreated, 2) coated with a shellac-based coating, 3) treated with 8.69 mM proline solution, or 4) dipped in the proline solution, allowed to dry, and then coated. The fruit were harvested in December (mid season) and late March (late season), stored at 4.5 °C, and sampled every other week for 10 weeks. All treatments significantly reduced CI symptoms (peel pitting) compared to the control, but shellac coating was more effective than proline treatment. The combination of coating and proline was similar to coating alone in reducing CI symptoms. Proline-treated fruit had higher proline concentration in the peel (flavedo), indicating uptake,

while coating had no effect on peel proline. Free amino acids and reducing sugars in the peel were not affected by coating or proline treatments, but total sugars were higher in the peel of coated fruit. The proline treatment had lower non-reducing sugar content than the other treatments, while reducing sugar levels were lower in the control and combination treatments. Fluctuations in peel sugar levels observed within the individual treatments suggest a rather complex situation possibly involving simultaneous consumption of simple sugars along with degradation of polysaccharides and possibly movement of sugars between different tissues. Ascorbic acid content in the juice was maintained at higher concentration in proline-treated fruit than in coated fruit. When the two harvest dates were compared, it was evident that CI symptoms in fruit from the late harvest were minimal and appeared much later in storage compared to the mid season harvest (six weeks versus two weeks). Higher contents of free amino acids, proline, and reducing sugars were found in the peel of fruit from second harvest compared to the first. It was concluded that all these constituents played an important role in alleviating CI symptoms. It is evident that proline plays an active role in reducing CI. However, the mechanism of coating and that of proline in reducing CI symptoms appear to be different with the possibility that reduction of water loss by coating physically impedes the cell collapse required for pitting to occur.

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(113) Evaluation of Alternative Colorants to Citrus Red II and Their Application on Citrus Fruit

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The humid subtropical climate of Florida citrus groves contributes to poor peel quality of oranges and their hybrids early in the season, and has resulted in fresh fruit packers using dye to increase their product's marketability. Citrus Red II (CR2), the most widely used commercial citrus dye in Florida, has been listed by the European Union (EU) and the International Agency for Research on Cancer (IARC) as a group 2B carcinogen. This has generated a negative perception in the mind of consumers, and increased the desire to find natural or food grade colorants to replace CR2 for use on citrus. In this research, three natural red/orange colorants, including annatto extract, paprika extract and paprika oleoresin, were selected based on their perceived favorable appearance on orange fruit. The relative stability of the natural colorants, with respect to CR2, was evaluated by applying them on test papers and orange fruits. All evaluated natural colorants were rapidly oxidized and faded when applied on test papers. Application of a carnauba wax after application of the colorants substantially reduced the oxidation rates of the natural dyes, resulting in slower decoloration. When applying the natural colorants to 'Hamlin' oranges before waxing, the treatments retained the improved color after storage in the dark at 5 °C, simulating cold storage, however, only annatto extract maintained a stable color when stored in a simulated market condition, at 23 °C under room light exposure.

(114) Impact of Maturity and Peel Characteristics on the Response of Mandarin Varieties to Wax Application and Storage

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Mandarins are prone to the development of off-flavors during storage that can make them less desirable to consumers. Prior research by our group has demonstrated the existence of varietal differences in the propensity for postharvest off-flavor formation in mandarins, although the factors that determine this are poorly understood. Ethanol, a primary metabolite of fermentation that accumulates in waxed mandarins, is commonly used as a marker of off-flavor. Ten mandarin varieties previously found to have greatly differing rates of ethanol accumulation during storage were harvested three times during the season (early-, mid-, and late-maturity) and stored for one week at 20 °C after waxing. Measurements of internal O_2 and CO_2, as well as peel O_2 permeability, were conducted during the initial 48 h after waxing, and then internal O_2, CO_2, and ethanol after one week at 20 °C. In addition, fruit from the mid-maturity harvest were evaluated for various peel anatomical characteristics. Internal O_2 concentration rapidly declined in the first 5 h after waxing from an average of 19% to less than 3% within the first 5 h, after which the internal O_2 began to increase again. There was a pronounced effect of season as ethanol concentrations tended to be higher and internal oxygen lower in late- as compared to early-season mandarins after storage. Ethanol concentration in the mid-season fruit differed greatly due to variety, ranging from a high of 1501 $mg \cdot L^{-1}$ to a low of 434 $mg \cdot L^{-1}$ for 'Pixie' and 'Fina Sodea', respectively, and similar differences were found in the other two harvests. None of the peel anatomical characteristics that were determined at harvest were correlated with the concentration of ethanol present in the fruit after storage, although measurements of the integrity of the wax layer showed relationship with the final internal O_2 concentration. The basis for varietal differences in ethanol accumulation remains to be determined.

(115) Effect of Low-dose Gamma Irradiation on the Postharvest Quality of Seedless Kishu Mandarins (*Citrus kinokuni mukakukishu*)

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Tephritid insects are commonly found on packaged citrus and postharvest treatments such as fumigation and cold treatment are used to mitigate the risk from these pests. In 2006, the USDA approved irradiation at a generic dose of 150 Gy for any tephritid fruit fly and 400 Gy for all insects except pupae and adult of Lepidoptera. In this work, seedless Kishu mandarins were treated with 0, 150, 400, and 1000 Gy. The fruit was stored at 6 °C and evaluated for quality after two days, three weeks and four weeks (3 weeks at 6 °C + 1 week at 20 °C) to determine the impact on quality shortly after treatment, after three weeks of sea shipment, and after three weeks of shipment plus one week under retail conditions. The immediate and dose-dependent impact of irradiation was seen in reduction of firmness of the pulp and an increase in titratable acidity. The concentrations of individual organic acids also increased following treatment. The fruit treated with 400 Gy always showed the lowest content of total soluble solids among irradiated fruit, with fruit treated with 150 and 1000 Gy showing similar values. This trend was also observed for individual sugars but only immediately after irradiation application. Hesperidin and narirutin were the most abundant of the seven tested phenolic compounds. The content of the majority of tested phenolic compounds increased immediately after irradiation application but their content tended to decrease in a dose-dependent fashion during the rest of the experiment. Irradiation did not significantly alter the tristimulus color of the flesh. Consumer tests of mandarin segments using nine point hedonic scales revealed insignificant differences in overall liking, taste, texture, color, and juiciness of the mandarin segments. The greatest impact of 400 and 1000 Gy treatment was development of rind damage a few days following irradiation, which manifested as dark coloration on the fruit peel. No internal damage was observed. The fruit treated with 400 and 1000 Gy developed severe fungal infections during the storage at 20 °C and therefore it was discarded before the completion of the experiment. In the 150 Gy samples, some rind damage was evident after three weeks of treatment but exposure to room temperature enhanced damage making the fruit unacceptable to consumers.

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(116) Use of Edible Coatings to Improve Weight Loss, Microbial Stability, Appearance, Texture, and Sensory Qualities for Fresh and Cooked Zucchini

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Various types of edible coatings were tested on sliced zucchini including chitosan (CHIT), whey protein concentrate (WPC), soy protein isolate (SPI), carboxymethyl cellulose (CMC), hydroxypropyl methylcellulose (HPMC) and soybean oil (SB), with or without various additives including calcium ascorbate (CAA), cysteine (CYS), glucose (GLUC), or ethanol (ETOH), and stored at 6 °C and 20 °C. Weight loss, visual appearance and microbial stability were assessed and CHIT, HPMC, SPI, and SB including CAA+ET as additives were selected for a second experiment where coated zucchini slices were stored at 6 °C and 12 °C . The use of additives contributed to higher L* values (lightness) and h^{o} (hue angle) while reducing b* values (yellowness-blueness) as an indication of less discoloration than for water-treated controls. CHIT, and SPI with additives CAA+ETOH were selected for a third experiment, as they had decreased weight loss, and improved appearance for fresh-cut slices. Since fresh-cut vegetables are often processed for the ultimate purpose of cooking, after four days of storage at 10 °C , coated slices were boiled, steamed, griddled, fried and microwaved. SPI and CAA+ETOH alone increased firmness of zucchini slices after boiling and along with CHIT, preserved firmness after steaming compared to water-treated controls. SPI +CAA+ETOH promoted an increase in overall color quality and visual linking for fresh samples, while SPI increased zucchini flavor, general flavor and overall liking of boiled and steamed samples. Both SPI and CHIT increased color quality and visual liking for microwaved zucchini samples.

(117) Transcriptomic Study on the Crispness Maintenance of 'Honeycrisp' Apple Fruit

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Fruit softening has long been a focus of postharvest studies

with the long-term goal of delaying its occurrence. However, there are fruit, like the 'Honeycrisp' apple, that has the ability to remain crisp during months of cold storage. Understanding how fruit like 'Honeycrisp' retain crispness would enable us to learn how to delay postharvest fruit softening. In order to study the molecular mechanisms behind the crispness maintenance trait, RNA-Seq technology was used to compare differential gene expression between fresh and stored fruit of 'Honeycrisp' and 'MN1764' (fruit lose firmness). In the comparison of fresh and stored fruit, 686 differentially expressed genes (DEGs) were identified for 'Honeycrisp', while 1048 DEGs were identified for 'MN1764' based on a P-value < 0.01 and a $\log_2$-fold change greater than 2 or less than –2. The DEGs were further categorized using the Gene Ontology (GO) database into cellular components, biological processes and molecular functions. DEGs encoding cellular components were mostly associated with membrane, cell wall and intracellular components. Biological process-related DEGs were mostly associated with oxidation-reduction reactions and carbohydrate metabolism, while molecular function-related DEGs were mostly associated with protein binding and catalytic activity. Among the DEGs related to cell wall modification, there were three up-regulated cellulose synthases, six down-regulated xyloglucan endotransglucosylases and three down-regulated β- galactosidase genes found only in 'Honeycrisp' but not in 'MN1764'. DEGs identified for 'MN176' included two up-regulated polygalacturonase genes, one up-regulated expansin gene, and three down-regulated cellulose synthase genes. These results will be used to focus future research efforts.

(118) Ripening-related Physicochemical Changes of Polysaccharides of 'Golden Delicious' Apples and Their Relationship with Postharvest Fruit Softening

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Several events have been related with the postharvest softening of apples, including the fruit dehydratation, modification of pectins and starch hydrolysis. However, the level of involvement of these factors on fruit softening is still unclear. In this work, 'Golden Delicious' apples were harvested at 167 DAFB and stored under ambient conditions (air/23°C), refrigeration (air/0 °C), and controlled atmosphere (2 kPa O_2 – 3 kPa CO_2) for up to 5 months. Samples of apples were monthly removed from storage, evaluated for moisture content and firmness, and used for the extraction of pectin and starch. Several physicochemical properties were evaluated in the extracted polysaccharides. The involvement of the moisture content of the fruits and the properties of extracted polysaccharides on fruit firmness were determined by correlation studies. The controlled atmosphere storage retarded the pectin degradation; however, the pectin content was similar for all treatments by the end of the experiment. The protein content in pectin dramatically increased after one month of storage and then decreased. This decrease was quicker in fruit kept at ambient conditions. The degree of methyl esterification of pectin increased during the first month of storage and then remained almost constant. The pectin from apples that had been stored in controlled atmosphere showed the lowest esterification degree. The extracted pectins contained two main fractions, which experienced the reduction of their peak molecular weight and abundance during storage. The intensity of these changes depended on the storage conditions, following the order of ambient > refrigeration > controlled atmosphere storage. The content of Gal, Ara and some mineral elements in pectins showed distinctive changes among experimental groups during storage. The starch content decreased as function of the storage time and conditions; with the starch hydrolysis being more intense in fruits hat had been stored at ambient conditions. The morphology of starch granules only could be determined during the first months of storage in refrigeration and controlled atmosphere due to the intense starch hydrolysis and the presence of unknown structures in the starch samples. The diameter of the starch granules was higher in fruit that had been stored in controlled atmosphere than in refrigeration. The starch granules were completely circular at the beginning of the experiment but this characteristic tended to diminish after two months of storage. The moisture content of fruits and some pectin properties seem to be more related fruit softening than starch content, hydrolysis, and morphology.

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(119) Impact of a Different Ripening Stage, as Defined by the Index of Absorbance (IAD), on Polyphenol Metabolism and Superficial Scald Development in Apple Fruit

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Ripening is the combination of a serious of physiological events occurring in the fruit at the end of its onthogenic life cycle. All these modifications led to the final fruit quality make-up. It is this that determines the most appropriate ripening stage of a fruit in order to increase storability and shelf life, while reducing fruit spoilage. The aim of this experiment was to tailor a postharvest 1-MCP application to control apple superficial scald based on the fruit ripening at harvest. Fruit of 'Granny Smith' cultivar were sorted into two ripening classes based on the "Index of Absorbance" (I_{AD}), measured with a DA-Meter, a portable vis/NIR spectroscopy device. Superficial scald and total content of polyphenols were assessed at 2-month intervals among 4 months of cold storage (1 °C). Results demonstrated that the incidence of superficial scald is directly regulated by the ripening stage at harvest, with more immature fruit being more susceptible to this physiopathy. Apple superficial scald resulted to be associated to an oxidation process leading to a specific up-regulation of the chlorogenic acid biosynthesis pathway. This compound is accumulated in the fruit skin during the scald appearance and oxidized by the action of polyphenol oxidase (PPO). The oxidized quinonic forms are responsible for the formation of melanin and the subsequent brown discoloration). The treatment with 1-methyl-cyclopropene (1-MCP) affects both the chlorogenic acid production and the PPO activities, blocking the superficial scald progression.

(120) Use of 1-MCP to Extend Postharvest Life of Hardy Kiwi Fruit and Anticancer Effect of the Fruit Extract

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The hardy kiwifruit (*Actinidia arguta* cv. Cheongsan), which was bred in Korea in 2005, has recently become popular in the market as demands for new tastes and healthy food increase. However, rapid fruit ripening after harvest limits fruit distribution to the market. To delay fruit ripening, hardy kiwifruits were treated with 20 mL/L 1-MCP for 16 h at 10 °C and subsequently stored at 1 ± 0.5 °C. Physicochemical changes and expressions of fruit ripening-related genes (*AcACO*, *AcACS*, and *AcLOX*) were analyzed. The anticancer properties of the fruit extracts were tested against five types of human cancer cells. The hardy kiwifruits without 1-MCP treatment showed increases in both respiration and ethylene production rates during fruit storage at 1 ± 0.5 °C. The 1-MCP treatment remarkably inhibited fruit ripening by reducing respiration and ethylene production rates. Transcript levels of *AcACO*, *AcACS*, and *AcLOX* were down-regulated by the 1-MCP treatment. Fruits with the 1-MCP treatment could be stored for up to five weeks by maintaining higher fruit firmness, ascorbic acid levels, and total phenolic contents compared to the control, which lost marketability completely due to over-ripening. The hardy kiwifruit extracts showed proliferative inhibitory effects to Hep3B and HeLa cells but not to HT29, HepG2, and LoVo cells. These results suggest that the application of 1-MCP at harvest effectively delayed the ripening process of the hardy kiwifruits, and the fruit extract had beneficial effects for the prevention of human cancer cell growth.

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(121) Activation of Ester Production in Japanese Apricot Fruit Stored under High-oxygen Atmosphere

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Various postharvest techniques have been developed to preserve freshness and avoid deterioration of fresh products such as fruits and vegetables by suppressing their metabolic changes toward senescence. We have been focusing on using postharvest metabolic changes in fruits as a means of material processing to achieve novel characters rather than just delaying senescence. Japanese apricot (*Prunus mume*) fruit is a popular material for liqueur in Japan. Usually mature green fruits are used for the liqueur. To produce aroma-rich Japanese apricot fruits, we have been investigating the post-harvest treatment on these fruits to increase their content of aromatic compounds such as volatile esters, including hexyl acetate or butyl acetate. Volatile ester biosynthesis was initiated earlier under high-oxygen atmosphere (upto 80 %) than under normal atmosphere, and the amount of esters also increased. These changes depended on ambient oxygen concentration. The composition of esters in fruits was also affected by storage period; hexanol and butanol esters increased during a storage period of less than 5 days and ethanol esters tended to increase after a storage period of more than 6 days. Alcohol acyltransferase (AAT) activity catalyzing ester biosynthesis and the lipoxygenase–hydroperoxide lyase (LOX–HPL) pathway for the synthesis of short-chain fatty acids and alcohols as precursors of esters were found to vary in a coordinate way with ester synthesis under high-oxygen atmosphere. It is considered that the increase in esters was caused by a combination of metabolic changes: 1) The LOX–HPL pathway is activated just after storage under high-oxygen atmosphere, 2) AAT activity is increased earlier under high-oxygen atmosphere than under normal atmosphere. The high-oxygen treatment developed in this study has made it possible to engineer fruit metabolism, and further produce fruits having increased amounts and modified composition of esters.

(122) Controlled Atmosphere and Dynamic CA-Chlorophyll Fluorescence Storage of 'McIntosh' and 'Delicious'

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Fruit from four orchards of 'Delicious' from western NY and 'McIntosh' from the Champlain region of NY were harvested, untreated or treated with 1-methylcyclopropene (1-MCP) and kept in controlled atmosphere (CA) and dynamic CA-chlorophyll fluorescence (DCA-CF) storage for up to 8 months. Oxygen levels for 'Delicious' were kept 0.2% above the fluorescence-derived low O_2 limit levels detected at 0.4% (0.5 °C) and 0.9% for 'McIntosh' (2 °C). 'Delicious' apples had 0% to 90% water core at harvest. After 4 months in storage, there was slightly higher firmness in the latter if fruit were not treated with 1-MCP, but otherwise few differences between CA and DCA-CF-stored fruit. Water core was present in fruit from two orchards that had water core at harvest, and at higher levels in DCA-CF-stored samples, although much lower than at harvest. After 8 months, DCA-CF 'Delicious' had less flesh browning than those in CA storage. Firmness was slightly lower in two of the orchards in CA; this was not observed, however, in fruit stored in DCA-CF or treated with 1-MCP. DCA-CF-stored 'McIntosh' had fewer disorders and were firmer after 4 storage months compared with those in CA conditions. Vascular and core browning developed by 8 months, and were observed at similar levels in both CA and DCA-CF environments. Lowest incidences of internal and external CO_2 injury occurred in DCA-CF-stored 'McIntosh'. The DCA-CF treatment often reduced senescent breakdown in the absence of 1-MCP, but in one orchard it was worse in DCA-CF than in CA, 1-MCP had a greater effect on firmness and quality while DCA-CF reduced certain disorders. For both cultivars, a combination of DCA-CF and 1-MCP often resulted in the greatest number of high quality fruit.

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(123) The Effect of Controlled Atmosphere Packaging on Overall Quality of 'Wonderful' Pomegranate

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The cold storage of fruits is a key step to guarantee the product quality. However, temperatures below 5 °C could cause chilling injury, decay, browning, husk pitting and discoloration of pomegranates. Controlled atmosphere could reduce pomegranate physiological disorders and pathogen growth. Therefore, the objective of this work was the assessment of different controlled atmosphere conditions on pomegranate overall quality under cold storage during 70 days. 'Wonderful' pomegranates (Vicuña, Coquimbo, Chile) were processed at 8 ± 1 °C, washed with sodium hypochlorite (200 $mg \cdot L^{-1}$ x 3 min) and then placed in 20 L sealed plastic containers connected to a gas panel mixer by 6 mm plastic hoses. 10 fruits were placed in each container where 5% O_2 to 5% CO_2 and 5% O_2 to 10% CO_2 gaseous combinations

were applied at 0 °C or 5 °C. Gas concentrations were measured with a portable gas analyzer. Respiratory rate, weight loss, color, chilling injury (%), total soluble solids, titritable acidity, and decay (%) were determined. Pomegranates stored at 0 °C showed lower respiratory rates than those stored at 5 °C with values ranging from 4–5.6 $mg \cdot kg^{-1} \cdot h^{-1}$ CO_2 and 4–8 $mg \cdot kg^{-1} \cdot h^{-1}$ CO_2, respectively. The pomegranate husk color was not affected (p 0.05) by the different atmospheres and storage temperatures with values of lightness (L), saturation (C) and tone (Hab) of 42–56, 40–54. and 27–41, respectively. The greater weight losses were observed in fruits stored in atmosphere of 5% CO_2 to 10% O_2. Fruit stored at 0 °C showed chilling injury from day 30 + 2, which was higher in 5% O_2 to 10% CO_2 treatment, with 100% of the fruit with moderate damage. In pomegranates stored at 5 °C damage was observed at 60 + 2 days in atmosphere of 5% O_2 to 10% CO_2, with 100% of fruit with slight damage. Controlled atmosphere caused a significant reduction on fruit decay due to an inhibition on mold growth mainly observed in 5% O_2 to 5% CO_2 atmosphere. Results showed the feasibility of this technology to extend the shelf life of pomegranates.

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Vegetable Crops Management 1

(380) Day/night Temperature Effects on Kale Photosynthesis and Leaf Morphology

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Red Russian Kale (*Brassica napus* var. *pabularia*) was grown under 25 day/night temperature combinations to quantify differences in yield, leaf morphology, development rate and impact on the photosynthetic capacity/behavior. Kale was germinated and growth under a 24 °C/13 °C (day/night) temperature with an 18-h photoperiod. Plants were moved to five environmental growth chambers (maintained to achieve a 10 °C, 15 °C, 20 °C, 25 °C, and 30 °C leaf temperature) with an 8-h photoperiod (300 $\mu mol \cdot m^{-2} \cdot s^{-1}$) when four true leaves had unfolded. Plants were moved among chambers at 0800 and 1600HR daily to achieve 25 day/night temperature regimes. Plants were grown in Sunshine LC8 media, were fertilized twice weekly with a 400 ppm N solution of Cal-Mag 15–5–15, and were watered as needed otherwise, with care taken not to leach pots. After 56 d, photosynthetic responses to temperature (10 °C to 30 °C; 5 °C interval), irradiance (0–1200 $\mu mol \cdot m^{-2} \cdot s^{-1}$; 200 $\mu mol \cdot m^{-2} \cdot s^{-1}$ interval), and carbon dioxide (CO_2) concentration (50–1200 ppm; 200 ppm interval) were collected on the youngest fully expanded leaf using a LI-COR LI-6400XT Portable Photosynthesis System. When one environmental variable was assessed, the other two were held constant: temperature = 20 °C, irradiance = 300 $umol \cdot m^{-2} \cdot s^{-1}$, CO_2 = 400 ppm. Photosynthesis of plants grown with 10 °C to 25 °C day temperatures saturated at 800 $\mu mol \cdot m^{-2} \cdot s^{-1}$, while photosynthesis of plants grown with a 30 °C day temperature saturated at 600 $\mu mol \cdot m^{-2} \cdot s^{-1}$ (400 ppm CO_2, 20 °C). Among plants growth at constant temperatures, the maximum and minimum photosynthetic rate occurred on plants grown at 10 °C (21.3 $\mu mol \cdot m^{-2} \cdot s^{-1}$ CO_2 fixed) and 25 °C (9.77 $\mu mol \cdot m^{-2} \cdot s^{-1}$ CO_2 fixed) when plants were exposed to high irradiance (1200 $\mu mol \cdot m^{-2} \cdot s^{-1}$) and ambient CO_2 (400 ppm). Among plants growth at constant temperatures, the maximum and minimum photosynthetic rate occurred on plants grown at 15 °C (19.5 $\mu mol \cdot m^{-2} \cdot s^{-1}$ CO_2 fixed) and 25C (14.2 $\mu mol \cdot m^{-2} \cdot s^{-1}$ CO_2 fixed) when plants were exposed to high CO_2 (1200 ppm) and ambient irradiance (300 $\mu mol \cdot m^{-2} \cdot s^{-1}$). Data were also collected on unfolded leaf number, leaf fresh and dry weight, and leaf dimensions (up to 4 expanded leaves). Fresh weight ranged from 8.2 g/leaf in the 20 °C/10 °C day/night temperature regime to 1.6 g/leaf in the 10 °C/30 °C day/night temperature regime. Photosynthetic response curves, leaf unfolding rates, and leaf fresh weight data presented here provide growers with critical information to optimize yield and make temperature, irradiance and CO_2 management decisions.

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(381) Light Source Effects on Hydroponically Grown Compact 'Winter Density' Bibb Lettuce

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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. The objective of this study was to determine the effects of different light sources on the growth of compact 'Winter Density' Bibb lettuce in a non-circulating hydroponic system. 'Winter Density' Bibb lettuce seedlings were started in Oasis cubes. Seedlings were transferred to 5.1-cm net pots and put in 1.9-liter containers containing a hydroponic nutrient solution. The solution was composed of Hydro-Gardens' Hobby Formula 10–8–22 hydroponic fertilizer with added magnesium sulfate (9.8% Mg). The lettuce was grown in a lab under high output T-5 fluorescent lights. The light

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level was 119.5 μmol·m^{-2}·s^{-1} with an air temperature of 22.6 °C. The photoperiod was 16 h. After 10 days, half of the plants in the containers were moved under red+blue+white LEDs for 10 more days. At the end of the study, plant height, shoot-root ratio, percentage of dry weight partitioned to shoots, nutrient solution used, and electrical conductivity of the remaining nutrient solution were greater under fluorescent lighting. Root dry weight, percentage of dry weight partitioned to roots, and shoot dry weight per nutrient solution used were greater under LED lighting. There were no significant differences in shoot dry weight, total plant dry weight, SPAD readings, and pH of the remaining nutrient solution. In conclusion, moving lettuce plants from initial fluorescent lighting to later LED lighting may enhance certain attributes of hydroponically grown compact lettuce.

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(383) Lettuce Screening for Growth, Quality, and Water Use Efficiency in a Hydroponic Culture System

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Field production of lettuce (*Lactuca sativa* L.) in southwest Texas is limited due to adverse environmental conditions, especially high temperatures and drought during the growing season. In addition, due to strict restrictions for surface and underground water resources, the vegetable industry is increasingly interested in maximizing water use efficiency (WUE) when growing high value leafy vegetables. Recirculated hydroponic culture offers several advantages over open field production. This study evaluated WUE, growth components and overall product quality of Bibb (cvs. Buttercrunch, Bibb), loose leaf (cvs. Bellatrix, Ezatrix, Caipira, Kremlin Red Leaf, Progreen 76, Ezfrill, Ezfilan, Pearl Gem) and Romaine (cvs. Sunbelt, Chabi) lettuce grown in a hydroponic culture system (NFT) at the Texas A&M AgriLife Research and Extension Center, Uvalde. Plants were grown in three cycles, October 2014, December 2014, and February 2015, for 57, 46, and 46 days, respectively, from seeding to harvest. Within the Bibb group, greatest fresh weight, leaf length, leaf number, °Brix and WUE [0.22–0.58 L·g^{-1} dry weight (DW)] were recorded for 'Buttercrunch'. Within the Romaine group, greatest fresh weight, leaf length, leaf chlorophyll (SPAD), and WUE (0.28–0.70 L·g^{-1} DW) were recorded for 'Sunbelt'. Conversely, these cultivars expressed moderate leaf tipburn injury during the first cycle. Within the looseleaf group, highest growth and WUE (0.66, 0.75, 0.72, and 0.59 L·g^{-1} DW) were recorded for 'Ezatrix', 'Caipira', 'Kremlin Red', and 'Pearl Gem', respectively. Expanded screening and selection of lettuce cultivars for reduced leaf tip burn, high WUE, and leaf quality in hydroponic culture is important to improve water productivity, extend the production season, and improve the final product quality with minimum pesticides and nitrate leaching to the environment.

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(384) Importance of Calibrating Cultural Greenhouse Growth Practices Using LED Technology in Tomato Production

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Production results achieved between two commercial tomato producers in North Carolina highlighted the importance of cultural practices when adding LED lighting. Growers added LED lighting to their greenhouses in Winter 2014. They were 10 miles apart geographically with identical weather patterns. The growers differed in growing methods, and tomato variety. To date production yield is significantly different. Grower A used hydroponic-cococoir, growing Heritage tomatoes in a 7400 square-foot greenhouse housing 2100 plants. The greenhouse was divided into three bays: non-lit bay; guard bay; and a bay with 42 LED lights (1 light/59 square feet), photoperiod 15 h. Plants were planted October 2014 and germinated under sole source LEDs. At 8 weeks seedings were transplanted to the greenhouse. Plants under LED lights initially showed signs of phosphorus stress as indicated by anthocyanin in the leaves. We speculated that this stress was because the lights illuminated prior to dawn while the plants were cold from the night. Increasing temperature in the greenhouse 2 °C eliminated stress. Water stress was introduced by manipulating fertigation at night to be delivered at 2-minute intervals. The first harvest of the LED-lit crop occurred in February, two weeks prior to the non-lit control. At the time of this submission yield under the LED lights provided a 32% increase over the non-lit control. Grower B used soil-based media in 5-gallon pots growing Trust tomatoes in two side-by-side 1300 square-foot greenhouses. One greenhouse served at the non-lit control and one was illuminated with 12 LED lights (1 light/109 ft^2), 15-h photoperiod. Plants were planted Nov. 2014 under the two growth conditions. As plants have matured the non-lit control has several indicators of stress, including ethylene and nitrogen, as measured by height and apparent vigor. The LED-grown plants were taller and with greater biomass. The first harvest occurred in March. At the time of this submission yield in the non-lit lights greenhouse demonstrate 40% more productivity over the LED greenhouse. Given the vigor of the LED plants they may eventually outperform the non-lit plants. This data will be available at the time of our presentation. Data from similar farms highlights the complexity of adding a new growth parameter. Careful consideration must be made when introducing LED lighting, or transitioning from other lighting. Growth strategies need to be reconsidered and managed properly, particularly with regard to heating and fertigation.

(385) Conditioning Transplants Affects Early Growth but Not Final Productivity

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Prior to transplanting in the field, it is common to expose vegetable seedlings to outdoor extremes (bright light, cooler temperatures, less irrigation, etc.) to reduce transplant shock. This is often done approximately one week before planting to allow plants to better withstand field conditions. During the 2014 growing season, pepper, tomato, and watermelon seedlings were subjected to common conditioning treatments for one week prior to planting. These included cool temperatures (10 °C), one half normal irrigation or fertilizer, brushing twice a day, and an untreated control. Conditioned transplants were planted early and late in the growing season to evaluate performance under cool or hot field conditions. We evaluated plant survival, early plant growth (weight, length, flowering, etc.), and productivity. While plant survival was not significantly different between conditioning treatments, cold treated pepper, tomato, and watermelon seedlings were significantly smaller 3-4 weeks after planting compared to the control or brushing. The one-half irrigation or fertilizer treatments often produced intermediate early growth responses. However, conditioned plants were not less productive and fruits produced were of similar quality to those from untreated controls. These results suggest conditioning effects on performance are transient and may not be necessary prior to planting.

(386) Overhead Irrigation Saves Water Significantly in Commercial Potato Production in Florida

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A trial was conducted on four private farms in Florida from 2012–14 to determine water savings of converting seepage irrigation to center pivot irrigation for potato production. There were two irrigation treatments: seepage and center pivot with four replicates. Rain gauges and flowmeters were installed for both treatments on each of the farms to monitor rainfall and water usage. Moisture sensors also monitored soil moisture. The results showed that the average water usage was 338 ± 99 mm and 752 ± 175 mm for center pivot and seepage in the first growing season, respectively. Water savings of center pivot irrigation were 55% (4136 m^3/ha). In the second growing season, which was wet, the corresponding average water usage was 193 ± 31 mm and 462 ± 145 mm. The water savings were 58.6% (2716 m^3/ha). Potato plants had greater leaf water potential and stronger tolerance to freeze damage with center pivot than with seepage. The tuber yields were 31.4 ± 2.0 and 33.4 ± 2.5 tons/ha for center pivot and seepage, respectively. The corresponding tuber yields in the second growing season were 42.3 ± 5.2 tons/ha and 46.5 ± 5.4 tons/ha. Seepage irrigation had higher soil nitrate contents and greater tuber yields as compared with center pivot irrigation. The results suggest that center pivot irrigation requires a new fertilize program. The overall water use efficiency (WUE) was 0.11 ± 0.05 and 0.05 ± 0.01 m^3 per kg tubers for seepage and center pivot, respectively. The WUE was 2.2-fold greater with center pivot than with seepage. This water savings and greater WUE can significantly enhance the agricultural and environmental sustainability.

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(387) Commercial Performance of Broccoli Varieties Selected for a New Climate

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Variety development through the Eastern Broccoli Project has resulted in initial releases from seed companies. These new varieties were trialed in various Eastern production systems to determine relative yield, marketability proportion, and holding time. The nine trial sites ranged from Maine to southern Florida. The new varieties were Burney, BC 1691, BC1764, and DuraPak19. They were compared to a popular Eastern variety, Green Magic. The various production systems ranged in gross yield from 300 to 1000 boxes per acre. The marketable yield of

the new varieties was between 50% and 80% of the gross yield. In general, most of the yield could be obtained with three cuts. While the varieties varied in maturity, the progression of production during the harvest period was quite similar among varieties. The field-holding ability was measured as loss to overmaturity at three days beyond peak maturity. That loss averaged 25%, but varied considerably. In general, the new varieties had less loss on field holding than the standard.

(388) Cucumber Plant Growth and Fruit Yield as Affected by 6-Benzyladenine and Magnesium Sulfate

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Cucumber (*Cucumis sativus*) is an important vegetable crop in Georgia, with a surface of 1,700 ha and a farmgate value of $41 M. Cucumber is exposed to heat stress conditions that affect fruit quality and fruit yield. Crop biostimulants have been shown to increase crop yield and quality under adverse environmental conditions. Benzyladenine (*BA*) is a cytokinin used for fruit thinning in apples and other fruit trees. Objective was to determine the effects of rate of *6- BA* alone or in combination with magnesium sulfate on chlorophyll SPAD values, plant growth, leaf gas exchange, leaf fluorescence, and fruit yield in cucumber. Experiment conducted at the University of Georgia Horticulture Farm, Tifton, during Fall 2010. Soil is loamy sand, with a pH of about 6.5. Cucumber ('Dasher II') was direct-seeded on 23 Aug. on raised beds (on 1.8 m centers). Plants were established using two rows per bed (36 cm apart) with a distance of 30 cm between plants within the row. Beds were covered with 1.5 m wide low-density polyethylene white plastic mulch. One driptape line was placed 2–3 cm deep into soil in the center of the bed. Experimental design was a randomized complete block with six replications and six treatments [three *6-BA* (*MaxCel®*) rates (0, 20, and 60 ppm) x two rates of magnesium sulfate (0 and 136 kg/ha)]. Benzyladenine was associated with reductions in chlorophyll SPAD values, particularly at high BA rate. Benzyladenine had no effect on leaf gas exchange, leaf fluorescence and marketable yield. Benzyladenine-treated plants showed delayed fruit production and enhanced vegetative top growth. Magnesium sulfate had no significant effects on chlorophyll SPAD values, vegetative top growth, leaf gas exchange, leaf fluorescence, or fruit yields.

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(389) Bell Pepper Plant Growth and Fruit Yield as Affected by S-ABA Concentration and Water Application Rate

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In the state of Georgia, bell pepper (*Capsicum annum* L.) has a surface of 2400 ha and a farmgate value of $78 M. Bell pepper is exposed to heat stress conditions that affect fruit quality and fruit yield. Crop biostimulants have shown to increase crop yield and quality under adverse environmental conditions. Abscisic acid (ABA) has many roles in plants but it is primarily associated with stress responses. Objective was to determine the effects of S-ABA concentration and water application rate on plant physiology and growth, and fruit yield in field-grown plants. Experiment was conducted at the University of Georgia Horticulture Farm, Tifton, during Spring 2012. Soil is loamy sand, with a pH of about 6.5. Experimental design was a randomized complete block with a factorial arrangement and eight treatment combinations [4 S-ABA (VBC-30151, Valent BioSciences) levels (0, 250, 500, 1000 ppm) x 2 water application volumes (250 and 1000 mL/m^2 of tray)]. Bell pepper ('Colossal') was planted to the field on 9 Apr. 2012 on raised beds (on 1.8 m centers); two rows per bed (36 cm apart) with a distance of 30 cm between plants within the row. Beds were covered with 1.5 m wide low-density polyethylene black plastic mulch; one drip tape line was placed 2–3 cm deep into the soil in the center of the bed. The field was fertilized before planting with 672 kg/ha of 10 N–10 P_2O_5–10 K_2O fertilizer. After planting, N and K_2O were applied weekly through the drip tape. Total amount of N and K_2O applied were 261 and 304 kg/ha, respectively. Plants were irrigated with an amount of water equivalent to 100% crop evapotranspiration (ETc). Weather data (air temperature and ETo) were obtained from a nearby University of Georgia weather station (< 300 m). Bell pepper plant growth, measured as stem diameter and plant height decreased with increased concentrations of S-ABA and increased water application rate. Leaf net photosynthesis and stomatal conductance of mature plants were not significantly affected by S-ABA concentration; they were increased when treated with the high water application rate. Despite the effects on plant growth, no significant effects of S-ABA concentration or water application rate on fruit number or fruit yield were found.

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(390) Developing No-till and Minimum Tillage Pumpkin Production in the Great Plains

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Pumpkins are a very popular crop in the Great Plains because they perform well and are profitable for growers through traditional and agritourism markets. However, traditional pumpkin production systems that utilize heavy reliance on mechanical tillage can be detrimental to long-term soil health. One particular challenge in the region is that the incorporation of fall-planted cover crops for pumpkin growers can be difficult due to the short planting/growing period in the fall after pumpkins are harvested. From 2012 to 2014, we conducted replicated trials to investigate the utility of various fall- and spring-planted cover crops for no-till pumpkin systems and compare the top performers with conventional tillage. Duplicate field trials were conducted at the Olathe Horticulture Research and Extension Center (Olathe, KS) and the John C. Pair Horticulture Center (Wichita, KS), which represent the eastern and south central growing regions in Kansas. The treatments included seven different cover crops/mixtures and one conventional tillage treatment. Two of the cover crop treatments were planted in the spring. Plots were treated similar to commercial pumpkin production in the region. At both locations, fall-planted rye/vetch and rye/pea cover crop mixtures performed comparably to the conventional tillage system in regard to total yield. Total pumpkin production using these cover crops ranged from 12.4 to 14.9 tons per acre at the two sites in 2014. In 2013, the spring-planted cover crops had the lowest biomass production of all of the cover crops ($P < 0.05$). The subsequent pumpkin crop experienced the highest weed pressure and lowest yield ($P < 0.05$). Conversely, in the 2014 trial, the spring-planted cover crops had the highest biomass ($P < 0.05$) and performed comparably to the conventional tillage treatment (P = NS). Our data shows that no-till systems can be highly successful when select cover crop mixtures are utilized and the pumpkin crop is managed properly. Although spring cover crops would be useful for growers that are not able plant fall cover crops, our work suggests that their performance is highly dependent on spring weather conditions, as they relate to planting date and subsequent biomass production. Additional trial observations showed that fertilizer management is critical, and fertigation is very useful for no-till systems. Further work is being conducted to verify the viability of these systems in 2015 and facilitate successful on-farm implementation of this technology in the region.

Specified Source(s) of Funding: NRCS Conservation Innovation Grant

(391) Growth and Physiological Responses of Chinese Cabbage 'Chungwang' to Different Temperatures during Early to Middle Growth Stages

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Changes of the growth patterns of Chinese cabbage (cv. 'Chungwang') in response to six different temperature treatments were investigated during the early to middle stages of growth. The temperature treatments consisted of 14 °C/9 °C (day/night; group I), 17 °C/12 °C (group II), 20°C/15 °C (group III), 23°C/18 °C (group IV), 26°C/21 °C (group V), and 29°C/24 °C (group VI) using the soil plant atmosphere research system. Fresh weight was the highest in group III as 1658.3 g, and it was decreased in group IV (1458.3 g), group I (1340.7 g), group II (1243.0 g), group V (1240.3 g), and group VI (1172.7 g). However, dry weight was relatively decreased in low temperature treatment groups. Leaf number and area were the higher in group V and VI during the early growth stage, but it was relatively increase in group III, and IV after 28 days from planting. Regarding photosynthetic rate and transpiration at the 28 days from planting, photosynthetic rate was the highest in the group IV, and it was relatively decreased in high temperature groups (group V and VI). On the contrary, transpiration was observed a relatively high value in group V and VI, and it was lower in the groups treated with low temperature.

(392) The Effect of Temperature on Germination of Southern-type Garlic during Early Growth Stage

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Changes of germination rate of southern type garlic were investigated using chambers with five temperature treatments of 10 °C, 15 °C, 20 °C, 25 °C, and 30 °C. Two sets of 32-hole tray, (total planted 64 garlic cloves), were set in each chamber, and investigated germination rate with daily-base. Germination rate of garlic were highest at 15 °C treatment, and were decreased by increasing or decreasing temperature from experiment. From 50% germination days at each temperature, which were estimated from curve fitting using experiment data, an exponential equation was developed to estimated germination rate from daily temperature. Based on the equation, germination rate was highest of 0.1007% per day at 13.4 °C. To test germination model, garlic were planted with different planting date in the field. Field experiment data revealed that germination model can predict well the initiation time and the pattern of germination of garlic with well cultivated condition.

Thursday, 6 August 2015

Fruit Breeding 2

(260) Evaluating Bacterial Spot [*Xanthomonas arboricola* pv. Pruni (*Xap*)] Resistance for Molecular Characterization and Incorporation of Marker-assisted Breeding (MAB) into the University of Arkansas Peach and Nectarine Breeding Program

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Bacterial spot [*Xanthomonas arboricola* pv. pruni (*Xap*)] is a serious disease of *Prunus* spp. worldwide 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. Incorporating bacterial spot resistance into newly developed peach cultivars is a more promising control measure and has been a key trait of interest in the University of Arkansas (UA) program. Marker-assisted breeding (MAB) is being pursued in the UA program to enhance traditional breeding techniques. Phenotypic data for *Xap* was collected in 2013 and 2014 across a range of cultivars, selections, and 13 seedling populations, using both field and laboratory data. Previously identified quantitative trait loci (QTL) for *Xap* fruit resistance (G1*Xap*F and G6*Xap*F) were analyzed across the material. The resulting alleles at each SNP loci were associated with the phenotypic data to differentiate individuals with susceptible (*su*) and or resistant (*R*) alleles. The validated SNP loci were directly used in marker-assisted parent selection (MAPS) in 2014, to pool resistance (*R*) alleles into the progeny. The SNP loci were next converted into breeder-friendly PCR-based DNA tests and used in marker-assisted seedling selection (MASS) in 2015 on several peach crosses to cull seedlings with *su* alleles. Pedigree-Based QTL Analysis (PBA) and association analysis are also being performed to identify additional QTLs controlling *Xap* resistance. Promising loci are being validated across the UA program and will be incorporated into MAPS and MASS in 2016 to enable further pyramiding of *R* alleles into high-quality cultivars.

Specified Source(s) of Funding: RosBREED SCRI grant

(031) Why Wait for the Fruit? DNA-informed Breeding in Rosaceae: Prediction of Apple, Peach, and Sweet Cherry Skin Color as a Case Study

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Much hype has been generated over the past 30 years regarding the potential positive impact of "molecular markers" on plant breeding. These "molecular markers", more appropriately termed DNA tests, were expected to have substantial impact in tree fruit breeding, due to long juvenility periods, expensive phenotyping procedures, and space requirements. To date, there are few examples of successful application of DNA tests to enhance breeder decision confidence, termed DNA-informed breeding, for fruit quality traits in perennial crops. A limited number of reliable, predictive DNA tests for breeding-relevant traits are likely a major contributor to this failure to meet expectations. Due to recent dedicated efforts to develop such tools, specifically those of RosBREED and FruitBreedomics projects, the tree fruit

breeding community is reaching a point at which this technology can begin to play a valuable role in the breeding process. DNA tests for the prediction of apple, peach, and sweet cherry fruit skin color are examples of some of the tools successfully developed and deployed for direct use in breeding programs. Based on genomic regions discovered by collaborators to be associated with anthocyanin-based fruit color traits, DNA tests were developed. In all three crops, the resulting simple sequence repeat tests differentiated alleles associated with various levels of red skin pigmentation. With the apple and peach tests, it is now possible to select parents with the genetic potential to produce high-blush seedlings and select seedlings predicted to have high-blush levels years before fruit evaluation if desired. In sweet cherry, blush and mahogany skin color are market-defining classes, each having different breeding targets and trait thresholds. Consequently, selecting parents that will produce seedlings of the desired class with the sweet cherry color DNA test can improve crossing outcomes. All three tests developed allow for the synergistic improvement of apple, peach, and sweet cherry fruit color, thanks in part to a conserved *MYB10* genetic mechanism in each crop. In addition to the skin color DNA tests, tests are available for the prediction of other valuable fruit quality traits including apple and peach texture and flavor and sweet cherry size and maturity date. So, why wait for the fruit to select germplasm with genetic potential to produce superior quality fruit? With skin color and other fruit quality DNA tests now developed, apple, peach, and sweet cherry breeders are well equipped to take the leap into DNA-informed breeding.

Specified Source(s) of Funding: USDA National Institute of Food and Agriculture—Specialty Crop Research Initiative project, "RosBREED: Combining disease resistance with horticultural quality in new rosaceous cultivars" (2014-51181-22378); Washington Tree Fruit Research Commission; Ore

(032) Heritability and Phenotypic Correlations among Bloom, Flower Density, and Fruit Set

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The peach breeding program at Texas A&M University has been working on the development of peach and nectarine cultivars adapted to the low and medium chill zones. As the major emphasis of the program is to introgress the superior horticultural traits from poorly adapted high chill germplasm into the marginal quality but well adapted low and medium chill germplasm, adaptation traits of bloom time, flower density and fruit set are essential to ensure consistent productivity. In conjunction with the RosBREED SCRI program, nine F_1 peach populations were characterized for bloom date over two years in both California and Texas. In addition to this, these populations growing in College Station were assessed for flower density (2 years) and fruit density (1 year). An all-random effects model (REML) was used to estimate variance components and a multivariate model was used to estimate phenotypic correlations between traits. All three traits showed high broad sense heritability as has been previously reported with other populations. Narrow sense heritability estimates for bloom date and fruit density were moderate to high whereas the narrow sense heritability estimate for flower density was low indicating a large non-additive genetic variance. Correlation analysis indicates that there is a good correlation between flower and fruit density. The next step in this study is to subject this data to a FlexQTL analysis to identify trait-marker associations.

(033) Validation of a Molecular Marker for Seedlessness in Muscadine Grapes

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Seedlessness is a crucial trait in the commercial success of table grapes, and the development of seedless cultivars is critically important in efforts to increase the consumer appeal of fresh-market muscadine grapes (*Vitis rotundifolia*). Muscadine is a member of the subgenus*Muscadinia*, while *Vitis vinifera* and several other grape species are members of the subgenus *Euvitis*. Because *Euvitis* and *Muscadinia* have different chromosome numbers, introducing stenospermocarpic seedlessness into *Muscadinia* from *Euvitis* is challenging. However, the University of Georgia breeding program has recently obtained the complex hybrids NC74CO49-10 and DRX60-40, which are able to serve as bridges between the two subgenera. Previous research has located a functional candidate gene for stenospermocarpic seedlessness, *VvAGL11*, in *V. vinifera*. An STS marker located in the regulatory region of *VvAGL11* allows for the detection of the dominant seedless allele in a wide variety of *Euvitis* genotypes. The objective of this study was to test the *VvAGL11* STS marker in two hybrid progenies in order to determine its usefulness for predicting seedlessness in *Euvitis* × *Muscadinia* hybrids. After assessing its performance in seedless *Euvitis* cultivars, the hybrid progenies, and a variety of muscadine cultivars, we were able to validate the marker. This marker has excellent potential to facilitate the breeding of new seedless muscadine cultivars.

