

# Manuscript Structure

---

The following pages show you **how a manuscript should look**.

## COVER PAGE

- A) A Detached Leaf Technique for Studying Race-specific Resistance to *Cladosporium caryigenum* in Pecan
- B) Patrick J. Conner<sup>1</sup>
- C) Department of Horticulture, University of Georgia, Coastal Plain Experiment Station, 4604 Research Way, Tifton, GA 31793
- D) I thank William Goff for help in obtaining the pathogen isolates used in this work.
- <sup>1</sup>To whom reprint requests should be addressed. Email address:  
pconner@tifton.cpes.peachnet.edu

## MANUSCRIPT SECTIONS (for blind review)

- E)** Subject Category: Genetics and Breeding
- F)** A Detached Leaf Technique for Studying Race-specific Resistance to *Cladosporium caryigenum* in Pecan
- G)** *Additional index words.* *Carya illinoensis*, scab, vertical resistance, fungus, microscopic, histology, stain, trypan blue, chlorazole black E
- H)** *Abstract.* A detached leaf screening technique was developed for studying specific interactions between pecan [*Carya illinoensis* (Wangenh.) C. Koch] cultivars and isolates of the pecan scab fungus *Cladosporium caryigenum*. Monoconidial isolates were obtained from leaf scab lesions on ‘Wichita’, ‘Desirable’, ‘Cape Fear’, and ‘Elliot’. Each isolate was then inoculated onto detached leaves of each of the four cultivars and fungal growth was observed under the microscope after eight days. ‘Wichita’, ‘Desirable’, and ‘Cape Fear’ isolates produced subcuticular hyphae at a much higher frequency when inoculated back onto the cultivar from which they were isolated in comparison to the other cultivars. The results obtained indicate that pecan scab is composed of multiple races with a high degree of specificity for host cultivars. A rapid whole-leaf staining system is presented which appears to have wide applicability to assessing fungal growth in leaves.

I)

a)

Pecans [*Carya illinoensis* (Wangenh.) C. Koch] are attacked by a wide range of pathogen and insect pests which cause substantial crop losses. In the humid growing conditions of the southeastern United States, the most economically damaging pest is the fungus *Cladosporium caryigenum* which causes pecan scab. Scab infection reduces both yield and quality of nuts, and if uncontrolled results in total crop loss (Sanderlin, 1994).

b)

#### Materials and Methods

*Isolate preparation.* Isolates were obtained from each of the four cultivars; 'Wichita' (Wi-Tif-2), 'Desirable' (De-Tif-3), 'Cape Fear' (Cf-Au-2), and 'Elliot' (El-Au-2). Conidia from individual lesions were suspended in a drop of water and spread across a petri dish containing 1% water agar. Plates were incubated at room temperature for 24 h and then single germinated conidia were transferred to potato dextrose agar containing the antibiotics streptomycin, chloramphenicol, and tetracycline at 50 g·L<sup>-1</sup>. Plates were placed in a growth chamber set at 24 °C with a 12-h photoperiod provided by fluorescent lights (115 μmol·m<sup>-2</sup>·s<sup>-1</sup>) for 2 weeks. After 1 to 2 weeks growth, conidia were harvested and the concentration adjusted to 1 × 10<sup>6</sup> conidia/mL of water with a hemacytometer.

c)

### Results

At 4 d PI conidia had germinated and formed germ tubes and appressoria on leaves of all four cultivars. Inoculating Wi-Tif-2 conidia on to 'Wichita' leaves showed over 40% (Fig. 1A) of the conidia penetrating the cuticle underneath the appressorium and producing clearly visible subcuticular hyphae between the cuticle and epidermal cell layer. Field inoculations validated the results from the detached leaf study in that the greatest infection frequency resulted from inoculation of a cultivar with an isolate obtained from that cultivar (Table 1). Isolate Wi-Tif-2 produced a large number of lesions on 'Wichita' leaves but not on the other three cultivars.

### Discussion

A detached leaf screening system is highly advantageous in this plant-pathogen system because the size of the host plant makes greenhouse and growth chamber studies difficult. Previous studies made use of a chloral hydrate-acid fuchsin staining system that requires several days to complete (Latham and Rushing, 1988; Yates et al., 1996). In summary, this research indicates that pecan cultivars display vertical or race-specific resistance to pecan scab. Results to date indicate that the scab pathogen consists of a large number of races, each well-adapted to its host cultivar. Therefore, a resistance breeding program should challenge potential new cultivars with a wide range of scab isolates in order to lower the likelihood of escapes being misclassified as resistant.

d)

Literature Cited

- Baxter, L.W. and S.G. Fagan. 1986. Method for maintaining three selected fungi. *Plant Dis.* 70:499-500.
- Bracewell, C. 1996. Pathogenic variation of *Cladosporium caryigenum* on resistant and susceptible pecan cultivars. MS Thesis, Univ. of Ga., Athens.
- Conner, P.J. 1999. The Georgia pecan breeding program. *Proc. S.E. Pecan Growers Assn.* 92:77-80.
- Converse, R.H. 1960. Physiologic specialization of *Fusicladium effusum* and its evaluation in vitro. *Phytopathology* 56:527-531.
- Ellis, H.C., P. Bertrand, and T.F. Crocker. 2000. 2000 Georgia pecan pest management guide. Univ. Ga. Coop. Ext. Serv. Bul. 841.
- Goff, W.D., M. Nesbitt, R. Mullenax, F. Raspberry, and B. Graves. 1998. Pest resistant cultivars as a way to reduce input costs, p. 79–90. In: B. McCraw, E.H. Dean, and B.W. Wood (eds.). *Pecan industry: Current situation and future challenges*. Proc. USDA–ARS 3rd Natl. Pecan Wkshp.
- Sparks, D. 1992. *Pecan cultivars: The Orchards Foundation*. Pecan Prod. Innovations, Watkinsville, Ga.
- Thompson, T.E. and L.J. Grauke. 1994. Genetic resistance to scab disease in pecan. *HortScience* 29:1078-1084.
- Yates, I.E., D. Maxey, S. Lee, D. Sparks, and C.C. Reilly. 1996. Developing the pecan scab fungus on susceptible and resistant host and nonhost leaves. *J. Amer. Soc. Hort. Sci.* 121:350-357.

J) Table 1. Number of scab lesions per square centimeter produced from field inoculations of four pecan cultivars with two pecan scab isolates.

Isolate	Time period <sup>z</sup> (d)	Cultivar inoculated			
		Wichita	Desirable	Cape Fear	Elliot
		No. scab lesions/cm <sup>2</sup>			
Wi-Tif-2	21	1.95 a <sup>y</sup>	0.00 b	0.00 b	0.00 b
De-Tif-3	21	0.03 a	1.59 b	0.00 a	0.00 a
De-Tif-3	28	0.00 a	1.13 b	0.00 a	--- <sup>x</sup>

<sup>z</sup>Number of days between inoculation and sample counts.