(034) A Functional, Consensus Linkage Map of Blueberry and Cranberry

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Blueberry (*Vaccinium* spp.) is an economically important small fruit crop (564.4 million pounds harvested in the U.S. with a value of $850.9 million in 2012), but relatively few genomic resources are available to researchers and breeders for the purposes of plant improvement. Traditional blueberry breeding is constrained by severe inbreeding depression, the complex nature of the polyploid genome (2n = 24, 4n = 48 and 6n = 72), and the relatively long period of juvenility. With the advent of next-generation sequencing (NGS) and the development of associated informatics tools to interpret this information, blueberry breeding efforts are likely to benefit immensely from these technologies. Toward this end, a genomic scaffolding of 9170 sequences with an N50 of 275 kb of the diploid blueberry 'W85-20' was created through a combination of NGS sequencing and Sanger BAC end reads. Four genetic linkage maps of blueberry and cranberry (a close relative in the genus *Vaccinium*) were also constructed for multiple purposes including understanding the genetic basis of important fruit characteristics, cold hardiness and climatic adaptability. These maps have for the most part used unrelated molecular markers and which include RAPDs, ESTs, EST and genomic-derived simple sequence repeats (SSRs), and SNPs. The goal of this research was to create a blueberry/cranberry consensus map of the four individual maps based on the scaffold locations of the associated molecular markers. Multiple software programs were used to predict the genomic location of the markers and to provide alignment (and in some cases, orientation) of genomic scaffolding. New SSRs markers were also designed for larger scaffolds and for targeting genes in the anthocyanin biosynthesis pathway. Locations of BAC end sequences are highlighted to provide a framework for further refinement of the blueberry sequence assembly. The map is functional in that it represents more than a third of the blueberry genome including several thousand annotated genes. This research provides both an immediate resource to current blueberry researchers and a roadmap for the completion of the sequenced blueberry genome.

Specified Source(s) of Funding: Plant Pathway Elucidation Project

(035) A Breeder-friendly DNA Fingerprinting Protocol for Blackberry Fruit

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In the event of alleged inappropriate use or an error in propagation of a cultivar, fruit breeders need easy and low-cost methods of identifying products from their breeding programs. Particularly important is the ability to identify the cultivar by fruit samples, since fruit samples may be the only plant part available to investigate propagation or use concern. Blackberry fruit has substantial maternal tissue in the receptacle, or torus, that can be used for DNA extraction. Microsatellite DNA polymorphisms provide a reliable opportunity for the exploitation, or "fingerprinting," of blackberry cultivars by using either fruit or leaf samples. A DNA-based identification protocol would ideally be fast and inexpensive and would use readily available tools in any standard molecular laboratory. In this study, we used fruit receptacle tissue for our cultivar differentiation and identification. Further, we used a low PCR annealing temperature of 50 °C. We were able to identify over 30 blackberry cultivars developed at the University of Arkansas by using as few as three microsatellite primer pairs with agarose-based gel electrophoresis. This project emphasizes the low-cost and efficiency of being able to use an in-house protocol to identify specific cultivars from one's own breeding program.

(036) Heritability of Fruit Splitting Tendency in Blueberry

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Rain-induced fruit splitting is a common problem in many blueberry production regions. Following a 2011 survey of British Columbia blueberry growers in which reduced split-

ting tendency ranked highly as an industry need, this trait has become one of the objectives of the BC blueberry breeding program. While laboratory methods have been developed to screen blueberry genotypes for splitting tendency and large differences have been observed between genotypes, little is known about the inheritance or heritability of this trait. As part of a multi-year study to identify sources of variation and track response to selection in the breeding program, we used a laboratory assay to determine the splitting tendencies of 2618 seedlings in 2014 from 51 full-sib families resulting from crosses between 16 parents. The mean proportion of split fruit in seedling families ranged from 2% to 27%, while the mean proportion of split fruit in their parents ranged from 0% to 46%. Using mid-parent regression, we obtained a moderately high preliminary heritability estimate for fruit splitting tendency (h^2 = 0.62). Future work will focus on determining combining ability and breeding values of parents, determining splitting tendency in broader germplasm, and studying response to selection over multiple breeding cycles.

(037) Analysis of Blackberry Fruit Firmness in Crispy Fruit Segregating Populations

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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. The University of Arkansas blackberry breeding program has released several cultivars with excellent postharvest quality for the fresh and shipping industries. Fruits having a crispy texture and exceptional firmness have been identified in the program. Two Arkansas selections carry this trait, A-2453T and A-2454T. They were used in 2011 in crosses with other Arkansas selections with the intention of increasing firmness in progeny. Another objective for these crosses was to evaluate the inheritance of firmness. In 2014, fruit firmness of five populations (1145, 1146, 1147, 1148, and 1151) was measured. All populations were from firm x crispy parents. Thirty to 37 plants were evaluated per population. Fruit compression, skin penetration, and drupelet penetration forces were measured. For penetration and compression, 1.0 mm and 7.2 cm cylinder probes were utilized, respectively. Fruit compression values indicated that four of five populations had progeny that exceeded the average firmness value of the firmest parent. Conversely, population 1146 produced no progeny exceeding the firmest parent, and most of the progeny were softer than either of the parents. The average firmness value of the firmest parent of each population was exceeded by 1.9 to 4.1 Newton (N) in the progeny, depending on the population. The number of individuals exceeding the parental force values varied from 2 (1146) to 17 individuals (1147). No progeny were measured to be in the "soft" category due to all parents being firm or crispy. Skin and receptacle penetration firmness measurement values were less consistent and values did not parallel the phenotype of the parents. Compression force values better explained the firmness of a genotype compared to penetration values. Fruit firmness reflected quantitative inheritance. Additional data is needed to quantify and fully explain the inheritance of exceptional firmness in very firm parent crosses, but the preliminary data shows great promise for achieving further firmness in blackberry progeny.

Organic Horticulture 2

(070) Incorporating Sensory Evaluations into Organic Vegetable Variety Trials

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Sensory evaluation is an often-overlooked assessment when conducting vegetable variety trials. Taste testing can help identify varieties with superior flavor, texture and culinary performance, which are important to consumers of fresh market organic produce. In addition to agronomic field evaluations, growers need sensory data to inform them on consumer preferences. Criteria to evaluate may include phenotype (i.e. shape, size, color), flavor, sweetness, texture, acidity, astringency, bitterness, culinary performance, and many others depending on the species. Both the OREI-funded Northern Organic Vegetable Improvement Collaborative (NOVIC) and Western SARE-funded Integrated Soil and Crop Management for Organic Potato Production (Ospud) have employed sensory evaluations to supplement field performance trial results. The NOVIC project conducts extensive variety trials of six vegetable crops with the goal of finding those that are well adapted to organic farming systems. In 2010 and 2011, in conjunction with the NOVIC sweet pepper trials, a panel of chefs and farmers evaluated culinary traits of nine commercially available varieties. Evaluations included overall appearance, color, flavor, sweetness, texture and overall liking of raw, sautéed and roasted preparations for each entry. The 'Stocky Red Roaster' pepper bred by collaborating breeder Frank Morton of Wild Garden Seed was very highly ranked by farmers and chefs for appearance and flavor, and as the result, seed sales for this pepper have increased dramatically. During the Ospud project (2005–07), variety taste tests were utilized to evaluate flavor, texture and overall liking of 14 potato varieties. Two potato varieties were identified to have not only late blight resistance but also superior flavor including 'Jacqueline Lee' (waxy yellow) and 'Defender' (russet); and 'Ama Rosa', a red fingerling breeding line that has since been released, was also identified to have superior flavor and appearance. Overall, sensory evaluations provided plant breeders, farmers and researchers

with desired, but not widely available, qualitative and quantitative data on sensory preferences in vegetable varieties, some of which they were not previously aware of. Farmers and chefs began to grow and cook with new varieties that were shown to perform well in the field and on the palate.

Specified Source(s) of Funding: OREI and Western SARE

(072) Yield and Economics of Organic and Conventional Tomatoes Grown in Soils Amended with Poultry Litter and Other Nutrients

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Environmental concerns about the runoff of phosphorus and nitrogen from poultry waste in estuaries have prompted strict regulations against leaving surface applied manure on soil, and have established acceptable levels within which they must be applied in Maryland. Thus, it is necessary to find suitable combinations of nutrients and acceptable levels of poultry litter (PL) to use in growing both organic and conventionally grown crops. A 2014 field study was conducted under organic and conventional systems to assess the effect of poultry litter on the yield and economics of heirloom tomatoes (*Lycopersicon esculentum*), 'Brandywine red' and 'Debarao plum', when surface applied and then disked in the soil. Four nutrient treatments were tested in the organic system, 1.5 tons/acre PL, 1.0 tons / acre PL plus Naturesafe 13–0–0, Naturesafe 13–0–0, and Phyta-Grow Big Red 13–0–0; and three levels at the conventional site, 1.5 tons/acre PL, 1.0 tons/acre PL plus 20–0–12 and 20–0–12 alone. For both systems, 'Debarao plum' had higher marketable yield than Brandywine red. There were no significant effects of treatments on yield of 'Brandywine red' in either system. 'Debarao plum' had the highest marketable yield from the 1.5 tons/acre PL treatment in the organic system. Economic analysis based on cost-benefit ratio and profitability index for the two cultivars and different nutrient treatments, showed that growing organic 'Debarao plum' tomatoes was the most profitable one with a profitability index greater than 4.0 at the 1.5 tons /acre PL. The overall results for this first year's performance indicate that growing 'Debarao plum' heirloom tomatoes organically can be more profitable than growing them conventionally from a business perspective.

Specified Source(s) of Funding: Evans Allen

(073) Ammonia Production Rates of Three Commonly Cultured Fish Species in Aquaponics Systems

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Aquaponics is the combination of soilless plant culture, or hydroponics, with recirculating aquaculture systems (RAS). The most prolific waste product generated in RAS is typically ammonia, which is ultimately converted via the nitrification cycle into nitrate, the preferred form of nitrogen for most plants. Since the amount of available nitrate in an aquaponic system is a direct result of ammonia production, a method for accurately manipulating ammonia levels is of utmost importance. An experiment was conducted to determine the daily amount of ammonia excreted per gram of each fish species using several feeds with differing protein concentrations. Trials were run using hybrid striped bass, koi, and tilapia. The experiment consisted of six feed diets and three replications. The feed diets used were 28%, 32%, 35%, 40%, and 44% protein, plus a control group that received no feed. The pH and ammonia levels of each tank were recorded daily using a pH meter and ammonia spectrophotometer, respectively. These trials demonstrated an increase in ammonia production that paralleled the increase in protein content of feed. Although there were differences in amounts produced between fish species, all species experienced a similar trend of increased ammonia production correlated with an increase in dietary protein intake. These findings are important as they can help producers manipulate the diet of their fish stock to produce a level of nitrogen that is neither deficient nor excessive for their selected vegetable crops. This ensures that vegetable crops maintain adequate growth rates, and that excessive feeding does not occur to minimize overall expenses.

(074) Organic Fertilizers for Greenhouse Production of Day-neutral Strawberries

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Organic, locally produced strawberries are in high demand and greenhouse production can help meet consumer need for fresh

berries, particularly in the extended off-season of northern climates. Organic fertility amendments require some microbial breakdown before nutrients become available, and little data exist on organic fertility recommendations for day-neutral strawberries grown in greenhouses. The affect of fertility on nutritional composition of the crop is also of interest in these systems. Our objective was to investigate a variety of organic fertility sources on day-neutral strawberry (*Fragaria* ×*ananassa* 'Albion') plants grown in a gutter system in the greenhouse. The fertility sources were: 1) fish emulsion; 2) poultry litter; 3) all-in-one potting mix with compost; 4) a custom mix of peat, vermiculite, leaf litter compost, greensand, rock phosphate, blood meal, and lime; and 5) a conventional fertilizer comparison. We measured yield, runners and flower production, vitamin C content of fruit, and the nutrient composition of the media was measured at planting and harvest. Results show that the poultry litter treatment significantly out yielded the other fertility treatments. The custom mix tested high in soluble salt concentration, resulting in low yield. Vitamin C content was highly variable, ranging from 35–88 mg/100g fw but did not significantly differ by fertility treatment. Flower number was highest in the all-in-one potting mix with compost and lowest in the custom mix and fish emulsion treatments. This experiment shows that 'Albion' strawberry plants respond differently to organic fertility sources and contributes to our effort to maximize yield and improve quality of organic, greenhouse grown strawberries.

(075) Soil Nutrients, Nitrogen Mineralization, and Microbial Biomass in Organically Fertilized Potting Media under Greenhouse Conditions

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The Winter Greenhouse Crop Organic Fertility Study seeks to determine best practices for organic winter greenhouse crop production and to understand soil dynamics in organic greenhouses systems. Most organic fertility amendments require some degree of microbial breakdown for nutrients to be available for plant growth, so this study focused on how nitrogen mineralization, microbial biomass, and media nutrient profile affected nutrient availability and subsequent plant growth to determine whether certain organic fertility options perform well under greenhouse conditions. Spinach (*Spinacia oleracea* var. *tyee*), day-neutral strawberry (*Fragaria* ×*ananassa* cv. Albion), and a mesclun mix of arugula (*Eruca sativa*), mizuna (*Brassica rapa* var. *nipposinica*), and red giant mustard (*Brassica juncea*) were used as model plants in this study. Those crops were selected by local restaurant owners and grocers as having potential for local sales in the late fall, winter, and early spring. Fertility amendments used were: 1) fish emulsion (Drammatic 2–5–0.2 on Sunshine Natural and Organic Potting Mix); 2) poultry litter (Sustane 8-4-4 on Sunshine Natural and Organic Potting Mix); 3) a commercially available "all in one" potting mix (Purple Cow Potting Mix 0.5–0.2–0.4); 4) a mix commonly used by organic winter greenhouse growers (peat, vermiculite, leaf litter compost, greensand, rock phosphate, blood meal, and lime); and 5) a conventional comparison (CalMag 15–5–15 on SunGro LC8 potting mix). Fertilizer rates were calculated based on field recommendations for nitrogen in low organic matter soils for each crop. The "all in one" potting mix and the organic winter greenhouse blend exceeded nitrogen recommendations. Media was collected at planting and at harvest, and was analyzed for nitrogen mineralization, microbial biomass, and nutrient content. Fresh weight and dry weight of leaves and berries was taken at harvest. Although both the "all in one" potting mix and the organic winter greenhouse mix both exceeded crop nitrogen requirements, these mixes did not consistently outperform the others in harvest weight. In spinach, maximum yield was 175.62 g per 50 plants in the "all in one" potting mix and minimum yield was 63.29 g per 50 plants in the organic winter greenhouse blend. Nitrogen mineralization was measured using a 7-day incubation KCl extraction, microbial biomass was measured using chloroform fumigation, and the media nutrient profiles were measured using a mass corrected Spurway media test. Preliminary data show media vary greatly in EC and micronutrients. This experiment will provide much needed insight into nutrient dynamics in organic greenhouse cropping systems.

Specified Source(s) of Funding: Minnesota Agriculture Experiment Station, USDA–ARS NFRI, and MN-DRIVE

(076) Use of Invasive Algae as a Potassium (K) Source Affects Growth and K Content in Pak Choi (*Brassica rapa* cv. Bonsai, Chinensis Group) under Greenhouse Conditions

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The application of locally available invasive algae biomass waste as a source of crop nutrients in Hawaii is a potential strategy to replace commercial chemical fertilizers, reduce production cost and increase grower profitability. Two greenhouse trials were conducted at the University of Hawaii at Manoa Magoon

facilities to study the effects of using invasive algae species as source of potassium (K) on growth, yield, and nutrient content in pak choi (*Brassica rapa* cv. Bonsai, Chinensis group). In the first greenhouse trial, three algae species (*Gracilaria salicornia*, *Kappaphycus alvarezii, Eucheuma denticulatum*) were evaluated for growth and mineral evaluated for growth and mineral nutrition of pak choi plants with five rates of K (0, 84, 168, 252, and 336 kg·ha^{-1}). The pak choi was directly seeded into 4-L pots and grown in peat moss based media. In the second greenhouse trial, pak choi was grown in peat and soil media at five rates of K provided through *Eucheuma denticulatum* and potassium nitrate (KNO_3). Results from the first greenhouse trial showed no significant differences among the three species in yield or leaf K content. Plant yield & K concentration in plant tissue were significantly increased with application rates. The maximum yield and leaf K concentration were obtained when algae was applied at 252 kg·ha^{-1} K. In the second greenhouse trial, KNO_3 was significantly higher than *Eucheuma* for yields in soil but not in peat media. Highest yields & leaf K content in both experiments were observed when K was provided between 224–284 kg·ha^{-1} K. These results suggest that the use of invasive algae biomass is effective in increasing yield and improving K nutrition of pak choi. Further field studies are needed to validate the yield response curves developed from greenhouse trials.

Specified Source(s) of Funding: Western SARE

(077) The Effect of Intensification on Nitrogen Losses from Diversified Vegetable Farms

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The effect of nitrogen fertilizer use on the environment via greenhouse gas emissions and leaching losses has been broadly characterized in agronomic crop production. However, it has been less well studied in horticultural systems, be they conventional or organic. This work, initiated in 2014, seeks to quantify nitrogen leaching, emission and plant uptake in conventional, organic and pasture-based rotational vegetable farms along a gradient of production intensity. The three systems presented in this work are 1) conventional, 2) medium-scale organic, and 3) organic high tunnel. The data presented here are from the first 1.5 years of a 3-year study of a vegetable rotation, consisting of bell pepper and table beet, to date. Each system was replicated three times. Nitrogen leaching (ammonium and nitrate) was measured using ion exchange resin lysimeters installed at 60 cm depth, replaced every 3 months. Greenhouse gas emissions (N_2O, NH_3, CO_2, and CH_4) were measured every 2 weeks using a FTIR-based field gas analyzer (Gasmet Technologies, Finland). Additionally, N mineralization was measured using ion-exchange resin bags placed at 7.5 cm and 22.5 cm deep, replaced monthly, as well as monthly soil sampling at 0–15 cm, 15–30, and 30–50 cm depths. To date, we find that N fluxes in each system are seasonally dependent. The findings from this research will helpful in minimizing nitrogen loss from the soil and minimizing the negative impact to the environment.

Specified Source(s) of Funding: USDA–NIFA Foundational Programs

(078) Cowpea Biomass Productivity Under Organic Management in the Southeastern United States As Influenced by Cultivar and Soil Phosphorus

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Cowpea (*Vigna unguiculata*) is a warm-season, multi-purpose legume that is well-adapted to the southeastern United States and has many traits that make it an attractive forage or cover crop for integration into organic production systems, including high rates of nitrogen fixation, phosphorus (P) use efficiency, regrowth ability, and high digestibility. Eight cowpea varieties were evaluated under organic management at two locations in summer 2014 for stand establishment, biomass productivity and weed biomass. The experiment was arranged in a strip-plot design with two soil phosphorus (P) levels, amended (45 kg P/ha) and unamended, to evaluate cultivar responsiveness to P fertilization in soils of low native soil P status (Mehlich-1 P < 10 mg P/kg). Cowpea was seeded at 222,300 seeds/ha, managed organically, and biomass harvested twice during the growing season. Stand counts four weeks after planting indicated the highest plant populations from 'Iron & Clay' (201,000 plants/ha), intermediate populations from 'Speckled Purplehull', 'IT85-867-5' and 'IT82E-18' (168,000 to 183,000 plant/ha) and lowest populations from ('Coronet', 'IAR7/8-5-4-1', 'KVx396', and 'IT97K-556-4'; 147,000 to 156,000 plants/ha), likely due to presence of seedling diseases caused by *Fusarium* spp. Biomass was significantly influenced by cultivar ($P < 0.001$) and soil P ($P = 0.08$), but not the interaction ($P > 0.1$). 'Speckled Purplehull' and 'Iron & Clay' had the highest annual biomass (5349 and 5092 kg/ha, respectively), likely due to an indeterminate growth habit, rapid regrowth ability, and potentially greater resistance to seedling diseases. Biomass was least from 'IAR7/8-5-4-1', 'Coronet' and 'IT82E-18' (2137 to 2849 kg/ha), likely due to low plant populations ('IAR7/8-5-4-1', 'Coronet') and more determinate growth habits ('Coronet', 'IT82E-18'). Interestingly, soil P amendment only slightly affected cowpea biomass ($P = 0.08$; 1998 kg/ha in P-amended versus. 2173 kg/ha in unamended treatments), likely due to slightly increased weed

biomass ($P < 0.05$; 2686 versus 2383 kg/ha) in P-amended treatments. Results suggest that cultivar choice is an important consideration given wide variability in cultivar biomass production and likely differences in seedling disease susceptibility.

(079) ESO-Cuc Eastern Sustainable Organic Cucurbit Project

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Organic growers are facing many challenges limiting their production of cucumbers, melons, and squash. Each year, aphid-vectored viruses, striped cucumber beetles, and downy mildew challenge these growers in the Eastern United States. To help address these pests, the NIFA–OREI sponsored grant known as ESO-Cuc, the Eastern Sustainable Organic Cucurbit Project, is underway. The ESO- Cuc is a multi-disciplinary, multi-institutional collaboration of plant pathologists, entomologists, extension specialists, and plant breeders at Auburn, Cornell and North Carolina State Universities, partnered with eOrganic and the Organic Seed Alliance, working to help growers producing organic zucchini/summer squash, melon and cucumbers in the Eastern United States. Popular cucurbit cultivars, with consumer-desired characteristics, often lack genetic resistance to pests. We are working to develop open-pollinated cultivars that are regionally adapted, tolerant to pests, flavorful and prolific. A key to making this process work is grower input. We determine what seeds need improvement by using a blend of surveys at grower meetings and conferences, needs assessments by the Organic Seed Alliance, and the direct feedback we get through on-farm evaluations of varieties during development. A critical lens on this process comes from research being conducted directly on these insects and pathogens and their nexus with cultural practices. Our job is to strengthen these classic favorites, characterize these pests, and present management strategies most suited for 21st century organic production.

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Ornamentals/Landscape and Turf 2

(326) Combating Rose Rosette—Monitoring the Extent and Diversity of the Disease

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Roses are grown worldwide for their beauty and fragrance. The flower from this woody perennial serves as the national flower to several countries, including the United States of America. In recent years, rose rosette disease (RRD) has become a problem that threatens the U.S. rose industry and is having a detrimental impact on the use of these plants in home and commercial landscapes. Only recently, in 2011, a virus (rose rosette virus) was identified as the causal agent of this disease. Prior to 2011, diagnosis of RRD was based on visual symptoms, which are not consistent between cultivars or plantings. Recent funding from the Specialty Crops Research Initiative program will allow for the development of a monitoring/survey program for rose rosette disease. One of the aims of the monitoring effort is to catalog symptoms and cultivar information so that potential tolerant and resistant plant materials might be discovered. The proposed collected information would also provide a better view into how this disease develops and it may shed light on the nature of the pathogen's interaction with the rose. To accomplish this goal, there must be a concerted effort to increase awareness and knowledge of the public and participating volunteers to rose rosette and the symptoms that it can produce. Then tools,

such as a reporting app, must be developed to enable volunteers to report on the roses that they are monitoring. The success of finding a solution to rose rosette disease can begin with the participation of an educated volunteer base and a system to be able to receive and analyze submitted information.

Specified Source(s) of Funding: National Institute of Food and Agriculture (NIFA) Specialty Crop Research Initiative project, "Combating Rose Rosette Disease: Short Term and Long Term Approaches" (2014-51181-22644/SCRI)

(327) Combating Rose Rosette: Pictorial Guide to Rose Rosette Disease Symptoms

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Roses are highly valued in nurseries and landscape plantings for their fragrance and attractive flowers. Rose rosette is a serious disease of roses and early identification of the disease is critical for successful management. This poster was developed to show the range of symptoms associated with rose rosette disease. Depending on the cultivar, the symptoms vary but may include witches' broom (rosette), proliferation of prickles (thorns), stunting, cane dieback, leaf distortion or discoloration, and blossom blight. This poster was prepared for display in county extension offices, retail centers, and nurseries to educate clients on rose rosette disease symptoms. Small images that are found in extension fact sheets are less useful since the images are small in size and image quality may be low. Therefore, this poster has high quality, full-color, large images that can be used to assist in rose rosette disease diagnosis.

Specified Source(s) of Funding: National Institute of Food and Agriculture (NIFA) Specialty Crop Research Initiative project, "Combating Rose Rosette Disease: Short Term and Long Term Approaches" (2014-51181-22644/SCRI)

(328) Rhizosphere Acidification and Iron Deficiency Chlorosis in Deciduous Azalea (*Rhododendron* Sect. *Pentanthera*) Offer Insight on pH Adaptability

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The genus *Rhododendron* (Ericaceae), and many other Ericaceous horticulture crops, is not readily amenable to cultivation on high pH and/or calcareous soils. Rhododendrons display symptoms of iron deficiency chlorosis when grown under such conditions due to the lack of soluble iron in the soil. In many landscape situations where high pH soils abound, this translates to decreased plant vigor and performance in the landscape. We measure rhizosphere acidification, or the acidification of root apoplast tissue and surrounding soil, as a candidate trait that potentially mitigates iron deficiency chlorosis by increasing iron solubility for root uptake. Presented is an application of the authors' previously developed methods for phenotyping rhizosphere acidification in vitro at high throughput using a MATLAB script (MathWorks, Inc.). We estimate genetic variances for rhizosphere acidification in two breeding populations: a factorial mating design comprising 10 advanced *Rhododendron* sect. *Pentanthera* cultivated selections and a maternal half sib mating design containing 28 wild, *Rhododendron viscosum* parents occurring in subpopulations across the southern United States. Additionally, we describe new high throughput methods for quantifying iron deficiency chlorosis using MATLAB to phenotype leaf color on seedling azalea progeny from the aforementioned mating designs. Finally, we present family level correlations between the degree of rhizosphere acidification measured in vitro and chlorosis severity on greenhouse grown azalea seedlings after subjecting progeny to varying liming (calcium carbonate) rates.

Specified Source(s) of Funding: University Minnesota Dept. of Horticultural Science, University of Minnesota Landscape Arboretum, Azalea Society of America

(329) Evaluation of Organic Fertilizer on Performance of St. Augustinegrass Cultivars

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Sustainable lawn care practices include reduced fertilizer and water inputs. Lawn fertilization with organic fertilizer sources are gaining acceptance in landscape maintenance practices. Interest in landscape water conservation practices is peaked by shortages in water supply across the United States. A goal of this study is to measure growth responses of st. augustinegrass [*Stenotaphrum secundatum* (Walt.) Kutze] 'Amerishade', 'Captiva', 'Delmar', 'Palmetto', and 'Raleigh' fertilized at three rates of organic fertilizer source while implementing water conservation practices. An organic fertilizer source was applied at a rate of 100, 200, and 300 $kg \cdot ha^{-1}$ N per year (low, medium, and high N) split over three applications with the first application in May 2014. Plots are irrigated using seasonal crop coefficients, minus rainfall, of 0.5, 0.6, and 0.7 for spring,

summer, and fall, respectively. A regular cutting height of 7.6 cm was maintained. Spring 2015 greenup ratings in both low N and high N treatments indicate no differences among cultivars. 'Raleigh', 'Palmetto', and 'Captiva' had significantly larger spring greenup ratings than 'Amerishade', but not larger than 'Delmar' in the medium N treatment. Leaf stomatal conductance means did not vary by cultivar. Density, color ratings, and soil nutrient analysis will be presented.

(330) Growth of Naiad in Substrates with Varying Percentages of Sand and Controlled-release Fertilizer

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Naiad (*Najas guadalupensis*) is a native aquatic plant in Florida. Very little has been published on its growth requirements. Many aquatic plants can be produced in submerged containers filled with sand. Our objective was to compare naiad growth in substrates with varying percentages of sand and at 4 fertilizer rates. Plants were placed in submerged containers filled with 100% sand, 75% sand 25% peat, 50% sand 50% peat, 25% sand 75% peat, and 100% peat. Each container had 0, 2.6, 5.2, or 10.4 grams of Osmocote 15 N–9 P_2O_5–12 K_2O incorporated into the containers prior to planting. We had four mesocosms for each fertilizer rate that held 1 container for each substrate. Containers were planted with three cuttings per container. Mesocosms were randomized and placed in a greenhouse for 8 weeks. Naiad shoot and root dry weight in 100% sand increased as the fertilizer rate increased from 0 to 5.2 and then decreased. Naiad shoot and root dry weight in 75% sand and 50% sand increased from 0 to 2.6 g and then decreased. In 25% sand and 0% sand, growth linearly decreased as fertilizer rate increased. Greatest growth was observed in 50% sand with 2.6 g of Osmocote. It appears that with the addition of an organic substrate component, less fertilizer was required for naiad growth.

(333) Micropropagation of Ornamental Grass *Miscanthus senensis* 'Strictus'

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Miscanthus sinensis can be a promising species for biomass production or beautiful ornamentals for landscaping. An efficient in vitro plant propagation system was established in Miscanthus senensis 'Strictus'. Meristems from the field plant were sterilized in 25% Clorox with two drops of Tween-20 and then cultured in the shoot germination medium [Murashige and Skoog (MS) charcoal (1 g/L) medium supplemented with 6-Benzylaminopurine (BA) at 1 mg/L for 4 weeks. Fifty percent of the explants germinated and produced in vitro shoots. Different plant growth regulator combinations were tested for multi-shoot production; the best results were obtained when 2 mg/L of BA was added in MS medium, with a mean of three shoots multiplied from a single shoot within 3 weeks. Single shoots were transferred to MS medium with 1 g/L activated charcoal for 2 weeks, and 100% of the shoots formed functional roots, which resulted in a 100% survival rate when acclimatized in potting soil. This research provides a promising method to large-scale propagation of Miscanthus senensis in a limited time.

(334) Micropropagation of Two Ornamental Grasses, *Schizachyrium scoparium* and *Sporobolus heterol*epis

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Efficient micropropagation systems were established for two ornamental grasses, *Schizachyrium scoparium* ('The Blue' and 'Minn Blue A') and *Sporobolus heterolepis* ('Tara'). Meristems were used to initiate in vitro cultures, and adventitious shoots were induced using various NAA and BA treatments. In vitro shoots of *S. scoparium* could multiply well on both MS solid medium and MS liquid medium supplemented with various combinations of NAA and BA, with the shoots from liquid medium growing stronger and faster. Roots were induced using MS medium supplemented with 0.1–0.5 mg/L of IBA or NAA for *S. scoparium*, while for *S. heterolepis*, roots were induced from MS medium without any growth regulators. The multiplication rate of our propagation system after 4 weeks was 7-fold for *S. scoparium* and 4-fold for *S. heterolepis*.

(335) Plant Select®: Plant Smarter

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Plant Select® is the country's leading source of plants designed to thrive in high plains and intermountain regions, a non-profit collaboration of Colorado State University, Denver Botanic

Gardens and horticulturists from around the world. Plant Select® in 2014 recently went through a re-branding exercise after 17 years of introducing and recommending superior landscape plants for the Rocky Mountain Region and beyond. Plant Select®has a smarter selection process and every plant endures a vigorous 7-point selection process, and winning plants must 1) thrive in a broad range of conditions, 2) flourish with less water, 3) be tough and resilient in challenging climates, 4) be one of a kind/unique, 5) have disease and insect resistance, 6) be long-lasting beauty, and 7) not be invasive. Over the years plants coming out of this program have many smart features including: beautiful, adaptable, durable, water wise, easy to care for, lower negative environmental impact and a higher positive impact and can be tough and beautiful at same time. These plants also have smart benefits to the consumer including: having the right plants for the right climate means more chances of success, having an environmentally smart garden, more garden beauty with less work, gardens that flourish longer with fewer resources, gardens that can save time and money and gardens that are smarter for the environment. Currently Plant Select® has a total of more than 240 partners including 79 licensed propagators and 58 retail garden center members. We also have 80 public demonstration gardens throughout the region. Trials and evaluations are done at both Colorado State University and Denver Botanic Gardens where 45 species were trialed in 2013 and 2014. Evaluations are also done at most of the demonstration gardens and plants are rated according to their performance at each location. Plants were ranked according to elevation range and *Acer tataricum* 'GarAnn' PP15023 ranked highest in both the 3000–5500 and 5500–7500 feet elevation ranges. *Prunus besseyii* 'P0015' (Pawnee Buttes) sand cherry ranked highest in the range over 7500 ft. Numerous marketing materials have been developed including a website with individual plant searches and customizable plant lists, video library, design gallery, downloadable designs, plant buyers source guide, newsletters, plant guide and brochures. For more information visit www.plantselect.org or email: info@plantselect.org.

Thursday, 6 August 2015

Plasticulture

(225) Planting Date Affects Yield and Harvest Duration of Organically Managed Salad Mixes in High Tunnels

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Salad mixes of baby-leaf lettuce, spinach and mustard greens are high cash-value crops for farmers and an important component of a healthy diet for consumers. A unique characteristic of salad mix production is the allowance for multiple harvests, as leaves of these vegetables can regrow after being cut. High tunnels are effectives tool in achieving season extension in vegetable production; however, information on growing salad mixes in high tunnels is limited. The study was conducted in Spring and Fall 2014 in Greensboro, NC, with an objective to identify ideal direct seeding time for salad green mixes in high tunnels. Lettuce mix 'Encore', spinach mix of 'Tyee', 'Emperor' and 'Corvair' and mustard green mix 'Ovation' were direct seeded sequentially on three planting dates (D1, D2, and D3) in high tunnels. Planting dates were 17 Feb., 27 Feb., and 11 March in spring, and 22 Sept., 2 Oct., and 13 Oct. in fall, respectively. Seeds were planted in four rows on 76.2-cm wide raised beds. Lettuce and mustard greens were thinned to 1.3 cm apart, and spinach was thinned to 2.5 cm apart. A completely randomized design with three replications was used. Each experimental plot consisted of a 152 cm bed. Harvests were conducted three times a week when leaves reached 8–10 cm high until mid-May or end-December. There were no significant differences among planting dates in total marketable yield of mustard green and spinach mixes for both seasons, while D2 of lettuce mix had a higher yield than D3 in both seasons. In the fall, D1 was harvested 2–7 and 9–21 days earlier than D2 and D3 for all salad mixes; while in the spring, the first harvest of D1 mustard green and spinach mixes occurred later than that of D2. Harvest of mustard green mix was terminated earlier than lettuce and spinach mixes in both seasons, with 5–6 and 9–12 effective harvests (marketable yield > 100g per plot) in spring and fall seasons. On average, the duration from direct seeding to the first harvest was 5–12.7 days shorter in the fall than that in the spring season. This experiment will be repeated in 2015 to draw conclusions on appropriate planting time for production of salad mixes in high tunnel.

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(226) Getting off the Grid: Solar Greenhouse Design and Rainwater Catchment Use

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Passively heated solar greenhouses are quite common in East Asia, with "Chinese solar greenhouse" designs having been in use since the 1930s. These designs are typically single-slope,

and utilize a thermal mass typically comprised of earth or other natural materials to capture solar gain, and may experience temperatures 25 °C to 30 °C warmer than field conditions without the use of active heating elements. Despite the significant promise of these low energy designs, solar greenhouses have been minimally adopted in North America. However, with the dramatic increase in adoption of season-extension technologies in recent years, coupled with growing demand for locally produced food, solar greenhouses may be a viable season-extending alternative with greater solar gains than high tunnels, without the heating cost of traditional greenhouses. In 2013, a 6 m x 22 m "Chinese style" solar greenhouse was constructed at the University of Kentucky (UK) Horticulture Research Farm. The greenhouse was divided into two sections with each containing a different media for thermal mass lining the north (south-facing) wall: 1) food-grade plastic barrels filled with water, and 2) a wall of corrugated metal and wood filled with sand approximately 30 cm thick. Data loggers recording temperature and relative humidity at 15-minute intervals were placed at various locations in the greenhouse, including in the media, immediately adjacent to the media, in the center of the tunnel, and at soil level in the center of the tunnels. Soil temperatures were also recorded at the center of the tunnel. Summaries of two years of air and soil temperature data as compared to high tunnels and field conditions at the same site are presented. In 2014, the University of Kentucky solar greenhouse was fitted with a rainwater catchment system utilizing an ultra-low pressure drip irrigation system. The system was designed to create a replicable model for rainwater catchments for season-extension structures utilizing locally available materials, without the use of high pressure for irrigation created by elevating water tanks or using pumps. This system has been found to cost under $500 for this design, and further develops the ability for solar greenhouse technologies to decrease the use of off-farm and energy-intensive inputs.

Specified Source(s) of Funding: Kentucky Horticulture Council, Kentucky NRCS Conservation Innovation Grant

Thursday, 6 August 2015

Vegetable Crops Management 2

(393) Performance of Nine Butternut Squash Varieties in Summer in the U.S. Virgin Islands

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Butternut squash (*Cucurbita moschata*) is a high value vegetable with similar flavor and texture to other Caribbean pumpkin (*Cucurbita pepo*) varieties. We evaluated the yield potential of nine butternut squash varieties on St. Croix, USVI. The experimental design was a complete randomized block consisting of nine cultivars [Waltham Butternut (WM), JWS 6823 PMR (JW), Metro (MO), Hunter (HR), Honey Nut (HN), Nutterbutter (NB), Tiana (TA), Butterbush (BB), and Pilgrim (PM)] with three replications. The field was prepared following standard cultivation practices (ploughing, harrowing, and rototilling). Squash were seeded on 9 June 2014, with 0.8 m in-row spacing and 1.5 m between rows for a total of 18,750 plants/ha. Plots were irrigated with 40 cm T-Tape (John Deere, Moline, IL) and fertigated weekly using soluble 20–20–20 fertilizer at a rate of 100 kg N/ha. The first harvest was 71 days after planting (DAP) and final harvest was 98 DAP. All varieties had similar total yield (JW = 7294; TA = 7040; HN = 6529; WM = 6390; PM = 5626; NB = 5301; MO = 5296 kg/ha) except for BB (2833 kg/ha) ($P > 0.05$). The marketable fruit weight was not different among the nine varieties ($P > 0.05$). HN had the highest sugar content at 11.7 °Brix, followed by MO (8.0 °Brix) and PM (7.2 °Brix). All the other varieties presented the same °Brix, ranging from 4.7 to 7 °Brix ($P < 0.0001$). TA presented 50% more melonworm moth (*Diaphania hyalinata*) than the varieties WM, NB, HR and BB ($P < 0.05$). HN had higher leaf miner (*Liriomyza sativa*) (48) than NB, PM, WM, JW (20–40), and BB. WM, JW, and BB were more tolerant to leaf miner than the other varieties (8–15) ($P < 0.05$). Silverleaf disorder, induced by the silverleaf whitefly (*Bemisia argentifolii*), was higher on HN, BB and TA (4) than PM (1), not been found on the other varieties ($P < 0.05$). JW had less powdery mildew than HR ($P < 0.05$). Results indicate that all varieties except BB have potential as a high value vegetable crop for St. Croix, USVI.

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(394) Yield of Tomatoes in High Tunnels: Stake and Weave versus Prune and String Support Systems

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Fresh market tomatoes grown in the soil in high tunnels (unheated greenhouses) are typically supported in order to improve yield and quality and make management easier. A variety of support systems are used but data on yield and quality of fruit from various systems is not readily available. We conducted trials in 2013 and 2014 in two high tunnels in Wanatah, IN, to compare yield of three tomato varieties grown using two support systems: stake and weave (W), or prune and string (S). Rows were spaced 4 ft. apart with plants 2 ft. apart in the row. In the stake and weave system plants were not pruned; stakes were placed every two plants, and string woven horizontally along either side of the plants along the row. In the prune and string system, indeterminate varieties Big Beef (BB) and Cherokee Purple (CP) were pruned to two main stems and each stem clipped

to a vertical string. For the determinate variety Mountain Fresh (MF) one branch just below the first main stem flower cluster and all branches above that cluster were left to grow, but all branches below the first cluster were pruned off. Initially 2 and later up to four or five stems per plant on MF were clipped to vertical strings. Each variety was treated as a separate experiment for analysis. Yield of marketable fruit was significantly greater with W than with S support system: BB averaged 15.3 and 6.5; CP averaged 6.8 and 1.4, and MF averaged 17.3 and 14.8 lb/plant for W and S, respectively. The percentage of total yield that was culled was less with W than with S for BB and CP, but not for MF: BB averaged 16.2 and 27.3, CP averaged 31.6 and 51.3, and MF averaged 13.8 and 13.3 percent cull by weight, for W and S, respectively. These results indicate that the stake and weave support system is likely to lead to greater marketable yield and a lower percentage of culls than pruning to two or several stems and clipping each stem to a vertical string.

(395) Performance of Cucumber Cultivars in Northern Climate

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Fruit yield and quality of 10 commercial cucumber (*Cucumis sativus*) cultivars (A&C Pickling, Bushy, Double Yield, Eureka, Marketmore 76, Marketmore 97, National Pickling, Parade, Russian Pickling, and Straight 8) were evaluated for local production in North Dakota. Seeds were sown directly in the field on June 20, 2014, on raised beds mulched with clear polyethylene film. Plants were spaced 3 feet (91 cm) apart on rows that were spaced 4 feet apart. Cucumber fruits were harvested weekly from 13 August for two months. 'Marketmore 76' and 'Eureka' produced the largest number of fruits (180 and 168 per 10 plants, respectively). Top yielding cultivars on a fruit weight basis were 'Marketmore 76' and 'A&C Pickling' with 62 kg and 60 kg per 10 plants, respectively. 'Bushy' had the lowest yield with 101 fruits and 29 kg per 10 plants. Soluble solids content did not vary significantly by cultivar with a range of 3.2 to 4.2. Two cucumber cultivars (Regal F_1 and Raider F_1) were also grown with 3 different mulching materials (bio-film, clear poly film, and black poly film) and with no mulching. The fruit yield was 20.7% higher with mulching, compared to no mulch. Mulching with black poly film provided the highest fruit yield for both cultivars tested.

(396) Evaluation of Pepper Cultivars for Production in Northern Great Plains

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Ten commercial sweet pepper (*Capsicum annum*) cultivars (Ace F_1, California Wonder, Carmen F_1, Jupiter, King Arthur F_1, King Crimson F_1, King of the North, Peacework, Ruby King, and Yankee Bell) were evaluated for their performance and fruit quality for local production in North Dakota. Seeds were germinated in cell packs containing Pro-Mix root substrate and seedlings at 6 true-leaf stage were transplanted into the field on 6 June 2014, about 2 weeks later than the normal planting time. Plants were spaced 1.5 feet (45 cm) apart in rows that were spaced 4 feet apart. Plants were grown in heavy clay soil and overhead irrigated as needed. Mature fruits with full pigmentation were harvested weekly from 13 September for four times. The number and weight of total fruits harvested and percent fruits marketable were obtained at each harvest time. Overall, the average fruit yield was highest in fourth harvest. While 'Ace F_1' had the highest fruit yield during the first week of harvest, 'King of the North' had the highest total average yield (8.5 kg/10 plants). 'Carmen F_1' produced the largest number of fruits (89 fruits/10 plants) followed by 'Ace F_1' at 81 fruits/10 plants. The fruits of 'Carmen F_1' also showed the highest soluble solids content (10.2% °Brix reading) compared to other cultivars which showed an average of 8.3%. Fruit qualities measured by sweetness, texture, flavor and appearance were also evaluated for each cultivar. Lycopene and other pigment contents of the fruit were also determined using lyophilized tissues.

Specified Source(s) of Funding: ND Specialty Crop Block Grant

(397) Spring and Fall Supersweet Corn Trials in Georgia

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In Spring and Fall 2014 evaluations of supersweet corn varieties were conducted in Attapulgus and Tifton, GA, respectively. In spring and fall there were 29 and 27 varieties of bicolor, yellow, and white corn evaluated, respectively. Trials were planted on 24 Mar. and 12 Aug. 2014 and managed using standard practices recommended by The University of Georgia. Plant populations were 64,555 per hectare. Emergence, vigor, yield, average ear length and width, row of kernels, tip coverage and tillers were recorded. There were significant differences in seed emergence and plant vigor in the spring-planted trial with five varieties having emergence rates below 90%. Emergence and plant vigor were well correlated. All varieties had high emergence and vigor ratings for the fall trial. The highest yielding varieties in spring were 2974 MXR, Awesome XR and BSS 0977, and the lowest were Obsession II, SC 1336, and 2760 MR. The highest yielding varieties in the fall were Obsession SC 1336, 1229, and 7143, and the lowest were Obsession II, Stellar XR and 3188 MR. In the fall, even the lowest yielding varieties had yields that were comparable to some of the higher yielding varieties in the spring. Yields in the fall averaged 150–200 more boxes per ha than in spring. There were significant differences in ear length

and width. Ear length on average for all varieties was greater in spring and ranged from 18.3 to 21.6 cm and 16.5 to 20.5 cm in fall. Conversely, ear width ranged was slightly, but significantly lower in spring than in fall. Ear width ranged from 4.0 to 5.1 cm in spring and 4.6 cm to 5.4 cm in fall. Kernel rows were variable and not significantly different among seasons, although were different among varieties. Lodging was not observed in the spring trial; however, four varieties, Bright White, Rainier, Stellar XR, CAPBF10-411, and 2974 MCR had lodging rates of greater than 25%. Significant differences were observed for quality and yield for varieties in spring and fall, suggesting that supersweet corn trials for the Southeastern U.S. should be conducted during both growing seasons to make scientifically based recommendations to growers.

Specified Source(s) of Funding: Georgia Vegetable Commodity Commission

(398) Rough Sweetpotato Weevil (*Blosyrus asellus*) Damage to Sweetpotato (*Ipomoea batatas*) Cultivars in Hawaii

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Sweetpotato, *Ipomoea batatas* (L.) Lam., production has increased in recent years in Hawaii and, based on 2011 data, was the 10th highest value crop in Hawaii. Production constraints have included three insect pests of quarantine significance as well as several diseases. In 2008 a new insect pest of quarantine significance, the rough sweetpotato weevil, *Blosyrus asellus* (Olivier) (Coleoptera: Curculionidae), was found on a commercial sweetpotato farm on the island of Oahu, with subsequent detection on the island of Hawaii in 2014. In contrast to other weevil pests of sweetpotato in Hawaii where the immature stage (grubs) feed inside the root, rough sweetpotato weevil grubs form grooves or channels on the root surface as they feed. At present, this pest is not known to occur on the U.S. Mainland. Ten sweet potato cultivars were evaluated for yield, and resistance to pests and diseases found along the Hamakua Coast of Hawaii Island. These cultivars included three from Hawaii ('Okinawan', 'Mokuau', and 'Kona B') and seven from the USDA Germplasm Repository in Griffin, Georgia ('Beauregard', 'Darby', 'Pelican Processor', 'Picadito', '392', 'L329', and 'ACC208'). Cuttings of these cultivars were planted in plots at a spacing of 1.5 m between rows and 0.3 m within rows, with 30 cuttings per plot. Due to limited number of cuttings, treatments of cultivars were replicated over time, with the first planting on 8 May 2014 and the second planting on 1 October 2014. Root damage by rough sweetpotato weevils was first observed at the harvest of the first planting. Traps designed to monitor the presence of rough sweetpotato weevil adults in each sweetpotato cultivar were deployed near the time of harvest of the second planting. Average trap catch across all ten varieties was 1.4 weevils/trap/day (range: 0.62–2.5 weevils/trap/day). Plants were harvested at 5 months and 4.5 months after planting, respectively. Marketable yields differed significantly among cultivars, ranging from 263 to 15,132 kg/ha. There were also significant differences among cultivars in root damage by rough sweetpotato weevil, with injury ranging from 23% to 100% of marketable yields. Root damage results suggest that resistance to damage by rough sweetpotato weevils may vary among sweetpotato cultivars.

Specified Source(s) of Funding: U.S. Department of Agriculture Hatch Act

(399) Determination of Optimum Plant Spacing for New Mexican Green Chile (*Capsicum annuum*)

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New Mexican-type green chile is harvested when the fruit are fully sized, but physiologically immature, and quality is impacted by fruit size. Yield and fruit size are impacted by cultivar genetics, environmental conditions, and field management. One of these management factors is the spacing between plants. The standard spacing between plants in New Mexico is 30 cm, and in furrow-irrigated fields, 102 cm row spacing is typical. Early season stand losses due to disease or abiotic disorders may greatly increase the average spacing between plants. In addition, plant spacing closer than 30 cm has been shown to benefit mechanical harvest efficiency in red chile. However, the impact to fruit size must be considered as a preliminary step in utilizing this technique for green chile. This study investigated the effect of chile plant spacing on final green chile yield, fruit quality and plant habit attributes. A field at New Mexico State University's Leyendecker Plant Science Research Center was direct seeded (2 kg/ac) with 'New Mexico 6-4,' a standard New Mexico-type chile cultivar, on 11 Apr. 2014. The field was furrow irrigated and fertilized according to standard production practices in the area. On 6 June, six thinning treatments (152, 61, 30, 20, 15, and 7 cm spacing between plants) were applied to the field in a RCB design with six replications. Each treatment plot consisted of four concurrent rows, 3 m in length. On 8 Sept., data was collected from the two inner rows in each plot. Thinning treatment had no discernable affect on plant height and no impact on distance to primary node; however, plant width was significantly greater at the wider plant spacing and narrower at the closer plant space treatments. Significantly more basal branches were counted on plants in the wider spacing treatments. Fruit weight, length, and wall thickness did not exhibit any treatment effects; however fruit were significantly wider in the wider plant spacing treatments. The overall yield was significantly less in the 152-cm treatment; however, there were no significant differences in

yields in the other thinning treatments. Closer plant spacing did not adversely affect fruit yield and minimally affected quality; therefore, closer plant spacing should be further investigated for potential to improve mechanical harvest efficiency of green chile.

(400) Effects of Topping on Marketable Yields in Several Cultivars of Brussels Sprout (*Brassica oleracea* var. *Gemmifera*)

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In New England, Brussels sprouts are grown primarily for direct market, and are harvested and marketed on the stalk. Many cultivars are available, but published comparisons to guide grower choice are lacking. In Brussels sprout production, removal of the apical meristem (topping) has been shown to increase yields in once-over harvests. However, recommendations regarding topping vary widely and the effects of this practice on currently available cultivars have not been studied. The objective of our study was to compare yields, performance, and response to topping for several Brussels sprout cultivars. Experiments were conducted in 2013 and 2014 in Durham, NH, at the NH Agricultural Experiment Station. Seeding and harvest occurred on 3 June and 6 Nov. in 2013, and on 12 May and 19 Oct. in 2014. We grew nine cultivars in each year, with five grown in both years. A split-plot design with four replicates was used, with cultivar as the main factor and topping as the split plot factor, and experimental units of six plants. For topping treatments, apical meristems were removed when basal sprouts first reached 1.25 to 2.5 cm diameter. This resulted in earlier topping dates in 2014 (4 Aug. through 23 Sept.) than in 2013 (10 Sept. through 18 Oct.). Number and weight of marketable sprouts were assessed for each stalk. For each plot, we estimated the percentage of sprouts that were too large, too small, and that showed Alternaria symptoms. We observed significant differences between cultivars for all measured traits. The effects of topping were variable, and appeared to be associated with maturity date. In 2013, topping either significantly increased or had no effect on yields, depending on cultivar. However, in 2014, topping increased yields for some cultivars, had no effect on others, and decreased yields for others. Taken together, our results suggest that topping has the potential to increase marketable yields for several cultivars, but that topping far in advance of harvest (60 d.) may negatively impact yields in terms of weight and number of marketable sprouts, and reduces stalk length.

Specified Source(s) of Funding: NH Agricultural Experiment Station, NH Vegetable & Berry Growers' Association

(401) Pot Vegetables for Cities

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With the growing population of cities, the trend of using built and unbuilt areas for growing food is gaining importance. The practice of homegarden is expanding where pot culture has occupied an important place because of its intensive culture, quality production, and mobility of pots both inside and outside the home (including veranda, window, and terrace). Solanaceous vegetable plants as well as cucurbitaceous vegetable climbers not only produce quality fruits but also decorate the households beautifully. Different kinds and varieties of vegetables with a range of nutritive values grown in pots are illustrated.

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Viticulture and Small Fruits 2

(343) Fruit Quality and Polyphenolic Compounds of 'Tupy' Blackberry Influenced by Pruning Time and Irrigation Management in a Subtropical Climate

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In the southern states of Brazil, the largest blackberry cultivation area in the country, the harvest season for blackberries is November to February. In São Paulo state, the climate is warmer than the far south and harvest begins in October. Using management techniques such as pruning and growth regulators, it is possible to begin the harvest period earlier. Fruit marketed outside the normal harvest season returns higher prices to growers. Our study examined berry weight and fruit quality impacts from winter pruning date and irrigation. The study was conducted at Fazenda Experimental São Manuel, São Manuel-SP, Brazil. Three-year-old 'Tupy' blackberries were trained to a 1.2 m high espalier-type trellis with four lateral canes retained in a "T" configuration. The experimental design was a 2 x 5 factoral, with two irrigation treatments (irrigated and non-irrigated) and five pruning-date treatments (pruning done on 5 May, 6 June, 7 July, 23 Aug., and 26 Sept.). There were four replications (six plants per replication. At the mid-point of the harvest period, 100 g of berries were collected from each replication and data recorded including average berry weight, titratable acidity, pH, soluble solids, and anthocyanin and total polyphenolic contents. There was an interaction between pruning date and

irrigation treatment for berry weight and fruit quality variables. Berry weight ranged from 6.5 (pruned in May-non irrigated) to 9.7 g (pruned in August-irrigated). Soluble solids ranged from 9.5 (pruned in May-non irrigated) to 12.0% (pruned in August-irrigated), and titratable acidity ranged from 0.66 (pruned in August-irrigated) to 1.44 mg/100g^{-1}fw of citric acid (pruned in June-non irrigated). The pH levels were different only among pruning dates, ranging from 3.1 (pruned in May and June) to 3.6 (pruned in September). The highest concentrations of total polyphenols (258.7 mg of galic acid/100g^{-1} fw) and anthocyanins (271.8 mg of cyanidin-3-glucoside/100g^{-1} fw) were found with pruning performed in May on nonirrigated plants. This was also a period when rainfall did not occur and temperatures were consistently lower than later in the harvest season. Our study showed that date of pruning had a substantial influence on quality of 'Tupy' blackberry and this could impact acceptance by fresh-market consumers.

(344) Valuation of the Northern Grapes Project Webinar Series

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The Northern Grapes Project was funded in 2011 through the USDA Specialty Crops Research Initiative, and has successfully delivered a wide range of outreach products to the target audience, the most popular of which is the Northern Grapes Project Webinar Series. Webinars are presented once monthly from November through April, and recordings are archived on the project website. Twenty-four webinars have been delivered to a live audience of over 2300 people, with over 6500 views of the recorded webinars. Post-webinar surveys show that viewers are satisfied with the series. When asked if the logistics of the webinar were satisfactory, 90% of respondents agreed or strongly agreed. Participants also indicated that they're finding the series to be educational: an average of 84% said their awareness and 80% said their knowledge of the subjects increased at a moderate or higher level. However, placing a dollar value on the webinar series would allow us to better estimate the impact of the series. Therefore, we modified two models published in the *Journal of Extension*, one that estimated the viewer time investment and the other that calculated the green savings of participating in webinars instead of attending presentations in person. Together, these two models indicated a $420,000 value of the series. Further, we surveyed the users of the webinar series, asking them how much they would pay to watch a live webinar and access the archived webinars, as well as how much money they had earned or saved from the webinar series information. The models and the responses from the survey allow us to generate an idea of the real dollar value of the webinar series.

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(345) Screening Grapevine Cultivars for Adaptability to Soil and Climatic Conditions in Wyoming

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Grape production in Wyoming evinces strong interest from producers exploring new crops in addition to traditional crops, as well as homeowners with backyard plantings. Low winter temperatures, late spring frosts, and a short growing season limit the cultivation of traditional cultivars in Wyoming. With the development of new cold-hardy grape cultivars, the scope for grapevine production in colder regions of the United States, including Wyoming, is rapidly expanding. The goal of the project is to identify promising grapevine cultivars for Wyoming, thus overcoming obstacles to initial vineyard establishment, resulting in increased production and early returns. Ten cold-hardy grapevine cultivars that have been developed from interspecific hybridization of *Vitis vinifera* with American grape species (*Vitis labrusca* and *Vitis riparia*) were planted at Sheridan and Powell, WY. Vines were planted at 10 feet × 5 feet spacing in 30-cm deep holes that were filled with compost and supplemented with 50 g 19:6:12 slow-release fertilizer. A drip irrigation system was installed to provide irrigation during periods of extreme drought. Vineyard irrigation was terminated at the end of September to initiate grapevine acclimation for winter conditions. Budbreak and vine survival rates were recorded in the spring to estimate vine winter damage and cold-hardiness of various cultivars. Preliminary results indicated significant variations among grapevine cultivars in timing of budbreak and vine survival rates at the two locations. Budbreak following dormancy among cultivars ranged from early (14 May) to late (9 June). A higher vine survival rate was recorded in Sheridan (73%) compared to the Powell location (40%). Among the various cultivars studied, 100% survival was recorded in 'Frontenac', 'Marechal Foch', and 'Osceola Muscat', at Sheridan, while 60% survival and regrowth was recorded in 'Frontenac Gris' and 'Elvira' at the Powell location. Grapevine cultivars exhibit a wide variation in growth and developmental response to varying soils and climate. Vine establishment following planting, growth and development, flowering, berry development, and ripening also vary regionally. Such variation in survival rates may be attributed to the differences in soil, climate, and topography of the two test sites. We are currently evaluating flowering and fruiting characteristics of grapevine cultivars. Identification of cultivars suitable for specific regions of Wyoming will assist growers make the right choice of cultivar/s, improve production and enable a faster recovery of establishment costs.

Specified Source(s) of Funding: USDA

An asterisk (*) following a name indicates the presenting author.

(346) A Spotted Wing Drosphophila Trapping Study in the Small Fruit and Grapes Plots and a Woodlot at Piketon, Ohio

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Spotted Wing Drosphophila (SWD), *Drosophila suzukii,* has been found in small fruits, such as blackberries, raspberries and strawberries in 24 counties in Ohio. This invasive pest attacks healthy fruits and can cause devastating crop losses. One key aspect of SWD management is early detection since the economic threshold is one SWD (male or female). It is important for researcher and growers to know where SWDs overwinters and when it first emerges in a mixed fruit planting with woods nearby. The research farm at OSU South Centers fits this criterion perfectly. There are plantings of blackberries, grapes, high tunnel raspberries, and plasticulture strawberries, and a wooded area. A comprehensive SWD trapping study was carried out in 2014 on our research farm. Multiple traps made out of clear 32 oz. deli cups baited with apple cider vinegar (and a drop of dish soap) were placed in each area of interest. Traps were first placed in the woods on 3April 2014, in the strawberry plot on 7 May in the blackberry plot on 16 June, in the raspberry patch on 16 June, and in the vineyard on 30 August 2014. Traps were changed and checked on a weekly basis. No SWDs were caught before 14 August on our research farm. Once the first SWD was caught in the woods on 14 August, more SWDs were found in blackberry and raspberry plots at the same time. No SWDs were found in the plasticulture strawberry plot. Only a small number of SWDs were caught in the blackberry plot after the initial catch since there were only limited amount of fruits present. More SWDs were caught in the high tunnel raspberry plot with the highest number of catches on 30 October. Only a small number of SWDs were caught in our vineyard with the high number on 30 October. The largest number of SWDs was caught in the woods among all plots with the highest catches on 13 November. It is likely that a lot of SWDs overwinter in the woods. These SWDs in the woods could be a potential threat to fruit patches nearby. It is still too early to tell if reducing SWDs in the woods can lead to significant reduction of SWDs in the fruit plots nearby.

(347) Performance of Eight Muscadine Cultivars and Selections in Southern Georgia

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Eight muscadine (*Vitis rotundifolia*) genotypes were evaluated over five years in a replicated test vineyard located in southern Georgia, USA. Genotypes included the six cultivars (Fry, Hall, Lane, Supreme, Tara, and Triumph) and two breeding program selections (Ga. 6-2-26 and Ga. 6-2-46). Cumulative yields ranged from 36 to 80 kg per 3-meter vine. Berry samples from each harvest were used estimate the berry weight, berry diameter, and soluble solids content. Berries were also evaluated to determine the percentage of berry rot, stem scar tears, and stem scar splits in order to calculate the usable yield of each genotype. The female cultivar (Fry) had the lowest yield as well as the lowest percentage of usable yield. 'Lane' is useful as an early black colored cultivar, but yields are low and the percentage of berries with torn or split stem scars is high. 'Hall' has an early harvest date and a high percentage of dry stem scars, but needs to be picked promptly to prevent loss from berry rots. 'Tara' had the lowest soluble solids content resulting in poor flavor. 'Triumph' was productive, but berry size was small and color is poor. 'Supreme' was very productive, especially for a female vine, but had a low percentage of dry stem scars. Ga. 6-2-26 and Ga. 6-2-46 are high yielding, mid-season cultivars that produce a high percentage of usable yield.

(348) Assessment of Vine Quality and Pruning Techniques in Oklahoma Vineyards

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Pruning is one of the most important jobs for a viticulturist. Proper pruning can improve fruit quality and stabilize production over time. By consistently limiting the number of shoots and leaves via dormant pruning, one is also working to produce the maximum crop without delaying maturity year after year. Failure to prune can lead to improper ripening, reduced cane maturity, reduced productivity of buds the following season, and a decrease in root mass. Therefore, pruning needs to regulate the number and positions of shoots on a vine, which, in turn, regulates cluster number and size. In April 2014, 26 vineyards throughout Oklahoma were surveyed for grapevine quality and pruning techniques. Measurements of spur diameter, internode length, and spurs retained per linear foot of row were taken. Data shows that among all cultivars observed, few spurs were within the desired range of 0.8 to 1.3 cm diameter. This indicates potential problems such as poor vigor (possibly due to own-rooted vines), poor nutrition, lack of adequate water, poor weed management, too much crop load in previous year, or leaving too many shoot/canes the previous years. Less of a problem was spur internode length. Although within the broad parameters of 2.5 to 10 cm, most cultivars in Oklahoma fell in the lower part of that range. The number of spurs per linear foot by cultivar was too many in most vineyards in Oklahoma. The desired range is ~2.5 spurs per linear foot of canopy; however, most observed were greater than 3 and most over 4. Overall, there were deficiencies identified in vine quality and pruning techniques that could be improved to deliver better grape crops in the future.

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(349) Environmental Stability in the Fall Acclimation Response of Cold-hardy Interspecific Hybrid Wine Grapes

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Cultivar development has allowed commercial wine production in North Dakota. Among the most grown cultivars in the region are Frontenac Gris, Marquette, and St. Croix. Though these cultivars have been adopted, some uncertainty exists in their year-to-year reliability. A key factor in determining reliable performance is fall acclimation to winter conditions. In a three-year study, vine acclimation response was tract at two locations in North Dakota for the three cultivars. Seven acclimation predictors were evaluated at each location for each half-hour decrease in photoperiod (15–12 hours daylight). Principal components analysis was used to reduce the seven predictor variables to four latent variables contributing 45.41%, 33.57%, 7.54%, and 6.62% of the total variability of the dataset respectively. Through correlations with the original predictors, it was determined that Factor 1 was positively associated with tissue maturation and tip abscission, Factor 2 was positively associated with stem growth and lateral shoot development, Factor 3 was positively associated with stem maturation and negatively associated with tip abscission and number of nodes, and Factor 4 was positively associated with lateral shoot formation and negatively with stem growth. All factors were evaluated using ANOVA as a randomized complete block design with three replications, six environments, three cultivars, and seven repeatedly measured photoperiods. Factors 1 and 3 were significant for genotype by environment by photoperiod interaction. Factors 2 and 4 were found to have genotype by environment interaction. Eberhart and Russell (1966) stability analysis was used to determine the relative stability of each cultivar. For Factor 1, within photoperiod, stability slopes tended to differ based on the ability of the cultivar to mature tissues when conditions were less conducive to maturation. This caused positive slopes to be attributed to cultivars showing below average maturation in environments not favorable to maturation. While St. Croix's stability slope remained near the mean across photoperiods, Marquette's stability slope tended to increase as the season progressed demonstrating the cultivar's reduced maturity in unfavorable environments compared to the mean of all cultivars. Alternatively, Frontenac Gris's stability slope tended to decrease as the season continued demonstrating it's higher than average maturity of tissues in unfavorable environments. The difference in slope between the two cultivars grew as the season progressed. The data from this study suggests that the relative differences in year-to-year survival may be partly explained by the relative stability in acclimation response of cultivars across differing environments.

(350) Examining Various Phytochemical Attributes of Southern Highbush and Rabbiteye Blueberry Genotypes

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Georgia was first in the nation for highbush blueberry production in 2014 with 96 million pounds produced. The production includes both rabbiteye (*V. virgatum* Aiton), sold as fresh and frozen, and southern highbush (species complex between *Vaccinium corymbosum* L. and *V. darrowii* Camp) sold primarily as fresh earlier in the season. The main objective of this study was to examine various phytochemical attributes of highbush and rabbiteye varieties grown in Georgia. Fruit harvested from nine southern highbush and seven rabbiteye blueberry genotypes at ca. 50% ripe at the University of Georgia Blueberry Research Farm near Alapaha, GA, were examined during 2014. Early, mid-, and late-season material was selected for both types to represent the Georgia blueberry market. Highbush genotypes included 'Camillia', 'Emerald', 'Farthing', 'Legacy', 'Meadowlark', 'Rebel', and 'Star', and two advanced breeding selections: TH-1111 and TH-1125. Rabbiteye genotypes included 'Alapaha', 'Brightwell', 'Ochlockonee', 'Powderblue', 'Premier', 'Tifblue', and 'Vernon'. Fruit were frozen for approximately 7–8 months before chemical analyses. Measurements included total titratable acids (TTA), soluble solids content (°brix), total monomeric anthocyanin concentration (mg/L cyanidin-3-glucoside equivalents), sugars, organic acids, antioxidants, and sugar acid ratio (°Brix /TTA and total sugars/total acids). Total sugar, organic acid, and antioxidant content were also determined. Overall, highbush genotypes were significantly higher ($P < 0.05$) for total titratable acids (0.69% vs. 0.43%), and rabbiteye genotypes were significantly higher for soluble solids (13.4% vs. 11.6%) and sugar acid ratio (°Brix /TTA) (34.5 vs. 23.3). Sucrose was significantly higher in rabbiteyes (2.54 mg/g vs. 0.10 mg/g) and total sugar content and sugar acid ratio (total sugar/total acid) were not significantly different between types. Rabbiteyes were significantly higher for three of the six organic acids (oxalic, succinic, and malic acid) and were over 60% higher for total acids (12.2 mg/g vs. 7.5 mg/g). For antioxidants, rabbiteyes were 23% higher for catechin (39.7μg/g vs. 32.3μg/g), two times higher for caffeic acid (108.6 μg/g vs. 52.7 μg/g), over four times higher for quercetin (7831 μg/g vs. 1743 μg/g), 50% higher for ferulic acid (33.0 μg/g vs. 22.0 μg/g) and 37% higher for total antioxidants (20,482 μg/g vs. 14,934 μg/g). Results from this study show variation within genotypes for fruit quality and suggest that rabbiteye varieties are quite high

in many important compounds. Future studies will be conducted to determine the effect of fruit quality across years and in consumer perception.

(351) Evaluating the Impact of Superabsorbent Polymers on Grapevine Water Management

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The United States ranked fourth with total grape yields of 6,692,950 metric tons in 2011. Oklahoma's wine industry has grown from three wineries in 2000 to over 50 wineries in 2012. Most of Oklahoma suffered extreme, severe, or moderate drought during the past several years. Growth, yield, and fruit quality of grapes depend on grapevine water status. Hence it is necessary to promote soil moisture by means of an integrated system that includes efficient irrigation and other water-saving production techniques. Super-absorbent polymers (SAPs) are one type of water-saving agents, which have segments of hydrophilic groups that can absorb and retain liquids and last 4 to5 years, which makes them very cost effective for long term maintenance situations. The SAPs can absorb natural water at around 100 to350 times its own weigh. In this experiment, five transplant grapevine cultivars (Cynthiana, Rubaiyat, Chardonel, Noiret, and Chambourcin) were used with four different levels of SAPs (0, 50, 100 and 150 g) in two particle sizes [small (s) = 0.8–1 mm and large (l) = 2–4 mm]. Water absorbing capacity (WA), electrolyte absorbing capacity, relative water content (RWC), and assessment of soil water were carried on in order to evaluate the impact of SAPs on grapevines in the first year. Significant correlations were observed among the height and number of leaf at week 12 as well as week 16 after planting. Small SAP showed higher WA with 151 in comparison with 29 in L-SAP. The highest RWC were observed using 100 g L-SAP (73%) followed by 50 g S-SAP (72%) after 16 weeks. Large-SAP showed a lower charge (10.45 g/g) and thus a decrease in absorbing capacity compared to that of S-SAP (33.25 g/g), which has a higher charge due to smaller particle size. Thus, the particle size has negligible effect on absorbing capacity of SAPs. Soil water content had an inverse relationship with the amount of added SAP, meaning that plots with higher superabsorbent remained at higher moisture levels. The average soil matric potential (an indicator of soil water content) during the growing season decreased from 27.1 centibars for the control treatment (no SAP) to 10.3 centibars for the 150 g L-SAP treatment. A similar trend was observed at plots where the grapevine did not survive, with matric potential ranging from 13.6 to 5.0 centibar for the same treatments, respectively.

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Weed Control & Pest Management

(235) Evaluation of Oxidant Biocide Formulations for Soil Sanitation

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Due to the phase-out of methyl bromide, alternative methods are needed for nursery soil sanitation. This study was conducted to explore various oxidation biocide formulations for deactivating pathogens in nursery soils. Soil respiration rates and deactivation of Bacillus subtilis spores were the two response variables being evaluated in this presentation. We hypothesized that a reduction in the native microbial population in soil types, (commercial top soil and potting soil) due to biocide treatments would reduce soil respiration rates. Furthermore, we suspected B. subtilis spore counts would be reduced. This experimental model was set up using several biocides: liquid chlorine dioxide, chlorine dioxide granules as a fumigant, ozone water, autoclave, and untreated soil (control). We evaluated the effects of repeated biocide applications of 2, 4, or 6 times and a single application of chlorine dioxide granules (fumigant) on commercial topsoil or potting soil. 300 μl of B. subtilisspores were introduced in the soil by means of inoculated steel washers. A single application of chlorine dioxide granules had an equivalent soil respiration rate as the autoclave treatment for potting soil. For the topsoil, the autoclave treatment had a slightly lower soil respiration rate than the chlorine dioxide granules. After a single application of chlorine dioxide as a liquid or granules, B. subtilis had an average log10 reduction of 0.69 and .030 respectively. In future research, we plan to leave inoculated washers in the soil for the full application treatment regimen or choose another method of inoculant introduction.

Specified Source(s) of Funding: USDA–APHIS Center for Plant Health Science and Technology

(236) Evaluation of an Oxidant Disinfectant's Ability to Prime Plant Defenses for Systemic Acquired Resistance in Light Red Kidney Bean Plants Inoculated with Common Bean Bacterial Wilt

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Plants are susceptible to a wide range of pathogens that can be detrimental to the horticulture industry. Pathogens can result in killing plants causing major losses in production or it can result in plants being unsaleable. Plants naturally have a plant defense system that can protect themselves against an attack from pathogens. This immunity is triggered only when the plant is being attacked due to it taking energy and resources. Plants can be primed with abiotic measures to induce plant defenses resulting in a systemic acquired resistance (SAR) against a wide range of pathogens. This primed state results in a stronger and faster response when an attack does take place. An important hormone that activates pathogenesis related proteins for defense for pathogens is salicylic acid (SA). Salicylic acid activates proteins that aid in killing the pathogen, isolating the pathogen from spreading and signaling the danger of the attack to the rest of the plant. Light red kidney bean plants were treated with Electro-Biocide™ (E-B) a proprietary blend of chlorine dioxide, surfactant, and pH buffer. The study's objective was to investigate if SAR can be obtained by E-B spray treatments. The E-B was investigated for horticultural use for this study due to it having a safe Environmental Protection Agency rating of IV, a pH buffer making it non-corrosive, ease of use as a foliar spray application, and its oxidizing power to sanitize surfaces. The following rates were evaluated: E-B 0 ppm (control), E-B 200 ppm and E-B 400 ppm. In addition to E-B, a commercially available product (Actigard™), which has been proven successful at inducing systemic acquired resistance, was evaluated as well. Spray treatments were replicated with non-inoculated plants and inoculated plants with a wilt disease caused by *Curtobacterium flaccumfaciens* pv. *flaccumfaciens*. Leaves were collected 5 days after treatment (DAT) for SA measurements and again at 43 DAT. Salicylic acid was measured by liquid chromatography tandem-mass spectrometry (LC-MS/MS). At 5 DAT for both inoculated and non-inoculated plants, the results showed that E-B 200 and 400 treatments had significantly higher concentrations of SA when compared to Actigard™ and the control. This indicates that the plants treated with E-B were primed. Results at 43 DAT showed non-inoculated plant treatments went down (back to normal range of SA) and that in inoculated treatments SA concentrations continued to rise. The E-B shows promise of an easy and safe foliar treatment for horticulturists to proactively combat diseases before infection happens.

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(237) Off-season Weed and Sting Nematode Management for Organic Strawberry

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In designing a cropping system for the production of organic strawberry, some of the factors that should be considered include: cropping system diversity, resilience to pests, soil fertility, and soil health. To this end, sunn hemp (*Crotalaria juncea* L.) and hairy indigo (*Indigofera hirsute* L.) cover crops were evaluated at four locations in north-central Florida during the summer off-season for the potential to suppress weeds in comparison with a weedy control. Sesame (*Sesamum indicum* L.) and a four-way legume mix of American jointvetch (*Aeschynomene americana* L.), hairy indigo, short-flower rattlebox (*C. breviflora* DC.), and sunn hemp were also evaluated at one of the locations. The susceptibility of different accessions of *Crotalaria* species including sunn hemp to the sting nematode (*Belonolaimus longicaudatus* Rau)—a key soilborne pest of strawberry in Florida—was also assessed in greenhouse experiments. Sunn hemp shoot biomass production exceeded that of hairy indigo at three of the four locations. Sesame shoot biomass was higher than hairy indigo but not significantly different from biomass obtained with sunn hemp and the four-way legume mix. Total weed biomass with sunn hemp and hairy indigo was suppressed in a similar manner at the three locations where sunn hemp biomass exceeded that of hairy indigo. Total weed biomass with sesame and the four-way mix also was significantly lower than in the weedy control. Of the eleven sunn hemp accessions evaluated, all exhibited lower susceptibility to sting nematodes than corn, which was used as a susceptible control. However, sunn hemp accessions differed in their susceptibility with no nematodes recovered from six accessions, whereas 12.8 nematodes per 100 cm^3 were recovered from the most susceptible accession. Although the single *C. breviflora* variety proved to not be significantly different from corn in susceptibility to sting nematodes, all four accessions of *C. ochroleuca* were either nonhosts or poor hosts. Of the nine *C. spectabilis* accessions evaluated, two were nonhosts and two were as susceptible as corn. Based on these results, in future evaluations of a four-way legume mix, *C. breviflora* will be replaced with *C. ochroleuca*.

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An asterisk (*) following a name indicates the presenting author.

(238) Effect of Prodiamine and Isoxaben Tank Mixture for Early Postemergence Control of Bittercress

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Hairy bittercress (*Cardamine hirsuta*) is consistently listed as one of the top ten most common and troublesome weeds in container nursery production. Previous research has shown that isoxaben can provide early postemergence control of bittercress before it reaches the flowering stage of growth. Isoxaben + prodiamine tank mixtures are popular among container nursery producers as both of these herbicides can be applied over the top of hundreds of ornamentals and provide a broader spectrum of weed control when combined. Research was conducted to determine if early postemergence control of bittercress is reduced when prodiamine is tank-mixed with isoxaben. Bittercress seed (0.1 g) were surface sown onto 7.6 cm pots filled with standard nursery growing media and fertilizer amendments at two separate dates in order to have two growth stages including small (seeded on 24 Feb. 2015, approximately 1.8 cm tall) and large (seeded on 24 Feb. 2015, approximately 5 cm tall). Four rates of isoxaben (Gallery® SC) (0.14, 0.28, 0.56, and 1.1 kg ai/ha) and two rates of prodiamine (Barricade®) (0.8 and 1.7 kg ai/ha) were applied alone and in tank mixtures using all possible combinations. A non-treated control group was also included. Treatments were applied to both growth stages of bittercress on 11 Mar. 2015 using a standard pressurized sprayer on an outdoor container pad. Plants received overhead irrigation (0.6 cm) one hour after treatment, were allowed to dry and then moved into a shaded greenhouse for the remainder of the trial. Bittercress control was assessed by taking visual control ratings at 1, 2, and 4 weeks after treatment (WAT). Fresh weights were determined at 4 WAT. Results showed that when applied alone, prodiamine only slightly reduced bittercress fresh weights when compared to the non-treated control. For both stages of growth, bittercress control increased with increasing rate of isoxaben and bittercress was completely controlled at the two highest rates. No antagonistic effects were noted across any isoxaben rate when prodiamine was added. While the best weed control will be achieved when preemergence herbicides are applied to weed free pots, results from this study indicate that isoxaben will continue to provide early postemergence control of bittercress when used in a tank mixture with prodiamine.

(239) Multifunctional Intercropping as a Cultural Strategy to Reduce Weed Pressure for Organic Vegetable Production

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A multi-layered canopy provided by intercropping multiple species can provide barriers for the spread of pests and diseases and can allow for a more efficient utilization of resources that reduce competition to target crops from weeds. As a result, intercropping can be an effective cultural control strategy for the management of weeds, pests, and diseases. Different combinations of peanut, watermelon, okra, cowpea, and pepper planted alone or in 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. Watermelon was selected as a smother crop and significantly reduced total weed biomass when planted alone and in all intercropping combinations in 2011. Total weed biomass was reduced by 81%, 83%, 88%, and 92% in treatments containing watermelon as compared to pepper, peanut, okra, and cowpea grown in monoculture, pepper grown in monoculture had significantly higher weed biomass than all other treatments in 2012, with 46% more weed biomass than the next highest yielding treatment. Sedges were consistently most effectively reduced and pepper, cowpea, peanut, and okra benefited most from intercropping in both years. Total above ground plant biomass was not a significant predictor of weed biomass. Weed biomass was a significant predictor of total fruit yield, however, accounting for 39% of yield variability. These findings suggest that three and four species intercropping combinations, whereby each crop is selected to perform a specific function within the system, may provide small-scale, sustainably minded producers a model system for the management of weeds.

Specified Source(s) of Funding: Southern Sustainable Agriculture Research and Education

(240) Timing Early Season Cucumber Beetle Control to Manage Bacterial Wilt in Muskmelon

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Muskmelon (*Cucumis melo var. reticulatus*), is one of the most important vegetable crops in the United States. It is grown throughout the United States, and Indiana ranked third in production after California and Arizona with 2088 Mg in 2013. Bacterial wilt of cucurbits, which is caused by (*Erwinia tracheiphila*) and vectored by striped cucumber beetle (*Acalymma vittata*), is one of the most serious diseases of muskmelon that

influences muskmelon quality and yield. The primary method for managing bacterial wilt is controlling the striped cucumber beetle before it can infect the plant. However, it is not known whether there is a critical stage during early plant growth when muskmelon plants are more susceptible to infection and therefore control of striped cucumber beetle is especially important. We conducted three field experiments at two locations (Lafayette and Vincennes, IN) in 2013 and 2014 to investigate whether there is a critical period for striped cucumber beetle control sometime during the first three weeks after muskmelons are transplanted to the field. We found that using row covers that exclude beetles, or seed treatment or soil drenches with insecticide thiamethoxam significantly reduces wilt and increases the number of marketable fruits and total yield compared to not controlling striped cucumber beetle, because these methods protect the plants from cucumber beetle feeding and increase plant vigor. However, the length of time row covers were left on the plants (for 7, 14, or 21 days after transplanting, DAT), or the time beetles were permitted to feed on plants (7, 14, or 21 DAT), or the time when beetles began to feed on plants (0, 7, 14, or 21 DAT) did not significantly influence disease or yield in a consistent manner, suggesting that there is no clear "critical period" during early muskmelon growth when controlling striped cucumber beetles is especially important. The data also show that maximum incidence of bacterial wilt occurred in June and July, which corresponds to the two generations of cucumber beetles.

Specified Source(s) of Funding: USAID

(241) Neem and Gliricidia Hedge Effects on Sweetpotato Production in the Caribbean

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Alternatives to the use of agrochemicals in traditional farming practices are needed in order to safeguard the environment of the Caribbean region. Potentially useful plant species for on-farm production of organic inputs include *Azadirachta indica* A. Juss. (Neem) and *Gliricidia sepium* (Jacq.) Kunth ex Walp. (Gliricidia). These species are known for pest-repelling and nitrogen-fixing properties, which can result in a decreased use of inorganic pesticides and fertilizers. Hedges of these species were tested for effects on crop growth and yield of sweetpotato [*Ipomoea batatas* (L.) Lam.], a potentially important crop for food security in the Caribbean. In this study, the performance of two sweetpotato varieties (Black Vine and Lovers Name) were compared at different distances (1, 3, 5, 7 and 9 m) from a 0.5-m tall hedge of alternating Neem and Gliricidia plants. It was conducted without inorganic fertilizer inputs as well as with and without the application of an inorganic pesticide (Actara). Several trends influenced by proximity to the Neem/Gliricidia hedge were: yield, tuber damage, chlorophyll indices and moisture levels. Yield was reduced by proximity to the hedge for the 'Black Vine' but not for the 'Lovers Name', for which tuberization occurs earlier. The extent of damage caused by white grub with increasing distance from the hedge was higher in both varieties without the use of Actara. Chlorophyll indices for the 'Lovers Name' increased overall with increased distance from the hedge. The use of Actara appeared to increase the chlorophyll index for the 'Lovers Name' as distance from the hedge increased. Soil moisture content was significantly affected by proximity to the hedge—the 'Lovers Name' showing higher percentages of moisture in the soil at 8.1 weeks after planting than the 'Black Vine'. The use of Actara along with proximity to the hedge also appeared to affect soil moisture, showing a decrease at 14.3 weeks after planting. Yields and damage to tubers were affected by proximity to the hedge with varietal effects and Actara interactions observed for chlorophyll indices and moisture levels. Organic inputs from hedges of Neem and Gliricidia can be beneficial for sweetpotato production in the region.

Specified Source(s) of Funding: The University of the West Indies Cave Hill Campus Graduate Studies Research Award

(242) *Pseudococcus comstocki* (Kuwana) Using Sex Pheromone in Pear Orchards in Korea

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This study was performed to test a mating disruption technique to control of *Pseudococcus comstocki* (Kuwana) in pear orchards. We used the attractiveness of rubber septa loaded with 3.0 mg and the mating disruptor of plastic releaser loaded with 30 mg this pheromone, 2,6-dimethyl-1,5-heptadien-3-yl acetate of *P. comstocki*. In pheromone mating disruption tests, catches were reduced by 17.7, 65.3, and 62.9% in orchards treated with 450, 900, and 1350 mg per 10a of the pheromone, respectively. At harvest, 3.4%, 2.9%, and 4.8% of fruits in orchards treated with 450, 900, and 1350 mg per 10a were damaged by *P. comstocki*, while 9.5% were damaged in the control orchard. Although the control effect was shown in the treatments, the *P. comstocki* was captured many numbers in late September

to early October in 2013. So, the 630 mg of pheromone were use in early May and 270 mg treated in early August in 2014. This treatment was shown 1.2% fruit damage rate and over 89% control value.

(245) Weed Management in Arizona Nurseries

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Current weed management needs in Arizona nurseries assessed and research areas identified through surveys, interviews, and visit to nursery sites. Compared to other management issues in nursery production, weed management is still a major production challenge in Arizona nursery; with *Chamaesyce prostrate* (prostrate spurge), *Cardamine hirsute* (bittercress) and *Baccharis sarothroides* (desert broom) listed as major problems in that order. Interviews, surveys and field visits reiterated that prostrate spurge is the number one problem in container nursery production. Nursery growers in Arizona have tried various pre-emergence herbicides to control spurges, but reported verbally that none of the chemicals has given satisfactory control of prostrate spurge. During the field visits, it was common to see field grown nursery stock, infested with spurge weeds and that a high level of control is demanded to manage competition from such weeds, and to keep field appearance attractive. First it became apparent that spurge is number one problem challenging their production and plant marketability. Second, herbicides and mulches play a critical role in managing weed populations but there are issues related to sanitation, calibration, rate of application, time, and uniform application of herbicides. Herbicide evaluations at two nursery sites in Phoenix, AZ, indicated that opportunities for improved control do exist, if growers use proper calibration, rate of application, time, and uniform application of herbicides, with granular formulations of pre-emergence herbicides [such as indaziflam (Marengo G)], which had a long-lasting effect on weed pressure for at least 3 months after treatment application or with currently used herbicides [such as the combination of dimethenamid + pendimethalin (FreeHand 1.75G)], which resulted in weed-free plots until eight weeks after treatment. Mulches proved as effective as herbicides and resulted in more than 90% control of spurges at least for eight weeks after treatment. Finally, we conclude that effective weed management in nursery crops should involve a combination of management options—such as sound sanitary, cultural practices, and proper use of mulches along with proper use of herbicides.

Specified Source(s) of Funding: Specialty Crop Block Grant–Farm Bill

Thursday, 6 August 2015

Commercial Horticulture

(135) Assessment of Rootball Planting Treatments of Two Species of Container-grown Trees

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Researchers have done extensive work assessing planting techniques for container-grown trees. The results are often very specific to species and soil type, so it is hard to make broad recommendations. We implemented a study to assess the differences in establishment success and growth of two different species of container-grown trees. We were interested in determining if different handling methods had an effect on establishment and growth of the trees, and what role site preparation plays during planting. To accomplish this, we selected *Acer rubrum* 'Brandywine' and *Nyssa sylvatica* 'Wildfire'. *A. rubrum* have very fibrous roots, while *N. sylvatica* have more woody root systems. Fifteen-gallon trees were placed in the hole with no rootball treatment, had the outer edges of the rootball shaved off two inches, or the rootball was thrashed with the sharp edge of a shovel. Soil treatments included a site preparation treatment, where composted leaves were added, and a no site preparation area. Growth measurements included caliper at 6" above rootball, height, and twig extension. After two years a third of the 120 trees were destructively harvested. Leaves and stems smaller than one-inch diameter were separated from larger branches and the trunk. These were oven-dried to obtain biomass dry weight. Roots were harvested using a 42"-tree spade and all soil was removed with either water or an air spade. We hung the rootballs and marked the original rootball diameter in the 15-gallon container. We separated roots into various size categories and recorded the number of each. In addition, we indicated if the roots came straight out from the rootball, girdled the trunk, or circled around the rootball. We found there was no significant difference in aboveground biomass growth. However, there was a significant difference in root architecture. Trees we placed in the holes with no treatment had the most trunk girdling and circling roots, and tended to be larger diameter. Those that were shaved or thrashed had fewer and smaller diameter circling or girdling roots. Roots will be oven-dried and weighed. We believe we will find significant differences between the rootball treatments. The study will continue through May, so at present we can offer no recommendations on best handling practices for container-grown trees.

Specified Source(s) of Funding: North Carolina Landscape and Nursery Association

(136) Tensile Properties of Bark of *Dirca* (Leatherwood)

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The genus *Dirca* consists of four species with strong, fibrous, tear-resistant bark. These characteristics resulted in Aboriginal Americans' use of the bark to make cordage and are reflected in its common names: leatherwood, thongwood, and ropewood. During a pilot study, we measured the tensile properties of bark of *Dirca Mexicana* by using an Instron 4500 Universal Testing Machine. The average ultimate tensile strength (maximum force sustained) of the bark was 52.13 MPa and the average Young's modulus (rate of change of strain vs. stress) was 2.131 GPa. We compared tensile properties of bark within all species in the genus and among taxonomically and ecologically allied genera. The biological novelty of bark of *Dirca* and potential industrial applications will be reported.

(137) Evaluating Production and Marketing of Asian Vegetables in West Virginia

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Asian vegetables include a diverse group of vegetables with very unique colors, shapes and flavors. Most Asian greens are cool season vegetables and should be grown as a spring or fall crop. With the use of low and high tunnels, some Asian greens can be successfully overwintered in West Virginia. There is a potentially strong commercial market for some Asian vegetables in West Virginia. Potential market outlets include restaurants, local farmers' markets and ethnic grocery stores. From 2012–15, diverse Asian vegetables have been evaluated for full-season production and market potential in West Virginia. Controlled environment using high tunnels, low tunnels and shade house production systems were evaluated. The best loose-leaf Asian greens evaluated in this study were 'Komatsuna', 'Yukina Savoy', 'Tatsoi' and 'Senposai'. 'Senposai' is a cross between green cabbage and komatsuna and is a relatively large plant, which produces leaves with a sweet, mild flavor. Senposai is an excellent replacement for collards in the garden. Loose-leaf greens can be harvested as full-size or baby-size (< 4-inch length) leaves. Full size leaves can be bunched (15–20 stems/bunch) and banded with a rubber band. The loose leaves should be washed and cooled immediately after harvest. Mizuna is an excellent salad green and can be harvested at any stage of growth. Some Asian greens can be harvested as both as intact heads or loose leaves. For example, 'Tokyo Bekana' is a Chinese cabbage that is a cold weather substitute for lettuce. Either loose leaves or the entire head is harvested depending on the market outlet. Most pac choy cabbages are harvested as intact heads. All of the pac choy cabbages evaluated were excellent and can be grown in low or high tunnels for extended season production. Baby pac choys can be sold to a variety of market outlets and often reach maturity quickly.

(138) Evaluation of Hop Cultivars for Commercial Production in Ontario: Yield, Quality, and Pest Susceptibility

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Hops, the female inflorescence of the hop plant (*Humulus lupulus* L.), are used in the brewing process and provide unique flavour and aroma to beer. Hops were grown in Ontario until the 1930s when acreage decreased due to disease outbreaks and market pressures. Recently there has been a renewed interest in hop production predominantly for craft and micro-breweries. Hop production is a small but growing industry in Ontario and growers require information to identify well adapted cultivars. A cultivar trial was planted at the Simcoe Research Station in 2013 to address this priority. This poster presents data from 2014. Ten commercial cultivars were included in the trial: Cascade, Hallertauer, Sterling, Northern Brewer, Zeus, Crystal, Chinook, Galena, Centennial and a naturalized cultivar named Bertwell. Potato leafhoppers, Japanese beetles, and two-spotted spider mites were the most common insect pests observed. Differences in incidence and severity of insect damage were observed among the cultivars. Japanese beetle feeding damage was least severe on 'Chinook' while 'Bertwell' and 'Galena' were the least affected by potato leafhoppers. Two-spotted spider mite counts were low throughout the season and did not differ among cultivars. Downy mildew was observed in late May to early June, but disease was sporadic and no differences were observed among the cultivars. 'Cascade', 'Zeus', 'Galena', and 'Chinook' produced the highest yields, however, cone quality was poor due to widespread Alternaria cone disorder. Severity of Alternaria was lowest on 'Cascade' and 'Bertwell'.

(139) Climate Change Impacts on Maple Syrup Yield in Nova Scotia, Canada

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Maple syrup yields have constantly been declining, which is of major concern to maple syrup producers in Nova Scotia, Canada. Climate change is suspected to contribute to this decline; nevertheless, no specific studies have been conducted in Nova Scotia to ascertain this. Furthermore, the industry faces the

challenge of identifying the optimal start date of the sap flow to maximize sap yields and subsequently increase economic returns. Sap flow is a consequence of the interactions between the tree's physiology, environment and weather; and our knowledge of the influence of weather on maple syrup in Nova Scotia is very limited. Owing to this gap, no indicators are currently available to scientifically assist in projecting tap date or harvest decision processes. These issues were addressed: (i) assessed the climate change scenario in Nova Scotia; (ii) evaluated link(s) between the climatic factors and syrup production; and (iii) modeled the relationships to predict syrup yield and sap flow dates. Historical weather data from various weather stations was collected from Environment Canada and the maple syrup production data was collected from growers across Nova Scotia. Changes in the weather parameters for mean temperature and effective growing degree days (EGDD) were assessed against the average maple syrup records from 1978–2013. We found that mean annual temperature has increased by 1 °C in the last 15 years. This increase has translated into an increased average EGDD of 125 days. The implications on the maple tree growth were multi-faceted and negative in relation to syrup yield. When historical syrup yields and EGDD were regressed, it was evident that the decline in syrup yields (0.65 to 0.33 L/tap/year) coincided with the increase in the EGDD in Nova Scotia. Simultaneously, during this period, the start date for the sap flow has started approximately five days earlier. However, the length of tapping season remains unchanged. These trends indicate a negative effect of climate change on Nova Scotia maple syrup production. Over 108 weather parameters were screened for their relationship with syrup yields, only six of the weather parameters strongly correlated with syrup yields and three weather parameters correlated with the start date of the sap flow. A neural network-based syrup yield model was constructed with these parameters to predict syrup yields and start date of sap flow. The syrup yield model exhibited strong potential to predict the syrup yields and start date; however, its ability is limited owing to the small size of training data currently available.

Thursday, 6 August 2015

Computer Applications in Horticulture

(282) Using the GoPro InfraBlue 22 Lens for NDVI Field Measurements?

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What is NDVI? It is defined as Normalized Difference Vegetation Index, and is a numerical indicator that uses the visible and near-infrared bands of the electromagnetic spectrum to assess plant vigor. The NDVI index has been integrated into remote sensing environments using various camera systems mounted on Unmanned Aerial Vehicles (UAVs) to assess the health and stress of crop plants. When using this technology, growers would be able to visualize the areas of the field that are stressed and, perhaps, rapidly mitigate a potential problem. The GoPro camera has gained general acceptance in UAV platforms due to its relatively low cost, light weight, and ability to shoot incredibly reliable high-quality footage/stills. While any consumer camera can collect blue, green, and red bands, capturing the NIR band for calculating a standardized NDVI index requires wavelength separation and subsequent spectral analysis of individual bands, not a simple lens replacement. The GoPro InfraBlue22 (IR Pro) lens system captures NIR, Green and Blue spectra and when used in conjunction with UAV platforms, it is interpreted as "pseudo-NDVI" by many agronomists. Our effort explored the use of a GoPro InfraBlue 22 lens system to assess field level, pseudo-NDVI measurements. Our work suggests that UAVs with GoPro InfraBlue can be viewed as an accompanying tool in precision agriculture that creates actionable data when used. Using a consumer UAV and flying a NDVI converted camera offers producers an inexpensive "first look" with a short return on investment. The system, in some cases, generates actionable data and can identify vegetation and crop stress, which can be correlated to ground data. Inexperience workers can be trained relatively easily to take the first steps into using aerial imagery through the use of UAVs.

(283) Website Resources for Free iOS and Android Apps for Extension Personnel

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Our college (College of Tropical Agriculture and Human Resources) received a grant to purchase tablets for extension agents and extension specialists to help assist them in their work. The extension personnel were those who spend a majority of their time out in the field. As such, there was an anticipated need of the extension personnel wanting information about which agricultural/horticultural related apps were available. The objective was to create websites that listed free iOS and free Android agricultural/horticultural related apps for extension personnel. Finding agricultural/horticultural related apps was done in several ways. Apps were searched for on specific subjects in the Apple iTunes Store and the Google Play Store. I also did Internet searches for apps. News aggregator apps, such as Zite, and RSS Feed apps, such as Feedly, were used to help find apps. I created two websites for iOS and Android apps using Google Sites. The apps were listed in a table having six columns—Name, Function, Description, Platform, Cost, and Developer. The apps were categorized by subject (Function)—botanical garden, crop information, crop protection, education, farm management, flowers, food, food safety, gardening, GIS (geographical information system), fruits, harvest, invasive species, news, pests, plant ID (identification), planting, plant nutrition, plant selection, production cost, social media, soil, trees, turfgrass, varieties, water, and weeds. The Description field gave a brief explanation of what the app does. The Platform field contained either iOS or Android. The Cost field was free. The creator of the app was put

in the Developer field. The two websites, one for iOS apps and one for Android apps, were called "Horticulture Applications (Apps) for iOS Mobile Devices" and "Horticulture Applications (Apps) for Android Mobile Devices." Each listed about 200 free apps. The two websites of free agricultural/horticultural apps provide a starting point and resource for extension personnel to find relevant apps.