<sup>y</sup>Any two means within a row not followed by the same letter are significantly different at  $P \leq 0.01$ .

<sup>x</sup>Inoculation test not performed.

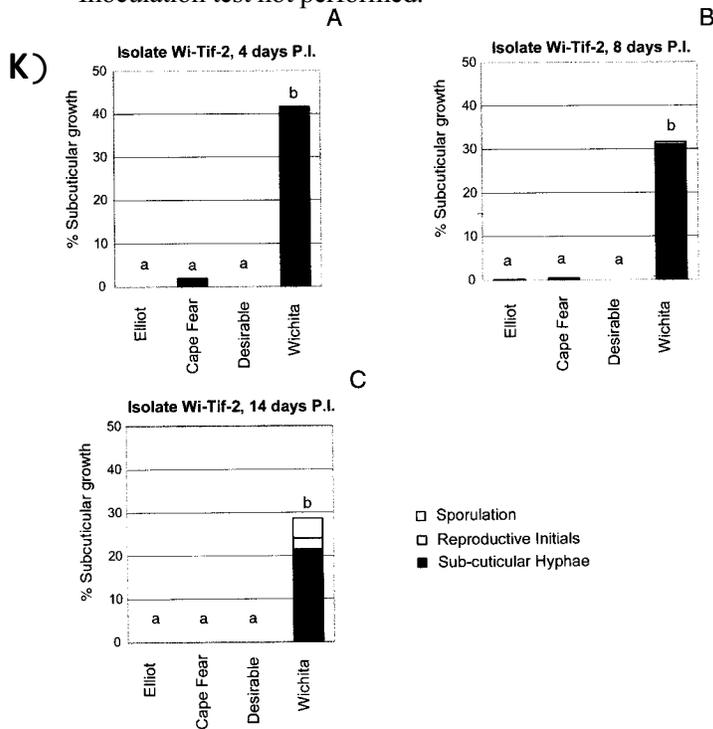


Fig. 1. Chronology of pathogen development on resistant and susceptible cultivars. Leaves of the four cultivars were inoculated with *Cladosporium caryigenum* isolated from ‘Wichita’. Leaves were examined microscopically at (A) 4, (B) 8, and (C) 14 d postinoculation. The percent of the germinated conidia producing subcuticular hyphae, reproductive initials, and sporulation were determined. Mean totals with a common letter are not different ( $P \leq 0.05$ ) by ANOVA on ranks test.

---

## COVER PAGE

### A) Title

The title of the paper should be a precise and concise description of the work performed and results gathered; it should be no longer than three typeset lines (12 to 15 words maximum). Use the most important key words of the paper to facilitate indexing and information retrieval.

- Worthless words and phrases—such as “influence of,” “effects of,” “results of,” “relies on,” “evaluation of,” “factors involved in,” and “tests on” are obvious and useless for indexing purposes.
- Binomial and authority—Give in the title of a paper only if the species is not widely known or when the common name does not unambiguously identify the organism. If the entire identification is given in the title, it should not be given elsewhere.
- Cultivar names—Provide when important (e.g., if only two *Malus* cultivars were used in a study, the title could say ‘Delicious’ and ‘Golden Delicious’).
- Common names of chemicals—Do not use full chemical names and trade or brand names in titles.
- Abbreviations and chemicals—Spell out abbreviations and chemical elements/compounds; avoid jargon.
- Numbers—One through nine should be spelled out.
- Capitalize all words—Except for articles such as “a” and “the”; prepositions such as “of,” “in,” “on,” “during,” “between,” “after,” “before,”; and conjunctions such as “and” and “but” that are not the first word.

### B) Byline

The byline includes the name(s) of the author(s) on one line, with a concise but

complete mailing address below.

Names of authors are given according to the preferences of the author(s)—full names (not initials) are encouraged. The spelling of names of foreign authors is in the native spelling with diacritical marks (if present). **Some diacritical marks cannot be made on a Macintosh. The vowel or consonant without the accent will be used.** Do not include degree abbreviations or professional titles as part of the author's name; if desired, they may be footnoted.

### C) Affiliation

The address should be that of the institution (or institutions) where the research was conducted. For addresses in the United States, use two-letter abbreviations for states, followed by the ZIP code. For foreign and Canadian addresses, include city, province (Canada) (abbreviated), postal code, and country name. Give the name of the city and country in English. The byline address normally includes departmental affiliation. When authors are in separate departments at the same institution, however, indicate this fact in footnotes on the title page. When authors are from separate institutions (or separate campuses of the same institution), indicate this fact in separate bylines, grouped by author seniority. If the author's address is different from the byline, indicate the current address as a footnote on the title page.

### D) Footnotes

Footnotes (except for those in tables) must be given on the cover page of the manuscript. They will appear as a group at the bottom of the first column of the first printed page.

Unnumbered footnote—The first (unnumbered) footnote is written as a block of copy (not as individual paragraphs) and includes the following (in sequence):

- Received for publication (date, to be filled in by Publications Office, that the Publications Dept. received the manuscript at the Headquarters office).
- Identification of the paper as part of the institution's publication series (if applicable). Add this entry (including the number of the journal series, paper, contribution, or publication) if required by the sponsor or host institution.
- Notes on the title (if applicable), e.g., indicating that the paper is a portion of a thesis submitted by one of the authors in fulfilling a degree requirement. Do not use footnote numbers in the title.
- Author's acknowledgments (if applicable). Insert any credit, acknowledgment, or thanks for financial, material, or informational assistance. Do not include professional titles (Dr., Prof., secretary), formal address (Mr., Mrs., Miss, Ms.), or degree abbreviations in this footnote. Use of full names is encouraged in credits. Use first person (e.g., "We thank John Doe for statistical advice.").

- General material disclaimer (if applicable). Trade or brand names generally should not be used in scientific literature. If their use is necessary, however, a general disclaimer may be advisable. The following disclaimer used by the U.S. Dept. of Agriculture may be used as a guide: “Mention of a trademark, proprietary product, or vendor does not constitute a guarantee or warranty of the product by the U.S. Dept. of Agriculture and does not imply its approval to the exclusion of other products or vendors that also may be suitable.” Many private institutions and state universities require their faculty or staff to use similar disclaimers. Institutional style will be accepted.
- Numbered footnotes. All other footnotes follow, indicated by superscript Arabic numerals. Numbered footnotes may include elaboration on the author’s professional title and/or institutional and departmental affiliation, followed by the current address if it is not the mailing address listed in the byline; the home institution(s) of the coauthor, junior author, and/or additional authors if different from that of the senior author, but the author(s) participated in the research at the senior author’s institution; the institution of a secondary author who participated or cooperated in the project while based at his/her home institution; and an indication that the author is deceased.
- Do not use footnotes in the text. Insert the appropriate information as a parenthetical phrase in the text. Do not footnote abstracts or additional index words.

## MANUSCRIPT SECTIONS

### E) Category

Choose your category from the list in the online database when submitting your paper.

### F) Title

### G) Additional Index Words

A list of five to seven key index words or phrases, not already used in the title, follows the byline. These words are used in the annual and cumulative indexes and for information storage and retrieval by indexing services. Include scientific names (without the name of the authority) and common names of plant species, common names of chemicals used (do not use full chemical names), and physiological and pathological terms. Spell out the same genus, even if it is mentioned more than once. The index words should be selected carefully to indicate content, not nouns selected randomly from the manuscript. Avoid general or broad words such as “yield” or “growth.”

## H) Abstract

The abstract should be a concise, self-explanatory, one-paragraph summation of the findings, not to exceed 5% of the length of the paper. Abstracts often are published by “extracting journals.” The abstract should be informative, rather than merely indicating what the study was about (e.g., avoid phrases such as “the results are discussed”). Do not duplicate the title in the abstract.

Include objectives of the study, the full scientific names (including the name of the authority) of organisms (unless already in the title), materials used, effects of major treatments, and major conclusions. Use specific rather than general statements. At the end of the abstract, list each chemical name used in the abstract followed by its common name or abbreviation in parentheses. If a chemical formula is used in text but not in the abstract, DO NOT include it in “Chemical Names.” Also, all measurements of time should be spelled out (e.g., days, minutes, hours, etc.)

Include only information presented in the text: The abstract must be consistent with statements in the article. Omit discussion citations, footnotes, references to tables and figures, and methods (unless the paper’s main emphasis is on methods).

## I) The Article

Every part of the manuscript must be double-spaced, including Literature Cited, tables, and figure captions.

### a) INTRODUCTION

The introduction (without a heading) should answer clearly and concisely the question “why was this research conducted?” It should include a statement of the problem that justifies doing the research or the hypothesis on which it is based, the findings of (and reference to) earlier work (if applicable) that will be challenged or developed, and the general approach and objectives.

### b) MATERIALS AND METHODS

The technical and experimental methods must be described so that the work may be replicable. For materials, give the appropriate technical specifications and

quantities and source or method of preparation. Give enough information to indicate how the research was conducted. Well-known tests or procedures should be cited but not described in detail. Describe any controls and the statistical procedures. Methods papers should be detailed enough to permit replication of the work. When specific equipment is mentioned in the text, include the model number followed by the name and location (model; city, state, country) of the manufacturer in parentheses.

### C) RESULTS AND DISCUSSION

Present results succinctly in a format consistent with experimental design, with emphasis on main effects and significant interactions. The text and tables should discuss the topics in the same sequence. **All figures and tables must be cited in numeric order in the text.** Interpret results in the discussion.

Report and discuss only those results that are relevant to the study. The discussion should compare and explain any differences in the results within the experiment or those contrary to previous studies. Discuss any practical applications of the study and areas for future research. Speculation is encouraged, but must be firmly founded in observation and subjected to tests, and identified apart from the discussion and conclusions. Close the discussion with a brief, pertinent conclusion or interpretive statement; complex conclusions should form a separate section but generally are not necessary if the information is included in the abstract. Avoid summaries indicating “future work is necessary” or “further work is under way” because “previews of coming attractions” are unacceptable and will not be published by ASHS. The section on “Results” can be combined with the section on “Discussion” or they can be separate.

### d) LITERATURE CITED

The reference section should include only published, significant, and relevant sources accessible through a library or an information system. These include journal articles, books, theses, dissertations, proceedings, bulletins, reports, and published abstracts of papers presented at meetings.

Unpublished work, privileged data, or information received personally should be noted parenthetically in the text [e.g., “(E.D. Brown, unpublished data)” or “(J.B. Smith, personal communication)”]. Papers or manuscripts submitted to a publisher may not be used in literature citations unless the work has been accepted for publication, in which case the work may be cited as “(In press.)” at the end of the citation.

All citations mentioned in the text must be included in the Literature Cited; also, all references listed in the Literature Cited must be mentioned somewhere in the text. Check the alphabetical reference list against literature citations in the text before submitting the manuscript for publication. **When two or more citations**

**are listed in the text, list the citations alphabetically first, then chronologically, e.g., “(Jones, 1998, 2000; Kader, 2001; Smith, 1996).”** Authors are responsible for verifying that each reference is complete, accurate, and traceable. Authors must check the original source—do not copy a reference from a previous list of citations, because the odds are that at least one error will be copied. Citations must appear exactly (misspellings included and followed by “[sic]”) as written in the original published work.

### **Citation format**

ASHS style for listing literature citations is the Harvard system, with the last name(s) of the author(s) and the year of the publication cited in the text.

List citations alphabetically (letter by letter not word by word) by last names of authors (then initials if last names are the same) and chronologically if duplicate author names appear. Authors are listed first by senior author (last name first, followed by initials) and then additional authors (initials first).

#### **Example:**

Jones, B.F., T.C. Wesson, and J.E. Smith. 1998a. Hollies. Wiley, New York.

Jones, B.F., Z.C. Wesson, and J.E. Smith. 1998b. Holly berries. Wiley, New York.

If a name is followed by “Jr.” or a Roman numeral, the correct form is “Smith, Jr., B.F.,” or “Smith, II., B.F.” Do not include professional and honorary titles. All authors of a reference must be listed. If an author is cited more than once, repeat the author’s name—do not substitute the underline for the author’s name. Names of foreign authors retain their native spellings and diacritical marks.

If a work has no author, give the name of the publisher or the organization (committee, agency, etc.) responsible for the work. If no authority is known, credit the work to the publisher, not to Anonymous. If an editor or editors is given, their names are followed by “(ed.)” or “(eds.),” respectively, followed by a period.

Following the name(s) of the author(s), give the year of publication (the copyright or publication date listed on the publication, not the actual release date), followed by a period. If no year is given, then either estimate the year in parentheses “(1918?)”—or indicate no date—e.g., “(n.d.)” If more than one work by the same author or set of authors is cited, list the publications in chronological order and, if the year is also identical, insert lowercase letters (in alphabetical sequence) after the date, according to the order in which they are cited in the text. All single-authored articles of a given individual precede multiple-authored articles of which that individual is senior author.