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Thursday, 6 August 2015

Growth Chambers and Controlled Environments 2

(195) Sole-source LED Lighting Impacts Mineral Nutrient Density of Chinese Kale

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Previous work has demonstrated narrow-band wavelengths of light from light-emitting diodes (LED) can increase concentrations of primary and secondary metabolites in brassica species. The objectives of this study were to measure the impacts of: 1) light quality; and 2) different levels of fertility on mineral nutrient density in shoot tissues of Chinese kale (*Brassica oleracea* var. *alboglabra*). 'Green Lance' Chinese kale was grown hydroponically in controlled environment chambers under an air temperature of 22 °C with a 16-h photoperiod using a light intensity of 350 μmol·m^{-2}·s^{-1}. Light quality treatments were established as: 1) fluorescent/incandescent light; 2) 10% blue (447 ± 5 nm) / 90% red (627 ± 5 nm) LED light; 3) 20% blue / 80% red LED light; and 4) 40% blue / 60% red LED light as sole source lighting. Plants within light treatments were cultured in either a 1/2 strength or a 1/4 strength Hoagland's #2 nutrient solution. The experiment was repeated three times. All plants were harvested 30 d after seeding and shoot tissues were analyzed for K, Mg, Ca, Fe, and Zn concentrations. Kale under the fluorescent/incandescent light treatment had significantly higher shoot fresh (FM) and dry mass (DM) compared to plants under all other LED light treatments. The percent shoot tissue DM was 10.7%, 10.5%, 10.5%, and 9.9% for the light treatments of fluorescent/incandescent light, 10% blue / 90% red LED light, 20% blue / 80% red LED light, and 40% blue / 60% red LED light, respectively. Because of higher total shoot tissue DM, plants under the fluorescent/incandescent light treatment had high mineral nutrient content on a per plant basis. However, baby leafy greens are typically packaged in bags, individually or in mixed species, for the prepared foods market. When minerals were expressed on a concentration basis as μg/g DM, all LED light treatments produced higher shoot tissue K, Mg, Ca, Fe, and Zn concentrations than the fluorescent/incandescent light treatment. Sole source LED lighting resulted in lower kale shoot tissue DM, which lead to lower nutrient content on a per plant basis. But, when minerals were expressed on a concentrations basis, LED light treatments resulted in higher nutrient density per edible serving. Sole source LED lighting may provide a nutritional advantage for baby leafy greens produced for the packaged market.

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(196) Daily Light Integral and Light Quality from Sole-source Light-emitting Diodes Impact Phytochemical Content of *Brassica* Microgreens

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Multi-layer vertical production systems using sole-source (SS) light-emitting diodes (LEDs) can be an effective alternative to more traditional methods of microgreens production. One significant benefit of using LEDs is the ability to select light qualities that have beneficial impacts on plant morphology and the synthesis of health-promoting phytochemicals. Therefore, the objective of this study was to quantify the effects of SS LEDs of different light qualities and intensities on the phytochemical content of *Brassica* microgreens. Specifically, the phytochemical measurements included: 1) total anthocyanins; 2) total and individual carotenoids; 3) total and individual chlorophyll; and 4) total phenolics. Purple kohlrabi (*Brassica oleracea* var. *gongylodes*), mustard (*Brassica juncea* 'Garnet Giant'), and mizuna (*Brassica rapa* var. *japonica*) were grown in hydroponic tray systems placed on multilayer shelves in a walk-in growth chamber. A daily light integral (DLI) of 6, 12, or 18 mol·m^{-2}·d^{-1} was achieved from SS LED arrays with light ratios (%) of red:green:blue 74:18:8 (R_{74}:G_{18}:B_8), red:blue 87:13 (R_{87}:B_{13}), or red:far-red:blue 84:7:9 (R_{84}:FR_7:B_9) with a total photon flux from 400 to 800 nm of 105, 210, or 315 μmol·m^{-2}·s^{-1} for 16-h, respectively. Phytochemical measurements were collected using spectrophotometry and high-performance liquid chromatography (HPLC) methodology. For kohlrabi, with increasing DLIs and light ratios of R_{87}:B_{13} or R_{84}:FR_7:B_9, total anthocyanins significantly increased compared to those grown under lower DLIs and light ratios of R_{74}:G_{18}:B_8. Conversely, total carotenoids significantly increased under lower DLIs for mizuna and mustard. Light quality increased total integrated chlorophyll under the light ratio of R_{87}:B_{13} compared to R_{84}:FR_7:B_9 and R_{74}:G_{18}:B_8 for kohlrabi and mustard. Light quality also influenced the total phenolic content of kohlrabi microgreens, with significantly increased levels for light ratios

An asterisk (*) following a name indicates the presenting author.

of R_{84}:FR_7:B_9 and R_{87}:B_{13} compared to R_{74}:G_{18}:B_8 under a DLI of 6 mol·m^{-2}·d^{-1}. However, the impacts of DLI on total phenolic content of kohlrabi were not significant. The results from this study may help microgreens producers select light qualities and intensities using SS LEDs to achieve preferred phytochemical contents of *Brassica* microgreens.

(197) LED Safety: Performance of Twelve Glasses Using Nine High-irradiance LEDs

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There is rapidly increasing radiant flux performance in the latest solid-state light emitting diodes (LEDs), driven by increasing applications, such as display backlighting, medical services, general illumination, and horticultural lighting. In horticultural applications blue and red LEDs have been widely used for photosynthesis and to explore plant response these two wavebands induce higher photosynthetic capacity than those in the green wavebands. However, it has been reported that blue light has the risk of photochemical injury such as ocular damages. In the International Electrotechnical Commission (IEC) standard 62471:2006—*Photobiological safety of lamps and lamp systems*, risk groups are classified into several categories based on physiological hazards and the wavelength range including ultraviolet radiation (actinic and near-UV), blue light hazard, and infrared hazard of the lens and cornea. Therefore, with increasing use horticultural LEDs users are at risk of being exposed to ocular and skin hazards as the level of radiation continue to increase. The objective of this work was to investigate transmission performances of different types of glasses under high irradiance level (1,000 W/m^2) for use in horticultural working areas. In this study 12 different glasses including welding glasses, safety glasses, polarized glasses, and brand name glasses, were examined under nine different monochromatic high-illuminant LED assemblies. The transmission performances of the glasses were acquired using a spectroradiometer (PS-100; Apogee, Logan, UT). The results of this study will provide specific information for users to select proper safety glasses based on their requirements.

(198) Effect of Spacing and Daily Light Integral on Growth of Sweet Basil (*Ocimum basilicum*)

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Basil (*Ocimum* L. spp.) is a commonly produced fresh culinary herb. Hydroponic greenhouse producers of fresh-cut culinary herbs want to maximize yield per unit area. One of the easiest ways to increase yield is to use high-density spacing. However, specific recommendations for spacing plants grown under high and low daily light integrals (DLIs) is lacking. Our objective was to quantify the effect of plant density and light intensity on productivity of sweet basil. Seeds of *Ocimum basilicum* L. 'Nufar' were sown into 162-count sheets of phenolic foam hydroponic propagation cubes, placed in a growth chamber with a target air temperature of 24 °C, and irrigated with de-ionized water or a nutrient solution. Two weeks after sowing, seedlings were transplanted into deep-flow technique (DFT) hydroponic systems with plants spaced 10, 15, 20, 25, or 30 cm apart. The mean greenhouse temperature was 22.1 °C, with mean DLIs of 5.0–6.3 (low) and 14.2–15.2 (high) mol·m^{-2}·d^{-1}. Nutrient solutions were maintained at a target pH of 6.0 and electrical conductivity of 1.6 mS·cm^{-1}. Three weeks after transplanting, 10 plants from each system were selected and height, node number, and branch number were recorded. Plants were harvested and the total fresh mass of each DFT system was recorded. Shoots were then placed in a forced air drier maintained at 67 °C for 3 days then weighed and dry mass was recorded. Fresh mass per m^2 increased with increasing plant density. In the high DLI house, decreasing spacing from 30 to 10 cm between plants increased fresh mass by 747 g·m^{-2}, though fresh mass per plant slightly decreased. A similar trend was observed under low-DLI conditions, where increasing density increased fresh mass by 489 g·m^{-2}. Fresh mass per plant also decreased under low DLI. Though trends are similar in low and high DLI conditions, yield per m^2 varied between the two different DLIs. For example, when basil was spaced on 10-cm centers, fresh mass was 334 g greater under high DLI compared to low DLI conditions. Increasing the DLI and density of plants are useful practices to increase fresh mass per unit area in hydroponic systems.

(199) Effects of Different Light-emitting Diode (LED) Lights on the Growth Response of Leafy Vegetables in a Closed-type Plant Factory System

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Growth of leafy vegetables as lettuce (*Lactuca sativa* L.), endive (*Cichorium endivia* L.), pak-choi (*Brassica campestris* var. *chinensis*), kale (*Brassica oleracea* var. *acephala*), arugula (*Eruca sativa*), and Treviso (*Cichorium intybus* L.) were investigated at different types of light sources in closed-type plant factory system. The specific light-emitting diodes (LEDs) chips used for plant cultivation were made by shifting green wavelength to yellow or red in order to promote plant growth. The light source were cool white fluorescent lamps (FL, the control), pink (V1, blue:red = 1:1) LEDs, yellow (V2, blue:green:red = 22:11:67) LEDs or purple (V3, blue:red = 1:3) LEDs, and each light was separately supplied and the intensity of its was adjusted to 100~120 μmol·m^{-2}·s^{-1} at plant level with a photoperiod consisted of 16 hours light and 8 hours darkness. The plants were hydroponically cultured at 23 °C ± 2 °C, 60% to 80% relative humidity (RH), and 1000 μmol·mol^{-1} CO_2. Fresh weight and shoot length of all the tested species treated with V3 were the greatest among all the tested light treatments. The number of leaves all tested species, except pak-choi, was greater in LEDs treatments than that in FL. Leaf area of all tested species was the greatest at V3. These results suggested that the V3, which is composed of blue and red wavelengths (1:3), provided the most the suitable light condition for vegetative growth of several leafy vegetables among the tested light sources. To produce high quality of vegetables in plant factory system, the optimum light conditions should be considered such as light intensity, photoperiod and ratios of mixing with other LEDs.

Thursday, 6 August 2015

Local Food Systems

(080) Maintaining a Way of Life: Trials and Tribulations of Farmers Market Families

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The Congressional Research Service forecasted that, in 2013, off-farm income would account for 82% of total farm income. The United States median household income in 2012 was $51,017, and farmers' median household incomes were approximately $55,000. Regarding small farms, 59% of either the farm operators or their spouses worked off-farm, suggesting that farming alone was not fruitful enough to support the family. Using a qualitative case study approach, this study sought to understand farmers' biggest challenges in order to identify areas for improvement so that farm families could better support themselves via their farming enterprises. One-on-one structured interviews were conducted with farmers selling products at the Fayetteville, AR, Farmers' Market. The farmers interviewed did not reference income as a challenge. Instead, it was found that competition and weather were their biggest challenges to a successful farming enterprise. Competition hindered sales for some farmers and discouraged them, whereas the weather could be unpredictable, and created the possibility of losing crops. Recommendations included farmers tracking produce sales by type and variety to make more informed decisions on what to grow and reduce competition; farmers researching and utilizing technology to mitigate damage from adverse weather events; market managers and farmers working together to find ways to attract a larger customer base; further studies should be done at a larger scale locally, regionally, and nationally; information from further studies should be utilized to increase sales of local produce.

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(081) Production of Cilantro (*Coriandrum sativum*) as a Fall Crop in Southern New England

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Cilantro is not a traditional vegetable for New England growers, but demand is growing as populations increase of ethnic groups for whom cilantro is traditional, and as the popularity of locally grown produce encourages people to try new foods. As an annual that does not overwinter in southern New England, cilantro is often planted in late Spring for harvest in the summer. However, cold, wet spring weather is often quickly followed by summer heat, causing cilantro to bolt. In contrast, Fall in New England is characterized by several months of gradually cooling weather that are ideal for production of leafy greens and herbs. In 2014, a Fall Cilantro Trial was conducted at the University of Rhode Island's Gardiner Crops Research Farm. Five cultivars were seeded into raised beds at a rate of 90 g/3 m on 14 August using a completely randomized design with four replications. The silt loam soil was amended with 5–10–10 fertilizer at a rate of 50 lbs/acre nitrogen prior to seeding. Multiple passes with a Johnny's 6-row seeder with the center two hoppers left empty were used to seed two banded rows 12 cm apart with 20 seeds per foot. Weeds were hand pulled and the trial was irrigated as needed using overhead sprinklers. Data were collected on emergence rate, susceptibility to Alternaria leafspot, total yield, and percent marketable yield. Cilantro was hand-harvested on 14 October by cutting stems 6 cm above the soil level. Climate data were tracked at the RIAES weather station, located approximately 200 m from the trial site. Days to complete emergence differed significantly between cultivars, with 'Calypso' emerging most

quickly. Total yields averaged 2.6 kg from 2.4 m of row and did not differ significantly between cultivars. However, marketable yields for 'Santo' were significantly reduced by severe leafspot. 'Calypso' was also significantly damaged by leafspot; marketable yields were reduced but were not significantly lower than for the other cultivars. 'Leisure' was the top-performing cultivar, combining strong establishment with resistance to leafspot and good yields.

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(082) SAFE: Sustainable Agriculture and Food Environment

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An increasing number of new and small farm operators in the United States are seeking technical information on agriculture and food systems. Many new and small farm operators have limited previous agricultural experience. The technical information sought by this group varies from traditional commodities to sustainable farm practices. We are actively engaging these emerging educational opportunities through a multi-faceted United States Department of Agriculture (USDA) National Institute of Food and Agriculture (NIFA) capacity building grant. The program, known as Sustainable Agriculture and Food Environment (SAFE), began in Fall 2013. Program initiatives include introduction of an online SAFE master's degree to provide a solution for this group of producer's need of specialized agricultural information. The program attempts to bridge technical information gaps through SAFE regional outreach events. The program has also allowed pursue of scholarly research opportunities within the field of sustainable agriculture. The SAFE Master of Agriculture Degree and certificate in Sustainable Agriculture are effective Fall 2015 with the first cohort of students. The program has held three outreach events through June 2015, which were all developed to meet concerns that producers expressed in a preliminary online survey. Two outreach events focused on vegetable production and marketing strategy information, and one event featured sustainable techniques in small-scale livestock production.

Thursday, 6 August 2015

Ornamental Plant Breeding 2

(054) Inheritance of Leaf Shape in Coleus

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Coleus [*Solenostemon scutellariodes* (L.) Codd.], with various leaf forms and shapes, can be used extensively for outdoor landscaping and decoration. Crosses between commercial cultivars were conducted to understand leaf shape inheritance of Coleus. Progeny from selfing or crossing cultivars with normal leaf width were all normal width, except that progeny from selfing 'Defiance' resulted in a 3:1 ratio (normal: narrow). These results indicated that leaf width characteristic was controlled by a single locus, while normal width (*W*) is dominant to narrow width (*w*). Progeny from crossing between shallow-lobed cultivars all had shallow-lobed leaves, while crossing between deep-lobed cultivars resulted in a 3:1 ratio (deep-lobe: shallow-lobe). Progeny from crossing between deep-lobed and shallow-lobed leaf cultivars segregated in a 1:1 ratio (deep-lobe: shallow-lobe). These suggested that leaf margin trait was controlled by a single locus, while deep-lobe (*L*) is dominant to shallow-lobe (*l*). Cultivars with crinkled surface were crossed, and progeny fit a 3:1 ratio (crinkled: smooth). Crossing between smooth leaf cultivars produced all smooth-leaved seedlings. Progeny from crossing between crinkled and smooth cultivars all had crinkled leaves. These suggested that leaf surface trait was governed by a single locus. Crinkled surface (*C*) is dominant to smooth surface (*c*). Crossing between regular-vein cultivars, between anastomosis cultivars, and between anastomosis and regular-vein cultivars fit a 0:1, 3:1 and 1:0 ratio (anastomosis: regular-vein) respectively in progeny. This indicated that leaf vein trait was governed by a single locus, and anastomosis vein (*G*) is dominant to regular vein (*g*).

(055) Inheritance of Leaf Blotch, Spot, and Stripe in Coleus

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Coleus [*Solenostemon scutellariodes* (L.) Codd.], with various leaf variegations and colors, can be used extensively for landscaping and decoration. Crosses between cultivars were conducted to understand leaf blotch, spot and stripe inheritance. Progeny from crossing purple-blotched cultivars resulted in a 1:0 or 3:1 ratio (blotched: non-blotched). Crossing non-blotched individuals produced all non-blotched progeny, and cross-blotched cultivars with non-blotched cultivars produced all blotched progenies. These results indicated that purple-blotched characteristic was controlled by a single locus, while blotch (*B*) is dominant to non-blotch (*b*). Selfing scattering spotted cultivars resulted in a 3:1 ratio (spotted: non-spotted) plants. Crossing between non-spot cultivars produced all non-spot plants, and crossing between spot and non-spot cultivar segregated in a 1:1 (spotted: non-spotted) ratio. This suggested that scattering spotted characteristic was controlled by a single locus, while scattering spot (*S*) is dominant to non-spot (*s*). Progeny from crosses between midrib-striped

cultivars segregated in a 1:0 or 3:1 ratio (stripe: non-stripe), while those from crossing between non-striped cultivars all produced leaves without any stripe. Progeny of crossing between midrib-striped cultivars and non-striped cultivars resulted in a 1:1 ratio (stripe: non-stripe). These suggested that midrib-striped trait was governed by a single locus, and midrib stripe (*M*) is dominant to non-stripe (*m*).

(056) Interspecific Compatibility of *Melastoma candidum* and *M. sanguineum*

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The cross compatibility between *M. candidum* and *M. sanguineum*, and morphological differences among offspring and their parents were investigated. Reciprocal crossings between *M. candidum* with *M. sanguineum* were conducted in 2014. Pollens from heteromorphic stamens germinated and grew into the bottom of stigma after 24 hours. For *M. candidum*, callose appeared in the upper part of stigma, and some appeared along pollen tube wall as well, while it was not obvious in *M. sanguineum*. The results showed that cross-compatibility between *M. sanguineum* and *M. candidum* was high. *M. candidum* (female) × *M. sanguineum* (male) had 83.33% fruit set with pollens from short stamens and 93.33% with pollens from long stamens. *M. sanguineum* (female) × *M. candidum* (male) had 76.67% fruit set of with pollens from short stamens and 80.00% with pollens from long stamens. The pollination effect of pollens from long stamens of *M. sanguineum* was better than that of pollens from short ones, while there was no significant difference between the pollens from heteromorphic stamens in *M. candidum*. Most offsprings have 39.47% greater plant height than the average of their parents and 55.35% longer leaves. The number of leaf vein was seven, which was the same as *M. candidum*. Heteromorphic stamens had no significant effects on the morphology of offspring. The leaf shape of offspring from obverse cross [*M. candidum* (female) × *M. sanguineum*(male)] was ovate-lanceolate and shoots were covered with short coarse pubescence, while that of the offspring from inverse cross [*M. sanguineum* (female) × *M. candidum*(male)] were ellipse-lanceolate and shoots were covered with scale pubescence.

(057) Pollen Germination and Storage of *Melastoma* Linn

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There are nearly 100 species of *Melastoma* Linn. (Melastomaceae) in the world, and nine of these species and one variety are native to China. Pollen viability and suitable storage conditions for pollen from *M. affine*, *M. candidum,* and *M. sanguineum* were investigated. Pollen viability was measured using a medium culture and three staining techniques, I_2-KI, 2,3,5-triphenyltetrazolium chloride (TTC), and benzidine-H_2O_2. In the culture medium study, an orthogonal test with four factors was conducted, sucrose (5, 10, and 20 g·L^{-1}), boric acid (50, 100, and 200 mg·L^{-1}), calcium chloride (50, 100, and 200 mg·L^{-1}), and temperature (20 °C, 25 °C, and 30 °C). Pollen tube germination of pollens from both long and short stamens was examined under microscope 2 h after being placed on medium. In vitro pollen germination of *M. affine* and *M. candidum*at 25 °C and 30 °C was higher than these at 20 °C. The best culture mediums for the pollen germination of *M. affine*, *M. sanguineum*, and *M. candidum* are: 1) 20 g·L^{-1} sucrose + 200 mg·L^{-1} H_3BO_3 + 100 mg·L^{-1} $CaCl_2$+30 °C: 2) 20 g·L^{-1} sucrose + 50 mg·L^{-1} H_3BO_3 + 100 mg·L^{-1}$CaCl_2$+20 °C, and 3) 10 g·L^{-1} sucrose + 100 mg·L^{-1} H_3BO_3 + 50 mg·L^{-1} $CaCl_2$+30 °C, respectively. For three pollen staining studies, I_2-KI could not separate the viable and non-viable pollens; pollen viability determined by TTC and benzidine-H_2O_2 was similar to pollen germination method. For pollen storage study, pollen were enclosed in silica gel and preserved at room temperature, 4 °C, –23 °C, or –80 °C, and pollen viability measured on 1, 5, 10, 15, 30, 60, 90, 120 days after storage. The results indicated that the lower preserved temperature, the higher pollen viability. –80 °C was the best pollen storage temperature, and after 120 days, the pollen viability of the three species still remained high.

(058) RAPD Analysis of an Easter Lily Chlorophyll Mutant

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A white edged leaf strip chimera mutant was obtained by in vitro mutation breeding. The flower bud was excised from the mutant and underwent tissue culture regeneration in an effort to isolate pure mutations. Three types of leaf color (white, yellow, and light green) shoots were regenerated from the flower bud; however, only light green color shoots rooted in rooting medium and were transferred to soil for greenhouse testing. Chlorophyll content and random amplified polymorphic DNA (RAPD) were evaluated between the regenerated green mutant plant and the control plant. The mutant plant had significantly lower chlorophyll content than the control, and DNA marker analysis showed clear DNA level differences, meaning a chlorophyll lacking mutant was created in Easter lily.

(059) Cross Compatibility of Three *Illicium* Species

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Illicium is an evergreen shrub with wide adaptation of soil types and shade tolerance. To increase its diversity, three species, *Illicium floridanum* Ellis (F), *Illicium lanceolatum* A.C. Smith (L), and *Illicium mexicanum* Ellis (M), and three cultivars [Alba (A), Pebblebrook (B), and Pink Frost (P)] were cross-pollinated for selecting new clones with better performance and adaptation. A total of 10 successful crosses were recorded and fruit sets were from 25% (L × M, B × P, and B × M) to 66.7% (P × M and M × P). Nine out of 10 crosses produced one mature fruit and M × P had two. The number of seeds ranged from 2–12 per fruit. Both the highest and lowest numbers of seeds per fruit were from the M × L cross. Pollen collected from *I. floridanum* 'Alba' was dusted with five other taxa and two mature fruits with 23 seeds were harvested only from M × A cross. Reciprocal crossed between M and L had much higher fruit and seed sets that that of F and L, which led to the conclusion that *I. lanceolatum* was more compatible with *I mexicanum* than *I. floridanum*. At the cultivar level, dwarf 'Pebblebrook' was compatible with 'Pink Frost' but we were not able to cross it with 'Alba'. All harvested seeds were be sowed after a 3-month cold stratification. Further hybridization of *Illicium* should include many more species and their cultivars.

(060) Photosynthetic Characteristics and Leaf Coloration Mechanism of the Hybrids between *Forsythia* 'Courtaneur' and *F. koreana* 'Suwon Gold'

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Crosses between *Forsythia* 'Courtaneur' (female parent) and *F. koreana* 'Suwon Gold' (male parent) were conducted in order to breed new *Forsythia* cultivars with vigorous growth and bright yellow leaves, and fifty two F_1 hybrid progenies with different leaf colors were obtained. The plant growth rate, foliar pigment contents, photosynthetic rate, microstructure and the ultrastructure of chloroplasts of leaves were investigated. The results showed that compared to the parent plants, the chlorophyll content of yellow leaf group was lower, palisade tissue was thinner, and structure of stroma lamella was not clear, so the photosynthetic activity was affected, leading to lower growth potential. The chlorophyll content of plants in the yellow-green leaf group was higher, thickness of palisade tissue was increased, structure of stroma lamella was clear, and the growth potential was improved. The study proved the basis of breeding new *Forsythia* cultivars with vigorous growth and bright yellow leaves.

(061) Genome Sequencing and Preliminary Assembly of Tung Tree (*Vernicia fordii*)

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Tung tree (*Vernicia fordii*) is an economically important non-edible woody oil tree originated in China. It is mainly distributed in subtropical areas of China and used to produce tung oil for centuries. Argentina, Africa, Paraguay and the United States have introduced and cultivated the tree. Tung tree seeds contain 50% to 60% oil with about 80 μmol α-eleostearic acid (9cis, 11trans, 13trans octadecatrienoic acid). Because of the three special conjugated double bonds in eleostearic acid, tung oil is easily oxidized and forms a unique polymer after being exposed to air, to form a tough, glossy, waterproof, insulative, and anticorrosive surface on the object it is coating. Tung oil is widely used in paints, varnishes, coatings, and finishes due to these excellent properties. Tung oil is also a high-quality raw material for producing biodiesel and composite functional material. Besides, tung tree is an important ornamental plant with bright-color flowers before leaves. The objective of this study was to sequence the tung tree genome. We obtained the low heterozygosity tung tree plant from inbred lines through SSR marker selection. DNA libraries with different insertion fragments (180bp, 500bp, 800bp, 3Kb, 10Kb, 15Kb, 20Kb) were constructed from the tung tree genome. These fragments were sequenced at both ends using paired-end sequencing method by Illumina Hiseq 2000. The PacBio library was constructed and sequenced by third generation sequencing. The Aleurites cordata Thunb., male and female plant of Vernicia montana, close relatives of Vernicia fordii, were used for resequencing of the genomes. We obtained the whole genome sequencing data followed by assembly and bioinformation analysis. The total amount of genome sequencing was 326.60G with a coverage of 249.46X. Preliminary analysis showed that the tung tree genome was 1.3G, not heterozygous but contained highly duplicated sequences. We obtained the preliminary assembly result with 60.6K of Contig N50 and 803.8K of scaffolds. Total length of the assembled sequence was 1.12G, approximately 85% of the predicted genome size. Transcriptome data were used to assess the genome data. The results showed that the coverage of unigenes was 94.97% and matching rate of reads achieved 88.3% to 95.6%. These data indicate that the assemble result of the tung tree genome is of high integrity. This study provides fundamental information for evaluating GC distribution and sequencing depth distribution, annotating genes, and analyzing evolution and biological functions in subsequent studies.

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Pomology 2

(437) Use of Innovative Plastic Films to Cover Cherry Orchard for Fruit Cracking Control and Fruit Quality Enhancement

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Today, most of the cherry orchards in North Italy are protected with plastic nets. The Department of Agricultural Science have begun to address the study on net-roofing systems in the early 90s, with the anti-rain net to avoid fruit cracking. Nowadays this research has become extremely relevant thanks to plastic films of new generation capable of advanced functions (able to pass specific wavelengths, or heat protective) that are not only anti-fruit cracking, but able also to control the maturation, to improve the fruit quality and also to be used to control the development of insects and plant diseases to some extent. In addition, the new pedestrian orchard realized with high density planting, do not represent a limit to mechanization in the protected orchards. The cover, which was a limit some time ago, has turned into an opportunity for development, and testing of new models of production. Moreover, other positive aspects have to be considered such as new simplified systems for opening and closing the nets that do represent another important reduction of the management cost. Although the initial expense of realization of the plastic roof is important, the advantages that this provides are indisputable and also their length can safely cover a span of time (in ordinary circumstances) of well 15–20 years. Moreover, it is expected that the innovations on roofing materials and techniques of management of the same, in short, from making additional benefits, allowing a reduction in costs, and an increase in both the quantity and the quality of the cherry production. Here are reported the results obtained on several cherry cultivars (Grace Star, Brooks, Early Bigi) covered with light diffusive, photoselective, and heat protective plastic films. The film, especially the light diffusive one, induced a higher fruit size, earlier ripening, and enhanced fruit skin color when combined with reflective mulch.

(438) Identification of Putative Fruit Growth Regulatory Genes in Apple

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Apple fruit growth is achieved through the combination of cell production and expansion. Molecular mechanisms regulating apple fruit growth are still poorly understood. Multiple genes regulating cell production or cell expansion, and organ growth have been identified in other species such as *Arabidopsis thaliana* and tomato (*Solanum lycopersicum*). The main objective of this study was to identify such genes from apple and to evaluate their roles in fruit growth regulation. Five gene families potentially associated with cell production or cell expansion were investigated: *CELL NUMBER REGULATOR* (*CNR*), *KLUH/CYP78A5* (*KLU*), *GROWTH-REGULATING FACTOR* (*GRF*), *GRF-INTERACTING FACTOR* (*GIF*), and *AUXIN-REGULATED GENE INVOLVED IN ORGAN SIZE* (*ARGOS*). Multiple candidate genes from these families were identified in apple based on their sequence similarity with genes from other species, and 33 were selected for further analysis. The expression levels of these candidate genes were analyzed across different stages of apple fruit development using quantitative RT-PCR. The effects of shading, pollination, and crop load reduction on the expression of these candidate genes were also investigated. Genes within the *KLUH/CYP78A5* family displayed low levels of expression in the fruit. However, several genes from the other families, especially *GIF*, *CNR* and *ARGOS*, displayed expression patterns consistent with roles in regulating cell production or cell expansion, and apple fruit growth. Further investigation of these genes may lead to a better understanding of mechanisms of fruit growth in apple.

(439) The Effects of Auxin, Gibberellins, and Defoliation on the Expression of Apple Flowering Genes (*Malus ×domestica* Borkh.)

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Flowering plays an important role in the apple industry. There are many issues associated with apple flowering especially with some high value cultivars such as Honeycrisp. It has been well established that plant growth regulators and defoliation treatments affect flowering. It is assumed this effect is preceded with a change in gene expression. MdTFL1 is a key gene involved in flowering repression, however MdFT1 promotes apple flowering. The interaction between PGRs and the floral initiation pathway is a key player to increase our understanding of apple flowering. In this study we are trying to understand the effect of exogenous applications of gibberellins and auxin, and defoliation treatments on the expression of MdFT1 and MdTFL1 genes and subsequent flower formation. We hypothesized that local application of gibberellins or defoliation will inhibit flowering, while local application of auxin will stimulate flowering. The inhibiting or stimulating effect will happen in response to increase or decrease in MdFT1 and MdTFL1 gene expression levels. We tagged bourses on 'Honeycrisp' apple trees, and randomly applied gibberellins, auxin or defoliation treatments. These treatments were applied locally at times previously shown to inhibit (gibberellins and defoliation) or stimulate (auxin) flowering. Samples were collected throughout the growing season to study the change in flowering gene expression and flower formation. Different treatments showed different flower formation levels. Both local defoliation and gibberellin treatments showed lower flowering formation compared with auxin and control treatments. Results of the effect of different treatments on MdFT1 and MdTFL1 genes using Quantitative PCR technique are being processed and will be presented.

(440) Correlation of IAD Values to Common Harvest Maturity Indicators in 'Honeycrisp' Apples

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In 'Honeycrisp' (*Malus domestica* Borkh.) the establishment of harvest times is crucial to maintain good quality fruit and determining an optimum maturity is hard to gauge, since a) 'Honeycrisp' maturation is strongly dependent on crop load and b) commercial quality/value is primarily determined via percent of red color formation. The DA meter is known to offer a fast, non-destructive way to monitor maturity progression of fruit and we hypothesized that I_{AD} values if correlated to any other common maturity parameter in 'Honeycrisp' might be useful to determine optimal harvest points. Correlations to common destructive maturity indices were made on 200 fruit each from two orchards in 2014, utilizing an average DA value of two readings (front, back)/fruit. Orchard 1 was picked 10 Sept. (single pick of 100 fruit from range of canopy positions). The recorded DA values ranged from 0.09 to 1.55. A large spread in background and red color was visually observed, and verified with laboratory readings. The DA values correlated in the field to background color, but regression analysis showed only a weak actual correlation. Fruit on sun side looked very similar in 0.31–1.2 range. Fruit in commercially harvestable range (based on visual clues) had DA values between 0.5–0.7. A linear regression analysis was performed for all maturity indices. Background color and starch exhibited the strongest relationship with the I_{AD} index ($r^2 = 0.43$ and 0.46). Firmness and fruit weight presented the weakest correlation ($r^2 = 0.08$ and 0.04). Fruit in the second orchard had a very narrow range in DA readings, with 70% of the fruit falling within I_{AD} of 0.61–0.9 and

no readings below 0.3. Regression analysis revealed red color to be the strongest correlated to the I_{AD} index ($r^2 = 0.26$), while all other values had weak correlations below r^2 of 0.1. Further studies need to be conducted to determine a specific model for this cultivar with the goal to establish stronger correlations and maintain reliability when using the I_{AD} index to non-destructively assess 'Honeycrisp' maturity and quality.

(441) Managing Bourse Shoot Growth to Maximize Flowering in Apple

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Consistent apple fruit production depends on regular flowering. Irregular flowering (biennial bearing) leads to challenges for apple industries around the world. Factors such as fruit weight, seed number per fruit, and bourse length are thought to influence flowering and could contribute to biennial bearing. Bourse shoots are vegetative shoots that arise just below flowers on flowering spurs. Over the last two decades the literature suggests that longer bourse shoots have a higher probability of forming flowers, however in a preliminary study on 'Honeycrisp' we found that bourses longer than 25 cm rarely formed flowers. In this study we hypothesized that bourse length is negatively correlated with flower formation and the time of bourse shoot growth termination plays an important role in flower formation. In two cultivars, 'Honeycrisp' (biennial cultivar) and 'Gala' (annual cultivar) we measured bourse length throughout the season on fruiting and de-fruited spurs, and determined floral status of buds at the end of the growing season. We found that, in 'Honeycrisp', bourse length correlated negatively with flower formation but in 'Gala' there was no effect of bourse length on flower formation. The time of terminal bud set was not affected by fruiting, although 'Honeycrisp' growth terminated at 42 days after full bloom whereas 'Gala' bourse shoots grew slowly throughout the growing season. Therefore bourse length plays a role in determining flower formation in 'Honeycrisp' but not 'Gala' and future research should develop methods to manage bourse length to optimize flowering.

(442) What Causes Weak Wood in Apple?

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Some apple scion/rootstock combinations are prone to graft union failure, which is characterized by the scion breaking off of the rootstock. This can occur at any time in the life of the tree, and no other signs of ill health may be observed beforehand. While factors like disease and environmental conditions can lead to graft failure, localized incompatibility is often considered to be the primary cause. Localized incompatibility occurs when the cambium between the scion and rootstock become discontinuous, causing a proliferation of disorganized parenchyma cells in place of regular xylem differentiation. Since there are no other external symptoms of localized incompatibility, combinations of scions and rootstocks may be planted without the grower being aware of the future risk. As new apple cultivars are bred, trees need to be screened for signs of incompatibility. In this study, two methods were used to screen young trees. The first combined light microscopy and computer image analysis to determine the percentages of the xylem cell types in the wood at the union. Tissues from the most recent growth ring were sectioned and stained using Toluidine Blue-O and were examined at 200 magnification. Xylem cells were divided into three tissue types based on their function within the wood: fibrous, conductive, and parenchymatous tissue. The percentages of the tissue types were calculated between the combinations using ImageJ. Weak combinations contained more parenchymatous tissue and less fibrous tissues than the strong combinations. Laser Ablation Tomography (LAT) was also evaluated for its use in screening histological traits of incompatibility. A laser system was used to ablate samples and photographs were taken and stacked to produce a three dimensional view of the union. Using LAT, we were able to distinguish some of the larger histological differences associated with localized incompatibility, including areas of poorly arranged parenchymatous tissue.

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(443) The Effect of Mechanical String Thinner Spindle Rotation Speed on Apple Spur Bud Removal

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Reducing apple crop load potential by spur pruning (artificial spur extinction; ASE) has been the focus of research since the mid-1990s. A hand-held tool was developed by researchers at Institut National de la Recherche Agronomique (INRA, Montpelier, France) to aid in ASE treatments [Equilifruit; 6 spurs/ cm^2 limb cross-sectional area (LCSA)]. The Equilifruit was developed for the Centrifugal training system, which utilizes ASE as the primary means of reducing bearing surface. The Equilifruit disk was tested in 2009 and 2010 as a hand-thinning gauge on tall spindle-trained apple trees in Pennsylvania, and resulted in appropriate crop loads and increased fruit size. ASE was tested on tall spindle apple trees in Australia, where researchers confirmed

the validity of the concept. As a result, ASE was recommended as a crop load management strategy. It is purportedly easy to train pruning crews to do ASE, but the practice is labor intensive. Studies were conducted on tall spindle 'GoldRush'/'M.9', and vertical axis 'Golden Delicious'/'Bud.9' apple trees to determine an appropriate spindle speed for mechanized ASE. Mechanical ASE was performed with a tractor-mounted mechanical string thinner (Darwin 300; Fruit-Tec, Deggenhauserertal, Germany) operated at 4.4 $km \cdot h^{-1}$ forward speed. To determine an appropriate spindle rotation speed, a string density of 270 strings was rotated at 210, 240, 270, and 300 rpm on 'GoldRush' apple trees, and at 270, 300, 330, 360, and 390 rpm on 'Golden Delicious'. Treatments were applied at green tip. Limb diameter was measured, and spurs were counted on two to three limbs per tree. Spur counts occurred before and after mechanical ASE. Spur removal (%) and spur density per cm^2 LCSA were calculated and analyzed using regression. 'GoldRush' spur removal increased linearly with increasing spindle speed. Spur density was linearly reduced from 12.9 to 8.9 buds per cm^2 LCSA. The number of remaining buds was supraoptimal, even at 300 rpm. 'Golden Delicious' spur removal increased linearly with increasing spindle speed. Spur density was linearly reduced from 13.6 to 2.9 buds per cm^2 LCSA. The regression equation showed that a spindle speed of 345 rpm would result in the target spur density of 6 buds/cm^2 LCSA. This technology has potential for mechanizing ASE.

(444) Shade Netting Reduces Sunburn Damage and Soil Moisture Depletion in 'Granny Smith' Apples

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Benefits associated with shade netting of apple orchards have been assessed in several countries, but few relevant experiences exist for Washington State, USA, a semi-arid region characterized by high light intensity and high temperature conditions. Here, environmental conditions increase the risk of plant stress and fruit sunburn damage. The aim of this study was to assess the effect of shade anti-hail nets on orchard microclimate, soil moisture and fruit sunburn. Seven-year-old 'Granny Smith'/M9 T337 apple trees were covered in 2013 with 22% white shade net by installing four pods, each of them covering a rectangular area of seven adjacent tree rows by 12 trees per row (18 m × 11 m × 5.2 m high). Uncovered trees served as control. Shade net reduced the maximum daily photosynthetically active radiation (PAR) by 32% ± 4.92 (std dev), with a maximum PAR value on a sunny day of 1649 and 1222 $mmol \cdot m^{-2} \cdot s^{-1}$ in the control and netted areas, respectively. Canopy air temperature was slightly lower during the day and higher at night under the net compared to the control, resulting in a 1.5 °C decrease in day-night temperature difference. Shade nets reduced soil moisture depletion at 0–30 cm depth, resulting in 20% higher soil water content compared to the control. No significant differences were observed deeper in the soil profile. Netting also significantly decreased fruit sunburn, resulting in 75% and 92% fruits with no sunburn damage in 2013 and 2014, respectively. Fruits from control plots with no sunburn damage represented 41% and 51% of sampled fruits in 2013 and 2014, respectively. Although preliminary, these results show that shade nets have a great potential to reduce sunburn damage and water requirements in semi-arid environments and might represent an important tool for increasing yields of high quality fruit.

Thursday, 6 August 2015

Teaching Methods 2

(274) Scan, Link, Learn: Campus Arboretum as Living Lab

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The Purdue Arboretum is a campus landscape arboretum that began as an idea in late 2008 to recreate the Purdue campus as a living laboratory. The mission of the Purdue Arboretum is to collect and display ornamental woody landscape plants from around the world in a way that enhances the educational, research, and outreach mission of Purdue University; promotes environmental sustainability; and increases the beauty of the Purdue campus. The Purdue Arboretum (2552 acres) is an outdoor laboratory that preserves valuable woody plant materials and increases the number of plants in established campus collections for student learning, fosters development of public education programs, supports research, demonstrates sustainable land stewardship, and provides areas for passive recreation. In August 2013, the Purdue Arboretum made available its new Scan, Link, and Learn educational initiative (www.arboretum.purdue.edu). This initiative involves an extensive, interactive mobile-learning platform, database, and the geo-location of all woody plants and landscape features, collectively called the Purdue Arboretum Explorer (http://mlp.arboretum.purdue.edu) and based off of the BG-Base and BG-Map database and mapping programs. Another important aspect of Scan, Link, and Learn is the labeling of one or more representatives of each of the 779 unique ornamental woody plant taxa on campus. Users can scan QR codes on a plant or landscape feature label, link to that plant or feature's page on the website, and learn by using the wide expanse of information available on the website and database for all aspects of the arboretum. The Purdue Arboretum Explorer mobile-learning platform and interactive database allows for protection and efficient management of the campus urban for-

est and woody plant collection, while also providing a resource used by academic departments, students, campus visitors, and researchers around the world. This platform features several key components: plants, sustainability initiatives, and landscape features (including art and geological features), all of which are included on the campus map. A self-guided sustainability tour has been developed which highlights landscape based sustainability applications. The Purdue Arboretum and the Purdue Arboretum Explorer application together embed ecological learning into the campus landscape and fulfill Purdue's goal of campus as a living laboratory. Content can be tuned to various audience levels from K-12 students up to graduate researchers, and fully integrates state-of-the-art tecnology and interfaces. This initiative fully realizes the mission of a land grant institution: education, research, and engagement.

(275) Where Health and Horticulture Intersect: A Navajo Wellness Collaboration

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Native Americans, including the Navajo, experience type-2 diabetes at four times the rate of the general U.S. population due in part to unhealthy diet and low levels of physical activity." The Navajo Nation recently initiated a "junk food" tax to discourage unhealthy food choices on the reservation. However, much of the Navajo Nation is considered a "food desert" leaving residents with few options for purchasing fresh fruits and vegetables. Community gardens can improve the health of residents because: 1) gardeners often adopt healthier diets by consuming what they produce; 2) children of gardeners learn healthier dietary habits early in life; and 3) gardening is a form of physical activity. In order to address the issue of limited access to healthy foods, we developed a multi-component, theory-based intervention that integrates community gardens, educational workshops and community outreach in Navajo communities. The aims of the project are to 1) Estimate the effects of an integrated intervention on adoption of gardening practices, vegetable and fruit intake and 2) Estimate the effects of the intervention on self-monitoring, self-efficacy, behavioral capability, and social norms related to gardening and vegetable and fruit consumption. The intervention emphasizes Navajo culture and tradition centered on story telling. Yeégo Gardening! (Let's Garden!) was launched in 2014 after Navajo Nation IRB approval. Two eastern Navajo Nation communities allowed their gardens to be used as "outdoor classrooms" for technical workshops to address previously identified barriers to gardening (e.g. lack of information on how to start a garden, poor soil, lack of water, how and what to harvest). Baseline and follow-up questionnaires were administered before and after the workshop series to consenting adults. For the 2015 growing season, we hosted a health fair/garden technique kick-off event with garden-based workshops coinciding with key aspects of gardening (e.g. seed selection, planting techniques, garden maintenance, when and what to harvest, and healthy cooking ideas). We modified our 2014 curriculum from being more "Master-gardener-like", to a more appropriate literacy level for beginning gardeners with little to no gardening knowledge. Preliminary results from the surveys will be presented. If the pilot is successful, a long-term benefit could be a reduction in risk factors associated with type-2 diabetes.

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(276) A Model for Establishing and Maintaining the Campus Landscape as a Significant and Dynamic Outdoor Classroom, Laboratory, and Therapy Center

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Research has shown that plants and the landscapes around us impact our lives. Plants have been shown to reduce anxiety and blood pressure, and to have mentally restorative and psychological benefits. These benefits can include but are not limited to improving our ability to cope with stress and improving our ability to focus and concentrate. Additionally, recent research suggests that university athletes show performance improvements when competing in venues with views of vegetation. These findings suggest that the university campus landscape and vegetation can affect the well being of the university community. A study that seeks to identify the factors that contribute to a useful and beneficial campus landscape will be discussed. Faculty who teach plant science, horticulture, and environmental sciences using the campus are limited by the landscapes surrounding their university structures. Often, a hands-on, practical experience with plant material is forfeited due to lack of suitable specimens on or adjacent to campus. Surveys of recent University of Tennessee graduates in the area of Plant Sciences indicate a desire for more hands-on practice and experience contributing to their degree. The need for a high quality teaching landscape for those teaching and studying plant sciences and horticulture was identified. Often, lack of resources and a suitable demonstration landscape are to blame. Additionally, beyond the natural sciences, little effort has been given to outdoor teaching resources that could

be used by other disciplines. A model of how a university can establish and maintain its campus grounds as a significant and dynamic outdoor classroom and laboratory for an array of academic disciplines will be examined.

(277) Cross-cultural Connections: How Key Hole Gardens Link Two Schools

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Iowa State University (ISU) College of Agriculture and Life Sciences (CALS) administers two collaborative school-garden, service-learning programs: 1) Uganda, initiated in 2006, is a partnership between ISU, Makerere University, local non-governmental organizations, and the Ministry of Education, with five schools in the Kamuli district, including Namasagali Primary School (NPS). The Ugandan school gardens produce crops and poultry for school feeding programs, and provide propagation materials for students' home gardens. 2) The EARTH Program (Education and Resiliency Through Horticulture) is on St. John U.S. Virgin Islands and began in 2010. EARTH is a partnership between ISU and Gifft Hill School (GHS), a private school and the only complete K-12 school on St. John. The focus of GHS's school garden is reconnecting children with their environment and food system, and teaching families to provide some of their own food, thereby lowering the cost of living. Both programs create and utilize outdoor learning laboratories and include hands-on learning experiences for school children and service-learning experiences for undergraduate students. These two programs are connected through ISU. To take advantage of this connection we have developed five cross-cultural learning experiences, enhancing the education of school children in both GHS, and NPS: 1) sixth grade pen pal program, 2) GHS National Honor Society fundraiser for school supplies for NPS students, 3) ISU program staff exchange and guest lecture, 4) Ugandan keyhole gardens at GHS, and 5) GHS high school students plan a future service-learning trip to Uganda. Ugandan keyhole gardens are circular raised beds with a central compost bin. Compostable materials and gray water are added to the bin, watering the garden with compost leachate via capillary action. In Uganda keyhole gardens are common as a kitchen garden and made with local hand-made bricks. At GHS, a keyhole garden was constructed from local, sustainable products (including recycled glass bottles and papercrete, a mixture of 25% shredded paper and 75% mortar by volume). These gardens and pen pal letters provide a lasting link and physical symbol of the relationship between the schools. Keyhole gardens, used as kitchen gardens, are suitable for culinary herbs and many vegetables, and are used for both education and demonstration purposes. Tropical gardens and African heritage provide a shared experience between the students from which discussions in lessons and pen pal letters can be built. They also allow students to compare garden types, and management practices across different physical and cultural situations.

(278) The Impact of a Living Green Wall on Student Attitudes and Moods

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Research documenting the positive effects of the presence of plants on human mood and mental health in an interior environment has been reported by other researchers for office and medical facility environments. This study focused on the impact of a living green-wall in an academic classroom setting. Standardized psychological tests and surveys were administered to experimental groups of students and to students who were enrolled in classes in the classroom with a green-wall and in an identical paired classroom without the presence of plants. The results revealed a significant difference in student responses between the classrooms. Students in the green-wall room scored significantly higher for personal restorative measures and significantly higher for happiness and peppy measures. The presence of plants in an academic classroom could potentially create a more positive learning environment compared to a room without plants. Details of the research methods and results will be presented.

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(279) Student Reflections on Service Learning Experiences in a Hydroponic Food Production Course

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The increasing interest in regional and local food systems is resulting in an upsurge of hydroponic food crop production. This greater awareness of where food is coming from is also providing an opportunity to increase dialog on food security as it relates

to regional and local communities. This interest and awareness about local food systems and food security can be integrated into greenhouse crop production curriculum and provide for unique learning experiences for students. In response to this interest at Iowa State University, a hydroponic food production course was created in the Department of Horticulture. Students were responsible for producing lettuce, cucumbers, and tomatoes in hydroponic production systems in the laboratory portion of the course. Crops were harvested weekly, packaged, and donated to a local perishable food pantry. Service learning was incorporated into the course to compliment the curriculum and provide an enriching volunteer experience for students. Students completed the service-learning component by volunteering in one of three ways at the food pantry where the produce was donated by: distributing the produce to the pantry; preparing a meal; or serving and doing clean-up following a meal. Students also submitted three written reflections during the course. The first reflection was completed at the beginning of the semester following an introduction and description of the food pantry by the executive director. The second reflection was completed following their volunteer experience. And the final reflection was submitted at the conclusion of the course and laboratory reflecting on the overall experience. Each group of reflections was evaluated to determine common words or themes. Analysis showed that for all three reflections, "food" was the most frequently used word and "people" was the second-most used word. Other words used frequently included "think" and "experience". Based on the results of written reflections, we believe that including the service-learning component of in the hydroponic production course enriched the student's experience and deepened their understanding of food security.