Titles should be lowercase except for the first word, proper names, or certain foreign-language conventions. Do not italicize titles except for words or phrases italicized in the title of the published work. Do not use quotation marks around

titles. If an article, book, or chapter title has a subtitle (indicated by a dash, colon, semicolon, smaller type, or different typeface), place a colon before the subtitle and capitalize the first letter of the first word. Never abbreviate titles. Titles of foreign publications retain their native spelling and diacritical marks. Languages that capitalize nouns (such as German) retain their capitalization, but the rest of the title should follow style in lowercase. Do not translate foreign titles into English unless a translated copy was used. Titles that have been translated or transliterated into Roman characters should carry a parenthetical note [e.g., “(in Russian)”] before the period ending the title.

When giving the name of a publisher, use the short form, e.g., “Wiley” not “John Wiley & Sons, Inc.,” or “Macmillan,” not “Macmillan Publishing Co.”

When the publisher is a professional society, abbreviate the name. Include the location of the publisher.

**When more than one location is listed for a publisher, give only the first one.**

The following is the correct spelling of several commonly used publishers:

**Commonly cited publishers**

Kluwer Academic Publishers

Macmillan

McGraw Hill

Pergamon Press

Springer-Verlag

Wiley

Spell out all publication titles with one-word names, e.g., *Ecology*, *Euphytica*, *Hilgardia*, *HortScience*, *Nature*, *Phytopathology*, and *Science*. Do not italicize publication titles. Capitalize the first letter of all words, but delete extraneous prepositions and articles. Abbreviate the roots of words when they stand alone or with a prefix, e.g., Anal. Biochem. (See “Abbreviations for Literature Cited” for abbreviations of commonly used words in periodical titles.) Give the volume number in Arabic numerals, followed by the issue number (if available) in Arabic numerals in parentheses. Issue numbers are only necessary if the publication’s pages are renumbered from 1 with each issue within a volume. The pagination of the publication follows, connected to the volume number and/or issue number by a colon, and all closed up (no spaces): 96(5):645–648. Give full pagination, e.g., use “1101–1102,” not “1101–2” or “1101–02.”

Supply the abstract number or university microfilm number for dissertations available from *Dissertation Abstracts* or on microfilm.

Electronic citations should follow the MLA-recommended minimum format as follows.

- 1) Name of author, editor, compiler, or translator of the source.
- 2) Year of electronic publication, latest update, or posting.
- 3) Title.
- 4) Date (day, month, year) author accessed the source.
- 5) Complete electronic address.

### **Specific examples of citations**

Commonly used citations for ASHS publications follow. Note punctuation and abbreviation in each case.

#### **ABSTRACT**

Nesmith, W.C. and W.M. Dowler. 1973. Cold hardiness of peach trees as affected by certain cultural practices. *HortScience* 8(3):267 (abstr.).

#### **ABSTRACT FOR HORTICULTURAL ABSTRACTS**

Gherghi, A., I. Bwrza, K. Millim, and O. Tudosescu. 1998. The behavior in controlled atmosphere storage of 'Jonathan' apples grown on different rootstocks (in Romanian). *Lucr. Stün. Inst. Cerc. Val. Leg. Fruct.* 9:71–75 (*Hort. Abstr.* 48:10310; 1978).

#### **BOOK**

Hartmann, H.T., D.E. Kester, and F.T. Davies, Jr. 1990. *Plant propagation principles and practices*. 5th ed. Prentice Hall, Englewood Cliffs, N.J.

#### **BOOK CHAPTER**

Brown, A.G. 1995. Apples, p. 3–37. In: J. Janick and J.N. Moore (eds.). *Advances in fruit breeding*. Purdue Univ. Press, West Lafayette, Ind.

#### **BULLETIN**

Rollins, H.A., F.S. Howlett, and E.H. Emmert. 2002. Factors affecting apple hardiness and methods of measuring resistance of tissue to low temperature injury. *Mich. Agr. Expt. Sta. Res. Bul.* 901.

#### **ELECTRONIC CITATION**

State of California. 2002. *California Code of Regulations, Title 3. Food and Agriculture*. Office of Administrative Law, Sacramento. 10 July 2002. <<http://ccr.oal.ca.gov/>>.

**PERIODICAL**

Goldberg, D., B. Cornat, and Y. Bar. 1991. The distribution of roots, water, and minerals as a result of trickle irrigation. *J. Amer. Soc. Hort. Sci.* 96:645–648.

**PROCEEDINGS**

American Society for Horticultural Science. Tropical Region. 2000. Proc. XVIII Annu. Mtg., Miami, 25–30 Oct. 2000. (*Proc. Trop. Reg. Amer. Soc. Hort. Sci.* 14).

**PROCEEDINGS PAPER**

Locascio, S.J., J.G.A. Fiskell, and P.E. Everett. 2000. Advances in watermelon fertility. *Proc. Trop. Reg. Amer. Soc. Hort. Sci.* 14:223–231.

**REPORTS**

U.S. Department of Agriculture. 1997. Agricultural statistics for 1996. U.S. Dept. Agr., Washington, D.C.

**THESIS OR DISSERTATION**

Reeder, J.D. 2001. Nitrogen transformations in revegetated coal spoils. Colo. State Univ., Fort Collins, PhD Diss. Abstr. 81-26447.

## ABBREVIATIONS

The following list gives some of the more commonly used abbreviations in ASHS literature citations (note the words that are not abbreviated). When the proper abbreviation is in doubt, spell out the word; production editors will abbreviate if appropriate. Generally, any word ending in “ology” is abbreviated “ol.” and any word ending in “culture” is abbreviated “cult.” See p. 36 for state and province abbreviations.

### **Abbreviations for Literature Cited**

Abstract	Abstr.	Commonwealth	Cmwlth.
Academy	Acad.	Communication	Commun.
Acta	Acta	Conference	Conf.
Advances	Adv.	Congress	Congr.
Agriculture	Agr.	Contribution(s)	Contrib.
Agronomy	Agron.	Cooperative	Coop.
America, -an	Amer.	Culture	Cult.
Analytical	Anal.	Cytology, -ical	Cytol.
Annals	Ann.	Department	Dept.
Annual	Annu.	Development	Dev.
Applied	Appl.	Digest	Dig.
Archives	Arch.	Disease	Dis.
Associate(s), -ed	Assoc.	Dissertation	Diss.
Association	Assn.	Distribution	Distrib.
Australian	Austral.	Division	Div.
Austrian	Aust.	Ecology, -ical	Ecol.
Biochemistry	Biochem.	Economy	Econ.
Biology	Biol.	Education	Educ.
Biotechnology	Biotechnol.	Encyclopedia	Encycl.
Botany	Bot.	Engineers, -ring	Eng.
Breeding	Breeding	Enology	Enol.
British, Britain	Brit.	Entomology, -ical	Entomol.
Bulletin	Bul.	Environment	Environ.
Bureau	Bur.	Experiment	Expt.
Canada, -ian	Can.	Extension	Ext.
Center	Ctr.	Fertilizer	Fert.
Chemical, -istry	Chem.	Forestry	For.
Circular	Circ.	Gazette	Gaz.
Citriculture	Citricult.	General	Gen.
Climatology, -ical	Climatol.	Genetics	Genet.
College	College	Government	Govt.
Colloquium	Colloq.	Handbook	Hdbk.
		Heredity	Hered.