(280) Tiny Houses for Northwest New Mexico: A Collaboration between San Juan College and the New Mexico State University Agricultural Science Center at Farmington to Demonstrate Sustainable Living

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Affordable housing on the Navajo Nation is problematic. Most of the Navajo Housing Authority units were built in the 1960s through 1980s. Many of these older units have fallen into disrepair. At least 20,000 Navajo households are estimated to still be without electricity. Tiny houses are gaining popularity in both rural and urban settings as more people become interested in sustainable or "green" living practices. Tiny houses have many benefits including: 1) reduced carbon footprint (reduced space means less energy consumption and less "stuff"); 2) a small floor plan enables affordably scaling up details like cabinetry and countertops that would otherwise be cost prohibitive in larger houses; and 3) less space equates to less mortgage. In 2012, the New Mexico State University (NMSU) ASC-Farmington, located on the Navajo Nation, recognized the need for year-round housing to accommodate visiting scientists, including graduate students. At the same time, the San Juan College (SJC) Buildings Program was seeking classroom building projects that could be accomplished in four semesters and demonstrate energy efficiency, affordability and sustainable living principals. Constructing a tiny house represented an opportunity for cross-institutional teaching and research collaboration. Students from the SJC Buildings Program became part of the learning experience in the construction of the house while SJC Horticulture students designed ornamental Xeriscape and edible garden outdoor spaces around the house. During the Fall 2012 semester, a gravel foundation was leveled on the SJC campus on which the one bedroom/one bathroom house was framed (14 ft. x 32 ft. or 448 sq. ft.). It took approximately two semesters for framing and roofing. Beginning in the Fall 2013 semester, windows were installed, the house was plumbed, and detailing the interior began. This entailed installing flooring, cabinetry, lighting, sinks and a tub. By June 2014, the foundation (concrete piers) was poured at the NMSU–ASC Farmington site. The house was then craned onto a flat-bed tractor trailer and moved from SJC to the NMSU–ASC Farmington where it was then craned onto the foundation. The house project demonstrates how community colleges and agricultural research stations can cooperate and several studies in sustainable living are now planned including monitoring household/landscape water and energy usage and determining perceptions and attitudes of tiny houses in northwest New Mexico. The house and landscape also serves as an important demonstration garden to the Navajo Nation.

(281) Utilizing Horticultural Education to Empower a Community and Enhance Individual and Environmental Health

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Park Falls, located in the Flambeau River valley, is home to almost 2500 Wisconsin residents, including more than 1000 elementary, middle, and high school students. Recent research and local dialogue highlight the need for a focus on healthy eating and renewable resources throughout the community. In response, the Flambeau River Community Growing Center has been developed to utilize waste streams from the Flambeau River Paper Mill while establishing a strong relationship between University of Wisconsin (UW), Madison, and the Park Falls community. Collaborators inlcude plant scientists from UW–Madison, engineers from Flambeau River Paper Mill, outreach staff from UW–Extension, and educators from Chequamegon School Distric. Flambeau River Community Growing Center has

also welcomed the broader Park Falls community throughout its development and operations. This has been a unique opportunity to introduce a UW presence in a northern Wisconsin community. Ultimately, we have utilized horticultural education to empower the community and enhance individual and environmental health.

Friday, 7 August 2015

Environmental Stress Physiology 2

(215) Effects of Salinity on Vegetative Response, Yield, and Fruit Quality Attributes of Commercial Piquin Peppers (*Capsicum annuum* L. var. *glabriusculum*)

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The accumulation of salts in the soil profile results from a number of natural and anthropogenic processes. In northern Mexico, salinity problems are primarily caused by low precipitation and deficient management of irrigation systems. Piquin pepper (*Capsicum annuum* L. var. glabriusculum) is a highly appreciated horticultural product in northern Mexico. Since piquin pepper plants are not fully domesticated, they still present rustic characteristics, which make them attractive for production in saline-affected soils. The objective of this project was to characterize the effects of the application of different NaCl treatments (0 to 400 mM) through the irrigation system on vegetative response, yield, and fruit quality of piquin pepper plants. Response variables included photosynthetic response, yield, biomass parameters, maturation, and fruit quality attributes (size and pungency levels). Our results indicate that the primary effect of increased NaCl in the irrigation water on photosynthesis started at higher concentrations than those reported for other peppers and crops. Increased NaCl concentration reduced vegetative growth and changed root:shoot relationships. While increased NaCl levels affected fruit yield, they did not have a significant effect on fruit quality parameters including fruit maturation, and pungency.

(216) Evaluation of Lettuce Genotypes for Salinity Tolerance

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Lettuce is one of the most commonly used salad vegetables and considered to be a relatively salt sensitive crop. Salinity is a major constraint to crop production in all important lettuce districts of the United States, and the water quality problem is exacerbated by the climate change. In order to identify salt-tolerant lettuce genotypes, 174 cultivars and germplasm accessions (54, 39, 34, 32, and 15 genotypes of butterhead, crisphead, romaine, leaf, and wild types, respectively) were screened in sand cultures under greenhouse conditions. Leaf fresh and dry weight (FW and DW), chlorophyll index and maximal photochemical efficiency (Fv/Fm) were measured four weeks after the varieties were seeded and grown in Hoagland nutrition solution either with or without 30/15 mM NaCl/$CaCl_2$. Generally chlorophyll index increased while Fv/Fm remained unchanged under salt stress. Some lettuce varieties showed salt tolerance (less than 10% reduction in FW) such as Morgana, PI 358020c, PI 342515 (butterhead), Laura (crisphead), PI 289023, PI 278066 (romaine), PI 171676a, PI 177423, PI 358018b, PI 342477 (leaf). The result of this study indicated that lettuce genotypes differ greatly in their salt sensitivity, which could be useful for growers to choose cultivars and for breeders to improve lettuce adaptation to salinity stress.

(217) Evaluation of Salt Tolerance and Proline Accumulation in Korean Potato Cultivars (*Solanum tuberosum* L.) using In Vitro Culture

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Salt tolerance in cultivated Korean potatoes (*Solanum tuberosum* L.) was evaluated through in vitro salt medium culture and proline concentration as affected by the salt treatment was analyzed. Various levels of NaCl (0, 75, 150, 225 mM) were added to the MS medium for salt treatment. Although the growth of all cultivars was inhibited by the NaCl treatments, relatively normal shoot and root growth was observed at the 75-mM NaCl treatment, while the growth was very poor at 150 and 225 mM NaCl. The shoot lengths in 'Haryeong', ' Superior', 'Jayoung', 'Dejima', and 'Desiree' were better than others. At low salt medium, the shoot weights of 'Dejima' and 'Superior' were heavier than the ones of other cultivars. Then, at high salt medium, 'Seohong' and 'Superior' showed heavier shoot weights than others. Root emergence was observed in seven cultivars (Seohong, Superior, Jayoung, Haryeong, Hongyoung, Desiree, and Sante) at 75 mM NaCl

and in three cultivars (Seohong, Superior, Haryeong) at 150 mM NaCl. There was no root in all cultivars at 225 mM NaCl. Meanwhile, proline concentration was dramatically increased by the NaCl treatments in all cultivars ($P < 0.001$). Then, any clear correlation was not observed between salt tolerance and the proline concentration. Proline concentration was relatively lower in the cultivars showing a good shoot and root growth than in the ones showing a bad growth. We are conducting more detail research to determine the relationships between salt tolerance and proline. In conclusion, based on the shoot and root growth in salt medium culture, 'Haryeong', 'Seohong', 'Superior', and 'Desiree' were relatively salt tolerant.

(218) Low-temperature Conditioning of Garlic "Seed" Cloves Induces Differential Response in Sprouts Proteome

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Low-temperature conditioning of garlic (*Allium sativum* L.) "seed" cloves at 5 °C for 5 weeks substitutes the initial climatic requirements of the crop and accelerates the development of the crop cycle. Also, reduces growth and plant weight as well as the crop yields and increases the synthesis of phenolic compounds and anthocyanins in the bulbs at harvest. Plant acclimation to low-temperature is associated with deep changes in proteome composition. Since proteins are directly involved in plant response to environmental conditions, proteomics studies can significantly contribute to unravel the possible relationships between protein abundance and low-temperature acclimation. Therefore, the aim of this work was to study the changes in the protein profiles of garlic "seed" cloves subjected to conditioning at low-temperature using proteomics approach. Two sets of garlic bulbs were used, one set was stored at room temperature (23 °C), and the other was conditioned at low temperature (5 °C) for five weeks. Three sets of 25 bulbs of each condition were separated and the cloves of medium size (5– 6 g) were selected. Total soluble proteins were extracted from sprouts of cloves with an adapted method and separated by isoelectric focusing using 24 cm strips, pH 4–7 and second dimension was carried out on 13% SDS-PAGE gels. 2-DE gels were stained with Coomassie blue and digitalized images were analyzed using Melanie v7.0. Sixty-two protein spots showing statistically significant changes in abundance between treatments were analyzed by LC-ESI-MS/MS. Eighty-one percentof the spots were identified by database search analysis using the Mascot search engine. According to Gene Ontology these proteins were grouped into nine different categories in function to the biological processes in which they are involved; cellular response to stress, carbohydrate binding, regulation of transcription, transport of macromolecules, protein folding, photosynthesis, carbohydrate metabolism, nucleotide metabolism, and miscellaneous. The results indicated significantly increased protein spots including RNA-binding protein, chaperone and S-adenosylmethionine synthetase. Significantly decreased protein in garlic sprouts spots subjected to cold conditioning, which include mannose-specific lectin, macrophage migration inhibitory factor, annexin D2-like and glutathione S-transferase. This is the first report that analyzes the garlic proteome modifications induced by low-temperature conditioning of the "seed" cloves.

(219) An Analysis of Historical Freeze Events and Determination of Blueberry and Peach Critical Bud Temperatures to Aid Growers in Freeze-related Risk Assessments

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Freeze damage can result in significant economic losses for growers of low-chill blueberry (*Vaccinium* spp.) and peach (*Prunus persica* L.) in subtropical climates. Freezes can be categorized as either radiative or advective. Radiation freezes are characterized by clear skies, winds less than five miles per hour, and the development of a temperature inversion layer. Advective freezes are characterized by winds greater than five miles per hour, cloudy skies, and the absence of a temperature inversion layer. The objective was to use historical weather data and to determine the critical temperatures for peach and blueberry floral buds in order to provide growers with additional information for their risk assessment decision-making process. Weather data from 2000–15 for three Florida locations, Alachua, Lake Alfred, and Frostproof, were downloaded from the Florida Automated Weather Network (FAWN) and analyzed. Hourly temperature, wind speed, dew point, and relative humidity were used to

determine the average number of days annually with sub-zero temperatures, the average of number of days per month with sub-zero temperatures, the duration of each freeze event, and to classify each event as a radiation or advective freeze. Preliminary analyses of critical bud temperatures for two low-chill peach and blueberry varieties were conducted using differential thermal analysis (DTA) and standard freezing tests during Fall and Winter 2014–15. Preliminary DTA results do not show a consistent correlation between the low temperature exotherm and lethal bud temperature determined by the standard freezing tests. This could be in part due to the low-chill varieties not fully entering into endodormancy. DTA will be continued into the future and the results will be compared against controlled freezing tests.

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Nursery Crops 2

(420) Effects of Paclobutrazol on the Growth of *Leucospermum* Hybrids

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Leucospermum hybrids have great potential for potted flowering plants. Our aim was to determine proper concentrations of Paclobutrazol, a gibberellin biosynthesis inhibitor, in order to produce compact *Leucospermum* hybrids that are better suited as potted plants. Rooted cuttings of 'Brandi Dela Cruz' and 'Debbie Hamrick' were planted in 1-gallon pots filled with potting media (50% volcanic cinder: 50% peat moss, v/v) after thoroughly mixing with 8 g of a slow-release fertilizer (Osmocote 14–14–14) and grown in the greenhouse with natural light and with a regular irrigation. Paclobutrazol (PBZ) was sprayed to the foliages of the plants at a concentration of 0, 25, 50, 75, 100, 125, or 150 ppm one week after transplanting. Plant height, the length of individual branches, and the numbers of leaves and branches were measured monthly during the five-month production period. Plant height and branch number increased as plant aged in both hybrids. Although the initial height of the two hybrids was not significantly different, 'Brandi Dela Cruz' grew taller and produced twice more branches compared to 'Debbie Hamrick'. A spray with PBZ at all the concentrations significantly reduced plant height of 'Brandi Dela Cruz' from two months after the treatment. Plant height and individual branch length were reduced by more than 30% at the highest concentration of PBZ. Meanwhile, PBZ did not have greater impact on controlling plant height and individual branch length of 'Debbie Hamrick', and only the highest concentration reduced plant height by less than 15%. The number of branches increased with plant age and concentration of PBZ. PBZ increased the number of branches in 'Brandi Dela Cruz' from the first month after treatment, while the number of branches increased from four months after the treatment in 'Debbie Hamrick'. In conclusion, PBZ significantly reduced plant height in both varieties, but the efficacy varied with variety tested. It appeared that PBZ has greater effects on 'Brandi Dela Cruz', a fast growing variety, while it has less effect on 'Debbie Hamrick', a slow growing variety. The results suggest that foliar application of PBZ is useful to control the growth of *Leucospermum* hybrids for potted plant production. Higher concentrations or multiple applications should be considered for a slow growing variety to more effectively control plant growth.

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(421) Influence of White Wood on Physical Properties of Pine Bark Substrates

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Bark has been an important component in horticultural substrates for years (and is rapidly increasing in greenhouse professional mixes and in retail potting soil mixes), and in the nursery industry bark is the most common substrate component used in the United States. Bark is obtained as a byproduct of the timber industry (pulp mills, saw mills, pole peeling operations, etc.) when it is striped off logs after harvest. The objective of this work was to evaluate the influence of white wood on the physical properties of pine bark substrates. To test these differences, fresh and aged pine barks from four different sources were obtained and tested. White wood was removed (by hand) from each pine bark material until enough volume of material was obtained to analyze physical properties using the North Carolina State University porometer method. All substrates were wet up as needed to have moisture contents between 50-60% to prevent substrate shrinkage/swellage when tested. The amount of air decreased and container capacity increased with the removal of white wood for the majority of bark samples tested. The amount of change in air and water percentages that occurred correlated with the size of the white wood particles in each substrate. Those with larger white wood pieces (from the fresh bark sources) showed a greater change in the amount of air and water percentages when comparing with and without white wood, than those with smaller pieces (from aged bark sources) of wood. Larger white wood particles naturally create more air space than smaller ones. As an example of the variation, 10% to 15% white wood in a bark substrate may not effect physical properties at all if the particle size of the white wood pieces is similar to the bark, but on the other hand, as little as 5% white

wood with a large (length or diameter) particle size can greatly change the physical properties of a bark. The variability in pine bark supplies can be likely influenced by many factors including species of pine tree, thickness of bark at time of removal, tree harvest season, method of bark removal from logs, variations in hammer milling, variations in bark handling and screening, and variations in bark pile management and aging. These variations can exist between/among different suppliers, but also it can (and very often do) vary from season to season at the same supplier.

(422) Pine Bark Substrate Source and Age Affect Seedling Toxicities

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Bark has been an important component in horticultural substrates for years (and is rapidly increasing in greenhouse professional mixes and in retail potting soil mixes), and in the nursery industry bark is the most common substrate component used in the United States. Bark is obtained as a byproduct of the timber industry (pulp mills, saw mills, pole peeling operations, etc.) when it is striped off logs after harvest. The objective of this work was to evaluate the potential and/or severity of pine bark toxicities on seedling germination and growth. A grow test method was used to observe any toxicities expressed in plants grown in pine bark substrates. Six pine bark sources and two different ages (fresh and aged) were tested. The method and duration of aging varied among suppliers. The aged materials were "ready for sale" from each supplier. For each substrate, 12, four-inch pots were filled and then seeded with one of three species: marigold, radish, and tomato. Four replications were used for each species with five seeds per pot. A control mix (60:20:20 peat/vermiculite/perlite) was used as well for comparison. Seeds germinated and grew for two weeks and then were thinned to one plant and grown for an additional two weeks. Seedling germination percentage was recorded. In addition, toxicities were observed and recorded. Toxicities were exhibited through foliar symptoms such as chlorosis, reddening, and limited growth (did not get beyond cotyledon stage). Seedling germination varied among pine bark sources and ages of pine bark when compared to the control mix for both marigold and tomato species. However, all sources and ages of pine barks showed an increase in germination percentage of radishes as compared to the control mix (95% to 100% vs. 90% for control mix). With few exceptions, all pine barks showed an equal or greater germination percentage than the control mix for marigolds and tomatoes. Those that did have lower germination percentage cannot be attributed to one particular source or age. Therefore, germination percentage is not predictable since two of three species varied greatly amongst different sources and ages. The variation in germination between and among bark ages and sources can be likely due to the particle size of the barks (which was extremely varied), with coarser materials not being supportive of seed germination even if there were no toxicities preventing germination.

(423) Influence of Sand on Physical Properties of Pine Bark Substrates of Different Ages and from Different Sources

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Bark has been an important component in horticultural substrates for years (and is rapidly increasing in greenhouse professional mixes and in retail potting soil mixes), and in the nursery industry bark is the most common substrate component used in the United States. Bark is obtained as a byproduct of the timber industry (pulp mills, saw mills, pole peeling operations, etc.) when it is striped off logs after harvest. Sand is still often added to bark nursery substrates, whether it be to add weight to prevent container blow overs or just because it is "tradition" and they always have done so. The objective of this work was to evaluate the influence of two grades of sand on the physical properties of pine barks of different ages and from different sources/suppliers. To determine the influence of sand on physical properties of pine bark substrates, four sources and two different ages (fresh and aged) were obtained and tested. Samples of each bark material were separated into three subsamples (3 L): one without sand, one amended with 10% (by volume) small grade fine sand, and one amended with 10% (by volume) large grade coarse sand. Once blended, substrates were wet up to 60% moisture content to prevent shrinkage/swellage during porometer testing. A total of 12 samples were tested for physical properties using the North Carolina State University porometer method. The effect of sand on the air and water properties of each pine bark was the same regardless of source or age. Bark amended with small grade sand showed an increase in water and a decrease in air space (compared to bark without sand). Those amended with large grade sand did not show a significant change in water (only varied 1% or 2%), however, did exhibit a decrease in air space. For both small and large grade sand amended barks, total porosity decreased by 5% or more as compared to bark without either sand. Whether sand can increase, decrease, or have absolutely no effect on air and water properties is completely dependent on the bark it is being added to if the particle size variations are very different.

(424) Optimizing Container Production and Propagation Protocols for Five Underutilized Northeastern United States Native Shrubs

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Corylus cornuta, Lonicera canadensis and *Viburnum acerifolium* are underutilized native shrubs with ornamental potential that are often found growing along roadsides in dry, gravely soils. One-gallon nursery containers with media composed of four parts aged pine bark, two parts sphagnum peat moss and one part sand, was amended with expanded shale at 20% and 50% to produce growing media resembling the natural soil in which these plants are found. Two rates of topdressed controlled-release 15 N–3.9 P–10 K fertilizer (Osmocote® Plus 8–9 month formulation), 1 g N and 2.5 g N, was also evaluated. Expanded shale did not improve plant growth for these species, and significantly larger plants of *L. Canadensis* were produced in control media (lacking expanded shale) than in amended media. For all species, there was no significant difference in plant size for the two fertility levels. One-gallon containers of *C. cornuta* and *V. acerifolium* in un-amended media were 35– 40 cm tall, 25–30 cm wide and had 4–7 shoots. One-gallon containers of *L. Canadensis* were 40 cm tall, 50 cm wide and had 9 shoots. In a separate study with *V. acerifolium* in one-gallon containers, plants were pruned to 14 cm or left unpruned (35 cm). At the end of the growing season, pruned plants were shorter (30 cm) than unpruned plants (50 cm), but visual quality ratings were two times greater for pruned plants, because they had equivalent height and width and a more symmetrical and full appearance. Softwood stem cutting propagation was conducted using three rates of indole-3-butyric acid (IBA) in talc (1000, 3000, and 8000 ppm) and a no hormone control for *Eubotrys racemosa* and *Viburnum lantanoides*. *E. racemosa* rooted at 100% and cuttings treated with 1000 or 3000 ppm IBA had significantly longer roots than the control. Due to its ease of propagation, adaptability to tough landscape conditions, and ornamental features including attractive red fall foliage, *E. racemosa* has the potential to become an important landscape plant and be utilized as an alternative to invasive *Euonymus alatus*. *V. lantanoide* is desirable for its outstanding ornamental traits, but it is reported to be difficult to propagate from cuttings. However, we achieved greater than 80% rooting for IBA-treated cuttings, and cuttings receiving 3000 or 8000 ppm IBA produced more and longer roots than the control. All five species could be viable commercial crops for nurseries looking to add native shrubs.

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(425) Comparison of Pine Bark from Multiple Suppliers: Variation in Available and Unavailable Water

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Bark has been an important component in horticultural substrates for years (and is rapidly increasing in greenhouse professional mixes and in retail potting soil mixes), and in the nursery industry bark is the most common substrate component used in the United States. Bark is obtained as a byproduct of the timber industry (pulp mills, saw mills, pole peeling operations, etc.) when it is striped off logs after harvest. The objective of this work was to evaluate the differences in available and unavailable water in pine bark substrates from different sources/suppliers. Two sources of aged pine bark at three different moisture contents (55%, 45%, and 35%) were tested to determine available and unavailable water (by vol). Source 1 was aged 1 month and Source 2, was aged nine months. Each pine bark had an initial moisture content (by weight) around 60%. This was adjusted to the desired testing moisture content (by weight) by air-drying samples then allowed to equilibrate for 24 hours. Once at the desired moisture content, small metal containers were filled with enough pine bark to cover the bottom of the container, approximately half the total volume or 25 mL (total volume of the container was 50 mL). The samples in the metal containers were then placed in a WP4C Dewpoint Potentiometer to measure the water potential (MPa). After obtaining the water potential (MPa), each sample was removed from the metal container and put onto a metal plate, weighed, and then inserted into a moisture balance to determine the dry weight, and confirm the sample was at the desired moisture content. Unavailable water was calculated as follows: subtracting wet weight and dry weight, multiplying by the density (g/cc), and then converting to a percentage. Container capacity and density were determined by using the NCSU porometer method. Available water was then calculated by subtracting the percent unavailable water from container capacity. Available water increased (and conversely unavailable water decreased) with decreasing moisture contents in Source 1 bark. Source 1 showed higher percentages of unavailable water than Source 2. This could be a result of Source 2 being aged more, different handling practices, milling practices, etc. Previous research on fresh and aged pine bark for growing nursery crops suggested that it is the available water in different pine barks (and bark ages) that cause plant growth differences and irrigation management differences.

(426) Rooting of Choke Cherry Cuttings in Response to a Commercial Liquid Extract of the Marine Macroalga *Ascophyllum nodosum*

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Choke cherry (*Prunus virginiana* L.) is an ecologically important species in land reclamation because of its extensive lateral root system that readily suckers and thus quickly creates dense thickets. Consequently, choke cherry provides rapid site occupancy that reestablishes nutrient cycling and prevents

erosion. Our overall goal is to increase root growth of choke cherry seedlings after spring planting on reclamation sites by improving seedling root system quality in the nursery. Earlier, we reported an increase in the early rooting of choke cherry seedlings in response to a liquid extract of *Ascophyllum nodosum* (L.) Le Jolis extract (ANE). The objectives of this research were to confirm the optimal rate and to gain an understanding of how ANE elicits rooting. We stratified (2 weeks at 21 °C/18 weeks at 4 °C) seeds from a single clone, and then placed them in a germination cabinet. After 7 days, we removed germinants, suspended them in vials of deionized water and placed them in a growth chamber (25 °C/20 °C D/N, 16-hour photoperiod, 75% relative humidity) to induce a geotropic response. After 7 days, we grouped germinants into sets such that both mean epicotyl–hypocotyl axis length was equal and leaf number/development was similar. Cuttings were taken 2–3 mm below the hypocotyl–radicle junction and suspended in magenta jars filled with ANE in deionized water at the following rates: 0 mL/L, 0.25 mL/L, and 0.5 mL/L. After 21 days, 100% of cuttings had rooted at the 0.25 and 0.5 mL/L rates. Mean number of total (secondary and tertiary) roots on cuttings was 8.4 and 4.5 at the 0.25 and 0.5 mL/L rates, respectively. No cuttings had rooted at the 0 mL/L rate after 28 d. After 28 days, mean number of secondary roots was 3.6 and 3.1, and mean length of the longest secondary root was 7.4 cm and 7.8 cm at the 0.25 and 0.5 mL/L rates, respectively. On the longest secondary root, mean number of tertiary roots and mean length of all tertiary roots were 7.2 and 4.4 and 10.3 cm and 10.9 cm, respectively, at the 0.25 and 0.5 mL/L rates. Callus formed at the excised surface in 17% of cuttings at the 0.25 mL/L rate and was not associated with root initiation. No callus formed at the 0.5 mL/L rate. Roots arose from the pericycle, later connecting to the vascular stele and extending through the cortical–epidermal layers.

(427) Development of a New Tool for Growers and Researchers to Better Understand Ornamental Operations

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Many growers are reluctant to change practices, particularly if a cost (e.g. time, money, materials etc.) is associated with the change in practice. One way to help inform grower decisions is through modeling their operation, showing potential areas for improvement. As part of a five-year, USDA–SCRI funded project, we will develop models to provide site-specific information for growers and researchers helping to inform users about current practices and to guide production decisions. Informed decision-making should benefit both grower profitability and environmental sustainability. These models will build upon existing Stella® models for greenhouse and container operations and will combine user inputs with research data to create outputs specific to individual operations. Models inputs will include water (rainfall and irrigation), fertilizer application (rate, type, and timing), and site-specific information (slope, container sizes, best management practices, etc.). This information will feed into the model, creating an operation-specific baseline of current practices. Once a baseline is defined, practices (i.e. decrease fertilizer rates or add BMPs) can be changed and the model run again to determine the impact of those changes. Economic information will also be included in the models to provide growers with information regarding the cost and benefits of changing practices. These models will become a user-friendly tool that both researchers and growers can use to better understand the impact of their operation and production practices, and how environmental impacts can be minimized.

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(428) The Effect of Hammer Mill Processing on Pine Bark Substrate Wettability

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The potential of a substrate component (organic or inorganic) to capture and retain water is integral for contributing to a material's water holding capacity and improving plant growth. Like most organic materials, pine bark becomes hydrophobic at low moisture levels. However some research has shown that the variation in size and structure of milled pine bark particles may contribute to water holding. The goal of this study was to examine the wettability of two different bark materials that were each processed, handled and aged in different ways. One bark material was obtained from a local supplier and the second bark material was processed (from whole bark nuggets) at the Substrate Processing and Research Center at North Carolina State University (NCSU). The two pine bark materials were tested at 50% and 25% initial moisture content (MC) by weight. Both barks were sieved to x-large, large, medium, and fine particle fractions and also tested at 50% and 25% MC in order to determine their wettability. Both bark materials (processed

commercially and at NCSU) hydrated significantly different at both 50% and 25% MC even at the same particle size distribution. The commercially processed pine bark and the pine bark processed and NCSU were reengineered in order to have the same particle size distribution. At 50% MC both bark materials reached maximum hydration after two hydration events. Bark processed at NCSU held significantly more water throughout the hydration testing with 63.6% after 10 hydration events, while the commercial bark only held 47.9% water after testing. At 25% MC, the NCSU bark initially wet up more than commercial bark at the same PSD with 23.9% and 17.9% respectively. The commercially processed bark wet up more slowly than NCSU bark, however both materials retained similar values after 10 hydration events. Particle size distribution alone does not provide enough characterization of an organic substrate in order to determine its ability to capture and retain water.

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Plant Biotechnology

(162) Investigating Peach Varieties using Plant Biotechnology and Best Management Practices

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Peach (*Prunus persica*) is one of the most important stone fruits in the southeastern states and has great economic and nutritional value. However due to Peach Tree Short Life (PTSL), yield is affected (Werner and Okie 1998). PTSL is a syndrome that is caused by interaction of abiotic and biotic factors that reasons damage to the above ground portion of the tree. To improve and develop better quality peach varieties we need to utilize best management practices, breeding and plant biotechnology techniques. Plant biotechnology techniques utilizing tissues from woody fruit trees have had little success due to its recalcitrant nature. Therefore, a reproducible protocol in peach could greatly expedite the plant development and is desirable. Contamination in woody tree tissue culture like peach is very difficult to eradicate, which has been reported in many woody plant species. The primary aim of this study was to develop a surface sterilization method to control contamination in peach cultures, which is prerequisite for in vitro study. This investigation was carried out to investigate the efficiency of plant growth regulators and different media on explant establishment. There are many factors that affect the in vitro growth of field grown explants like the cultivar, explant types, medium and growth regulators. Various explants were collected from newly established High Density Peach Orchard at the FVSU–ARS. Nodal segments were surface sterilized with constant agitation in 8.25% fungicide, then agitated in 0.5% Mercuric chloride for 20 minutes followed by three rinses with distilled waster. Leaf tissues were surface sterilized either with 0.25% (w/v) mercuric chloride for 2.5, 5, 10 minutes or with 10% sodium hypochlorite for 2.5, 5, 10 minutes. Explants were inoculated on various media. The best medium for bud break in peach was BAP, Ad.S., and Kinetin on Woody Plant Medium (WPM). Embryo rescue is an important aspect of in vitro plant biotechnology. Immature (1- to 6-week-old) peach fruits were collected and surface sterilized in 75% ethanol for 30 minutes. Embryos were isolated from peach fruit manually. The embryos were placed on embryo culture media with high sucrose contain medium. Responses observed from this study include callus, root formation and somatic embryo formation. Embryo cultures survived more than one year after induction.

(163) Establishment of Anther Culture of *Swida wilsoniana*

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Swida wilsoniana (Wilson's dogwood) is an ornamental tree with white-cream flowers and exfoliating bark. It is also a candidate plant for bioenergy fuel because of the high oil content in its fruit. Anther culture is the most efficient technique for obtaining a large number of haploid plants in a breeding program. Basal media, light conditions, sucrose concentrations, and pretreatments of anthers at 4 °C or 32 °C were investigated for maximum callus induction from Wilson's dogwood anthers in five separate experiments. All media were supplemented with 1.0 mg·L^{-1} 2,4-D (2,4-dichlorophenoxyacetic acid), 0.5 mg·L^{-1} NAA (1-naphthaleneacetic acid), and 0.4 mg·L^{-1} 6-BA (6-benzylaminopurine). Basal media, namely, Gamborg medium (B5), Miller medium, Murashige and Skoog (MS) medium, or woody plant medium (WPM) were compared. MS was the best basal medium with 25.4% of anthers forming callus. When anthers were cultured in constant dark, about 30 times more callus were formed compared to a 12-h/12-h (light/dark) cycle. Anthers cultured on medium supplemented with 30 g·L^{-1} sucrose achieved the maximum callus induction of 28.3%. Pretreatment of anthers at 4 °C for nine days resulted in 36.7% callus induction, while a pretreatment at 32 °C for one day produced a 30.8% callus induction. In conclusion, anthers of Wilson's dogwood could be stored at 4 °C for nine days and then cultured in the dark on MS medium supplemented with 1.0 mg·L^{-1} 2,4-D, 0.5 mg·L^{-1}

NAA, 0.4 mg·L^{-1} 6-BA, and 30 g·L^{-1} sucrose to yield the most callus induction.

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(164) Evaluation of Citrus-derived Constitutive Promoters in Citrus, *Nicotiana benthamiana*, and Grapevine

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Citrus is affected by a plethora of biotic and abiotic challenges. The long juvenile phase in citrus (varying from 5–20 years) makes rapid cultivar improvement through conventional breeding difficult. The development of new cultivars via genetic engineering can provide a much faster alternative for citrus improvement. The production of genetically modified (GM) crops containing viral and/or bacterial sequences is however controversial due to potential but unsubstantiated environmental and health risks. Development of GM citrus by utilizing solely citrus DNA can also help build confidence in the evaluation and acceptance of GM foods/plant by both regulatory agencies and the general public. We have identified several constitutive promoters from *Citrus clementine* cv. Nules that regulate transgene expression at high levels in dicotyledonous plants including *Citrus sinensis* × *Poncirus trifoliate* cv. Carrizo, *Nicotiana benthamiana* and *Vitis vinifera* cv. Thomson Seedless. The genomic sequence upstream of the transcription start site of seven Ubiquitin and one Rubisco small subunit gene was identified from the citrus genome database and characterized using the Vector NTI® sequence analysis software. A 1-kb upstream sequence was cloned from genomic DNA and verified by Sanger sequencing. Two sets of transformation vectors (one set containing the respective promoter driving the*gus* gene and the other set driving a *VvmybA1* reporter gene, that induces the anthocyanin biosynthesis) were produced and incorporated into each of the three cultivars via *Agrobacterium* mediated transformation. Gene expression generally followed a similar trend in all three plant species studied. In citrus, plants containing the UBQ3 promoter had the highest gene activity followed by the UBQ9, RBCS1A and the UBQ10 promoter. The remaining promoters were functionally weak in their ability to drive the *gus* gene. In *Nicotiana benthamiana*, plants containing the UBQ9 promoter had the highest gene activity followed by the UBQ3, RBCS1A and the UBQ10 promoter. In *Vitis vinifera* the UBQ9 promoter had the highest overall gene activity followed by the UBQ3, UBQ10 and the RBCS1A promoter. Transient grapevine embryos weakly expressed both the *gus* and the *VvmybA1* gene(s) driven by the RBCS1A promoter but activity improved on transfer to light. Both UBQ3 and UBQ9 promoters were significantly superior to the control d35S promoter. Our results demonstrate the utility of using endogenous promoter sequences to drive transgenes for the genetic improvement of citrus and other crops.

(165) Optimizing Parameters for Precision Breeding of Grapevine

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Reporter genes such as the green fluorescence protein (GFP) and β-glucoridinase (GUS) are routinely used to monitor gene insertion and expression in plant transformation studies. However, their use is limited by the need for expensive equipment and/or enzymatic assays for tracking gene expression. Additionally, the occurrence of such sequences in transgenic crops has resulted in unsubstantiated claims of health and environmental hazards. The use of plant-derived reporter gene systems serve as valuable tools for gene insertion and plant regeneration of perennial fruit species such as grapevine. To evaluate the efficiency of a grapevine-derived reporter gene system, the *Vitis vinifera* MybA1 gene (VvMybA1) was placed along with a nptII gene under the control of a CaMv35S promoter. Embryogenic cultures of grape cultivars 'Bronx Seedless', 'Merlot', and 'Thompson Seedless' were produced from leaves or floral tissues. Somatic embryos at the mid-cotyledonary stage of development were co-cultivated with *Agrobacterium* harboring the VvMybA1 gene. Transient and stable gene expression was recorded in co-cultivated embryogenic cultures and independent plant lines were recovered via secondary embryogenesis. Stable gene insertion and expression in independent plant lines was confirmed by PCR and RT-PCR. Scanning electron microscopy was performed to study potential changes in leaf cell structure caused by VvMybA1 gene expression and subsequent anthocyanin accumulation. Transient anthocyanin expression was evidenced by red spots on somatic embryo explants after three days of co-cultivation. No difference in stable gene expression and embryo line production was observed between the VvMybA1 reporter gene system and existing reporter genes, GFP and GUS. Although plant lines expressing the VvMybA1 gene exhibited normal growth and development, leaf cells appeared much larger and distorted, apparently due to

hyperaccumulation of anthocyanin. We are currently exploring the possibility of using the VvMYbA1 reporter gene specifically in cell culture, with an embryo specific promoter. Gene expression at the cell culture stage would enable convenient identification of gene insertional events, while allowing normal growth and development following plant regeneration.

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(166) In Vitro Conservation Methods in Rain Lilies

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Zephyranthes is valued as conventional and native landscaping ornamental plant as well as a traditional Chinese medicinal herb and has been attributed with various pharmacological activities such antidiabetic and anti-HIV. This study was carried out to evaluate the potential of in vitro conservation methods using the artificial seed and encapsulation-dehydration cryopreservation technique for seed embryos in *Zephyranthes atamasca* and *Z. grandiflora*. Seed embryos were selected for encapsulation with different concentration of sodium alginate (3%, 4%, and 5%) and calcium chloride (either 25, 50, 75, and 100 mM) followed by no encapsulated embryo as a control. The greatest viability of encapsulated seeds achieved was 95% in *Z. grandiflora* and 85% in *Z. atamasca* with the combination of 4% sodium alginate with 100 mM calcium chloride after 2 weeks at 5 °C. After optimizing the gelling agents, embryos were immersed in 1/2-strength liquid MS medium supplemented with 0, 20, 30, 40, and 50 g/L sucrose for three days. The highest viability with A_{530nm}0.12 and A_{530nm}0.16 were achieved when embryos were cultured in pretreatment medium with 30 g/L sucrose in *Z. grandiflora* and *Z. atamasca,* respectively. Once the optimum concentration of sucrose was determined, the pretreatment duration was evaluated; embryos were pretreated at different intervals (0, 1, 2, 3, 4, and 5 days) with the aim of conditioning them to withstand freezing stress. The greatest viability was observed after 2 days of pretreatment with A_{530nm}0.76 and A_{530nm}0.61 in *Z. grandiflora* and *Z. atamasca,* respectively. Dehydration under the air current of a laminar airflow cabinet was used after 1, 2, 3, 4, 5, and 6 h. The highest viability by TTC assay after cryopreservation was observed with 54% viability for *Z. grandiflora* and 48% viability with *Z. atamasca,* after 2 h of dehydration, whereas the control treatment (0 h drying) showed 9% viability for *Z. grandiflora*and 7% viability with *Z. atamasca* viability followed by ~96% viability in non-freezing treatment. Rain lilies embryos were successfully preserved and functioned as an artificial seed in *Z. atamasca* and *Z. grandiflora*. In addition, the cryopreservation technique using encapsulation-dehydration method has been established for the rain lilies embryo and can be used for other flowers embryos with few modifications.

(167) Monitoring of Genes Responding to Ionizing Radiation in Tradescantia

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A species belonging to the genus Trandescantia has been studied as a sensitive plant to ionizing radiation. Purple color of the stamen hair stem has been reported to change to pink or white when it is exposed to radiation. In this study a hybrid clone BNL4430 was used to evaluate biological and genetical assays when exposed to gamma radiation. The gamma irradiation ranged from 50–1000 mGy dose was achieved in the phytotron facility equipped with a 60 Co radiation source at the Korea Atomic Energy Research Institute, Korea. Dose-somatic pink response relationships were depicted by radiation intensities at days after treatment for two weeks. As expected greater color changes in stamen hair were detected with higher radiation dose and more stamen hair changed as days elapsed after treatment. An Illumina Hi-seq was used to profile differentially expressed genes responding to radiation intensities and 233,483 transcripts were obtained from the RNA-seq analysis. The average length of the transcripts was 1229 bp and length for N50 was 1808 bp. A total of 347 and 314 up- or down-regulated genes were annotated at the lowest dose 50 mGy, respectively. The genes showing two-fold change were categorized by their functions in the gene ontology (GO) analysis. Many up-regulated genes at 50mGy compared with non-radiation control were heat-shock protein family that was reported to protect protein function or folding. Reverse transcripted PCR (RT-PCR) and real-time RT PCR were performed to validate gene expression, which were collectively used to evaluate gene potential as an in situ monitoring tool for any radiation exposure.

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(168) Transcriptome Sequencing Reveals Fatty Acid Synthesis Pathway in *Eucommia ulmoides* Oliv.

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Eucommia ulmoides Oliv. is one of the important economic and medicinal plants in China. *E. ulmoides* oil; extracted from the kernels; contains high content of α-linolenic acid, which ranges from 38.7% to 67.6%. Past research on *E.ulmoides* mainly focused on the cultivation and conventional breeding of the tree. However the molecular mechanism related to fatty acid synthesis pathway in *E.ulmoides*'s kernel is still uncovered. The objective of this study was to generate information for better understanding of fatty acid biosynthesis by transcriptomic analyses. Transcriptome sequencing was conducted on kernels of 60 and 150 DAF (days after flowering) in varieties 'HuaZhong No.10' and 'HuaZhong No.6'. De novo assembly generated a total of 96469 unigenes with an average length of 690 bp. Among them, 49856 unigenes accounted for 51.68% of all-unigene were annotated against NR (non-redundant), GO (Gene Ontology) and COG (Clusters of Orthologous Groups) databases, 38983 unigenes were assigned 3 categories and 56 branches by comparing with CO database, and 20699 unigenes were assigned 25 categories with COG database. In addition, 11975 unigenes identified by functional annotation against KEGG (Kyoto Encyclopedia of Genes and Genomes) database were mapped to 117 metabolic pathways. The real-time quantitative RT-PCR (qPCR) analysis showed that the expression levels of 10 fatty acid synthesis–related unigenes (*fabG, accA, fabZ, fabF, FATB, fabI, FATA, ACAC, fabD, accB*) gradually declined in 150 DAF kernels compared to 60 DAF kernels from 'HuaZhong No. 10' and 'HuaZhong No. 6'. qPCR also showed that the expression levels of these genes in 60 DAF kernels from 'HuaZhong No. 10' were significantly higher than those from 'HuaZhong No. 6'. The expression profiles of the 10 genes were in agreement with the transcriptome data in the developing kernels of *E. ulmoides*. This study provides an important foundation for further characterizing the functional genes involved in the process of seed development in *E. ulmoides*.

(169) Development of Gene-targeted Markers for Verticillium Resistance in Chile Peppers (*Capsicum*)

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Verticillium wilt, caused primarily by *Verticillium dahlia*, is a devastating disease of chile pepper (*Capsicum* sp.) Development of functional gene markers located in or near the candidate genes of host resistance to *V. dahlia* promises to be an efficient and effective approach for germplasm evaluation and resistant gene incorporation in chile peppers. A resistant accession, NM14C661, and a susceptible accession, NM14C107 to Verticillium wilt have been identified in *Capsicum annuum* L. In this study, using *Ve* genes in tomato and potato as reference sequences, conserved *Ve* homologs were pinpointed in chile pepper genome by similarity gene analysis. Based on the conserved *Ve* homologs, specific primer pairs were designed, and *Ve* homologs from accessions NM14C661 and NM14C107 were amplified, cloned and sequenced. Allelic gene-targeted markers were developed for Verticillium wilt resistance in chile pepper. This research will substantively benefit chile pepper cultivar improvement by introgressing Verticillium wilt resistance using molecular assisted selections.

Plant Nutrient Management

(227) The Influence of Fertilizers from Different Nitrogen Sources on Strawberry (*Fragaria* x*ananassa*) Production

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The United States is a leading producer of strawberries worldwide, accounting for approximately 30% of the total world strawberry production. While the majority of the U.S. strawberry production is conventional, consumer demand for organic strawberries has been increasing in recent years and interest in organic strawberry production is growing among producers. Hydrolyzed fish fertilizer and sodium nitrate-based fertilizer have been used through the fustigation system by organic strawberry growers in Florida. The two types of fertilizers differ in nitrogen source and release rate as well as contribution to soil biological activity. In this greenhouse study, fertilizers from different nitrogen sources used in organic and conventional production, respectively, were compared in terms of their effects on strawberry growth and yield performance. Plants were grown in 7.6-L pots filled with sandy soil from the certified organic field at Plant Science Research and Education Unit in Citra, FL. Plug plants of two strawberry cultivars Sensation™ Brand 'Florida127' and Winterstar™ were transplanted on Oct. 30, 2014. The fertilizer treatments included Neptune's Harvest 2–0–2 with the ingredients of hydrolyzed fish, molasses, and seaweed extract, Gator 96002/3–0–6 0–0 organic liquid blended with sodium nitrate, and a conventional fertilizer 6–0–8. Potassium fertilizer was added in the Neptune's Harvest and conventional fertilizer treatments to match the amount of both nitrogen and potassium provided by the Gator organic liquid treatment. A randomized complete-block design with four replications was used. The fertilizer effect was significant

on strawberry early yield, and significant differences in plant growth and fruit yield were observed among strawberry cultivars. Plants fertilized with Neptune's Harvest 2–0–2 showed higher total fruit yield than Gator 96002/3–0–6 0–0 organic liquid during Dec. 2014. Interestingly, conventional fertilization did not differ significantly from the other two fertilizer treatments. Sensation™ Brand 'Florida127' showed fewer marketable fruit per plant than Winterstar™, whereas Winterstar™ exhibited lower average fruit weight during December 2014 to January 2015. With respect to the growth parameters at early stage, Winterstar™ plants demonstrated significantly larger crown, while Sensation™ Brand 'Florida127' was higher in plant leaf number.

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(228) Determining Meaningful Electrical Conductivity Values from In Situ Substrate Measurements

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Electrical conductivity (EC) measurements in both soils and soilless substrates have been used to make fertilizer decisions and to manage salt buildup. Pore water electrical conductivity (EC_p) cannot be measured directly in substrates, and is often modeled from in-situ measurements of bulk EC (EC_b), substrate water content (sometimes represented as a single dielectric permittivity (ε) value), and a variety of substrate-specific coefficients. Our group analyzed data from three different soilless substrate types as well as stonewool to better understand the limitations and the robustness of two models to predict EC_p from EC_b and dielectric permittivity. In addition, we collected ε values measured at different frequencies in stonewool to determine if additional parameters could improve model accuracy. Our data suggest that existing models for EC_p are most accurate (10%) at very high volumetric water contents with as much as 100% error at lower volumetric water contents. Our multifrequency data in stonewool allowed us to develop a new approach, where we were able to get an EC_p prediction independent of a bulk EC measurement. The success of the mutifrequency approach in stonewool is promising for a new, more accurate EC_p model for both soils and soilless substrates.

(230) Effects of Varying Potassium Levels on Yields and Petiole Potassium Levels for Organically Fertilized High Tunnel Tomato

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High tunnels provide a longer growing season and warmer overall temperatures than field sites. As a result, crops grown in high tunnels often exhibit increased biomass production, nutrient uptake, and yields. We therefore hypothesized that macronutrient uptake by high tunnel tomato crops may exceed levels previously determined for field-grown tomato crops. The objective of this research was to investigate the relationship between applied potassium (K) and fruit yield for high tunnel tomato crops using organic sources of fertility. In 2014, indeterminate beefsteak tomatoes were grown in high tunnels in three sites (cv. Geronimo in Durham and North Haverhill, NH, and cv. Rebelski in Monmouth, ME). Initial soil K_2O levels averaged 188 mg/kg Mehlich-3 extractable K in Durham, NH, 176 mg/kg in North Haverhill, NH, and 79 mg/kg in Monmouth, ME. Depending on the site, plants received 6 or 7 levels of supplemental K_2O using potassium sulfate (0 N–0 P_2O_5–54.5 K_2O), ranging from 0 to 1,008 kg/ha K_2O. All treatments received constant supplemental nitrogen at 423 kg/ha using a mixture of blood meal and soybean meal. The blood and soy meal provided an additional 122 kg/ha K_2O to all treatment levels. A randomized complete-block design with 4–6 replicates was used. Yields of marketable and unmarketable fruit were measured and petiole sap K levels were measured mid-harvest and at the end of the growing season. Supplemental K levels were highly correlated with midseason soil K levels in all sites. Supplemental K levels were not correlated with midseason petiole sap K levels, but were correlated with end-of-season petiole sap K levels in all sites. However, supplemental K levels in all sites were not significantly correlated with fruit yield, suggesting that K availability did not limit yields in these experiments. The absence of a strong yield response to K may have been due to high background soil K levels, a relatively short growing season due to late planting, or because K requirements for high tunnel tomatoes are lower than we had hypothesized.

(231) Yield of Purslane (*Portulaca oleracea* L.) as a Function of the Concentration of Nutrient Solution

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In 2013, 491 hectares of purslane (*Portulaca oleracea* L.) were harvested. Recently, this crop has regained importance due to its nutraceutical properties due to its antioxidant content of Omega fatty acids. However, scarce information is available regarding its mineral nutrition. The objective was to evaluate the effect of the concentration of the Steiner nutrient solution on the yield of purslane 'Americana'. The experiment was set up in a greenhouse with plastic cover located at 18°58'51''NL; 99°13'55''WL and a height of 1866 m; in Cuernavaca, Morelos, Mexico. The substrate was germinating mix BM2 Berger® and 6-inch pots were used. The sowing was done on 12 Feb. 2015. From sowing to germination, the pots were watered with purified water and since the seedlings had four leaf until plants were harvested they were watered daily with Steiner nutrient solution in percentages of 25, 50, 75, 100, and 125, corresponding to 0.5, 1.0, 1.5, 2.0, and 2.5 $dS \cdot m^{-1}$ EC, respectively. The experimental unit was a potted plant, a completely randomized design with seven replications was used and the yield (aerial biomass) to 46 days after sowing was evaluated. With 75% and 100% concentrations of Steiner nutrient solution the highest yield per plant (104.6 y 99.7 g, respectively) was obtained.