Horticulture, -ae, -al	Hort.	Propagation	Prop.
Industry, -ial	Ind.	Protection	Protection
Information	Info.	Publication(s)	Publ.
Institute, -ion	Inst.	Quarterly	Qrtly.
International	Intl.	Region	Reg.
Irrigation	Irr.	Regulator, -ion, -y	Regulat.
Japanese	Jpn.	Report(s)	Rpt.
Journal	J.	Reporter	Rptr.
Laboratory, -ies	Lab.	Research	Res.
Leaflet	Lflt.	Resources	Resources
Letters	Lett.	Review(s), Revue(s)	Rev.
Magazine	Mag.	Science(s)	Sci.
Management	Mgt.	Scientia	Scientia
Market	Mkt.	Scientific	Scientific
Marketing	Mktg.	Series	Ser.
Meeting	Mtg.	Service	Serv.
Meteorology, -ical	Meteorol.	Society	Soc.
Microscopy	Microsc.	Soil	Soil
Molecular	Mol.	Special	Spec.
Monograph	Monogr.	Standard	Std.
Mycology, -ical	Mycol.	Station	Sta.
National	Natl.	Statistics, -ical	Stat.
Nematology, -ical	Nematol.	Supplement(s)	Suppl.
Netherlands	Neth.	Symposium	Symp.
New Zealand	N.Z.	Technical, -que	Tech.
Newsletter	Nwsl.	Technology, -ical	Technol.
Nucleic	Nucl.	Temperature	Temp.
Nutrition, -al	Nutr.	Thesis	Thesis
Official	Offic.	Transactions	Trans.
Pathology, -ical	Pathol.	Tropical	Trop.
Photosynthesis	Photosyn.	United States (modifier)	U.S.
Physics, -ical	Phys.	U.S. Department	U.S. Dept.
Physiology, -ical, -ia	Physiol.	of Agriculture	Agr.
Phytology, -ical	Phytol.	University	Univ.
Phytopathology, -ical	Phytopathol.	Variety, -ies	Var.
Planta	Planta	Vegetable(s)	Veg.
Plantae, -arum	Plant.	Virology	Virol.
Pomology, -ical	Pomol.	Viticulture	Viticult.
Proceedings	Proc.	Volume (bibliographic)	Vol.
Products	Prod.	Workshop	Wkshp.
Progress	Prog.	Yearbook	Yrbk.

## J) Tables

Tables should document but not duplicate data already given in the text. **Make a separate table for each data set; that is, do not design a table that contains another table.**

Start each table (with all parts double-spaced) on a separate page and number each table with Arabic numerals (e.g., Table 1, Table 2, etc.). Place tables after Literature Cited. The title, column and row headings, and footnotes of each table should be self-explanatory. Capitalize only the first letter of the first word of each column and row heading.

To identify tabular footnotes, use lowercase letters starting from the end of the alphabet (sequence z, y, x...). If letters or symbols are used to indicate statistical significance at different levels, use (with explanatory footnotes) either lowercase letters from the beginning of the alphabet (a, b, c...) or a single asterisk (\*) for  $P \leq 0.05$ , either uppercase letters from the beginning of the alphabet (A, B, C...) or a double asterisk (\*\*) for  $P \leq 0.01$ , and a triple asterisk (\*\*\*) for  $P \leq 0.001$ .

As an example, the following footnote adequately identifies letters in mean separation tests:

<sup>z</sup>Mean separation (in rows, columns, etc.) by Duncan's multiple range test at  $P \leq 0.05$  (lowercase letters) or 0.01 (uppercase letters).

The following footnote is suitable when symbols are used to designate significance:  
NS, \*, \*\*, \*\*\* Nonsignificant or significant at  $P \leq 0.05$ , 0.01, or 0.001, respectively.

## K) Figures

Illustrations are often the best means for presenting scientific data, revealing trends, or recording natural appearance. Data presented in tables should not be duplicated in figures.

Identify all graphs, line drawings, and photographs with consecutive Arabic numerals (e.g., Fig. 1, 2, or 3).

Number the figures in the sequence in which they are cited in the text.

All figures must be cited.

**Cite figures in text in the following manner:**

...as shown in Fig. 1

...as shown in Figs. 1–3

...as shown in Fig. 1A (but Fig. 1A and B, or Fig. 1A–C, **NOT Figs. 1A and B**)

Information in captions should be clear and concise and understood independently from the text (all acronyms and

abbreviations should be spelled out as in the text).

Legends and equations may be in the figure. Symbols used in graphs and charts should be keyed. If symbols are necessary for reference in the text, then choose standard symbols, such as the triangle, box, or circle. Complex symbols do not translate from disks and cannot be replicated easily.

Black-and-white photographs must be clear, with sharp focus and good density.

**Color reproduction is available at additional cost.**

For graphs or photographs that are grouped as one composite figure, place letters on each frame to correspond to the caption. Assign letters from left to right, then top to bottom. Be sure that letters are of uniform height and density and that they will be legible when reproduced (e.g., if the background in a photograph is dark, do not use black letters).

For electronic graphics, you may embed them in the text file. If submitting them as separate files, TIFF, EPS, JPG, or PDF formats are preferred.

Lettering should be of a consistent size and style. Size and boldness of lettering on figures should be gauged for legibility in the final production size; letters or numerals 3 mm high or higher generally are satisfactory.

Abbreviations and symbols used in figures must conform to the style used in the text. Acronyms used in the figure should be spelled out in the caption.

Use of perspective or three-dimensional graphics is discouraged in bar and line graphs.

Use single quotation marks for cultivar names within captions but not when they are placed on the axes of a graph. Make all symbols and scatter-plot dots large enough to reproduce clearly without blurring.

Figures with similar types of data and the same horizontal scales should be stacked, when feasible.

Do not italicize or bold the identification “Fig.” in the caption.

# Style Guidelines

---

The manuscript must conform to current standards of English usage and style. ASHS, in general, conforms to the 14th edition of *The Chicago Manual of Style*.

Clarity of writing is necessary. Avoid wording in “notebook style” (i.e., using incomplete sentences and omitting prepositions, verbs, and articles). First- and third-person pronouns are accepted and preferred for clarity. Use the active voice whenever possible.

WEAK: The plants were watered by the experimenters once a week.

STRONG: We watered the plants weekly.

All papers must use American English spellings. Because ASHS publications have a broad international readership, avoid slang, jargon, local vernacular, and coined terms.

When discussing a horticultural crop as a class, the singular form may be used (e.g., “this trait is common in apple.”).