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(232) Growing Snapdragon and Cyclamen with Pelletized Soy-bioplastic Fertilizers

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Research examining soy-based bioplastic containers for containerized crop production has demonstrated that soy bioplastics can supply nutrients to plants. Nutrients become available after transplanting (≈ 2 weeks) and can sustain plant growth without supplemental fertilizer. Using soy-based materials similar to those of biocontainers, we created pelletized fertilizers to be incorporated into soilless substrate similarly to controlled-release fertilizers (CRF). We evaluated the growth of snapdragon (*Antirrhinum majus* L.) and cyclamen (*Cyclamen persicum* Mill.) grown with one of two pelletized soy-bioplastic fertilizers [soy bioplastic compounded with bio-based polylactic acid (PLA) or polyhydroxyalkanoates (PHA), each containing 15% biochar] or a commercially available synthetic CRF. These species were chosen because snapdragon is sensitive to ammoniacal nitrogen and cyclamen is sensitive to elevated levels of root-zone salts. Our objectives were to determine the efficacy of soy-bioplastic fertilizers compared to a traditional CRF for growing sensitive crops. Snapdragon and cyclamen seedlings were transplanted into 11.4-cm round containers filled with commercial soilless substrate comprised of sphagnum peat moss and perlite. For fertilizer treatments, containers received 0, 0.16, 0.32, 0.62, or 1.24 g of nitrogen (N). Plants were grown for five (snapdragon) or ten (cyclamen) weeks. Shoot dry mass (SDM) was quantified, as well as nutrient concentration and N-uptake of foliage. The SDM and nutrient concentration and uptake varied within species depending on the amount and type of fertilizer applied. Snapdragon plants supplied with 0.62 or 1.24 g N from either type of soy-bioplastic fertilizer died before the end of five weeks, while plants with CRF provided had the largest SDM across all fertilizer treatments above 0 g N. The N concentration of snapdragon was greater in plants with either type of soy-bioplastic fertilizer applied compared to plants grown with CRF (at 0.16 and 0.32 g N), but N uptake was less due to diminished growth. Cyclamen fertilized with either soy-bioplastic fertilizer had similar or less SDM, depending on the amount of N applied. Similar trends occurred for the nutrient content in the foliage. Nitrogen uptake of cyclamen was less for plants fertilized with either soy-bioplastic fertilizer compared to plants fertilized with CRF. The effectiveness of soy-based fertilizers was favorable at lower application levels but showed a diminishing return with sensitive species fertilized at higher levels. Our results provide proof-of-concept that soy-bioplastic fertilizers could be an optional fertilizer for containerized plants, but formulations require further development to improve their properties for use with a broad range of species.

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(233) Maize (*Zea mays* L.) Monosaccharides Content as Affected by Zinc Sulfate Following Systematic Application of Mineral Fertilizers to Carbonate Chernozem Soil Type

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A three-year field experiment with zinc sulfate supplements was conducted in Moldova to study maize (*Zea mays* L.) monosaccharides contents in years 13 through 15 years of systematic

application of mineral fertilizers (no-fertilizer control, P60, N60K60, N60P60K60, N90P60K60, N60P90K60 kg ha^{-1}) to carbonate chernozem. Zinc treatments for three years were P60Zn10, N60P60K60Zn5, N90P60K60Zn5, and N60P90K60Zn10 on half of each long-term treatment. The soil at the experiment site was a chernozem, containing: humus 4.3%, total nitrogen 0.29%, $CaCO_3$ 1.7%, and plant available phosphorus and potassium averaging 0.88 and 34.5 mg/100 g respectively, extractable cations Ca^{2+} and Mg^{2+} 31 and 2.9 meq/100g respectively, with pH_{H2O} value of 7.9 at the 0–20 cm soil depth. Long-term phosphorus application induced zinc deficiency and decreased synthesis of carbohydrates and chlorophyll in maize. Zinc treatments compared to no zinc application significantly increased total monosaccharides in leaves (dry weight ranges 1.63% to 1.93% vs. 0.93% to 0.97%) and in stems (range 12.2% to 14.17% vs. 6.93% to 7.07% of at the 5–6 leaves stage. Chlorophyll concentrations (fresh weight ranges 14.07–17.73 mg% vs. 6.6–10.3 mg%) were significantly higher in plants supplied with zinc than those without zinc. Overall, zinc significantly increased leaf area 17.07 to 84.33 dm^2 per plant. Significant positive correlations were observed between monosaccharides in leaves or stems and chlorophyll content ($r = 0.67$ and $r = 0.70$ respectively), as well as between monosaccharides in leaves or stems and leaf area values ($r = 0.73$ and $r = 0.83$). Hence, the use of zinc sulfate following systematic repeated application of phosphorous fertilizers to carbonate chernozem is essential to improving maize carbohydrates metabolism. The results were obtained in Moldavian Scientific-Research Institute of Soil Science and Agricultural Chemistry, Chisinau, Moldova.

(234) Low Irradiance Combined with High Relative Humidity Induce Leaf Tipburn in *Eustoma grandiflorum*

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Leaf tipburn (TB) of *Eustoma grandiflorum* (Raf.) Shinn. is a calcium-deficiency disorder. Low irradiance combined with high relative humidity would reduce transpiration stream and thus may induce this disorder. Vegetative plants of *Eustoma* 'King of Orchid' with five fully expanded leaf pairs were placed in a growth room at 25°C/18 °C (day/night) and received two treatments: high irradiance (HI; 285 μmol·m^{-2}·s^{-1} photosynthetic photon flux, *PPF*) combined with moderate relative humidity (MRH; mean 74% RH), and low irradiance (LI; 212 μmol·m^{-2}·s^{-1} *PPF*) combined with high relative humidity (HRH; mean 91% RH). Artificial lighting was provided by high-pressure sodium lamps for 12 h per day. Plants for both treatments had microscopically visible sepals 11 days after treatments (DAT). Leaf tipburn occurred at 18 DAT only in plants under LI and HRH conditions. Consistently lower transpiration was found in the first to third leaves under flower bud at LI and HRH, whereas no significant difference in stomatal density and stomatal conductance between treatments. Plants under LI and HRH conditions produced expanding leaves with reduced vasculature density that may limit calcium transport to the leaf tip.

Friday, 7 August 2015

Postharvest 3

(124) Proteome Changes in Banana Fruit in Response to High Temperature and Ethylene Treatments

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Banana (*Musa* AAA group) is one of the most consumed fruit in the world due to its eating quality and nutritional value. As a typical climacteric fruit, banana responds to ethylene treatment which stimulates ripening including color, flavour (aroma and taste) and nutritional development. It has also been reported that chlorophyll breakdown and color formation in banana is inhibited by ripening temperatures above 24 °C. At these temperatures, chlorophyll degradation is reduced, but the rate of senescence is increased. In order to gain a fundamental understanding of the effect of treatments with high temperature and ethylene, a quantitative proteomic study employing stable isotope dimethyl labeling was conducted. In this study, green (immature), untreated banana fruit were subjected to an ethylene treatment of 10 μl/L for 24 hours at 20 °C. After ethylene treatment, both treated and untreated fruit were stored at 20 °C or 30 °C for 7 days. Fruit were sampled after 0, 1, 4, and 7 days of storage and color, chlorophyll fluorescence and volatile production were evaluated. Quantitative proteomic analysis was conducted on fruit stored 4 days. In total, 413 common proteins were identified and quantified from two biological replicates. Among them, 91 proteins were found to change significantly in response to high temperature and ethylene treatment. Cluster analysis grouped these 91 proteins into 7 clusters. Ethylene treatment induced 40 proteins that were related to pathogen resistance, cell wall metabolism, ethylene biosynthesis, allergens and ribosomal proteins, while 36 proteins that decreased were associated with fatty acid and lipid metabolism, redox-oxidative response, protein biosynthesis and modifications. Storage at

30 °C induced an increase in 32 proteins mainly in clusters 1 and 3, which were in association with pathogenesis related proteins, cysteine synthase and branched amino acids biosynthesis, while decreasing 53 proteins in clusters 2, 4, 5, and 7 that associated with photosynthesis II oxygen evolving protein, photosynthesis I reaction centre, sugar metabolism, redox-oxidative system and fatty acid metabolism. Differences between the effects of ethylene and heat treatments on proteins were also revealed and discussed. Identification and quantification of proteins were linked with quality changes. This study demonstrates that both ethylene and high temperature influence banana fruit ripening and senescence at the proteomic level and reveals that high temperature accelerates banana fruit ripening.

(125) Handling of Refrigeration (Temperature and Time) During Shipping of 'Ataulfo' Mango Exported from Mexico to the United States

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The purpose of this assay was to evaluate the effect of temperature and refrigeration time on quality and shelf-life of 'Ataulfo' mango fruit intended for exportation from Mexico to the United States. Fruit treated with quarantine hot water treatment (115.0 °F for 75 min.) and hydrocooling (69.8 °F to 73.4 °F for 30 min.) were collected from a packing line in a commercial packinghouse. Fruit had uniform size, good external appearance and freedom from mechanical damage, pests, and diseases. Ten batches of 35 fruit were submitted to refrigeration at 53.6 °F, 57.2 °F, or 60.8 °F and three times of shipping simulation (3, 5, or 7 days). One of the batches was the control treatment without refrigeration. After finishing the respective shipping times, fruit were kept under market simulation (71.6 °F ± 3 °F; 75 ± 10% RH) until full ripeness. Variables analyzed were: weight loss, external appearance, peel color, firmness, pulp color, total soluble solids, tritatable acidity, and ratio °Brix/Acidity. Sampling was done before refrigeration, at the end of refrigeration period, one week after, and at consumption stage. Refrigeration decreased weight loss at the end of shipping simulation and slightly at consumption stage. It did not affect the external fruit appearance, which was good to fair for all treatments at the end of shipping simulation, but lower for the control fruit at consumption stage. In addition, refrigeration delayed the ripening process and lengthened shelf life since it retarded the skin color development, maintained pulp firmness, slowed down the intensity of pulp color and delayed total soluble solids content, as well as, acidity decline. However, control fruit showed a higher ratio °Brix/Acidity at consumption stage. Refrigeration at 53.6 °F, 57.2 °F, or 60.8 °F did not show any chilling injury at any sampling time. The times of refrigerated shipping simulation did not affect weight loss, external appearance or peel color, but they maintained pulp firmness and delayed pulp color, total soluble solids development, and acidity decline. However, temperature and refrigerated shipping times decreased the ratio of °Brix/Acidity at consumption stage comparing to control fruit, indicating the best temperature for ripening mango is at 71.6 °F ± 3 °F. In conclusion, 'Ataulfo' mango fruit for exporting from Mexico to the United States can be shipped under relatively warm temperatures (53.6 °F to 60.8 °F) without affecting quality and shelf life.

(126) Effect of Different Postharvest Treatments to Delay Mango Fruit Softening

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Mexico is the seventh largest producer and first exporter of mango fruit, and produces more than 50 mango cultivars; the second most important is the 'Manila' cultivar. Despite this variety's high sensory quality is not involved in the export market due to its high metabolic activity, which causes an accelerated decrease in firmness and short shelf life. It has been reported that application of calcium infiltration, hexanal vapor, salicylic acid infiltration and wax application delay fruit softening by different mechanisms and maintain the fruit quality during postharvest handling prolonging its shelf life. The aim of this study was to evaluate the effect of these postharvest treatments to delay the softening of mango cv. 'Manila'. A sample of 1000 fruits harvested at 3/4 ripeness maturity were divided in order to apply the following treatments, calcium infiltrations, hexanal vapor and salicylic acid infiltrations at different concentrations as well as wax coating. Fruit was stored for 15 days at 20 °C. At the end of storage, calcium treatments did not show significant differences in firmness, total soluble solids, and weight loss at any applied concentration (5–10 N, 14–18 °Brix and 13% to18% for treatments and control, respectively). Also, treatments with salicylic acid did not show significant differences in firmness,

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total soluble solids, and weight loss at any applied concentration (6–11 N, 15–18 °Brix and 16% to 18% for treatments and control, respectively). Hexanal treatments delayed the fruit softening (7 and 16 N for 1 ppm for 7 h and control, respectively) but the hexanal concentration was associated with skin browning and stopped the ripening process (9 and 15 °Brix for 1 ppm for 7 h and control, respectively). Wax coating was the most effective treatment for delay mango softening with values of 9 N for wax coating and 17 N for control; and also showed significant difference in weight loss (5% for wax coating and 13% for control). The application of wax coating is the best treatment to delay the softening process in mango 'Manila' and also improved visual appearance.

(127) Study of Different Agents that Improve Firmness of Guava Fruits during Ripening

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Guava (*Psidium guajava* L.) is a climacteric fruit that is mainly consumed fresh. However, it is a highly perishable fruit, which ripens quickly (5 to 7 days at room temperature) with accelerated firmness loss and quality changes. In addition, the over production in the last months of the year causes drop of price and market saturation. For this reason it is important to look for postharvest alternatives in order to maintain the fruit firmness which could help to increase its commercialization in faraway markets. Applications of calcium as well as the use of inhibitors of ethylene action (1-MCP) in postharvest have managed to maintain firmness and fruit quality, due their ability to strengthen the bonds between the polysaccharides of the cell wall maintains the stability of the membrane against the hydrolytic enzyme action, reduces the water absorption and delays the senescence. Nevertheless there has been no success in maintaining fruit quality for its exportation. Therefore the objective of this work was to evaluate different firmness agents based on calcium during storage of guava 'Media China'. Guavas were treated in preharvest with KelatexCa+B® and Ca-Metalosate® and in postharvest were treated with $CaCl_2$ (0%, 1%, 2%, and 3%) at vacuum and atmospheric pressure, Ca-Metalosate®, Mg-Metalosate® and their combination (0.08 M, respectively) and XP-Amino (0,1,2 and 3%) and stored at 10 °C for 8 days. Fruits were analyzed at day 0 and 8. Weight loss (WL), total soluble solids (TSS), titratable acidity (AT), firmness (F), and visual quality (VQ) were measured. TSS and AT showed no significant differences between treatments. In preharvest fruit treated with Ca-Metalosate® presented the best firmness (46 N ± 15), whereas in post-harvest fruit treated with 3% $CaCl_2$ (40 N ± 12) was the best while fruit treated with KelatexCa+B and 3% XP-Amino had the lowest firmness [(24 ± 6) and (26 ± 12), respectively]. The results showed that fruit treated in pre-harvest presented the best firmness, showing no significant difference with control (39 N ± 13), although the visual quality and subjective firmness were better. Suggesting that, the application of preharvest calcium could maintain firmness and quality of guava fruits. Therefore it is necessary to conduct further studies maintaining our target on applications of calcium on preharvest.

(128) Packing and Refrigeration for Mangaba Preservation

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Mangaba (*Hancornia speciosa* Gomes - Apocynaceae) is a native Brazilian fruit that the production is predominantly extractive. Nevertheless, due the human exploration of coast areas in Brazil, this species is endangered. The species has high social, economic, and cultural importance in areas where it occurs. The work was to evaluate the use of packaging in cold storage of mangaba (10 °C). A factorial of 3 x 5 completely randomized design was used [three packing systems: control (unpacked), fruits placed in polystyrene trays wrapped with PVC film, and polyethylene terephthalate trays—PET for five storage periods], with four replications. During the 8 days of storage, an increase in the soluble solids–SS content (12 to 15. 27), titratable acidity–TA (4.5 to 5. 09), vitamin C (133. 77 to 267. 54) and pH (3.19 to 3.60) was noted. The PET packaging resulted in more acidic fruits (5.24) and less SS/TA (2.73). Packaging did not influence the other characteristics.

(129) Preliminary Report on Jujube Fruit Cold Storage and Nutrient Changes

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Jujubes belong to the Rhamnaceae family and have a high vitamin C content. More and more people are interested in growing and consuming jujubes in the United States. The bottlenecks now are limited cultivars and research support. Jujube fruit storage and processing information is very limited in the United States. In 2014, a preliminary cold storage study was conducted with cul-

tivars Li and Sherwood in a walk-in cooler at New Mexico State University Sustainable Agriculture Sciences Center at Alcalde, NM. Quart sized zip lock bags with punched holes were used. With limited fruit supplies, we only tested one maturity stage for each cultivar: 20% to 30% red/brown color for mid-season cultivar Li and 15% to 25% red/brown color for late season cultivar Sherwood. 'Li' with 20% to 30% red color could be stored for 3–4 weeks while 'Sherwood' with 15% to 25% red color were kept well for 8–10 weeks with marketable quality at temperatures of 0 °C to 4 °C. As cold storage proceeded, jujube fruit started to have more red/brown color and pitting after four weeks for 'Li' and eight weeks for 'Sherwood'. Fruit turned soft but was not rotten. 'Sherwood' had higher vitamin C content (428 mg/100g fresh weight) than 'Li' (329 mg/100g fresh weight). Fruit vitamin C content kept constant and dropped slightly at later stage of storage. 'Li' retained 90% of its original vitamin C content after six weeks of cold storage while 'Sherwood' still retained 90% of its original vitamin C content after 10 weeks of storage. Fruit sugar content stayed constant and increased slightly for 'Li' at week 6. For 'Sherwood', the total sugar content remained constant during the 10-week storage period, but after week 6, sucrose content decreased while glucose and fructose increased. Though there are more questions than answers for jujube cold storage, the results from this preliminary study are promising. As more late-maturing cultivars become available, and with more accurate temperature control, it could be possible to store jujube fruit for two months or longer, which will give growers more marketing choices.

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(130) Effect of Ripening Stage at Harvest on Phytochemical Composition of Huamiche (*Ferocactus histrix*) Fruit

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Ferocactus histrix, a member of the Cactaceae family, is an important, underutilized barrel cacti from the central arid part of México. Traditionally, the stem, floral bottoms, and fruit (huamiches) have been consumed in rural communities, however, its phytochemical composition and nutraceutical potential is still unknown. Phytochemical and physicochemical characterization of the fruit could enhance sustainable production of *F. histrix* in arid and semiarid regions. The fruit from these cacti present an oval shaped, a characteristic bittersweet flavor, and yellow or red external color attributed to betalain pigments (betaxanthins and betacyanins). In this work, total phenolic, flavonoid, and betalain content, DPPH antioxidant capacity, color parameters (L*, a*, b*), titrable acidity, pH, TSS, weight, and size were measured in red and yellow *F. histrix* fruit at two ripening stages (ripe and unripe) collected at San Luis de la Paz, Guanajuato (N 21°16'48.43", W100°30'16.68"). Overall, yellow fruit were larger and heavier than red fruit, and the phytochemical contents and physicochemical variables were affected by the ripening stage. The highest phenolic and flavonoid contents were observed in unripe red fruit, 15.1 ± 2.7 mg EAG/g and 10.8 ± 1.9 mg EC/g respectively. Total betalain content was also higher in unripe fruit (≈ 20%) despite the color. Maximum betacianin and betaxanthin contents were observed for red and yellow unripe fruit, respectively. *Ferocactus histrix* fruit have similar or higher phytochemical contents compared to other cacti fruit, and could represent a source of nutraceutical food.

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(131) Pepino Dulce (*Solanum muricatum* Ait.) in Chile: Postharvest Storage Potential

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Pepino dulce (*Solanum muricatum* Ait.), native species from the Andes area of Peru and Chile, is widely distributed in South America. It has been commercially and experimentally grown in several countries among them Chile, Peru, Colombia, United States, Israel, New Zealand, Australia, and Spain. Among approximately 1500 species described in the *Solanum* genus, pepino is one of the few domesticated and cultivated for food purposes. Pepino has been described as a succulent, juicy, and sweet fruit. In Chile studies about pepino dulce are scarce, and some reasons may lie in the fact that pepino is classified as a secondary and exotic fruit, with a reduced product availability due to low cultivated area, and to minimum economic importance compared to other mayor crops such as table grape, apple, etc. All these problems have delayed the innovation and technology for this crop in Chile. Previous studies of pepino postharvest physiology have determined this fruit species to be chilling sensitive to temperatures lower than 5 °C and to physiological problems such as woolliness and internal browning. Potential storage time still remains unclear, and being highly dependent on fruit maturity. In regard to the climacteric behavior, pepino is not free of controversy since it has been described as climacteric and non-climacteric fruit. The aim of this study was to elucidate the physiological behavior of pepino dulce, and to study its storage potential. Five different harvest times were studied, fruits were collected from Ovalle (IV Region) north of Chile. Pepino fruits were stored at 20 °C and 7 °C and analyzed for respiration rate, internal ethylene production, and quality parameters (color, size, firmness, soluble solids, acidity, etc.) each harvest time. A sixth

harvest was collected and stored under different postharvest conditions such as regular atmosphere, controlled-atmosphere and ethylene inhibitor (1-MCP) and evaluated after 10, 20, 30 and 40 days at 7 °C. Pepino fruit showed a climacteric pattern but very low respiration rate and ethylene levels, 12 mL CO_2 per k/h and 0.1 μL C_2H_4 per k/h, respectively. The effects of storage conditions will be discussed.

Specified Source(s) of Funding: FONDECYT-CHILE

(132) Effect of High Tunnel Production on Pre- and Postharvest Losses of Fresh Produce

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The production of fresh vegetables in high tunnels has increased rapidly in the United States due to expansion of organic and local markets. However, little is known about the effect of this system on the pre- and postharvest losses of fresh produce. The aim of this work was to determine how high tunnel production affects the pre- and postharvest losses by using tomato and spinach as model crops. In 2014, a study was performed at the Kansas State University Olathe Horticulture Research and Extension Center. We utilized a randomized complete-block design with six replications and typical production practices for the area were used. Two tomato types (hybrid red 'BHN 589' and heirloom 'Cherokee Purple') were grown. Samples were harvested at the pink maturity stage based on the USDA color/maturity classification map. Fruit that were free from defects were stored at 12.5 °C and 25 °C for 21 days. Fruit respiration rate was measured every 24 hours during storage. Additionally, color (CIE L*a*b* index) texture, as well as incidence and severity of decay were evaluated daily. The main effect of high tunnel vs. open-field production of heirloom and hybrid tomatoes showed that a 65.6% increase ($P < 0.001$) in total yield (lb/plant), and a 91.0% increase ($P < 0.0001$) in marketable yield of fruit (lb/plant). The average marketability of tomatoes grown in the high tunnel was 84.8%, which was a 15.8% increase over the open-field and was statistically significant ($P < 0.001$). During fall 2014, 'Corvair' spinach was planted using the same experimental design. Leaves were harvested at the mature stage. Spinach samples were stored at 3 °C and 13 °C and evaluated using similar methods as listed above for tomatoes. Using high tunnels for organic production could reduce food losses by protecting the crop during production in addition to extending postharvest shelf life. Further experiments will be conducted in 2015 to determine if this trend is consistent across multiple growing seasons.

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(133) Changes in Quality during Storage of Yellow Squash

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In Fall 2014, six commercial varieties and six advanced selections of yellow crookneck and straightneck squash were evaluated to determine the impact of variety and harvest packing methods on storage quality. Squash were grown on plastic mulch using standard practices in Tifton, Georgia. Fruit were harvested and either washed in a sodium hypochlorite solution (150 ppm) immediately after harvest and prior to packing for storage or harvested and packed without washing. Squash were stored in vented clamshell containers at 12.7 °C and 95% relative humidity. Weight loss was measured for fruit at three harvest dates using both washing treatments for a storage period of two weeks. Weight loss was similar during storage for both washing methods; however, there were differences between harvest date and for rate of weight loss during storage. This was attributed to different weather conditions at harvest. There were also significant differences between varieties for weight loss, with the straightneck variety Enterprise having lless weight loss during storage than other varieties. Firmness was also measured during storage. Crookneck varieties had a significantly greater loss of firmness during storage and became unmarketable due to loss of firmness after 8 and 11 days of storage; while only one variety of straightneck squash, 'Multipik', became unmarketable due to loss of firmness during storage. There were no differences in firmness changes in storage between washing methods. However, there were differences in visual decay between postharvest treatments. Fruit that were submerged in the sodium hypochlorite bath had little detectable decay during the 14-day storage period. However, fruit that were picked and stored without washing had visual decay symptoms that rendered many of them unmarketable after eight days in storage. These results suggest that crookneck varieties of squash may lose firmness quickly in storage rendering them unmarketable, while straightneck varieties are able to be stored longer prior to sale. In addition, squash that is field-packed without washing must be marketed shortly after harvest, while those that are washed in a sodium hypochlorite solution may be stored longer.

(134) Rapid Curing as a Means of Minimizing Postharvest Losses In Early Potatoes

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Early season potatoes (*Solanum tuberosum* L.) are harvested before adequate development of the periderm (skin-set), making them susceptible to wounding during harvesting and postharvest handling. The objective of this research was to evaluate "rapid curing," where tubers are stored for short periods under higher temperatures and relative humidity (RH) than standard curing conditions, as a means of expediting wound-healing in two tablestock potato cultivars. 'Fabula' and 'Red LaSoda' potatoes were grown during two spring seasons following commercial practices. Plant vines were killed at horticultural maturity to promote skin-set; however, 'Fabula' has inherent seed dormancy that results in delayed periderm maturation. Tubers were hand-harvested three weeks after vine kill. To accurately document wound healing, periderm and underlying cortical tissue (20-mm diameter, 2-mm deep) was carefully excised from the equatorial region of each tuber (n = 50). Half of the tubers were placed in rapid curing conditions of 20 °C, 90% to 95% relative humidity (RH) (T-20) for 5 days, then transferred to simulated commercial storage conditions (10 °C, 80% to 85% RH) for 9 days. The other half were stored continuously at 10 °C, 80% to 85% RH (T-10). Fresh weight loss, dry matter content and histochemical analyses were conducted at 0, 5, and 14 days; the depth of suberized cell layers on the wound periderm measured the extent of wound-healing. 'Fabula' T-20 tubers had a significantly thicker suberized layer (16.5 μm) than T-10 (12.5 μm) after 5 d. After an additional 9 daysat 10 °C, 80% to 85% RH, the suberized layer of T-20 tubers increased to 24.0 μm, whereas there was no measurable increase in suberization in T-10 tubers. Higher curing temperatures resulted in significantly higher weight loss; cumulative weight loss at the end of storage was 2.8% and 3.6% for T-10 and T-20 tubers, respectively. 'Red LaSoda' followed a similar trend as 'Fabula'; T-20 tubers had a significantly thicker suberized layer (26.8 μm) than T-10 tubers (13.6 μm) at 14 days. Average weight loss in both storage conditions was 1.5% at 14 days; the more mature native periderm of 'Red LaSoda' tubers possibly minimized weight loss under the high curing temperatures. Tuber dry matter content was not affected by storage condition or duration, averaging 13.3% and 14.9% in 'Fabula' and 'Red LaSoda', respectively. These results indicate that a minimum of 5 days at 10 °C, 80% to 85% RH was sufficient to promote adequate wound-healing, while minimizing fresh weight loss, in these early season cultivars.

Seed & Stand Establishment

(284) Lettuce Transplanting – A Potential Late Summer Planting Strategy for Yuma Iceberg Lettuce Production

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Transplanting is a widely used strategy for rapid establishment of the stand in the field under unfavorable climate conditions and to achieve earlier yields than that with direct seeding. Yuma Valley, AZ, is the major winter lettuce production site in the United States (15,978 ha) and producers currently use direct seedling followed by manual thinning as a standard practice. Direct seeding earlier than September is problematic as it likely results in undesirable bolting due to exposure to high temperature and long photoperiod. Therefore, use of seedlings grown under relatively cooler climate inside a controlled environment facility or in a selected geographical location may delay bolting so that lettuce heads could be harvestable before plants exhibit bolting. A preliminary experiment was conducted for 15 Aug.–2 Dec. 2014 using a half-acre field plot at Yuma Agriculture Center. Iceberg lettuce seeds of two cultivars (Syngenta 7101A and Vanguard 1221) were sown in 128 cell-trays containing peat-based substrate on 15 Aug.; grown to develop 4–5 true leaves inside a walk-in growth room (20.4 °C ± 1.8°C average air temperature, 245 ± 35 μmol·m^{-2}·s^{-1} photosynthetic photon flux with white LEDs, and 12-h photoperiod); and transplanted in the soil beds conventionally prepared in the experimental field plot on 12 Sept. 2014 (T-815 plants, hereafter). Direct seeding was performed on 15 August and 12 Sept. (D-815 and D-912 plants, hereafter), followed by thinning three weeks after seeding. Standard field lettuce cultivation practices were applied afterward. All T-815 plants survived to harvest while some loss was observed for D-815 plants at the end of September. The D-815 plants and T-815 plants were matured to harvest on 7 Nov., approximately one month earlier than the conventional D-912 plants (harvested on 2 Dec.). Both D-815 and T-815 lettuces exhibited core extension at the time of harvest but D-815 had significantly greater core length (5.5 ± 0.25 cm) than T-815 (4.6 ± 0.09 cm). A small percentage of D-815 plants showed advanced stage of bolting with extended flower stalks. Harvested lettuce fresh weight was also significantly greater for T-815 (4.6 ± 0.07 kg for a box of 12 heads) than D-815 plants (3.8 ± 0.12 kg per box). However, while transplanting showed some merit in achieving earlier yield and mitigating bolting at the early seeding date (15 August) examined in this experiment, the highest yield and head quality were achieved for the D-912 plants, suggesting that use of transplants need to be evaluated over various planting dates.

Specified Source(s) of Funding: Arizona Iceberg Lettuce Research Council

(285) Surfactant Coated Seeds Improve Biomass of Turf in Hydrophobic Sand

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Hydrophobic soils can cause many problems for turf growth. Soil surfactants have been known to improve seed germination and growth in hydrophobic soils by enhancing water movement through the soil profile, thus increasing water availability to the seeds. In previous research, surfactant coated seeds have increased soil volumetric water content and improved seed germination under severe environmental stress. A greenhouse study was conducted in Paulsboro, NJ, to determine if surfactant treated perennial ryegrass seeds improved turfgrass growth in a hydrophobic soil. Perennial ryegrass seeds were coated with a high (HSC) and low rate (LSC) of surfactant and placed in pots containing either a laboratory created hydrophobic sand with a contact angle of 103.1° or a standard hydrophilic greens grade sand with a contact angle of 33.4°. Surfactant coated seeds were seeded at a rate equivalent to 8 lb/1000 ft^2. The pots received 0.5 cm of water upon being placed in the greenhouse and thereafter 0.25 cm of water per day which equals 1.75 cm of irrigation per week. In the hydrophobic sand, HSC resulted in turf with a statistically significant higher biomass when compared to untreated seed LSC did not yield any significant difference from the uncoated seed. In the hydrophilic greens grade sand, treatment differences were not significant. When water repellency was evaluated, it was observed that the HSC, and to a lesser extent LSC reduced soil hydrophobicity in the top inch of the soil. This study indicates that HSC can lead to improved turf biomass in a hydrophobic sand and suggests that both surfactant treatments can reduce soil hydrophobicity in the upper soil profile.

(286) Autopathic Effect of Capsaicin (8-methyl-N-vanillyl-6-nonenamide) on *Capsicum annuum* L. Seed Germination

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Recently, a new class of chile peppers (*Capsicum* spp.), that rate more than 1,000,000 Scoville heat units have become very popular, in the vernacular these are called "super-hots". However, it has been observed that germination of "super hot" chile pepper seed is slower and reduced, compared to other chile peppers with lower heat levels. Germination is a principal component of seedling establishment and survival. After imbibition, radicle emergence is the first visible sign of seed germination and is considered a valuable evaluation of seed vigor in crops. The objective of this work was to determine the effect of capsaicin (the compound causing the heat) on chile pepper seed germination. Two no heat cultivars, 'Keystone Resistant Giant' and 'Pimiento L.' were chosen. Seeds were treated with 0, 500, or 1500 ppm capsaicin, and placed in 25 °C for 20 days, and scored daily. A successful germination was recorded when radicle emergence reached ≥ 2 mm. The osmotic potential of the 500 and 1500 ppm capsaicin solutions was not high enough to act as a salt (0.16 and 0.22 Kpa, respectively), and reduce or prevent germination. We found capsaicin had a major inhibiting effect on seed germination. Capsaicin treatment resulted not only in reduced and delayed germination, but also in inconsistent germination. There was a significant effect of cultivar treatment, with the control (0 ppm) and 500 ppm capsicin treated seeds of 'Keystone Resistant Giant' having higher germination percent than the control and 500 ppm treated seeds of 'Pimiento L.' seeds, while the 1500 ppm capsaicin treated seeds of 'Pimiento L' had higher germination percent than the 1500 ppm treated seeds of 'Keystone Resistant Giant'. The major implication of this work is to increase germination percent and uniformity of seeds from "super-hot" chile peppers, whereas a seed wash would be beneficial.

(287) Scarification and Environmental Effects on Seed Germination in Minnesota Hardy *Prunus*

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For Prunus seeds to germinate, deep physiological and mechanical dormancies must be overcome. Even with long periods of cold stratification, germination rates are poor in many Prunus species. In addition, very little is known about the germination requirements in winter-hardy Prunus cultivars bred for Minnesota conditions (USDA Z3-4). The objective of this study was to determine effective methods to break seed dormancy in 12 plum (*P. domestica, P. americana* × *P. salicina*), 4 tart cherry (*P. cerasus*) and 3 apricot (*P. armeniaca*) cultivars. In 2012 and 2014, open-pollinated seeds of each cultivar were collected, dried, and refrigerated prior to treatment. For each cultivar, half of the seeds were scarified prior to planting then all seeds were subsequently warm stratified for two weeks prior to cold stratification. Cold stratification took place either in a cooler (120 days at ~6 °C) or overwintered in field (average air temperature of –3.9 °C, range: –24.4°C to 21.7 °C). After stratification in the cooler, pots were placed in greenhouse and seed germination was recorded weekly for eight weeks. Pots in field were monitored for germination in situ. Seed germination was highest in the greenhouse environment regardless of scarification. In 2012, the highest germination percentages were observed in the apricot cultivars (30% to 100% in greenhouse; 15% to 75% in field), the lowest were observed in tart cherry cultivars (less than 10% to 30% in greenhouse; 0% to 30% in field) and the plum cultivars were highly variable. In the greenhouse environment, germination began within the first week of removal from the cooler. Apricot cultivars showed the fastest rates of

germination with a high percentage germinating within the first three weeks.

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Water Utilization & Management

(246) Clean WateR3—Reduce, Remediate, Recycle: The Genesis of a SCRI-CAP Project

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In September 2014, researchers received funding for a SCRI-Coordinated Agricultural Project (CAP) entitled "Clean WateR^3–Reduce, Remediate, Recycle—Enhancing Alternative Water Resources Availability and Use to Increase Profitability in Specialty Crops." This project was initiated as a coordinated effort among a number of scientists through a multistate research group (NC1186 Water Management and Quality for Ornamental Crop Production and Health) and resulted in a 2011 SCRI planning grant titled "Containment, Remediation, and Recycling of Irrigation Water for Sustainable Ornamental Crop Production." Planning grant dollars were used to bring together scientists and stakeholders, conduct a national survey, and discuss and identify water use and management strategies employed by progressive growers throughout the United States. Furthermore, funds were used to recruit scientists from various disciplines (socioeconomics, engineering, horticultural systems, plant pathology, environmental toxicology, and Extension), bring together a trans-disciplinary, multi-institutional research team, and over 18 months prioritize research areas of concern, refine project goals, and develop project objectives. Grant preparation was an iterative process that entailed two writing workshops for the team as a whole and a final core-writing group workshop prior to proposal submission. Overarching project goals encourage recycling and reuse of remediated irrigation runoff via developing an online decision support model available for grower use, and to research and select runoff treatment (remediation) technologies (TTs) suited for implementation at the individual site level. The Clean WateR^3 team has already held its first project and Advisory Board meeting, where research on project objectives—including barriers to adoption—were refined and initiated. Outcomes of this project will help growers treat and reuse operational water to save valuable water resources, and reduce the environmental impact of runoff water.

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(247) Water Relations, Gas Exchange, and Yield of Pepper Cultivars under Water Deficit Stress

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Deficit irrigation has been used as an agricultural water management strategy to maximize water productivity in vegetable crops worldwide. Eight pepper (*Capsicum spp.*) cultivars in four distinctive groups differing in pungency levels [Serrano (Diablo and Alcon); Jalapeno (TAMU-JAL and TAMU-J222); Bell (81447 and S1122); and Habanero (TMH and TAM-Orange)] were evaluated under field conditions for their water relations, gas exchange (photosynthesis, intercellular CO_2, and stomatal conductance), and yield under water deficit. The experiment was conducted in two sites, Uvalde in the Wintergarden region, and Amarillo in the Texas High Plains. Pepper cultivars were grown at three irrigation levels (100%, 75%, and 50% of crop evapotranspiration (ET_c) requirement). Peppers from the Habanero group had lower gas exchange rates, midday stem water potential, and yield than those in serrano, jalapeno and bell groups. However, gas exchange and midday stem water potential within groups (jalapeno, bell, and Habanero) were similar. At both sites and across cultivars, the 50% ET_c treatment significantly reduced gas exchange rates, midday stem water potential, and marketable yield. The reduction of photosynthesis was mainly attributed to stomatal closure. However, except for jalapenos at the Uvalde site, marketable yields within each group were similar at 100% and 75% ET_c treatments. Therefore, deficit irrigation at 75%

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ET_c improved pepper water productivity in these water-limited regions of Texas.

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(248) Evaluating a Physiological-based, On-demand Irrigation System for Container-grown Woody Plants with Different Water Requirements

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Two sensor-based irrigation scheduling systems were compared for water use and plant growth in container-grown Green Velvet boxwood (*Buxus sempervirens* L. x *B. microphylla* Siebold & Zucc. var. *koreana* 'Green Velvet') and slender deutzia (*Deutzia gracilis* Siebold & Zucc). These crops were chosen because they have different water requirements during production. The two sensor-based irrigation systems included a physiological-based on-demand (OD) irrigation system where the set point was derived from the relationship between substrate moisture and photosynthetic rate. The second system was a daily water use (DWU) method where the amount of water used by the crop was replaced each day. The objective of the study was to evaluate and compare water use and growth metrics using the OD and DWU irrigation scheduling regimes for two container-grown woody plants that differed in their water use demand. Both plants transpired at a faster rate at 1.5 kPa than at 0.5 kPa. Deutzia plants transpired at a higher rate than boxwood under both VPD conditions. There were no differences in root and shoot biomass or growth index due to the irrigation schedule employed for either boxwood or deutzia. For boxwood plants, OD irrigation reduced water consumption by 35.5% and increased WUE by 54.5% compared to DWU. Total water use of deutzia in OD zones was decreased by 26.5% compared to DWU. One consideration explaining reduced water use for OD irrigation is that plants were irrigated on average every 3.4 days in boxwood and 1.6 days in deutzia. This contrasts to the daily irrigation event with DWU. Since each irrigation event is inefficient (less than 50% of irrigation volume entering the container substrate), the more frequent irrigation events associated with DWU treatments would lead to greater water losses thus increasing water use and decreasing water use efficiency. Both DWU and OD reduced water use by 41% and 68% compared to a traditional timer-based inch per day irrigation application in boxwood. For deutzia, there were similar trends; water use was reduced compared to traditional overhead irrigation applications by 61% and 70%, respectively, for DWU and OD treatments. DWU offers the labor scheduling advantage of a standard time of day when irrigation will operate, and OD offers the advantage of watering as needed, potentially reducing water stress as the season progresses and as the plant size and atmospheric demand increase.

Specified Source(s) of Funding: Hatch

(249) Effects of Water Stress on Physiology and Growth of Potted Primocane-fruiting Blackberries in a Controlled Environment

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A greenhouse experiment was conducted at the University of Arkansas Agricultural Research and Extension Center in Fayetteville to evaluate physiological and growth effects of water stress on potted Prime-Ark® 45 primocane-fruiting blackberries. After plants were actively growing, treatments of 40%, 70%, and 100% (CK) daily transpired water replenishment were imposed and plant response was studied. To estimate soil evaporation, water loss from pots without plants was measured. Physiological and growth responses were recorded for a 70-day experimental period. Reduced water replenishment led to reductions in net assimilation, evapotranspiration, and stomatal conductance for the 40% treatment. Net assimilation peaked at day 45 for the 70% and CK treatments (17.4 and 16.4 $\mu mol \cdot m^{-2} \cdot s^{-1}$, respectively), with the 40% treatment being significantly lower for all dates. Vapor pressure deficit (VPD), however, was significantly greater in the 40% treatment throughout the experiment with highest measurement of 4.5 kPa at day 62. Photosynthetic water use efficiency (WUE_p) peaked at day 52 in the 70% treatment and was significantly greater than the 40% treatment. Although there were few differences in physiological measurements between the 70% and CK treatments, there were multiple differences between all treatments in growth response. The 40% treatment resulted in 89% less total cane length compared to the CK treatment. Cane diameter of the 70% treatment was 18% less than the CK treatment and the 40% treatment resulted in a 29% decrease. Total leaf area differed significantly with the CK treatment having 18,782 cm^2, the 70% treatment having 9598 cm^2, and the 40% treatment having 847 cm^2 leaf area. The CK treatment used the most water (58.6 L) and resulted in the greatest biomass (266 g), whereas the 70% treatment used significantly less water (33.6 L) and had less biomass (188 g). The 40% treatment biomass (46.8 g) was reduced by 83% compared to the CK treatment. The 70% treatment had no significant difference in WUE than the CK treatment. The 40% treatment water use was so minimal that

it did not differ from the plant-less treatment (0.58 and 0.54 L, respectively). The 70% treatment began flowering and fruiting earlier than other treatments. These data provide a foundation for additional research on blackberry water use and irrigation management.

(250) Low-cost Open-source Microcontrollers to Build Automated Irrigation and Fertigation Systems Using Soil Moisture and Electrical Conductivity Sensors

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Low-cost, open-source, embedded computers and microcontrollers can be used to build sensor-based automated systems to supply plants with on-demand water and fertilizer. The Raspberry Pi is a credit-card size embedded computer capable of running Linux and software written in Python, C, or C++. The Arduino is a prototyping platform centered on a microcontroller board and open-source development environment. We designed, built, and tested two independent systems using soil moisture and EC sensors to control irrigation and fertigation in geranium (*Pelargonium hortorum* Bailey) 'Maverick Violet' grown in 6-inch pots with peat:perlite substrate. Pore water electrical conductivity (EC), temperature, and volumetric water content (VWC) data were collected, added to a database, and made available online. The Raspberry Pi-based controller was designed to be self-contained, hosting its database and communicating with the internet by Wi-Fi. The Arduino-based controller was designed to be energy-efficient, and the data was transmitted to a database using XBee radios. A web application using twitter/BootStrap was written to query the databases and provided graphs online. Water and fertilizer solution with 600 mg L^{-1} nitrogen (15–5–15 Cal-Mg) were provided by different drip irrigation lines, based on sensor measurements taken every 15 minutes. When the VWC dropped below the tested thresholds (from 0.15 to 0.5 $m^3 \cdot m^{-3}$), the systems compared the EC to a threshold (from 0.5 to 3.0 $dS \cdot m^{-1}$). If the measured EC was higher than the threshold EC, a 24-VAC solenoid valve was opened and the plants were irrigated for 30 seconds; if the measured EC was lower than the threshold EC, another valve was opened and the plants were fertigated for 30 seconds. Our systems did not control irrigation and fertigation properly. The connection with the database was unstable due to the authentication protocol used by the network and the communication between sensors and microcontrollers was problematic, resulting in random loss of data and storage of unrealistic values. As a result, valves opened at the wrong times, not allowing a precise control. More studies are needed before these microcontrollers can be recommended for agricultural applications.

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(251) Examining the Role of Substrate Moisture Sensor Placement in Container Volumetric Water Content Measurement Accuracy

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Substrate moisture sensors permit growers to utilize precise and dynamic irrigation scheduling that improves water use efficiency and reduces overall water use while maintaining or improving plant quality and production schedules compared to conventional, static timer-based irrigation practices. Measurement accuracy influences the efficacy of sensor-based systems. Sensor placement, both orientation to the surface and depth in substrate, may influence the ability to generate accurate substrate moisture measurements. Yet, sensor placement is a variable that is often not investigated. Experiments were initiated to determine which of five EC-5 capacitance sensor placements best estimates whole container volumetric water content (VWC) for 11.4 L containers filled with a pine bark substrate amended with 15% sphagnum peat moss and planted with *Hibiscus moscheutos*. Five sensor placements were tested; two placements were inserted into the substrate surface either vertically or diagonally and the remaining three sensors were horizontally inserted through the container sidewall at 5 cm, 10 cm, and 15 cm from the base of the container. All placements showed a strong linear relationship ($r^2 > 0.92$) with VWC determined gravimetrically and converted to a volume basis, indicating they all are appropriate indicators of container substrate moisture. Sensors in the vertical placement had a more accurate slope than 15 cm from the base, but the y-intercept was further from zero. Sensors placed horizontally at 15 cm above the base had a y-intercept closer to zero than horizontally placed sensors at 5 cm from the base and vertical and diagonal sensors, but the slope was less accurate (P-value 0.0148) than the vertical placement. For this species and container size, no probe placement was universally preferable to the other placements, but using surface installed placements (vertical and diagonal) may be most practical for sensor calibration and ease of installation and removal at harvest, while choosing a horizontal placement may be most practical for hand weeding, pruning, and agrichemical applications and may be more protected from dislodging.

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(252) The Effects of AquaSmart-coated Sand Products on Growth and Water Use of Greenhouse-grown Ornamentals and Nutrient Leaching in Greenhouse Media

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Water usage is one of the primary continuing costs for new and established greenhouse operations. One way in which growers have been working to reduce water costs is by using wetting agents and hydrophilic polymers. These products help increase the water-holding capacity of the media, and can allow for less frequent irrigation while maintaining desired growth rates. AquaSmart Enterprises, LLC markets a super-absorbent, coated sand product to the greenhouse ornamentals industry. The product should increase water-holding capacity and reduce plant water use in container substrate. The objectives of this study were to evaluate the effects of AquaSmart polymer coated sand products on growth and water use of greenhouse-grown ornamentals and nutrient leaching from greenhouse media. The study was conducted at the Oklahoma State University Research Greenhouse Facility in Stillwater, OK, in 2014 and 2015. Six common ornamental species were tested using three application rates of AquaSmart and a nontreated control to compare plant water use and growth rates within species. The nutrient study used the same product application rates, and generated nutrient release curves for each rate.

(253) Irrigation Scheduling: A Water Balance Approach to Improve Water Efficiency for South Texas Horticultural Crops

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When water resources are limiting, growers need to change to more water conserving methods to raise crops. The purpose of this project was to evaluate the water balance approach as a water scheduling and water saving technique with drip irrigation with plastic, drip without plastic, and furrow irrigated watermelon. The water balance approach to irrigation scheduling keeps track of soil water deficit by accounting for all water additions and subtractions from the soil root zone. 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 subsampling. Irrigation was determined by employing a water balance approach, replacing ET water loss within the drip and furrow irrigated plots. Subsurface drip irrigation was compared to irrigating to soil saturation point in furrow irrigated plots. The furrow system was irrigated without producing runoff by blocking furrows at the lower end of the field. Harvested watermelon was measured for size and weight to determine produce yield and quality. The lowest amount of irrigation water used was in the drip with plastic treated plots, which resulted in the highest average yield and best overall irrigation use efficiency compared to other systems.