Do not use a comparative without stating the standard for comparison. For example, “treatment A produced larger apples” is obscure—larger than what? While some comparisons are inferred by context or a previous statement, many are vague. Restructuring the sentence may be preferred.

## CHEMICAL TERMINOLOGY

### Chemical Nomenclature and Formulas

Whenever possible, simplify chemical formulas and names for readability and typographical considerations. Use the common name or abbreviation of a chemical—not the chemical name—in the title, the additional index words, and the abstract. At the end of the abstract, list each chemical name that was used in the abstract followed by its common name or abbreviation in parentheses. If a chemical is first mentioned in the text, give the full chemical name in parentheses following the common name or abbreviation; thereafter, the common name or abbreviation may be used. Give the specific analog to abbreviation in subscript (e.g., GA<sub>3</sub>). Greek characters may be used in full formulas; do not substitute Roman-letter equivalents for Greek symbols.

Indicate chemical elements and common compounds by their chemical symbols. Spell out the chemical name only if confusion may result with other symbols or with words or numerals: helium (He), oxygen (O), iodine (I), and arsenic (As).

Do not begin sentences with a chemical symbol (e.g., “P is necessary for growth.” is not acceptable). Give formulas for molecules of elemental gases (e.g., H<sub>2</sub>O). Indicate isotopes different from the normal with superscript numbers preceding the element symbol [e.g., <sup>14</sup>C(2-chloroethyl)phosphonic acid].

General mention of a salt or its concentration in solution may be given as the simplest formula (e.g., Na<sub>2</sub>SO<sub>4</sub>). Give full molecular formulas for hydrated salts [e.g., BaCl<sub>2</sub>·2H<sub>2</sub>O (use the raised period, with no space before and after the period for water of hydration)]. Indicate ion charges with superscripts (e.g., H<sup>+</sup>, Cl<sup>-</sup>); use Ca<sup>2+</sup>, not Ca<sup>++</sup> or Ca<sup>+2</sup>.

All experimental materials must be characterized as to chemical content. Use care in reporting information on proprietary materials.

## Fertilizer Analysis

Report amounts and proportions of nutrients in elemental terms, not as oxides (e.g., K, not K<sub>2</sub>O, or P, not P<sub>2</sub>O<sub>5</sub>). In general, nitrogen–phosphorus–potassium fertilizer reference may be abbreviated N–P–K, with en-dashes. Give the source of the nutrient (e.g., sulfate, nitrate, etc.). Where proportions are given, list the amounts up to one decimal point without spaces between the numerals and the element, with en-dashes separating each [e.g., 10N–4.3P–8.3K, not 10-4.3-8.3 (N-P-K) or 10N–4P–8K]. When sulfur (or any other element) analysis is important (such as with a sulfur-coated urea), report S (or the other element) (e.g., 44N–0P–0K–13S. For the two commonly used slow-release fertilizers (Osmocote 14–14–14 and Osmocote 18–6–12), use 14N–4.2P–11.6K and 18N–2.6P–9.9K, respectively. To describe the rate of incorporation (e.g., 8, 16, and 32 g/pot), writing “8 g (Osmocote 144.211.6)/pot” each time the rate is mentioned or discussed is not necessary; once defined, only the concentration needs to be specified. Use the following formula to convert to the proper format:  $P = 0.437 \times P_2O_5$  and  $K = 0.830 \times K_2O$ , so a fertilizer with the analysis 10–10–10 would be reported at 10N–4.4P–8.3K.

## Pesticides and Plant Growth Regulators

Common or generic names and abbreviations of pesticides should conform to those approved by the American National Standards Institute Committee K62 on Common Names for Pest Control Chemicals.

## Trade or Brand Names

Trade or brand names are not permanent; try to refer to the generic form of what you are using (e.g., “We used a tissue to wipe the thermometer.” instead of “We used a Kleenex to wipe the thermometer.”). If you must use brand names,

avoid using them without clarification. In general, refer to trade or brand names only parenthetically with the active ingredient, chemical formula, purity, and diluent or solvent stated clearly in the text and emphasized in preference to the commercial product; also, include the name, city, and state/country of the company that produces the product. Capitalize the first letter of trade or brand names. Avoid use of trade names in titles. If using trade names is unavoidable, include a footnote that disclaims endorsement of similar products of like properties (this is mandatory in some agencies and institutions).

#### Nomenclature Use in ASHS Publications

	Title	Additional index words	Abstract	Text
<b>Plants</b>				
Common name	Well-known crops	Yes	Yes	Yes
Scientific name	Little-known species Ambiguous common name	Well-known crops	Yes	Mention first time
Authority	No	No	Yes	Mention first time if not in abstract
<b>Chemicals</b>				
Common name	Yes	Yes	Yes	Yes
Chemical name	No	No	In parentheses after common name and at end of abstract	Mention first time if not in abstract; also give name of manufacturer and its location
Trade or brand name	No	No	No	Yes (parenthetically)

## DATES

Spell out the names of the days (Sunday through Saturday) in all cases.

Use Arabic numerals for all calendar dates. Abbreviate all months (except May, June, and July) when they are used with a number (e.g., year or date), but spell out the name of the month when it is used alone or at the beginning of a sentence. Abbreviations for months: Jan., Feb., Mar., Apr., Aug., Sept., Oct., Nov., and Dec.

When indicating a specific date, give day (one or two digits), month (abbreviated),

and year (four digits), if necessary, in that order (e.g., 2 Sept. 1983 or 13 July). When indicating a specific month, do not insert a comma between the month and the year (e.g., Oct. 1926). Do not use Arabic numerals for months; “4/3/83” could indicate 3 Apr. 1983 in the United States, but 4 Mar. 1983 in other parts of the world.

When referring to a specific season given with the year, capitalize the first letter (e.g., “Spring 1941”), but “the plants were harvested in summer.”

When referring to a span of 12 months (such as a fiscal year) that includes parts of 2 years or to a continuous period of more than 12 months that includes parts of 2 or more years, use the abbreviated notation (e.g., “1907–08” or “1939–43”). When referring to a span of years that includes change-of-century years, use the full notation (e.g., “1994–2002”).

When referring to a group of continuous years, add the plural “s” without an apostrophe (e.g., “1890s”).

Julian Day is not an acceptable measure of time from the end of the last year. Julian Day = number of days elapsed since 1 Jan. 4713 BCE.

## DORMANCY TERMINOLOGY

Dormancy is a temporary suspension of visible growth of any plant structure containing a meristem. Ecodormancy includes all cases of dormancy due to unsuitable environmental factors (e.g., temperature extremes and nutrient deficiencies). Endodormancy is used when the dormancy is regulated by physiological factors inside the structure (e.g., chilling responses and photoperiod responses). Paradormancy is regulated by physiological factors outside the affected structure (e.g., apical dominance and photoperiodic responses).