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Floriculture 3

(373) Photoperiod and Irradiance Affect *Monadenium coccineum* Flowering

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Monadenium coccineum (Pax.) is a succulent plant indigenous to Tanzania with potential as a new flowering potted plant. Plants bloom with inconspicuous flowers, but have brightly colored red bracts surrounding flowers that are ornamental. We determined how photoperiod and irradiance affected flowering to allow for production scheduling. One hundred and twenty rooted cuttings (7–8 nodes) were grown under natural daylight + 25 μmol·m^{-2}·s^{-1} supplemental high-pressure sodium lighting [0800–0200HR; 22 °C/18 °C (day/night) temperature] until 13 Dec. when plants were pruned to five nodes. After two weeks, plants were placed under short days (SD, 8-h; covered from 1600–0800 HR), or long days (LD, 16-h). Under both photoperiods, plants received +0, +25, +50, or +100 μmol·m^{-2}·s^{-1} supplemental lighting (high-pressure sodium lamps). The LD treatments were provided by providing night interruption lighting (2 μmol·m^{-2}·s^{-1}; 2200–0200HR ("0" irradiance treatment) or lighting from 0800–0200 HR. After four weeks, three plants from each irradiance treatment (12 of 15 plants) under SD were moved to each irradiance treatment under LD, and vise versa. Data were collected on time to anthesis, node number below the first flower, branch number, and flower number on one branch. Plants flowered fastest under the continuous LD+100 μmol·m^{-2}·s^{-1} treatment (41 d),

or when moved from any of the SD treatments to the LD+100 μmol·m^{-2}·s^{-1} treatment (44–49 d). Plants that flowered fastest had the lowest node number below the first flower (1 leaf), 1.7 branches, 3–4 flowers per branch, and 6–7 total flowers. Plants grown under continuous night interruption lighting and plants moved from SD+100 μmol·m^{-2}·s^{-1} to night interruption lighting did not flower. Also many plants moved from LD to ambient SD, as well as, plants grown under continuous ambient SD did not flower. All plants flowered in the LD+25 μmol·m^{-2}·s^{-1} moved to SD+100 μmol·m^{-2}·s^{-1} treatment and the night interruption moved to SD+25 μmol·m^{-2}·s^{-1} treatment, but they had the longest days to anthesis (82 d). Plants with the greatest flower number (grown under continuous SD+25 μmol·m^{-2}·s^{-1} treatment) had 19 flowers per plant, 6.3 flowers per branch, 3 branches, 3 leaves below the first flower, and flowered in 52 d. Data here suggest that *M. coccineum* is a facultative LD plant, with a facultative irradiance response.

Specified Source(s) of Funding: Minnesota Agriculture Experiment Station and USDA–ARS FNRI

(374) Nitrogen and Phosphorus Rates Influence Growth, Flowering, and Nutrient Uptake in *Iris germanica* L.'Immortality'

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The influence of nitrogen (N) and phosphorus (P) fertigation rates on plant growth and uptake of essential nutrients was evaluated in container-grown *I*ris *germanica* 'Immortality'. Factorial combinations of three N (5, 10, or 15 mM) rates and three P (5, 10, or 15 mM) rates were applied to iris plants twice per week from March to September 2013. Plant height and leaf SPAD data were collected during the growing season. Plants were harvested in December to measure dry weight (DW) and analyze essential mineral elements concentration. Increasing N rates increased plant height, leaf SPAD, tissue dry weight and uptake of many essential elements potassium (K), calcium (Ca) and iron (Fe). P rates did not affect plant height or DW and only increased leaf SPAD in October. Increasing P rates increased concentration of P in leaves and roots and decreased boron (B) concentration in the leaves but did not influence net uptake of other nutrients. Concentrations of N, K, Ca, magnesium (Mg) and zinc (Zn) decreased in plant tissue in order of leaf > rhizome > root regardless the treatment. K was the only macroelement to have higher concentrations in roots than rhizomes. The average N:P ratio ranged from 4.7–7.5, 2.4–4 and 6–8.7 in leaves, roots and rhizomes, respectively. Compared to the common recommended threshold N: P ratio of 16:1, plants in this study may be N limited; however, P supply was sufficient, even at 5 mM P application.

(375) The Effects of Environmental Factors, Stem Caliper, and Pruning Height on Axillary Bud Development in *Dracaena* 'Waikiki' and *Dracaena* 'Ruth Luka' Grown from Stem Cuttings

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While it is common industry practice to grow multiple cuttings of *Dracaena* in one pot, the number of branches produced by each cutting will greatly affect the finished appearance of the plant. We studied the ability of rooted stem cuttings of each plant to produce multiple shoots when pruned to various heights, using newly introduced varieties Waikiki and Ruth Luka. Rooted cuttings were pruned to 5.08 cm, 15.24 cm, or 25.4 cm (2, 6, or 10 inches) in height and were grown under 60% or 30% shade. Stem caliper of cuttings was measured at pot rim height and again at 5.08 cm, 15.24 cm, or 25.4 cm. The experiments were set up with six plants per treatment within each block and two randomized blocks of plants. Greenhouse environmental conditions for light and temperature were measured both by the greenhouse weather station and by several HOBO pendant recorders placed among the plants. All *Dracaena* 'Waikiki' pruned to 5.08 cm produced two bud breaks per plant when grown at 60% shade. At 15.24 cm, 83% produced two breaks and 17% only one break. At 25.4 cm, 50% of plants produced two breaks and 50% produced one break per plant. In the 30% shade experiment, 50% of 'Waikiki' pruned to 5.08 cm produced two shoots while 50% produced only one. At 15.24 cm, 67% produced two breaks while 33% produced only one. At 25.4 cm, 50% of plants produced two shoots while 50% produced only one. Unpruned cuttings under either shade regime did not produce side shoots. *Dracaena* 'Ruth Luka' grown at 60% shade and pruned to 5.08 cm produced only one bud break on 92% of plants; 8% produced two breaks. For plants pruned at 15.24 cm or 25.4 cm, 83% produced one break and 17% produced two breaks. With 'Ruth Luka' grown under 30% shade and pruned to 5.08 cm, 8% produced three shoots, 8% produced three shoots, 33% produced two, and 50% produced one. At 15.24 cm, 33% produced two shoots and 67% produced only one. At 25.4 cm, 50% produced two shoots and 50% produced one shoot. Unpruned cuttings under either shade regime did not produce side shoots.

An asterisk (*) following a name indicates the presenting author.

(376) Varying Durations of High Temperature Affects Flowering Time and Flowering Shoot Morphology in Pointsettia

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Two cultivars of poinsettia (*Euphorbia pulcherrima* Willd. Ex Klotzsch) were grown in greenhouses in Overton, TX, to determine the effects of varying periods of elevated temperature on flowering time and morphology. Plants were potted in early September and pinched to 5 nodes two weeks later for natural season flowering. Plants were exposed to either 0, 1, 2, 3, 4, 5, 6, 7, or 8 weeks of a high temperature treatment consisting of a daily average temperature of 27 °C starting at the time of the pinch. For the rest of the forcing period, an average daily temperature of 22 °C was maintained. Dates of first bract color, visible bud, and anthesis were recorded for each plant. Anthesis of 'Tikal Red' plants was delayed by 2–7 weeks of high temperature treatment, but not by 1 or 8 weeks of treatment when compared to plants receiving no high temperature treatment. Days to visible bud from transplant behaved in a similar pattern, but days to first bract color was delayed by heat treatment in a linear fashion. Data indicate that floral initiation is delayed for 'Tikal Red', but floral development is hastened by high temperature treatment. However, anthesis, days to visible bud, and days to first bract color of 'Prestige Red' plants was strongly delayed in all aspects by the high temperature treatment as the duration of treatment increased. At anthesis, number of leaves, transitional bracts, fully expanded and pigmented bracts, and height was recorded for the distal flowering shoot on each plant. Effects of high temperature on plant morphology were not related to timing of floral developmental events. Increasing duration of high temperature treatment resulted in taller plants with increased leaf number and node length in both cultivars. However, for 'Tikal Red', six or more weeks of high temperature resulted in more transitional bracts and 8 weeks of treatment reduced the number of fully developed bracts when compared to untreated plants. For 'Prestige Red', numbers of both bract types were unaffected by high temperature treatment.

Specified Source(s) of Funding: Dummen NA

(377) Effects of Substrate Drenches Containing Ethephon on Containerized Annual Bedding Plants are Affected by Concentration and Application Timing

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Ethephon is a plant growth regulator that has several effects on flowering ornamental plants, including delayed flowering, enhanced lateral branching, and suppression of stem elongation. Traditionally, ethephon has been applied to plants using foliar sprays. However, recent research has shown that applying ethephon with substrate drenches can elicit the same suite of responses observed when applied in foliar sprays. However, there are no data on how concentration and application timing affect the efficacy of substrate drenches containing ethephon. Our objectives were to quantify the effects of ethephon concentration, timing of substrate drench application, and their interaction on the growth, size, and flowering of annual bedding plants. Angelonia (*Angelonia angustifolia* Benth.), geranium (*Pelargonium hortorum* L.H. Bailey), and vinca [*Catharanthus roseus* (L.) G. Don.] seedlings were planted in 4-inch diameter round containers filled with a commercial, soilless growing substrate comprised of sphagnum peat moss and perlite. Zero, 5, 10, 15, or 20 days after planting seedlings, 70-mL aliquots containing 0, 50, 100, or 200 ppm ethephon were applied to the surface of the substrate. The date the first flower opened, height of the plant from the surface of the growing substrate to the top of the plant canopy and the widths at the widest point of the plant and perpendicular from that widest point were recorded for each individual plant and time to flower was calculated. Species varied in their growth and flowering responses to ethephon concentration, drench application timing, and their interaction. When 100 or 200 ppm ethephon drenches were applied 0 d after planting, plants remained in visible bud, while applications at 20 d after planting had minimal effect on flowering for angelonia and geranium. Width of geranium was only affected by ethephon concentration, not application timing. Alternatively, ethephon and application timing interacted to affect the width of angelonia and vinca; plant widths were suppressed with ethephon concentration 0 d after planting yet minimal effect was observed when applications were made 20 d after planting. The shoot and root dry mass, and the height of all three species were similarly affected; with early ethephon applications made immediately after planting have a greater impact than later applications. Ethephon drenches are effective in controlling the height and width of containerized floriculture crops. However, based on the results of our research, the application timing of substrate drenches should be determined based on the desired effects and the concentration of the solution.

(378) Determining the Optimum Supplemental LED Intensity for Winter Production of Cut Snapdragons at Northern Latitudes

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Cut flower production at northern latitudes typically requires supplemental lighting during the darker months. With LED technologies poised to overtake traditional HID for greenhouse assimilation lighting, it is important to determine the optimum supplemental LED light levels as well as spectral composition for the production of various commodities and ambient lighting conditions. Lighting manufacturers, suppliers and growers need this information to guide design and operational protocols for greenhouse production. This project investigated the production of cut snapdragons (*Antirrhinum majus* 'Opus Apple'), using four levels of LED supplemental lighting (measured at pot level): 55, 95, 135, 175 $\mu mol \cdot m^{-2} \cdot s^{-1}$ provided daily on a 14-h photoperiod. Each lighting treatment was concurrently replicated four times, for a total of 16 experimental plots. Plugs at the 2–4 true leaf stage were transplanted into 8" pots, three per pot, on Dec. 5, 2015. Pots were arranged in a 3 x 3 square under each lighting treatment (27 plants per plot). The greenhouse environment was set at 14 °C day and 12 °C night with a constant 65% relative humidity. The plants were grown over a full crop cycle and harvested after the bottom three florets were fully open. Growth metrics such as plant height, stem diameter, number of leaves and branches, chlorophyll content, and date to first floret opening were measured regularly. Harvest metrics including: stem and inflorescence length, number of leaves and lateral branches, number of florets, and fresh weights of inflorescence, stem, leaves and lateral branches were taken on all flowers immediately after harvest. Four plants on each plot were further measured for chlorophyll content, leaf area, and dry weights. Early vegetative growth metrics showed that stem length decreased and stem diameter increased as supplemental light intensity increased. Mean leaf chlorophyll content index (i.e. SPAD readings) measured at solar noon on 23 Feb. 2015 were 94.6, 114.1, 122.2 and 1370.2 for the 55, 95, 135, 175 $\mu mol \cdot m^{-2} \cdot s^{-1}$ treatments respectively. Relative to the 55 $\mu mol \cdot m^{-2} \cdot s^{-1}$ treatment, the 95, 135 and 175 $\mu mol \cdot m^{-2} \cdot s^{-1}$ treatments reduced the time to first floret opening by 4.7, 5.8, and 13.2 days respectively. The percentage of plants that produced marketable flowers were 85%, 98%, 98%, and 100% for the 55, 95, 135, and 175 $\mu mol \cdot m^{-2} \cdot s^{-1}$ treatments, respectively. Days between first floret opening and harvest were not substantially different between the light treatments. Other growth and harvest metrics will be also reported in this poster.

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(379) A New Landscaping Garden Chrysanthemum Cultivar 'Madang Ball' with Red–Purple Petals, Spreading and Semidouble Type

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'Madang Ball' is the newest garden chrysanthemum (*Dendranthema grandiflorum*) released from the Yesan Chrysanthemum Experiment Station in Chungcheongnam-do ARES. 'Madang Ball' is the result of cross pollination between 'Magic Ball' and 'Getallila'. The characteristics were investigated from 2010 to 2013 for the evaluation and selection of this variety in natural culture conditions. It is a vigorous and uniform plant that usually begins blooming in early October. It has semidouble-type flowers, red-purple color petals, and a spreading plant shape. Flower diameter is 3.1cm and the number of flowers is 851. These were checked for local adaptability on growth and flowering characteristics in the cities of Yesan-gun and Suwon.

Genetics & Germplasm 2

(013) Functional Annotation and the Effect of Curing on the Expression of Skinning Injury Response Genes in Sweetpotato Cultivars

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Skinning injury in sweetpotatoes (*Ipomoea batatas*) is responsible for significant postharvest loss resulting from storage diseases and weight loss. Unfortunately, there is no report on the genes involved in wound healing of sweetpotato and a better understanding will

facilitate improved breeding strategies. An annealing control primer (ACP) system was used to identify genes expressed after skinning injury of sweetpotato cultivar L07-146 storage roots. Using 20 ACPs, 63 differentially expressed genes (DEGs), 19 contigs were identified. Functional annotation of the 19 DEGs revealed that genes previously shown to respond to a(biotic) stress responses; genes involved in RNA, DNA related and gene expression; genes involved in cellular communication and signal transduction; and genes involved in metabolism, energy and cytoskeleton formation. Studies showed that genes involved lignin and suberin have been shown to hasten wound healing and curing has been shown to improve storability of root crops. We further analyzed the expression pattern of genes involved in lignin and suberin biosynthesis in response to skinning injury in cured (28 °C, RH 85%) and non-cured (ambient) conditions in storage roots of a resistance (LA 10-70) and susceptible (LA 07-146) sweetpotato cultivars. The purpose was to study their transcript abundance in order to understand the tolerance to skinning injury mechanism associated with lignin and suberin formation in both cultivars. All skinning treatments were conducted on freshly harvested storage roots of both cultivars. This study revealed that these genes were regulated in opposite fashion in skinning resistant- and susceptible cultivars of sweetpotato with difference in timing of their induction under curing condition. These results also showed a clear evidence for a coordinated gene signaling cascade in pre- and lignin biosynthesis pathway. Taken together, this study demonstrated that major differences in skinning tolerance between these two cultivars were due to the ability of the skinning resistant cultivar to maintain highly regulated order in its transcript activity of genes involved in pre-lignin (TAL) and in lignin biosynthesis (PAL, CCOMT, and CAD) and prevented early expression of Ext gene in response to skinning and in curing conditions.

(014) Genetic Variations of *Magnolia sieboldii* K. Koch 'Colossus' and *Magnolia grandiflora* L. 'Kay Parris' F_1 Seedlings Using ISSR Markers

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Magnolia sieboldii K. Koch 'Colossus' (2n = 2x = 38) is a deciduous shrub or small tree and *Magnolia grandiflora* L. 'Kay Parris' (2n = 6x = 114) a densely pyramidal evergreen tree. In May 2013, several controlled crosses were performed between two individuals of these species. Seeds were harvested in August 2013 and subjected to a float test to determine viability. Aril tissue was removed from the 25 viable seeds. Following a brief rinse in 10% NaClO, seeds were stratified in slightly moist spaghnum peat for five months. Twenty-one seeds had germinated by March 2014 and 9 seedlings survived in early production after transplanting to 1-gallon containers. ISSR markers were used to analyze genetic variations and assessed inheritance of the remaining 9 F_1 seedlings. Plants were accessioned and assigned a letter, with A being the most vigorous and H being the least vigorous individuals. A total of 584 bands were generated from 10 primers, in which 463 bands (79.3%) were polymorphic. UPGMA tree revealed that all the seedlings were much closer to their hexaploid pollen parent (*M. grandiflora* 'Kay Parris') and more distant from their diploid seed parent (*M. sieboldii* 'Colossus'), supporting early foliage morphology. Seedling C is most similar to the pollen parent, both in regard to foliage proportions, margin undulation, and proximity. Seedling G is unique among the F_1, displaying lanceolate leaves. Other seedlings grouped within the tree have slight morphological variations that may be analyzed for correlation to the UPGMA tree as they continue to mature and growth habit variations become evident. Further studies will include verification of the putative 2n = 4x = 76 ploidy level and selection of the best individuals for future controlled crosses and determination of reproductive fecundity.

(015) Breeding Compatibility with *Camellia azalea*

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Camellia azalea Wei. (syn. *C. changii*) was discovered in China in 1986. *Camellias* typically bloom for two or three months and grow in phases of vegetative or reproductive growth. *C. azalea* is very different in that it blooms every month of the year in a greenhouse setting. This single ever-blooming characteristic makes *C. azalea* an attractive breeding parent. From 2008 to 2014, 2401 controlled crosses were made with *C. azalea* as the maternal (770 crosses) or paternal (1631 crosses) parent. Many different species and cultivars were used in these interspecific crosses with a wide range of compatibility ranging from 0% to over 60% fruit set. Overall, fruit set occurred 19% or 8% of the time with *C. azalea* as the maternal or paternal parent. The primary species used in crosses with *C. azalea* as the maternal parent were various *C. japonica* cultivars and straight species (351 crosses with 28.1% fruit set), *C. albogigas* (47 crosses with 8.5% fruit set) and *C.* ×*williamsii* 'Aida' (43 crosses with 16.3% fruit set). There were over 20 more species and non-*C. japonica* cultivars that were also evaluated as paternal parents. Among the *C. japonica* cultivars that were used as pollen parents at least 10 times, 'Lady de Saumarez' and 'Longwood Centennial' had the highest fruit set of 62.5 and 42.6%. The primary species used in crosses with *C. azalea* as the paternal parent were *C. japonica* (466 crosses with 12.7% fruit set), *C. wenshanesis* (108 crosses with 8.3% fruit set), and *C. sasanqua* 'Narumigata' (104 crosses with 0% fruit set). There were over 30 more species and non-*C. japonica* cultivars that were also

evaluated as maternal parents. Among the *C. japonica* cultivars that were used as seed parents at least 10 times, 'Longwood Centennial' and 'Longwood Valentine' had the highest fruit set of 58.3% and 50.0%. Although fruit set occurred, many of the seeds inside the fruit were underdeveloped and considered non-viable. A total of 487 seeds have been collected from these crosses and only 154 have been determined to be viable. All viable seed have *C. japonica* as a straight species or cultivar as the maternal parent and 104 of these have germinated. All seeds that were considered nonviable have been placed into an embryo rescue and somatic embryogenesis program.

(016) Anthracnose Resistance in Andean Beans

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Anthracnose is a seed-borne disease of common bean (*Phaseolus vulgaris* L.) caused by the fungus *Colletotrichum lindemuthianum*, and is cosmopolitan in distribution. It is one of the most economically important diseases of common bean, and can cause devastation to farmers' fields, resulting in yield losses as high as 95% in susceptible bean cultivars. The objectives of this study were: (i) identify new sources of anthracnose resistance in a diverse panel of Andean beans comprised of multiple seed types and market classes from the Americas, Africa, and Europe, and (ii) explore the genetic basis of this resistance using Genome-wide association analysis (GWAS). Numerous resistant lines were identified within the 230 bean lines screened for all eight races of anthracnose included in the study (races 7, 39, 55, 65, 73, 109, 2047, and 3481). Outputs from the GWAS indicated major QTL for resistance within Andean beans on four linkage groups: Pv01, Pv02, Pv04, and Pv11.

(017) Genetic Diversity of North American Wild Kidney Bean (*Phaseolus polystachios*) in the Eastern United States

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North American wild kidney bean or thicket bean [*Phaseolus polystachios* (L.) Britton, Sterns, & Poggenb.] is a perennial vine found in the eastern United States from Texas to Connecticut. Habitat destruction and urbanization are limiting its distribution: e.g., it was once prevalent in the Detroit River International Wildlife Refuge, but has not been seen there since the late 1800s. Crop wild relatives are a critical source of genetic diversity, often holding untapped genes for breeding of domesticated plants in agriculture for disease resistance, yield, quality, and adaptation to climate change, as well as ecologically important members of natural habitat. The closest cultivated relative of *P. polystachios* is *P. lunatus,* the lima bean. Through coevolution in its natural habitat, *P. polystachios* may have acquired true resistance to the ubiquitous pathogen white mold (*Sclerotinia sclerotiorum*) and provide a source for interspecific transfer. The Western Regional Plant Introduction Station of the National Plant Germplasm System holds over 17,000 accessions of *Phaseolus* from 47 species groups, but has only 10 accessions of the wild *Phaseolus polystachios*, five of which were only recently collected in Florida. Planning is underway for a collection trip throughout the Midwest to increase the diversity of *P. polystachios* within the collection. Understanding genetic diversity is critical for identifying areas to target for recovering maximum genetic representation. Molecular markers are an important tool for analyzing the extent and distribution of genetic diversity within and among wild populations and are important for identifying geographic gaps for collecting underrepresented genotypes. We analyzed nine accessions from the USDA collection along with sixteen herbarium samples provided by the Smithsonian Institution using 231 AFLP molecular markers from six primer combinations. While the DNA from the herbarium samples was somewhat degraded, markers at and below 200 bp were readily discernible and showed four distinct clusters. One herbarium sample from Florida was distinct from the others and, because of the lobed leaves, is likely *P. smilacifolius*. The USDA accession from Texas was very unique and has been reclassified as *P. texensis*. The level of distinction among the samples studied here reinforces the need for continued collection of this diverse species.

(018) Cryopreservation Techniques of Plumules of Brazilian Green Dwarf Coconut Accession (BGD)

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The objective was to evaluate the effect of cryoprotectant solutions and immersion times on the survival and regeneration of Brazilian green dwarf (BGD) accession. Encapsulation-dehydration and the droplet-vitrification techniques were tested in plumules excised from mature zygotic embryos of Coconut fruits (10–11 months) of Active Germplasm Bank of Embrapa Coastal Tablelands, Sergipe, Brazil. The plumules, after the desinfection, were initially precultured for 72 hours in Y3 medium with 0.12 M sucrose. For the encapsulation, the plumules were suspended in 3% (w/v) sodium alginate in a growth regulator- and calcium-free liquid MS medium supplemented with 0.1 M sucrose. The plumules with some alginate solution were dispensed into a liquid MS medium containing 100 mM calcium chloride

and 0.1 M sucrose to form beads. Thereafter the beads were transferred to cryoprotectant solutions composed by Y3 medium supplemented with 0.5 or 1.0 M sucrose and incubated on rotary shaker providing gentle shaking for 48 hours at 25°C ± 2°C in the absence of light. Half of the beads, from each treatment, was then transferred to a recovery medium (–LN), while the other half of the beads was placed in 2 mL sterile cryogenic vials and rapidly cooled by direct immersion into liquid nitrogen (+LN) by 24 h. For the droplet-vitrification technique the explants were immersed in the PVS2 vitrification solution (30% DMSO plus 1 M sucrose, or 15% DMSO plus 1.0 M sucrose in a hormone-free liquid MS medium) for 30, 45 and 60 minutes. After dehydrating the plumules were transferred to aluminum foil containing drops of 10 μL PVS2/foil and introduced into sterile polypropylene cryotubes and quickly immersed in liquid nitrogen by 24 h. After cryopreservation, cryogenic vials containing beads or aluminum foil were thawed in a water bath at 38 °C ± 2 °C for 2–3 minutes and then cultured on regeneration medium. After three months, the explants (–LN and +LN) were evaluated for the percentage of survival and induction of somatic embryogenesis. The regenerative capacity of BGD plumules (control) was 80% through somatic embryogenesis. The cryoprotectant solutions composed through Y3 medium supplemented with 0.5 or 1 M sucrose provide 86.67 and 66.67%, respectively, of survival in plumule encapsulated. The immersion in PVS2 solution for 30 minutes promoted 100% survival. Both methods and can be recommended for future BGD accession coconut cryopreservation protocols.

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(019) Genetic Diversity and Population Structure of Collard Landraces Collected in the Southeast

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Collard (*Brassica oleracea* L. covar. Acephala var. viridis) is a common vegetable grown throughout the southeastern United States. This non-heading, leafy-green cole crop is mostly grown during cooler seasons (e.g., fall through spring), but in some areas it is effectively grown year round. In the past, the home collard patch and even commercial plantings made use of local varieties that were saved by individual gardeners or farmers. Evidence indicates that many of these local varieties were true heirlooms saved for many decades and passed down from one generation to the next. Through much of the 20th Century, the regional diversity of collard was probably very significant; however, genetic erosion of the germplasm pool for this vegetable occurred as commercial hybrids became popular and widely grown by vegetable producers as well as home gardeners. With the support of the USDA Plant Exploration Office, we traveled the Southeast from 2003 to 2006 in search of collard landraces, obtaining close to 90 samples from various seed-savers, a majority of whom were aging and not apt to pass on seed of their particular saved variety. Using the Illumina 60K *Brassica* SNP BeadChip array of 52,157 SNPs, we assessed the genetic diversity of 75 of the collard landraces and clarified the relationship of collard to the main *B. oleracea* crop varieties. The collard landraces had twice the polymorphic markers (11,322 SNPs) and ten times the variety-specific alleles (521 alleles) of the remaining varieties. Although other relationships varied, the previous placement of collard with cabbage and Portuguese tronchuda cabbage was confirmed with STRUCTURE, PCoA, phylogenetic analyses using 15,951 unlinked markers.

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(020) Genetic Diversity and Association Analysis for Bolting, Tallness, and Erectness in Spinach

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Spinach (*Spinacia oleracea* L., 2n = 2x = 12) is an economically important vegetable crop worldwide. The objective of this research is to conduct association analysis for tallness, erectness, and bolting in spinach. 298 USDA spinach germplasm accessions were used as an association panel in this study and were genotyped using genotyping by sequencing (GBS). The 4077 SNPs identified from GBS data were used for the association study using TASSEL 5 and GAPIT. 13 SNPs were identified to be associated with bolting with P value < 0.0001 (LOD > 4.0) and $R^2 > 6.6\%$; 19 SNPs associated with tallness $P < 0.0001$ (LOD > 4.0) and $R^2 > 6.1\%$; and 28 SNPs associated with erectness with $P < 0.0001$ (LOD > 4.0) and $R^2 > 8.1$. After validation of these SNP markers in a larger spinach panel, the validated SNP markers can be used in spinach molecular breeding through marker-assisted selection. This research will provide SNP markers for molecular breeding and genetic diversity information for selecting parents in spinach breeding programs.

(021) Inheritance and Molecular Mapping of Serpentine Leafminer (*Liriomyza trifolii* Burgess) Resistance in Romaine lettuce (*Lactuca sativa* L.) Valmaine

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Serpentine leafminer (*Liriomyza trifolii* Burgess) is an economically important pest of lettuce in the United States. Farmers have relied on pesticides to control L. trifolii for decades. However, L. trifolii can develop resistance to frequently applied insecticides within a few years. Nonchemical methods of controlling the pest are desirable. Host plant resistance has been long sought in plant breeding. Identification of genes controlling L. trifolii resistance is being conducted in a population comprised of 125 F_2 plants derived from a cross between 'Valmaine' (resistant) and 'Okeechobee' (susceptible). Progeny testing on F_2 individuals showed 22 homozygous dominant, 64 heterozygous, and 39 homozygous recessive, fitting the ratio 1:2:1 (r = 4 .696, P = 0.0956). In addition, 64 segregating individuals produced 573 resistant and 212 susceptible plants, fitting the ratio 3:1 (r = 1.685, P = 0.1942). These results support the hypothesis of a single dominant allele controlling the *L. trifolii* resistance in romaine lettuce 'Valmaine'. Amplified fragment length polymorphisms (AFLPs) marker system is being used to map the resistance gene. Identification of closely linked markers will facilitate the transfer of the *L. trifolii* resistance gene to elite lettuce cultivars through marker-assisted selection.

(022) A Dominant Gene for the Banded Cucumber Beetle Resistance in Lettuce

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Banded cucumber beetle (*Diabrotica balteata*) is an insect pest of lettuce in Florida and needs pesticide application for control. The romaine lettuce (*Lactuca sativa*) cultivar 'Valmaine' is resistant to the banded cucumber beetle. A population developed from a cross between 'Valmaine' (resistant) and 'Okeechobee' (susceptible) was used for determination of the inheritance for the resistance. The segregation ratio was found to be 3 (resistance) : 1 (susceptibility) in the F_2 and 1(homozygous resistance) : 2 (heterozygosity) : 1 (homozygous susceptibility) among the F_3 families. It appears that the resistance is controlled by a dominant gene in 'Valmaine'. The bulked segregant analysis (BSA) is being conducted to map the resistant gene with amplified fragment length polymorphism (AFLP) markers, target region amplification polymorphism (TRAP) markers, and single nucleotide polymorphism (SNP) markers. Markers closely linked to the resistant gene will be useful for marker-assisted breeding for development of new lettuce cultivars with improved yield and horticultural traits and resistance to the banded cucumber beetle resistance.

Growth Chambers and Controlled Environments 3

(200) Plant Responses and Water Uptake of Lettuce Grown Under Different Spectra of Supplemental Lighting

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Successful plant production depends on providing adequate environmental conditions for plant growth. In low-light environments, growth and development of GH-grown vegetables is enhanced by use of supplemental lighting (SL), which helps to increase the total daily light integral (DLI) that plants receive. Studies have examined growth and morphological responses of different vegetables using light-emitting diodes (LEDs) as SL sources. However, the effect of LED SL on water uptake has not been determined. Since physiological changes in response to differences in light spectra have been reported, light spectra from SL may play a key role regulating water relations in plants by inducing changes in stomatal conductance and transpiration. The objective of this study is to quantify growth, leaf gas-exchange responses, and water requirements of lettuce (*Lactuca sativa* L. 'Cherokee') plants grown under one of six SL treatments. A variant solar DLI will occur naturally for all treatments, and a constant DLI of 2.6 $mol \cdot m^{-2} \cdot d^{-1}$ will be provided to all plants receiving SL. Plants will be grown in a glass-glazed GH for five weeks and water applications will be monitored based on the available water in each container. Results from this experiment reflecting growth, water requirement and gas exchange will be presented.

(201) Air Temperature Affects the Growth and Development of Basil (*Ocimum*) Species

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Basil (*Ocimum* L. spp.) is the most popular fresh culinary herb. An increased demand for locally grown food is causing

greenhouse producers to expand production of hydroponically grown culinary herbs. However, the effect of air temperature on growth and development of basil is not well understood. Our objective was to quantify the effect of temperature on growth and development of basil species. Seeds of four cultivars [sweet basil (*Ocimum basilicum* L. 'Nufar'), holy basil (*O. tenuiflorum* L. 'Holy'), lemon basil (*O. citriodorum* Vis. 'Lime'), and lemon basil (*O. basilicum* L. 'Sweet Dani')] were sown in 288-cell plug trays filled with a soilless peat-based germination substrate, placed in an environmental growth chamber with a target air temperature of 24 °C, and grown for three weeks. Seedlings were then transplanted into 10-cm containers filled with a commercial soilless substrate comprised of sphagnum peat moss and perlite. Ten plants of each species were placed in five different growth chambers with target air temperatures of 11 °C, 17 °C, 23 °C, 29 °C, or 35 °C. Plants were fertilized once a week with 200 ppm N from a complete, balanced, water-soluble fertilizer. Three weeks after placing plants into temperature treatments, chlorophyll fluorescence, plant height, node and branch number, and flowering data were recorded. Plants were harvested and shoot fresh mass was recorded. Shoots were then placed in a forced air drier maintained at 67 °C for 3 d then weighed and dry mass was recorded. The leaf unfolding rate was influenced by temperature and varied among species. For example, the node appearance rate of sweet basil increased from 0.03 to 0.30 nodes per day as the temperature increased from 11 °C to 29 °C and then decreased to 0.28 nodes per day as the temperature further increased to 35 °C. Similarly, fresh mass was influenced by air temperature and species. As temperature increased to 29 °C fresh mass increased; as temperature increased from 29 °C to 35 °C fresh mass decreased for all species. Using the data from our experiments, we were able to calculate the base and optimal temperatures for all four basil species in this experiment. Furthermore, we were able to use data from plants grown within the linear range of air temperatures to develop models that may be used to predict growth and development of basil grown at different air temperatures.

(202) Mapping Monthly Distribution of Daily Light Integrals Across China

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Daily light integral (DLI, $mol \cdot m^{-2} \cdot d^{-1}$) is the total amount of photosynthetically active radiation received over a 24-hour period. It is a useful light measurement related to plant growth. To provide an estimate of the light quantities delivered to different locations across the country throughout the year, contour maps were developed using solar global-horizontal radiation data recorded from 1973 to 2002 at 45 meteorological observation stations in China. The maps demonstrated the mean daily light integral for each month of the year across the contiguous China. Northern China received the lowest DLI of 5–10 $mol \cdot m^{-2} \cdot d^{-1}$ in December, while northwestern China had the highest DLI of 45–50 $mol \cdot m^{-2} \cdot d^{-1}$ in May, June, and July. From October through March, DLI primarily differed between northern and southern China, while from May to August DLI varied between eastern and western China. The DLI changed quickly during the months before and after the vernal and autumnal equinoxes. These contour maps can be used to estimate the necessity and/or amount of supplemental lighting inside greenhouses in various geographical locations.

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(203) High Tunnel Microclimate in Early Spring and Late Fall

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High tunnels are unheated structures that modify the microclimate to achieve extended season production of specialty crops. Microclimate modifications by high tunnels have been reported but conditions have not been characterized for much of the southeast. The objective of this study was to characterize the high tunnel microclimate during fall and winter seasons in the Piedmont of North Carolina (zone 7). In October 2014, microclimate measurements of air and soil temperature, relative humidity, solar radiation (SR), and photosynthetically active radiation (PAR) were started in a 30' x 96' high tunnel located in Greensboro, North Carolina, using Spectrum WatchDog data loggers. In the high tunnel, one season of salad greens were planted and harvested, followed by winter cover crops. Row covers were laid over the vegetables and the Watchdog when outside temperatures were expected to be below 10 °C. Air temperature measurements indicated that the high tunnel would offer at least one hardiness zone of protection. The lowest air temperatures in November were at –9.7 °C/0 °C (outside/inside

high tunnel), while in February the numbers were –20.7 °C/–10.6 °C, respectively. Soil temperatures kept relatively high in the high tunnel. The lowest soil temperatures outside/inside high tunnel were 5.9 °C/9.2 °C in November, and –15.1 °C/2.2 °C in February. Growing Degree Days (GDDs) at the 4.4 °C and 10 °C base were greater inside the high tunnel. The total GDDs for the month of November were 293.6 and 184.0 inside, and 153.2 and 73.0 outside the high tunnel, respectively. PAR and SR levels were lower inside the high tunnel. A cloudy day (9 February) had an average hourly reading of PAR at 131.2 $\mu mol \cdot m^{-2} \cdot s^{-1}$ and SR at 64.1 watt/m inside the high tunnel; while the readings were 194.4 $\mu mol \cdot m^{-2} \cdot s^{-1}$ for PAR and 90.4 watt/m^2 for SR outside the high tunnel. This reflects a reduction of 33% in PAR and 30% in SR. On a sunny day (11 February), the average PAR and SR were 611.6 $\mu mol \cdot m^{-2} \cdot s^{-1}$ and 332.4 watt/m inside the high tunnel, and 866.6 $\mu mol \cdot m^{-2} \cdot s^{-1}$ and 410.5 watt/m outside the tunnel, which were 30% and 20% reduction, respectively. The preliminary result suggests that, using a high tunnel in zone 7, cool season vegetables can be grown from late fall to early spring, and warm season vegetables can only be grown in late fall and early spring. This research will continue for another year to confirm the preliminary results.

Specified Source(s) of Funding: Specialty Crop Block Grant

(204) Influence on Uniform Primordia Formation of *Pleurotus ostreatus* by Postincubation Period and Temperature

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In this experiment, we aim to investigate the effects of three postincubation period conditions during incubation on uniform primordia formation and cultural characteristics of oyster mushroom (*Pleurotus ostreatus*). Three postincubation periods (35, 40, and 45 days) and control were treated for 30 days. Two incubation room temperatures (23 °C and 26 °C) and control were treated 20 °C. The substrate temperature of Suhan No. 1 and Gonji No. 7, oyster mushroom varieties, were tend to increase 24 °C to 27 °C at 11–14 days after inoculation and then maintained in treatment temperature during postincubation period. The longer postincubation days and the higher postincubation room temperature room were lower side primordia formation of two cultivars. However, the higher postincubation temperature of room resulted in the higher percentage of primordia formation of two cultivars. In addition, the yields were the highest and non-product ratio of fruit body in 35–40 day, 23 °C of postincubation conditions were the lower than other treatments.

(205) Growing High-value Ornamental Seedlings under White Light-emitting Diodes

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An increasing amount of research has been conducted with monochromatic red (R) and blue (B) light-emitting diodes (LEDs) to obtain desirable plant growth responses. However, plants appear purplish under such dichromatic light, which makes detection of nutritional deficiencies and physiological disorders difficult. We grew seedlings of begonia (*Begonia* ×*semperflorens*), geranium (*Pelargonium* ×*horturum*), petunia (*Petunia* ×*hybrida*), and snapdragon (*Antirrhinum majus*) at 20 °C under six sole-source LED lighting treatments, many with white (W) LEDs, with an 18-h photoperiod. The following treatments delivered a PPF of 160 $\mu mol \cdot m^{-2} \cdot s^{-1}$ using B (peak = 451 nm), green (G, peak = 521 nm), R (peak = 660 nm), and/or W (peak = 552) LEDs: W_{100} (100% light from W LEDs), $W_{75}+R_{25}$, $W_{45}+R_{55}$, $W_{25}+R_{75}$, $R_{40}+G_{40}+B_{20}$, and $R_{85}+B_{15}$ (which delivered 15%, 11%, 7%, 4%, 19%, and 15% B light, respectively). Compared with the $R_{85}+B_{15}$ treatment, preliminary results indicate that plants grown under W LED treatments were of similar or slightly taller height and had similar or slightly greater leaf area. Increases in plant height and leaf area under W light LED treatments could be attributed to a decreasing percentage of B light in the W LED treatments. The calculated yield photon flux of the W LED treatments ranged from the same to 11% less than that of $R_{85}+B_{15}$, but shoot dry weight was similar among treatments. We conclude that W LEDs that emit ≥ 15% B light can produce seedlings similar to those under dichromatic R+B light while enabling people to more easily evaluate plant growth.

Specified Source(s) of Funding: Michigan State University's Project GREEEN, Osram Opto Semiconductors, and companies supportive of MSU Floriculture research.

Friday, 7 August 2015

Produce Quality, Safety, and Health Properties 2

(091) Screening Glucosinolates, Their Hydrolysis Products, and Quinone Reductase Anticancer Activity of the USDA Arugula Germplasm Collection

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Rocket or arugula (*Eruca sativa* Mill.) is common leafy vegetable consumed since ancient times in the Mediterranean region as a vegetable and for its medicinal properties. Arugula contains the phytochemical glucosinolates glucoerucin and glucoraphanin that are precursors of erucin and sulforaphane, isothiocyanates that provide mammalian anticancer bioactivity. Leaf tissue of 41 arugula USDA germplasm accessions were harvested from the greenhouse and assayed for glucosinolate and hydrolysis products concentrations by high performance liquid chromatography and gas chromatography, respectively. Glucoraphanin, glucoerucin, and dimeric glucosativin were the major glucosinolates with concentrations ranging from 0.51–8.66, 0.58–7.32, and 3.16–17.45 μmol/g dry weight, respectively. Concentrations of hydrolysis products of glucoraphanin (sulforaphane) and glucoerucin (erucin) ranged from 0.18–6.45 and 0.28–4.30 μmol/g dry weight, respectively. There were significant positive correlations between glucoraphanin and sulforaphane ($r^2 = 0.82$) as well as between glucoerucin and erucin ($r^2 = 0.79$). Nitrile forms of hydrolysis products were not detected by GC-MS and GC-FID, suggesting that there was no epithiospecifier protein activity in arugula. Quinone reductase (QR) activity as an anticancer biomarker was measured on leaf samples of 41 arugula germplasm accessions. There was more than 2.3-fold QR inducing activity difference between lowest and highest accessions. This information will be useful for the identification and development of arugula cultivars with improved health promoting properties.

(092) Photoperiod and Irradiance Affect Red Russian Kale Leaf Nutrient Content

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Red Russian Kale plants (*Brassica napus* var. *pabularia*) were grown under short days (8 hour; daylight from 0800–1600 HR) or long days (18 hour; daylight plus supplemental lighting from 0600–2200 HR) in a greenhouse with a 24 °C/13 °C (day/night) temperature regime in St. Paul, MN. Under each photoperiod, plants were grown under either of four irradiance levels. Irradiance levels were ambient daylight, +25, +50 or +100 μmol·m^{-2}·s^{-1} supplemental high-pressure sodium lighting, resulting in eight photoperiod/irradiance lighting regimes from December to February. Plants were fertilized with 15–5–15 Cal-Mag fertilizer (200 ppm N) in the irrigation water as needed. Samples (fifth leaf from bottom of stem) were collected from five plants (one sample per plant) from each photoperiod/irradiance lighting regime. Total leaf number was also counted, leaf fresh and dry weights were determined, and leaf nutrient content (P, K, Ca, Mg, Fe, Mn, Zn, Cu, and B) was determined using an inductively-coupled plasma spectrophotometer. Total dietary fiber and vitamin C levels were measured from tissue frozen at –80 °C. Leaf total dietary fiber was highest (4.29 g/100 g tissue) and lowest (3.32 g/100 g tissue) on plants grown under the 8-h photoperiod with 100 μmol·m^{-2}·s^{-1} supplemental irradiance, and 8-h photoperiod under ambient light, respectively. Vitamin C content was highest (40.8 mg/100 g) in plants grown under an 8-h photoperiod plus 100 μmol·m^{-2}·s^{-1} supplemental irradiance. Results indicate vitamin C and total dietary fiber content of Red Russian Kale can be optimized for plants grown at 24 °C/13 °C (day/night) temperature under an 8-h photoperiod plus 100 μmol·m^{-2}·s^{-1} supplemental high pressure sodium lighting. Photoperiod and irradiance effects on leaf mineral content will also be discussed.

Specified Source(s) of Funding: Minnesota Agriculture Experiment Station, USDA–ARS, and MN-DRIVE

(093) Elevated Levels of Potassium in Greenhouse Red Romaine Lettuce Impacts Mineral Nutrient Content and Nutritional Quality

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Potassium (K) is an essential plant mineral nutrient that can have significant influence on increasing many phytonutrients compounds in fruits and vegetables. However, K is not a constituent of organic or structural compounds in the plant. The involvement of K in many physiological and biochemical processes leads to plant growth, yield, and quality attributes. Among the plant mineral nutrients, potassium (K) has been shown to have a strong impact on fruit quality attributes that determine marketability, consumer preference, and critically important human-health phytonutrients. In recent years, research has demonstrated that flavonoids and vitamin C intake has many benefits in human diets due to antioxidant activity. Consumer preference for more flavorful produce has also sparked interest to increase these quality characteristics. Although K has been examined for quality parameter in many fruits and vegetables, research in lettuce (*Lactuca sativa*) production is lacking. Thus, the purpose of this study was to determine the impact of K on yield, biomass, mineral elements, soluble sugars, and phytonutrients in red romaine lettuce. Seeds of 'Cimmarone' romaine lettuce were grown in 1.8-L containers in the greenhouse at 21 °C/17 °C (day/night) under a 10-h photoperiod. Lettuce plants were arranged in a randomized complete-block design with four replications. Plants were treated with provided K as K_2O at the rates of 3.36, 6.72, 13.44, and 26.88 g per 1.8-L container. The

K treatments were applied at three different times throughout the study. Plants were harvested at 55 days after seeding and weighed for fresh mass and subsamples taken for analytical analysis. In red romaine lettuce, there were differences in mineral nutrients. Concentrations of soluble sugars, vitamin C, and flavonoids will also be discussed. These results demonstrate that elevated levels of K can have a significant impact on nutritional quality in greenhouse grown red romaine lettuce.

Specified Source(s) of Funding: Mississippi Agriculture and Forestry Experiment Station

(094) Postharvest Evaluation of Essential Oil on Lettuce and Other Leafy Greens

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As alternatives to chlorinated water, some plant-derived essential oils (EOs) have been evaluated at the microbial level as potential washing sanitizers on fresh produce. Although lettuce is frequently studied for the efficacy of EOs as antimicrobials, effects on postharvest quality are rarely reported. In this experiment, the effects of EOs on quality of lettuce and other leafy greens were evaluated. Treatments included semi-water soluble whey protein emulsified thyme, cinnamon, and clove bud oils at 0.05%, 0.1%, and 0.5% with whey protein emulsion without oil and water with 200 ppm free chlorine as controls. Locally purchased romaine lettuce leaves were dipped for one minute in solutions, then stored at 4 °C, (95% to 100% relative humidity). Two leaf systems (whole leaf vs. fresh cut leaf) were investigated; small sections of leaf (2.5 by 5.5 cm in size) were found to effectively emulate EO events. A 0–5 rating scale was developed to follow severity of leaf damage, and ratings were done at 48 hours after treatment when symptoms were worst. Significantly higher damage was found on leaves treated with any of the three EOs at 0.5%, compared to those with EOs applied at lower rates or with controls. Damage at the 0.5% rate was generally classified as necrosis and browning, with thyme oil resulting in the highest damage rating among the three EOs. At lower rates (0.1% and 0.05%), thyme oil caused minor damage described as glassy spots, while cinnamon and clove bud oil caused no damage. Electrolyte leakage from leaves was significantly higher (> 50%) for all three EOs at the 0.5% rate, indicating leaf membrane was damaged and a higher percentage of electrolyte was leaked out of the cells. Electrolyte leakage was lower (< 20%) from leaves treated with 0.05% and 0.1% oils and was not statistically different from the controls. In addition to this experiment, other leafy greens (cabbage, kale, and baby spinach) also showed damage when treated with 0.5% of all three EOs. Using a vapor system (7 uL/L) in place of dipping, romaine lettuce showed damage after seven days; thyme oil vapor caused severe pink spots on both ribs and photosynthetic tissue, while clove bud and cinnamon oils caused moderate browning on only photosynthetic tissue. Our results indicate that leafy green quality is highly dependent on the type and amount of EOs used and application systems that will deliver efficacious antimicrobial activity without postharvest damage need to be developed.

Specified Source(s) of Funding: OREI

(095) Fertility Treatment Affects Vitamin C, Fiber, and Total Nutrient Content in Mizuna and Red Giant Mustard

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'Red Giant Mustard' (*Brassica juncea*) and 'Mizuna' (*Brassica rapa* var. *nipposinica*) plants were grown at the University of Minnesota St. Paul Campus (St. Paul, MN) in a greenhouse from December to February under an 18-h photoperiod (natural daylight plus 50 $\mu mol \cdot m^{-2} \cdot s^{-1}$ high pressure sodium lighting from 0800 to 0200 HR) and a 24 °C/13 °C day/night temperature. Plants were grown using five different fertility treatments, including four organic treatments and one conventional control (Cal Mag 15–5–15 in SunGro LC8© media), to determine their effects on 'Red Giant Mustard' and 'Mizuna' growth and nutrient content. Biomass yield, vitamin C and total dietary fiber varied with fertility treatment. Total dietary fiber and vitamin C levels were measured from tissue frozen at –80 °C. Foliar nutrients (P, K, Ca, Mg, Fe, Mn, B, Cu) were determined using an inductively-coupled plasma spectrophotometer. The experiment was replicated four times in time and the experiment was duplicated. The poultry litter treatment with Sunshine Natural and Organic Planting Mix© had the highest vitamin C content in both crops (16.0 mg/100 g in Mizuna and 20.8 mg/100 g in 'Red Giant Mustard'). Both crops had similar vitamin C responses to the five fertility treatments, but were not associated with biomass yield, and there were no positive correlations between increases or decreases in biomass yield in relation to vitamin C content. Total dietary fiber ranged from 2–4 g/100 g per sample, indicating both crops can contribute a significant fiber to the diet, compared with other leafy vegetables, such as 'Romaine' or 'Iceberg' lettuce. Results indicated that fertility plays a role in vitamin C synthesis and/or accumulation, both crops can contribute a moderate amount of dietary fiber to the diet, and biomass yield may not be associated with changes in

vitamin C content. Fertility effects on leaf mineral content will also be discussed.