## EQUATIONS

When a short equation is used in the text, use parentheses and slant lines to simplify the equation. Simplify complex formulas or equations for legibility or present them as line art and include them with the figures.

Leave space before and after arithmetic symbols. If an equation needs to be divided in the text or a table heading, split it after the arithmetic symbol. Leave line spaces above and below equations in the text and center equations.

Do not number all displayed equations, unless the equation is complex or is referred to elsewhere in discussion. If numbering is necessary, use Arabic numerals placed in brackets (not in parentheses) to the far right of the equation or at the right margin. Set connecting words between equations on lines by themselves, flush against the left margin. When superscript and subscript are combined, indicate which symbol comes first. Refer to an equation in the text as “Eq. [3]” or “Eq. [10].”

## FOREIGN NAMES AND WORDS

### Names

In general, alphabetize using the particle, not the family, name.

#### DUTCH OR BELGIAN

When alphabetizing, the particle that precedes the family name remains lowercase, e.g., J. van Zanten becomes van Zanten, J. Some American authors of Belgian or Dutch extraction, however, capitalize the particle, e.g., De Hertogh, A.A.

#### CHINESE

The family name precedes the given name (usually hyphenated) when written in Chinese (e.g., Chiang Ching-kuo, when alphabetized, would be Chiang, C.). In American and British journals, however, a Chinese name usually is Anglicized and transposed; e.g., Ching-kuo Chiang.

#### EGYPTIAN

Arabic names without prefixes or variants place the family name after the given name. Shawki A. Moustafa, therefore, would be cited as Moustafa, S.A. When the particle “el” alone or a prefix or its variant (el, ibn, abdel, abdoul, abu, abou, or about) precedes a name, it is hyphenated to the word it precedes in the citation; e.g., Mahoud el Barkooki is cited as el-Barkooki, M. The particle or prefix remains lowercase.

#### FRENCH

The definitive articles (le, la, or les) alone or combined with prepositions (de, du, or des) precede the name in the citation and remain either capitalized or lowercase as they were in the original (e.g., Charles de Gaulle becomes de Gaulle, C., and Maurice LeBeau becomes LeBeau, M.)

#### GERMAN

Names containing articles or their abbreviations precede the family name in a citation and remain lowercase (e.g., Klaus von Krupp becomes von Krupp, K.)

#### INDIAN

Modern Indian names place the given name before the family name. If the family name is preceded by Sen or Das, it should remain capitalized and lead the citation (e.g., Natoobhai D. Sen Dhur becomes Sen Dhur, N.D.)

#### INDONESIAN

Family names are written last. Some Indonesians, however, have only one name (e.g., Soetono).

## JAPANESE OR KOREAN

The family name always comes first when written in Japanese or Korean. Western form usually places the given name first (e.g., Yashiro Kosaka is cited as Kosaka, Y.)

## PORTUGUESE

Citations should carry the particle (do, da, das, dos) in lowercase before the family name (e.g., Alberto Alvares do Santos becomes do Santos, A.A.)

## SPANISH

Some Spanish names and names of Spanish origin include the maternal after the paternal family name. In the transposed name, the paternal name precedes the maternal name (e.g., Jose Manuel Hernandez Gonzales becomes Hernandez G., J.M., or Carlos Perez y Martinez becomes Perez y Martinez, C.). Note that the maternal name is not separated from the paternal name by a comma in the citation.

## VIETNAMESE

The family name precedes the given name, but the first name, which is the last element, must be transposed with the middle name (e.g., Ngo Van Hai becomes Ngo, H.V.)

## Words

Whenever Latin or foreign words or phrases are used, they should be italicized if they have not been naturalized in English, but their abbreviations are not italicized (e.g., *id est*, *nomen novam*, *pro bono publico*, and *raison d'etat* but “i.e.” and “nom.nov.”). Terms that have become part of modern English—such as “media,” “data,” and “bureau” or “in vitro,” “in vivo,” and “in situ”—are not italicized. Pretentious use of foreign phrases is discouraged if a sound English equivalent is available.

Use American, rather than British, spelling (e.g., “color,” not “colour”; “center,” not “centre”; “program,” not “programme”; “rationalize,” not “rationalise”; and “gasoline,” not “petrol.” However, retain the original spelling in quotations and Literature Cited.

Capitalize the names of foreign places when they occur as part of a proper name. In languages where nouns or proper adjectives are always capitalized, retain this style in the text and literature citations. Do not capitalize a Latin preposition in the title unless it is the first word (e.g., “Viruses Effect in Vitro Propagation of Rose,” but “In Vitro Selection for Allelopathy in Tomato.”)

All foreign languages that use alphabet characters other than Roman characters and their standard diacritical marks must be transliterated to English. Such languages include Slavic (including Russian), Hebrew, Arabic, Japanese, Korean, and Chinese. Although Greek characters are available (because Greek is used extensively in mathematics), modern Greek should be transliterated to English.

## GENETIC TERMINOLOGY

### Gene Names, Symbols, and Descriptions

Identify genes by name. The name should be short (one to three words) and describe the mutant form, if identifiable as such. Otherwise, it should identify the nonprimitive form unless it has been identified previously by long usage of the primitive form. Write the names of genes in italics in Latin or English; (e.g., *male sterile*). Capitalize the first word only if the mutant form is dominant (e.g., *Early flowering*). If one or more mimics exist and the same basic name is used, identify the gene further with a number following a hyphen (e.g., *chlorophyll deficient-2*).

Start the gene symbol with the first letter of the gene name, capitalized if dominant, followed by one or two letters to distinguish it from other symbols (e.g., *Red*, *R*; *green flesh*, *gf*; and *green petal*, *gp*). Identify multiple alleles by the symbol, followed by a letter or letters as superscript(s) (e.g., *Redspotted*, *R<sup>s</sup>*; and *Red-tinged*, *R'*).

Describe a gene in the text according to its phenotype, sufficiently to describe its effect(s), but as briefly as possible.

### Linkage

Linkage information should include the names and symbols of the linked genes, the linkage detection  $\chi^2$  value and probability, the recombination value and standard error, the phase (coupling or repulsion), the heterogeneity  $\chi^2$  value (if more than one population was studied), and the type of population(s) studied ( $F_2$  or BC).

## GEOGRAPHY

Always spell out the names of countries, states (in the United States), or provinces (in Canada) when they stand alone (e.g., there is no city cited). Use U.S. post office abbreviations for states and provinces when they are given with the city or county.

Leave a space between the numerical value and the symbol (e.g., “10 g,” not “10g”). In a series of measurements, give the unit (except for the percent sign) at the end (e.g., “3 to 10 °C” or “3, 6, and 9 m” but “10%, 59%, and 104%”).