Specified Source(s) of Funding: Minnesota Agriculture Experiment Station, USDA–ARS FNRI, MN-DRIVE

(096) Variations in Glucosinolate Contents and Quinone Reductase-inducing Activities among Florets, Leaves, and Roots of Broccoli Plants

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Glucosinolates are a group of sulfur-containing phytonutrient found in Brassica vegetables known to reduce cancer risk by upregulating Phase II enzymes such as quinone reductase (QR). To investigate organ-dependent variations, five broccoli varieties were cultivated and their florets, leaves, and roots were separately harvested and the glucosinolate contents as well as QR-inducing activities were evaluated. In all, five tested varieties broccoli roots showed higher total glucosinolate contents (37.8 μmol·g^{-1}) compared to florets (10.4 μmol·g^{-1}) and leaves (5.4 μmol·g^{-1}). Each organ exhibited a different composition of glucosinolates in that the major form of glucosinolate was glucoraphanin (31.2%), glucobrassicin (44.3%), and gluconasturtiin (41.9%) in florets, leaves, and roots, respectively. Different broccoli organs showed different QR-inducing effects. Roots exhibited 2.5-fold higher QR-inducing activity compared to control, which was similar to florets (2.5-fold) but significantly higher than leaves (1.7-fold). Variety-dependent difference in QR-inducing effects, however, were not observed. Eleven kinds of quantified glucosinolates glucoraphanin ($r = 0.67^{**}$) and total glucosinolate ($r = 0.51^{**}$) contents showed higher positive correlationship with QR-inducing activity. These results suggest that different broccoli organs (such as florets, leaves, and roots) may have different profiles of glucosinolates, which may in turn result in different anticancer capability.

Specified Source(s) of Funding: Soonchunhyang University Research Fund

(097) Fructans from Non-differentiated Garlic (*Allium sativum*): Extraction, Characterization, and Possible Applications

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Garlic (*Allium sativum*) is one of the 20 principal vegetables cultivated around the world due to its culinary attributes and medical properties, some of which are because of its high fructan content. During plant development, temperature and photoperiod can affect bulb quality. One of the main defects presented in the field is the no or low formation of cloves, producing bulbs with a soft consistency and appearance that cannot serve as a "seed" for the next crop generation. These plants have no commercial value and this defect can reduce yeilds by 50%. This problem could be related to fructans biosynthesis, which are fructose polymers linked by b bonds that present different polymerization degrees depending on the physiological stage of the plant. Fructans have an important agro-industrial quality for their different functional and nutritional properties. The aim of this work was to extract and characterize fructans from non-differentiated garlic (NDG) that could be an important source of this type of oligosaccharides. Fructans from NDG harvest 2013–14 were extracted and compared with fructans from differentiat garlic (DG), white onion (WO), and commercial inulin (CI). Samples were used to quantify reducing sugars (RS), fructan content, and polymerization degree (DP), along with the carbohydrate profile by thin-layer chromatography (TLC). Water absorption index (WAI) and oil absorption capacity (OAC) of fructans were also determined. WO had the highest content (4.82%) of RS, and CI had the lowest content (1.41%). Fructan content was similar between DG (96.65%) and CI (97.18%); WO had 22.32%, NDGNDG had 82.33% of fructan content. DP varied considerably from 2 for WO to 23 for CI; DP for NDG was significantly lower (8) than NG (13). These differences were observed on TLC. Results shown that fructans from NDG can absorb more than 40% of weight in water; meanwhile, results from OAC show that DG and NDG have the same capacity (2.54 g/g and 2.50 g/g respectively). Results indicate that non-differentiated garlic has agro-industrial potential for its fructan content and DP could be used as fat replacement stabilizers or texturizing agents.

Friday, 7 August 2015

Propagation 2

(183) The Effects of Media, Hormones, and Stem Diameter on Adventitious Rooting of *Acacia confusa* Stem Cuttings

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The Formosa Acacia (*Acacia confusa*) is a woody perennial species native to Southeast Asia. This tree has historically been used for teas, condiments, lumber, and traditional medicines. Seed propagation is common with *A. confusa*, but there is a lack of information regarding its potential for asexual propagation. Our investigation focused on the influence of media, hormones, and stem diameter of stem cutting rooting success. The experiment was a two-way factorial (media hormones) arrangement on a complete randomized block design. Cuttings were all selected from the same three-year old mother plant and randomly placed in four media treatments; 1) Berger BP-P commercial mix, 2) 1:1 ratio of coir and peat, 3) perlite, and 4) 1:1 ratio of peat and perlite. In each media treatment, half of the cuttings were subjected to a 0.3% IBA (Indole-3-butyric Acid) treatment. All treatment combinations were placed on an automated misting bench with bottom heat in the greenhouse for eight weeks. Upon data collection, cutting diameters were all measured directly above the second node. Each individual was assessed for the presence of rooting and the number of roots. The use of IBA significantly increased the presence of rooting and the number of roots per cutting in all media treatments. Media treatments containing perlite produced fewer rooting individuals and reduced number of roots per cutting. These data provide preliminary observations toward developing efficient asexual propagation protocol for *A. confusa*.

(184) In Vitro Seed Germination of *Hydrangea paniculata* Sieb

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Hydrangea paniculata Sieb. is a popular ornamental plant in the United States for its long-lasting flowers and cold hardiness. To introduce these treats to other *Hydrangea* species, cross-pollination had been carried out with very limited number of seeds. Conventional seed germination by many researches yielded no survival seedlings so far and in vitro seed germination had been investigated in this study. Seeds of *H. paniculata* were sterilized under 16 combinations of 75% alcohol and 8% NaClO. The perfect germination rate was achieved under treatment of 75% alcohol for 30 seconds and 8% NaClO for one minute. All other treatments had 30% to 100% contamination. *H. paniculata* seeds could be germinated under B-5, MS (full or half strength), and WPM media with 75% or higher germination rates. B-5 media were recommended because it had the biggest root mass (total root lengths of 10 cm). Darkness was not needed for *Hydrangea* seed germination and light conditions promoted uniform seedlings and shortened overall germination time. The optimized protocol for in vitro seed germination of *H. paniculata* was established and we should apply it for the in vitro germination for *Hydrangea* interspecific hybridization seeds.

(185) Rooting of *Kalmia latifolia* Stem Cuttings with Three Dosages of Hormones

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Kalmia latifolia L. (*Ericaceae*) is a native evergreen shrub or small tree with attractive flowers and the difficulty in cutting propagation limited its popularity in landscape. Three dosages of hormones were applied to stem cuttings of *Kalmia latifolia* 'Elf' and 'Starburst' from November 2013 to June 2014. Cuttings were sprayed with 25 $mg \cdot L^{-1}$ K-IBA one month before taking cuttings (pretreatment), then prepared with liquid K-IBA and powdery Hormodin at 1000, 3000, and 8000 $mg \cdot L^{-1}$, and finished with 1000, 3000, and 8000 $mg \cdot L^{-1}$ K-IBA after four months for cuttings with calla. For both cultivars, pretreatment did not improve the rooting of stem cuttings. It is possible that plants did not have too much activity during winter months to absorb the hormone. Timing of pretreatment should be further investigated. Rooting occurred on stem cuttings of 'Elf' and 'Starburst' under 8000 $mg \cdot L^{-1}$ K-IBA treatment with lower rooting percentage of 12.5% and 6.3% respectively, which indicated that rooting of *Kalmia* was very difficult and required higher hormone concentrations. Majority of stem cuttings did have calla and sequentially treated with third hormone treatments. 'Elf' and 'Starburst' cuttings treated with 1000 $mg \cdot L^{-1}$ K-IBA produced the rooting percentage of 75% and 100%, respectively. Further studies should address the better timing and methods for rooting hormone application of *Kalmia latifolia* stem cuttings.

(186) Tissue Culture Program on Guam Focuses Its Attention on Orchid Propagation and Establishment of Local Workforce

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The small-scale commercial production of orchids on Guam has always been linked to the limited availability of clean, disease-free planting material. There are no tissue culture commercial laboratories on Guam and nearly all potted orchids are imported from Thailand, Taiwan, the Philippines, Hawaii

and California. In 2013 Guam's Department of Agriculture in collaboration with the University of Guam initiated a large-scale tissue culture propagation program focusing on two most popular orchid genus: Dendrobium and Phalaenopsis. Once the program was initiated and the facility had an abundance of orchid plantlets, an outreach program was initiated targeting local nurseries and schools. Workshops and classroom presentations as well as field demonstrations for diverse audiences resulted in an enthusiastic response from businesses and the general public. A desire to develop commercial and sustainable tissue culture orchid production became evident. This ambitious goal could be achieved providing the existence of an educated and trained local workforce. Since neither the University of Guam nor the local Community College offer relevant classes, the Tissue Culture Lab focused its attention on offering hands-on experience for high school students and Community College students interested in biological subjects. During the summer internship students were monetarily compensated for 30 hours per week. Responsibilities were rotated to ensure a well-rounded training and students were fully accountable for their performance. Some students (apprentices) have already expressed the desire to find employment in the commercial workforce once private laboratories are created. Details related to program establishment, management and challenges will be presented and discussed.

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(187) Response of Rudimentary Zygotic Embryos of *Ilex crenata* Thunb. to Plant Growth Regulators

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Seed germination of *Ilex crenata* Thunb. usually takes 2–3 years, which significantly limits the breeding and selection of new cultivars. Rudimentary zygotic embryos of *Ilex crenata* Thunb. 'Sky Pencil' seedlings were removed from dark purple mature fruits and cultured aseptically on quarter-strength Murashige and Skoog medium containing 3% sucrose, 0.65% agar, and supplemented with or without auxins [2,4-Dichlorophenoxyacetic acid (2,4-D), 1-Naphthaleneacetic acid (NAA), and Indole-3-butyric acid (IBA)] or cytokinins [benzyladenine (6-BA), kinetin (KT), zeatin (ZT), thidiazuron (TDZ), and isopentenyladenine (2-ip)]. All cultured embryos were incubated in darkness at 27 °C ± 2 °C and data were taken after six weeks. Auxins could induce zygotic embryo to seedlings (both shoots and roots), shoots, or calli. The maximum percentage (100%) of embryos germination was achieved when the media supplemented with 2,4-D at 0.1 $mg \cdot L^{-1}$. Media with higher concentrations of 2,4-D (0.5–2.0 $mg \cdot L^{-1}$) or NAA (1.0–2.0 $mg \cdot L^{-1}$) induced significantly more calli than that of other treatments. When 2,4-D concentration was at 0.5 $mg \cdot L^{-1}$, the highest shoots induction percentage (70.4%) was yielded. Cytokinins could not induce embryo to calli alone. Lower concentrations of ZT (0.1–1.0 $mg \cdot L^{-1}$), TDZ (0.1–1.0 $mg \cdot L^{-1}$), or 2-ip (0.1–0.5 $mg \cdot L^{-1}$) promoted embryo germination. However, media containing 0.5–2.0 $mg \cdot L^{-1}$ 6-BA, 0.5–2.0 $mg \cdot L^{-1}$ KT, or 2.0 $mg \cdot L^{-1}$ 2-ip were totally ineffective in inducing embryo growth. The highest shoots induction percentage was produced under treatment of ZT at 2.0 $mg \cdot L^{-1}$. Comparing traditional seed germination, zygotic embryos could be germinated for weeks. We recommend 1/4 MS media with 2,4-D at 0.1 $mg \cdot L^{-1}$ for embryo germination and 2,4-D at 0.5–2.0 $mg \cdot L^{-1}$ for callus induction.

(188) Effect of Cutting Time and Scion Type on Rooting of *Acanthus ilicifolius*, *Codariocalyx motorius*, and *Citrus medica* var. *sarcodactylis*

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This study was conducted to identify appropriate cutting time and cion type on cutting of Acanthus ilicifolius, Codariocalyx motorius, and Citrus medica var. sarcodactylis. Scions were prepared to approximately 5 cm length of greenwood, semi-hardwood, and hardwood and immediately planted in 100 x 100 x 65 mm rockwool cube 26 May and 26 August, respectively. They were cultivated with natural temperature in a greenhouse and irrigated once a day. Eight weeks after planting, rooting percentage and growth of root and shoot were measured. Rooting percentage was highest in greenwood cuttings. A. ilicifolius and C. medica var. sarcodactylis showed the highest rooting percentage (84.7%, 91.7%) in greenwood cuttings at 26 May. In contrast, rooting percentage of C. motorius in greenwood cutting on 26 August was the highest with number of 83.3% among all treatments. And those of C. motorius in each treatment were relatively lower than other plants. A. ilicifolius in semi-hardwood cutting on 26 May, C. motorius on greenwood cutting on 26 May, and C. medica var. sarcodactylis in greenwood cutting on 26 May showed the highest growth response such as length and fresh weight of root and shoot. Regardless of plants, growth of root and shoot tended to be higher in semi-hardwood or greenwood cutting on 26 May among all treatments. Based on this study, greenwood cutting is the most effective method for cutting of those plants. However appropriate cutting time is May for A. ilicifolius and C. medica var. sarcodactyli and August for C. motorius.

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Temperate Tree Nut Crops

(288) Antioxidant Capacity and Zinc Content of 'Wichita' Pecan Kernels Is Increased by Soil Zinc Fertilizer Application

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Pecans possess higher kernel antioxidant activity than any other tree nut. Antioxidants in the diet function to counteract damaging effects of free radicals and may play an important role in prevention of numerous chronic and age-related diseases. Pecan trees in the western United States, where soils are typically alkaline and calcareous, require frequent zinc (Zn) fertilizer applications to maintain normal canopy growth and development as well as nut production. Our objective was to investigate the relationships between the antioxidant content in pecan kernels with tree zinc nutrition. The study was conducted in 2014 in a commercial pecan orchard in San Simon, AZ. Trees were fertilized with Zn (as Zn EDTA injected through a microsprinkler irrigation system) at one of three seasonal rates: 4, 2, or 0 kg·ha^{-1} Zn. Leaf tissue zinc concentrations for the treatments were 32, 24, and 14 mg·kg^{-1}, respectively. Treatment plots each consisted of 12 'Wichita' pecan trees arranged in a randomized complete-block design with four blocks. Nuts were harvested at maturity from all trees within each plot and subsamples were collected for analyses of kernel Zn, oil yield, and antioxidant capacity. Lipids were quantified on a mass percent basis from hexane extractions of homogenized kernels. Antioxidant capacities (AC) were evaluated by 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical microplate assay. Extracts were obtained from the defatted kernel meal. AC was expressed as Trolox Equivalents·g^{-1} of pecan kernel sample (TE·g^{-1}). Kernel Zn concentrations were 43, 38, and 14 mg·kg^{-1} for the 4, 2, and 0 kg·ha^{-1} Zn rates, respectively. Kernel oil content ranged from 68% to 73%, but was not impacted by Zn fertilizer application. Defatted kernels of the two Zn treatments had significantly higher AC values than the control (0 kg·ha^{-1} Zn); average AC was 0.135, 0.132, and 0.116 TE·g^{-1} for 4, 2, and 0 kg·ha^{-1} Zn rates, respectively. In conclusion, soil application of Zn fertilizer improved human health-promoting aspects of pecan kernels, which may be valuable for product promotion amongst health-conscious consumers.

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(289) Mechanical Pruning Direction and Frequency Impacts on Light Interception in Southwestern Pecan Orchards

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Pecan (*Carya illinoinensis*) tree performance is highly sensitive to sunlight availability. As orchards mature, tree canopies become tall and grow together, so that large portions of canopies receive inadequate sunlight for pistillate flower production, kernel development, and shoot survival. Under these conditions, alternate bearing intensifies and both average yields and nut quality drop dramatically. Over the past two decades in the southwestern United States, mechanical pruning has been widely accepted as a method for sunlight management in mature pecan orchards. Mechanical pruning, however, also reduces canopy interception of photosynthetically active radiation (PAR), which might counteract the benefits of improved canopy light distribution by reducing total canopy carbon fixation. The objectives of our studies were to characterize effects of mechanical pruning direction and frequency on PAR interception in mature pecan orchard canopies. An all-terrain-vehicle was instrumented with a 7.6-m wide array of 18 light bars (each composed of 80 PAR sensors) and a global positioning satellite (GPS) unit. As the vehicle moved through the orchard research plots PAR and GPS locations in the orchard were logged at a rate of 2 Hz, which translated to simultaneous data recording from all 18 light bars every 0.75 m along the vehicle transect. Experiment 1 was conducted in a mature 'Wichita' pecan orchard in Sahuarita, AZ, where tree rows were mechanically pruned in either only the east-west (E-W) direction or only in the north-south (N-S) direction. Experiment 2 was conducted in a mature 'Western' pecan orchard in Las Cruces, NM, where trees have been mechanically pruned at three frequencies: every year (Trt 1), every other year (Trt 2), or every third year (Trt 3). Experiment 2 also included a control that was mechanically pruned last in Winter 2005–06. Historical yield data collected in a 6-year period in Experiment 1 show 9.5% higher productivity in the 'Wichita' blocks with N-S tree-row orientation, while PAR measurements in the summer of 2014 showed that N-S orientated rows had a 4.31% increase in overall light interception compared with E-W oriented rows. In Experiment 2 'Western' pecan 9-year cumulative yield decreased with increasing pruning frequency. Canopy PAR interception in 2014 for the Control was 63.4% of full sun, while the canopies in Trt 1, Trt 2, and Trt 3 had 48.5%, 41.3%, and 44.9% PAR interception, respectively. These results help clarify how pecan growers in the Southwest may

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use mechanical pruning to optimize both canopy PAR interception and distribution.

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(290) 'Gasaway' Source of Resistance to Eastern Filbert Blight Provides a Predictable Level of Tolerance but Not Complete Resistance in New Jersey

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The disease eastern filbert blight (EFB), caused by the fungus *Anisogramma anomala*, limits hazelnut (*Corylus avellana*) production in North America. Further, its management causes significant expense in Oregon, where 99% of the U.S. crop is grown. The development and use of resistant cultivars is considered to be the most effective management strategy. In the 1970s, 'Gasaway', a late-flowering pollinizer, was found to be resistant to EFB in the Pacific northwestern United States. It was later shown to carry a dominant allele at a single locus in a heterozygous state that conferred resistance to its offspring in a predictable Mendelian pattern. 'Gasaway' was subsequently used in breeding at Oregon State University. A number of improved, EFB-resistant cultivars have since been released, several which are now being widely planted in Oregon. To examine the usefulness of the 'Gasaway' source of resistance in New Jersey where climatic conditions and isolates of the pathogen differ, clonal trees of 'Gasaway' and its offspring 'Delta', 'Epsilon', 'Gamma', 'Jefferson', 'Santiam', 'Theta', VR20-11, 'Yamhill', and 'Zimmerman' were evaluated, with some being observed for over a decade. Further, a total of 32 full-sibling progenies representing 1339 plants segregating for 'Gasaway' resistance were also evaluated. Here we present a comprehensive summary of our observations on the 'Gasaway' related plants. Our results strongly show that the single dominant allele continues to provide a useful and predictable level of high tolerance (not complete resistance) inherited in a simple Mendelian pattern. However, yet-to-be described modifying genes/factors support the final phenotype, which can range from completely resistant to only moderately tolerant. Until the modifying factors are elucidated, long-term field evaluation and selection remains necessary to identify recombinants that express the highest levels of resistance.

(291) Novel Sources of Resistance to Eastern Filbert Blight in Hazelnut

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Eastern filbert blight (EFB), caused by the pyrenomycete *Anisogramma anomala*, is a serious threat to the hazelnut industry in the Pacific Northwest. The fungus is endemic in the eastern United States where it occasionally produces small cankers on the wild American hazelnut (*C. americana*). In contrast, most cultivars of the commercially important European hazelnut (*C. avellana*) are susceptible. Recommended cultural practices including scouting, pruning out infected branches, and fungicide applications slow disease spread but are expensive. Genetic resistance is the most promising control method. Recent OSU releases carry a dominant allele for resistance from 'Gasaway'. However, 'Gasaway' and some of its offspring have been infected by isolates from New Jersey, Minnesota, and Michigan. There is an urgent need to find and study new sources of resistance. We investigated 12 new sources of EFB resistance: 'Grand Traverse', *C. heterophylla* 'Ogyoo', 'Yoder #5', *C. Americana* 'Rush', 'Uebov', and seven selections from a Forestry Institute in Moscow, Russia. Seedling populations segregating for resistance were inoculated by either exposure of potted trees under a structure topped with diseased branches or greenhouse inoculation. The DNA extracted from these seedlings was amplified with primers for microsatellite markers on linkage group 6 (LG6). Resistance from 'Grand Traverse' and *C. heterophylla* 'Ogyoo' was correlated with LG6 marker scores while resistance from 'Yoder #5' and 'Rush' was not. Disease scores of seedlings segregating for resistance from 'Uebov' were correlated ($r = 0.72$) with scores for the marker LG682-431, indicated that this resistance locus was also on linkage group 6. Seven Moscow selections that remained free of EFB following greenhouse inoculation were crossed with susceptible parents and ~60 seedlings of each progeny were inoculated in the greenhouse. Very few seedlings of Moscow selections N01, N01-06, and N01-07 remained free of disease and were likely escapes. In contrast, seedlings of Moscow selections N23, N26, N27 and Moscow N37 segregated in a 1:1 ratio, indicating control by a single locus and a dominant allele for resistance. Resistance from Moscow N26 appears to be on LG6, while resistance from N23, N27 and N37 was not correlated with an LG6 allele. Resistance from these new sources will be mapped, and linked markers developed and used in pyramiding different resistance genes for durable EFB resistance.

(292) Sexual Reproduction in the Chinese Chestnut (*Castanea mollissima* Blume)

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Chinese chestnut (*Castanea mollissima* Blume) has noteworthy ecological, economic, and cultural importance in the Northern Hemisphere, especially in China. However, it is particularly prone to erratic fruit set showing very low and has little work on the reproduction biology. In order to clarify the sexual reproduction in Chinese chestnut, a cultivar named 'Yanshanzaofeng' was employed for microscopy analysis. The results showed that the catkins with floral primordia were formed in the buds of one-year-old shoots in late April. The sex differentiation was completed in early May. Later, the anther wall layers completely developed by mid-May and consisted of epidermis, endothecium, middle layers, and glandular tapetum, and the anther wall was of the basic type. Microspore mother cells underwent meiosis through simultaneous cytokinesis in later May and gave rise to tetrads of microspores, which were tetrahedrally arranged. Mature pollens contained two cells with three germ pores. Anthers were dehiscent and pollen grains shed on approximately on 15 June. While the female flowers were formed in early May and could be divided into female flower cluster primordium differentiation phase, alabastrum primordium differentiation, stigma primordium differentiation, stigma elongation, ovary formation and blooming phase. The ovule primordium was formed in middle June. The ovary was eight or nine locules, and each locule contained two anatropous ovules that were bitegmic and crassinucellate. The embryo sac was mature between later June and early July, and the development of embryo sac conformed to the *Polygonum* type. When the anthers were dehiscent, the pollen tube passed through the basal style about two weeks. The pollen tube came into the embryo sac between later June and early July, and the syngamy was of premitotic type. The development of the endosperm was nuclear endosperm. The zygote developed from the proembryo to the clavate, globular, torpedo-shaped and cotyledon stage embryoid, and the development of embryo was of *Onagrad* type. The mature embryo formed in early August and the endosperm disappeared between later August and early September. A large number of abortive ovules were observed in the development of female gametophytes in middle July, which showed the cavity of embryo and degeneration of nucellus tissue. The abortive ovules were identified as one of the major factors causing the low seed set in 'Yanshanzaofeng'.

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(293) Study on Pollen Xenia Effect of Four Cultivars in *Castanea henryi*

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Castanea henryi is an important non-wood forest tree in south of China. In *C. henryi* the pollen xenia is of great importance for nut production. Pollen xenia phenomenon does not only affect the setting rate, but also influence the appearance and quality of nut. To elucidate this phenomenon, investigations on the pollen xenia effect in *C. henryi,* 'Chushuhong' (C), 'Tiezhen' (T), 'Youzhen' (Y), and Huangzhen' (H), four cultivars were used as materials. Twenty pollination combinations including self- and cross-pollination and natural pollination were undertaken in Chenzhou chestnut orchard. The results are showed that pollen xenia effect was significant difference among the fruit ripening, fruit setting, the size of the barbed shell and nut, soluble sugar, fat, protein and amylose and vitamin C, but there were no significant among the seed rate, total starch and moisture areas. The fruit quality of the 20 pollination combinations was evaluated by analyzing the main components of fruit, and their quality in a descending order as follows: C × Y> Cck> C × H> H × Y> C × C> C × T> Hck> H × H> T × T> T × C> H × C> Tck> Y × C> H × T> Y × T> Yck> Y × H> T × Y> T × H. Thus, the combination of C × Y was the best choice. This paper provides the theoretical basis for the rational allocation pollination cultivars in practice, and may improve nut yield and quality.

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Vegetable Crops Management 3

(402) Biodegradable Plastics as Alternative to Polyethylene Mulch for Watermelon Production Systems

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Polyethylene mulch is widely used for vegetable production in the United States as a tool to conserve water, control weeds and produce earlier and cleaner products. However, the increasing labor costs for mulch removal and disposal after harvest,

and air and soil environmental pollution are major concerns. The objectives of this study were to assess yield, fruit quality, mulch degradation, soil microbial activity and nutrient changes in watermelons grown with biodegradable plastic mulches. Watermelon (*Citrullus lanatus* L.) cv. Stargazer was grown at the Texas A&M AgriLife Research Center at Uvalde, TX, during Spring 2014 using three biodegradable experimental mulch formulations (4030, 4031, and 4032; EcoPoly Solutions Inc., Ontario, Canada) and two polyethylene (control and experimental 4035) plastic mulches. Yield, fruit sugar content (°Brix), and mulch degradation percentage were evaluated. At the end of experiment, soil nutrient and microbial activity of control and 4032 biodegradable plastic mulch were also determined. Our result showed that total yield and sugar content of watermelon grown with biodegradable and polyethylene mulches did not differ significantly. However, the degradation percentage of biodegradable mulches was 10% to 20%, 40% to 60%, and 90% to 100% at 4, 8, and 12 months after field transplanting, respectively. Additionally, the degradation speed of 4032 and 4030 mulch was about 20% faster than 4031. There were no statistical differences in soil total and active bacteria and total and active fungi, although nitrate content increased ($P = 0.08$) in soils with the 4032 biodegradable as compared to polyethylene mulch. Detailed chemical and biological soil analyses are required to evaluate the long-term impact of biodegradable mulches on soil nutrients and microbial activity. The future implementation of biodegradable mulches into commercial vegetable farming practices appears promising.

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(403) Effects of Organic Biofungicides versus Conventional Fungicides on Powdery Mildew in Pumpkins

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There are challenges growing pumpkins (*Cucurbita maxima*) in the southeast United States with weed, insect, and disease pressures. One of the major pests that infect pumpkins is powdery mildew (*Phyllactina spp.*), a fungal disease that can decrease photosynthesis and cause extensive early defoliation. Growers are advised to spray with fungicides every seven days to achieve acceptable yields. With the increased interest in growing naturally/organically this study was initiated to trial the organic fungicides Oso (Polyoxin D zinc salt), Double Nickel (*Bacillus amyloliquefaciens* strain D747), and Cueva (copper octanoate) as compared to the inorganic standard Bravo WS (chlorothalanil) and Quadris (aoxystrobin). Three pumpkin cultivars; 'Early Giant', 'Mustang', and 'Gold Medal' were direct seeded by hand 7 July at the North Mississippi Research & Extension Center in Verona, MS, during Summer 2014. The treatments were initiated one week after emergence and applied as a foliar spray, at recommended label rates, on a 7-day interval using a motorized back pack sprayer until harvest. The experimental design was a randomized complete block with 4 replications. Plant beds were formed with a press-pan-type bed shaper, 6 in high and 30 in wide. In-row plant spacing was 2.0 ft. and beds were spaced 12.0 ft. apart, center-to-center. Every plot consisted of 18 plants, three from each cultivar, with each cultivar harvested separately. Plots were rated for percentage of disease on foliage every 14 days in August and September. There were no significant disease foliage differences for the treatments. However, among the cultivars Mustang had the best disease rating. The first harvest was 7 October, when the majority of the pumpkins were orange. Pumpkins were counted, weighed, and measured for height and circumference. The treatments show that pumpkin weight, height, and circumference were reduced in the Double Nickel/Cueva mix. Also the standard treatment of Bravo WS/Quadris had the most number of pumpkins per plot, although not significantly different than Double Nickel/Cueva or the control. The organic fungicides trialed demonstrated efficacy to be as effective as the conventional fungicides used in the current study.

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(404) Meeting the Demand for Organic Sweetpotato Production in the Great Plains and Midwest

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Sweetpotatoes are nutritious, easily stored and marketed, well adapted to organic production, and fit large or small farming operations. However, the Midwest and Great Plains are not traditional sweetpotato producing regions and availability of certified organic slips can be limiting. In 2006 the Kansas State University John C. Pair Horticultural Center initiated a program to produce and provide certified organic sweetpotato slips to growers throughout the state interested in growing sweetpotatoes. The goal of this outreach was to demonstrate sweetpotato as a viable vegetable crop in the state and provide the propagation material. The target audience was small organic farmers in Kansas marketing primarily at local farmers markets. Varieties offered in 2006 were 'Beauregard', 'O'Henry', and 'NC Japanese'. Slips were packaged and shipped at a cost of $0.06 per slip to offset the cost of production and shipping. Farmers inexperienced with sweetpotatoes were hesitant and lacked confidence. As a result only a few hundred slips were shipped. Since 2006, farmer confidence has increased and sweetpotato production has dramatically increased across the region. In 2015 more than 90 farmers across 27 states ordered over 250,000 slips total, at $0.12 per slip. Varieties offered include 'Beauregard', 'O'Henry', and 'Murasaki'. Sweetpotatoes are bedded in early April and covered with 5 cm of soil. Clear

plastic mulch is then placed over the beds. When emerging shoots reach the soil surface the plastic is removed and shoots are allowed to grow. By June 1 shoots have reached 25 cm in length. They are cut by hand, packed in boxes and shipped to their destination via UPS ground delivery service. Cutting and shipping occurs on the same day. Once all orders have been filled, additional slips are cut and planted to produce sweetpotatoes for the following year's crop of slips. Each year foundation seed is acquired from North Carolina and increased over two years to meet production goals. The crop is irrigated as needed and manual weeding is used to control weeds. Sweetpotatoes are harvested in early- to mid-September and cured and stored in a large insulated room until bedded in spring. Cover crops are employed to control weeds, improve soil organic matter, and reduce soil erosion. Funds received from the sale of slips are used to employ summer student workers and maintain equipment. Through this effort of providing certified organic slips annually, sweetpotato production across the region has dramatically increased.

(407) Out of the Landfill and Into the Field: Suitability of Wastes as Agricultural Amendments

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Wastes, from municipal and industrial sources, can be used as agricultural amendments and many are locally available. As an alternative to mineral fertilizers they provide plant nutrients and organic carbon, the main component of soil organic matter. Land application prevents the need to landfill or incinerate wastes, sequesters carbon in the soil, and recycles nutrients that would otherwise be lost. However, the properties of waste amendments are less consistent than mineral fertilizers, and there is concern about their potential to contribute problematic levels of salt or heavy metals. To establish their suitability as agricultural amendments, the properties of six wastes were determined: paper fiber sludge/chicken manure (PF), biosolids/yard waste co-compost (BS), multi-source compost (MS), yard waste compost (YW), dehydrated food waste (FW), and gelatin waste (GW) (n = 1–2). All amendments had consistent electrical conductivity from year to year (< 10 mS/cm), whereas pH was more variable and ranged from 4.9– 7.9. The most variable pH was for BS, which ranged from 5.1–7.9. The presence of seashells ($CaCO_3$) in DF and MS meant that 16% and 47%, respectively, of the total C was not available to microorganisms, which influences estimates of carbon and nutrient availability. Waste amendments varied in texture, density and moisture content, which affect their decomposition in the soil, as well as practical considerations like transportation and spreading equipment. While none of the wastes had heavy metal concentrations that exceeded the U.S. EPA's limits set for land application of biosolids, the arsenic content of YW exceeded the agency's more restrictive limits. The nutrient levels of waste amendments also differed: most had a low to moderate N concentration (0.4% to 3.7%), although GW contained 4.9% total N. All wastes had a C:N ratio below 25:1, the threshold above which N immobilization is likely, except for PF. Unlike mineral fertilizers, over 95% of N in the waste amendments was in organic forms. Amendments were not good sources of P, except GW (3.9%), which contained almost equal parts N and P. Finally, wastes contained varying amounts of K but were all low in comparison to mineral fertilizer. My results showed that the amendments studied did not have problematic levels of salt, heavy metals or acidity, and had low to moderate concentrations of plant nutrients. Amendment properties varied across amendment type and year-to-year from the same amendment source, stressing the importance of regular testing prior to application.

(408) Growing Potato Profitably for Organic Dry Matter Production in Western Nebraska

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Can potatoes be grown profitably for organic dry matter production? The objective of this study was to grow potatoes under organic conditions and reduce the cost of seed in western Nebraska. Operational costs would be planting, cultivating, and harvest; estimated at US$70/a. The major and variable cost is seed purchasing. In earlier comparison trials, the cultivar Atlantic was the most promising of the several cultivars and types tested. Using 'Atlantic', identification of the most profitable seed size and spacing to plant to achieve the right balance between seed cost and yield resulting in the highest net income. No irrigation, fertilization or pesticides were applied. Rain from planting to harvest was 7.9 cm (3.1 in), 42% of normal, and temperature 22.2 °C (72 °F), about 1o above normal. Cut seed-pieces, weighing 34, 57, 64, 71, and 85 g, were planted at 15, 23, 30, 38, and 46 cm apart in rows spaced 91 cm at Scottsbluff, NE, following dry bean. The highest yields, >11.2 Mg/ha, and lowest stand, < 70%, were obtained when plants were spaced 6 or 9 inches regardless of seed weight. Seed weight did not play a significant role; however seed-pieces > 57 g performed the best. Calculating net income, fixed costs were assumed to be $173/ha ($70/a), cut seed cost to be $30/a ($12/a), and sales for dehydration to be $8.80/100 kg ($4/cwt). A profit greater than $247/ha ($100/a) was achieved when seed pieces, < 71 g (< 2.5 oz), were planted 38 or 46 cm (15 or 18 in) apart. This study is continuing, however, it may be economically feasible to grow a crop targeted for potato organic dry matter production in western Nebraska.

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An asterisk (*) following a name indicates the presenting author.

(409) Performance of Poly-coated Urea for the Production of Vidalia Onions

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There has been an increased interest in the use of controlled release fertilizers in vegetable crops. To determine the suitability of two commercially available PCU products Duration 120 (Koch Fertilizer; Wichita, KS) and ESN smart nitrogen (N) (Agrium Inc.; Denver, CO) for Vidalia onion production. The varieties Golden Eye and Sapelo Sweet were used. Fertilizer treatments were 180 kg·ha^{-1} N and 146 kg·ha^{-1} N applied preplant using both PCU products. The 146 kg·ha^{-1} N treatment received an additional 34 kg·ha^{-1} N prior to bulbing using calcium nitrate. Other treatments consisted of a preplant complete fertilizer (10N-4.4P-8.3K) applied at 56 kg·ha^{-1} N with an additional 34 and 90 kg·ha^{-1} N applied prior to bulbing using calcium nitrate and ESN, respectively. A control treatment using current recommendations for Vidalia onions (160 kg·ha^{-1} N for the season) was included. Plants were managed according to standard practices with the exception of fertilizer treatments. Mesh bags containing both PCU products were placed at depths of 15 cm and excavated throughout the season to determine N release. Approximately 58% N was released from ESN within the first month of growth and then release rates decreased. The Duration product had a linear release pattern with a slower initial N release than ESN. At 117 days after placement the ESN product released approximately 90% of N, while the Duration product had released approximately 85% of N. Total marketable yields were higher in 'Sapelo Sweet' than 'Golden Eye' due to a higher percentage of colossal bulbs produced by 'Sapelo Sweet'. For 'Sapelo Sweet', applications of Duration and ESN at planting (146 kg·ha^{-1} N) followed by an application of calcium nitrate later in the season yielded no differently than the control or treatments receiving the preplant complete fertilizer followed by an application of ESN and calcium nitrate. In 'Golden Eye', the results were similar. This suggests PCU fertilizers can be used for production of Vidalia Onion, but they should be partnered with a soluble N-source or applications split over the season.

(410) Contribution of Urea Nitrogen to Soil Fertility: Production of Indigenous Underutilized Vegetables and Food Security in Southwest Nigeria

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One in nine of the world's population suffers from chronic hunger in 2011–13. With increasing demand for high valued food and adverse impacts of climate change in Africa and globally, indigenous underutilized vegetables of southwest Nigeria which are collected wild as weeds, are gradually disappearing. The vegetables have both nutritional and therapeutic uses. Cultivation of the vegetables for commercial purpose could contribute to climate change adaptation and mitigation in the region. Urea fertilizer is the most fertilizer used for vegetable production worldwide. There is the need for information on the effects of urea nitrogen, fertilizer on soil quality and production of the vegetables. This study examined the effects of nitrogen fertilizer (urea) on soil organic carbon, total nitrogen, pH and exchangeable cations, and yield and nutrient composition of *Solanum macrocarpon* (Igbagba) and *Solanum scabrum* (Ogunmo) in Iwaro, Ondo State, Ogbomosho, Oyo State derived savanna, and OmiOkun Ile-Ife, Osun State, rainforest agro-ecological zones of southwestern Nigeria. The study was a 4 x 4 arranged into a Completely Randomized and replicated four times. Urea was applied at 0, 40, 80 and 160 kg·ha^{-1} N. Soil properties were determined before and after fertilizer application. Vegetable shoot yield and nutrient contents were determined. Data collected were subjected to statistics analysis. Results showed that soil organic carbon and total nitrogen were significantly higher and more acidic while exchangeable cations were not affected in Omiokun compared with that of Iwaro and Ogbomosho. Fresh shoot yield from Omiokun, Iwaro and Ogbomosho were 9.01, 3.21 and 5.87 kg/6 m for *Solanum macrocarpon* and 19.58, 9.83, and 8.06 kg/6 m for *Solanum scabrum,* respectively, which increased consistently with increasing rates of N application. *S. marcrocapon* leaf nutrient contents in percentage ranges from 3.5% to 10.1% Ca, 4.03% to 9.6% Mg, 4.6% to 5.8% K and 0.5% to 0.9% Na, and 27.0–143.2 mg/100g for Fe while 1.9–6.1 Ca, 1.6–4.6 Mg, 2.2–3.1 K and 0.2–0.5 Na, and 51.7–71.4 mg100/g for Fe were obtained for *S. scabrum*, It was concluded that the soils have low fertility. Application of 80 kg·ha^{-1} N was recommended for *S. scabrum* and *S. macrocarpon*. Through greater production and consumption of indigenous vegetables, malnutrition can be reduced significantly and healthy diets promoted, and income increased. Vegetable production, processing, and value addision could serve as a source of employment for the teeming youth population of Nigeria.

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(411) Commercial Extract from the Brown Seaweed *Ascophyllum nodosum* (Acadian®) Improves Yield and Quality of Hydroponically Grown Grape Tomato

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Tomatoes are the leading greenhouse vegetable grown in North America and the world. Grape, cherry, and plum varieties are gaining popularity as a healthy snack food and are becoming more commonly grown in greenhouse production. Almost

all greenhouse tomatoes are produced hydroponically using computerized production systems and grown in media such as rock wool or coconut fiber. In the United States and Canada, growers normally transplant new plants into their greenhouses in December and the first ripe tomatoes are produced in late March. A greenhouse experiment at the Dr. James S. Craigie Research Center in Cornwallis, Nova Scotia, was designed to test the effects of Acadian® extract (a derivative from *Ascophyllum nodosum*) in the production of hydroponically grown greenhouse grape tomatoes (*Lycopersicon esculentum* Mill. var. Amsterdam). *Ascophyllum nodosum* seaweed extract (ASE) treatments in combination with a standard hydroponic fertilizer were applied to the root systems of grape tomato plants through the irrigation system. Fruit production and quality of the ASE-treated plants was compared to fertilizer-only treated plants. With the inclusion of ASE into the fertilizer program, the average number of fruit produced per plant increased by 9.5% and the total weight of fruit per plant by 8.1%. An increase of 13.4% in fruit wall thickness and a 10.9% increase in skin firmness were observed in the ASE treatments as well. Both of these parameters may lead to improved shelf life. These results indicated that ASE applications increased yields and improved the quality of hydroponically grown grape tomatoes, which ultimately improves the economic return for the user.

(412) Soluble Fertilizer at Transplant and Early Season Plastic Mulch Increase Tomato Yield in Soil with Adequate Fertility

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Transplant solutions containing soluble phosphorous (P) fertilizers are often recommended for vegetable transplants, regardless of existing soil fertility. This is thought to increase early-season root growth and nutrient uptake. Soil warming, via plastic mulch, is another method to increase early-season root growth and nutrient uptake in vegetables. We examined the interaction between three fertilizer treatments applied at transplant [water, 28–0–0 urea ammonium nitrate (UAN), or 10–34–0 ammonium polyphosphate (APP)] under mulched (26 days of black plastic at the beginning of the season) or bare-ground conditions. In a factorial design of these treatments in 2014, 'Plum Dandy' tomatoes, marketed as a determinate cultivar, were grown in Waseca, MN, in Webster clay loam soil testing high for phosphorus (35 ppm). Plastic mulch increased 10-cm soil temperature by 1.1 °C. An unusually cool summer and early frost caused a late and abbreviated harvest. Mulched plants flowered an average of 27 days after transplant (DAT), and un-mulched plants flowered 29 DAT. Plants fertilized at transplant flowered less than one day earlier than unfertilized transplants. Cumulative mass of fruit harvested at ripeness stage 4, 5, or 6 was 6.0 kg from plants treated with APP at transplant, and 5.0 kg from plants treated with water at transplant. Plastic mulch increased total cumulative yield by 34%. At the final harvest before frost, substantially less green fruit weight remained on plants fertilized with APP and grown with early-season plastic mulch (58%) compared to APP-fertilized un-mulched (64%) or un-fertilized mulched (63%) transplants. Results of UAN fertilizer treatments were intermediate between water and APP treatments.

Specified Source(s) of Funding: Minnesota Agricultural Experiment Station

Waste Utilization in Horticulture

(158) Seed Germination and Plant Growth Using Composted and Vermicomposted Pulp Mill Waste

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For many years the horticulture industry has been interested in using stabilized organic wastes as components of container growing mixes and landscape soil amendments. This research project involves the use of a commercial peat-based container mix (Fafard 3B) amended with different composted and vermicomposted pulp mill wastes. Compost and vermicompost treatments each consisted of non-amended control, 10%, 20%, 40%, and 100% (v/v). Three plant species were selected for the germination trial: Celebrity tomato (*Solanum lycopersicum* 'Celebrity'), Black-eyed Susan vine (*Thunbergia alata*), and Black Magic kale (*Brassica oleracea* var. *sabellica* 'Black Magic'). Seeds of each variety were direct sown into 35-cell plug trays and grown in a greenhouse under high humidity and ambient temperatures. Germination percentages were recorded for 17 days beginning 20 September 2014. After 17 days the tomatoes and kale were transplanted into larger containers using the control peat-based container mix and plant height was recorded weekly for 49 days. The greatest tomato germination in the vermicompost treatments occurred with the control, 20% and 40% treatments, while the compost treatments resulted in germination greater than 83% with the 100% treatment having 100% germination. The 10%, 20% and 40% vermicompost treatments had greater kale germination than the control with little germination in the 100% treatment. The compost treatments all had greater kale germination than the control with the 100% compost treatment having the greatest germination at 80%. The germination of black-eyed Susan vine in the 10%, 20% and 40% vermicompost treatments was greater than the control; seeds in the 100% treatment failed to germinate. In the compost treatments the Black-eyed Susan vine had the greatest germination in 40% compost (34%). The tomato height measurements results revealed the control and 10% treatments were almost 30% taller than the other vermicompost treatments.

The tomato plant heights were similar for compost treatments and 50% greater than the 100% compost treatment. Measuring kale height, both the vermicompost treatments and compost treatments resulted in greater plant heights compared to the control treatment. More research will be conducted to clarify germination and plant growth differences resulting from the composted and vermicomposted pulp mill wastes.

(159) Converting Seepage Irrigation into Center Pivot Irrigation to Save Water for Commercial Snap Bean Production in Southwest Florida

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A commercial snap bean (var. 'Caprice') trial was conducted to determine water savings from conversion of seepage into overhead irrigation. This trial was conducted on Jones Potato Farm, Parrish, Florida from February 2014 to April 2014. There were two treatments including seepage and center pivot with four replications. Water flow meters and soil moisture sensors were employed to measure water usage and monitor soil moisture, temperature, and electrical conductivity. Rainfall during the growing season was recorded with a rain gauge at each of the treatments. Biomass, yields, and the width/length of 30 snap beans were measured at harvest. The yield was significantly higher in seepage with an average of 14527.3 ± 709 lb/acre than in center pivot with an average of 8851.8 ± 281 lb/acre. Seepage irrigation used 118,139 gallons/acre (4.4 acre-inches) while center pivot irrigation used 50,090 gallons/acre (1.8 acre-inches). Center pivot irrigation saved 57.6% (68,049 gallons/acre). This particular trial shows that overhead irrigation had 39% lower in bean yields. This is likely due to the use of an established fertilizer program for seepage irrigation that has been used for decades. This fertilizer program uses most of the nitrogen fertilizer up front. However, this program is not suitable for overhead irrigation. To improve bean yields where overhead irrigation is used, fertigation should be considered. Further research using fertigation is planned.

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(160) Tips for Growers on Recycling Used Plastic Film and Containers

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Virtually all types of horticultural plastics—including mulch film, greenhouse and tunnel covers, irrigation tubing and drip tape, nursery pots and trays—can be recycled, some more easily than others. These tips are for growers, for Extension and research horticulturalists who work with them, and for industry representativess who sell plastics to growers. We will cover: 1) How to prepare horticultural plastics for recycling. 2) Equipment and methods to efficiently remove plastic from the fields and compact it for transport to recycling markets. 3) Hoops to jump, hurdles to clear and issues that arise in collection and processing. 4) Costs of recycling, and who pays. 5) Viable recycling markets in different areas of the country. 6) Why geography matters. 7) Engaging new and prospective markets. 8) Where to find educational and outreach materials that promote and explain how to recycle agricultural plastics

(161) Heavy Metals Uptake in Plant Parts of Hot Pepper Grown in Recycled Waste

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In agricultural practices, composting and land application of wastes are increasingly popular ways for exploring organic waste as a source of organic matter, while decreasing the amount of waste diverted to landfills. Bioaccumulation and entry of heavy metals from recycled waste into the food chain have turned heavy metals as major environmental pollutants. The main objectives of this investigation were to quantify concentrations of seven metals (Cd, Pb, Ni, Mo, Cu, Zn, and Cr) in the fruits, leaves, stem and roots of *Capsicum annuum* L. (cv. Xcatic) plants grown under four soil management practices: yard waste, sewage sludge, chicken manure, and no-mulch bare soil. Elemental analyses were performed using inductively coupled plasma mass spectrometer (ICP-MS). Cadmium, Pb, and Ni are the metals of great concern to human health since plants can accumulate them and introduce them into the food chain. Concentration of Pb in pepper leaves (0.89 $\mu g \cdot g^{-1}$ dry weight) was significantly greater ($P < 0.05$) than in fruits, stem and roots. While, Ni was greater in the roots (1.5 $\mu g \cdot g^{-1}$ dry weight) and Cd was greater in the leaves (0.22 $\mu g \cdot g^{-1}$ dry weight) compared to the other plant parts. Regardless of soil treatment, Cu and Zn were taken up and accumulated in the fruits. The impact of potentially toxic trace metals in sludge applied to cropland can be reduced by growing low-accumulator crops which do not accumulate these metals in their edible portions and by reducing the rate at which recycled wastes are applied.

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