**Preferred style for some forms of measurement and abbreviation is indicated in the “Acronyms, Abbreviations, and Symbols” table; these style preferences are maintained to avoid symbol confusion.**

## ACRONYMS, ABBREVIATIONS, AND SYMBOLS

Abbreviations and symbols save space and, when used with discretion in the text, simplify complex expressions. Acronyms are words formed from the initial letter of each of the successive parts or major parts of a compound term; they are considered abbreviations in this manual. Symbols are arbitrary or conventional signs to represent operations, quantities, elements, relations, or qualities. Correct usage of symbols is important because an incorrect symbol may change the entire meaning of a quantity.

Use an abbreviation or symbol for a standard unit of measurement in the text only if the unit is preceded by a number (see “Measurements and Units” for accepted uses of abbreviations). Do not abbreviate units of measurement when they appear by themselves in the text (e.g., “the % of the concn used was the same for both trials” is incorrect (spell out “%” and “concn”). Spell out the name of a unit of measurement that follows a spelled-out number, as at the start of a sentence (e.g., “Nine milligrams is a lethal dose”).

Certain abbreviations (such as those for organic chemicals and standard procedures) are not acceptable without explanation. Define such abbreviations at the first mention by following the written-out term with the abbreviation enclosed in parentheses [e.g., “1 *H*-indole-3-acetic acid (IAA)” and “thin-layer chromatography (TLC)]; use the abbreviation thereafter. Likewise, identify in parentheses symbols that have yet to achieve common usage when first introduced and reidentify, if necessary, to avoid confusion with similar symbols [e.g., newtons and nitrogen share the same symbol (N)]. Use standard or widely accepted abbreviations in tables and figures, if necessary, for format considerations. Avoid using abbreviations in titles of papers.

Do not letter space the uppercase abbreviations for chemical expressions (e.g., TAA), organizations (e.g., ANSI), or government agencies (e.g., NIH). “ASHS” may be used on the first reference, without full name, except in byline addresses.

Letter space the parts of a lowercase abbreviation of a compound term only if no period is between them (e.g., “et al.,” and “sp gr”—but “a.i.,” “i.e.,” and “gen.nov.” Lowercase abbreviations of many compound terms are written without periods and without spaces between the parts (e.g., “mp” and “df”).

Do not italicize abbreviations of Latin terms; periods follow only the terms abbreviated. For example, “*et alla*,” “*et cetera*,” “*id est*,” and “*exempli gratia*” are abbreviated “et al.,” “etc.,” “i.e.,” and “e.g.,” respectively. Use “et al.” to indicate additional authors, not “etc.” The abbreviation “e.g.” precedes an example; the abbreviation “i.e.” precedes a clarification. A pair of commas separates “i.e.” and “e.g.” from their references.

### Acronyms, Abbreviations, and Symbols

Word/unit	Abbrev./symbol	Accepted usage
active ingredient	a.i.	all uses
analysis of variance	ANOVA	second and subsequent uses
asterisk	*	use only for levels of significance within tables, not for footnotes.
at	@	spell out, do not use symbol except for e-mail
average	avg	table column heads only
base pair	bp	second and subsequent uses
by (dimension, interaction)	×	all uses
chilling injury	CI	second and subsequent uses
chi square value	$\chi^2$	statistical reporting
coefficient of determination	$R^2$ , $r^2$	statistical reporting; $R^2$ for three or more variables, $r^2$ for two variables (italics)
coefficient of variation	cv	all uses
colony-forming units	cfu	second and subsequent uses
company	Co.	when used as part of a proper noun
concentration	concn	table column heads only
controlled atmosphere	CA	second and subsequent uses
crossed with	x	lowercase
cross species (interspecific hybrid)	×	(math ×, no space between the symbol and the specific epithet)
cultivar(s)	cv., cvs.	formal nomenclature only (after a specific epithet)
degree(s) of freedom	df	statistical reporting
electrical conductivity	EC	second and subsequent uses
enzyme-linked immunosorbent assay	ELISA	second and subsequent uses
equation	Eq.	with numerals only; enclose numeral in brackets as side heading for equation within text

experiment	Expt.	with numerals; table column heads
Figure(s)	Fig(s).	with numerals only
filial generations	F <sub>1</sub> , F <sub>2</sub>	all uses (with subscripts)
gas-liquid chromatography	GLC	second and subsequent uses
height	ht	table column heads only
honestly significant difference	HSD	with numerals only
high-performance liquid chromatography	HPLC	second and subsequent uses
hours (24-h time)	HR	clock time only
infrared	IR	second and subsequent uses
inside diameter	i.d.	all uses
latitude	lat.	with numerals only
least significant difference	LSD	second and subsequent uses
logarithm, common (to base 10)	log	with numerals only
logarithm, natural	ln	with numerals only
longitude	long.	with numerals only
magnification, power of	×	before numeral, no space (e.g., ×40)
Malling	M.	followed by period (e.g., M.26)
Malling-Merton	M.M.	followed by period (e.g., M.M.106)
mean of a sample	X, Y	statistical reporting (uppercase under bar)
modified atmosphere	MA	second and subsequent uses
month	mo.	tables and graphs only
nonsignificant	NS	tables and footnotes only
number	no.	with numerals; in table column heads, do not use #
number of observations in a sample	n	statistical reporting
number of observations in the population	N	statistical reporting
osmotic potential	Ψ <sub>s</sub>	second and subsequent uses
outside diameter	o.d.	all uses
parental generations	P <sub>1</sub> , P <sub>2</sub>	all uses (with subscripts)
photosynthesis (net)	P <sub>n</sub>	second and subsequent uses

photosynthetically		
active radiation	<i>PAR</i>	second and subsequent uses; note italics
photosynthetic photon		
flux	<i>PPF</i>	second and subsequent uses; note italics
plant introduction	PI	all uses
polyvinyl chloride	PVC	second and subsequent uses
probability	<i>P</i>	with numerals only (italic)
randomly amplified		
polymorphic DNA	RAPD	second and subsequent uses; do not use RAPDs, instead use RAPD markers
relative humidity	RH	with numerals only; second and subsequent uses
restricted fragment		
length polymorphism	RFLP	second and subsequent uses; plural—RFLPs—okay
sample coefficient		
of linear correlation	<i>r</i>	statistical reporting (italic)
scanning electron		
microscopy	SEM	second and subsequent uses not abbreviated in abstract
simple sequence		
repeats	SSR	
species	sp.	formal nomenclature only; spell out in titles (singular and plural)
standard deviation		
of a sample	SD	all uses
standard error of the		
mean of a sample	SE	all uses
stomatal conductance	$g_s$	second and subsequent uses (note italics for “g”)
Student’s <i>t</i> statistic	<i>t</i>	statistical reporting (italic)
subspecies	ssp.	formal nomenclature only (singular and plural)
temperature	temp	table column heads only
thin-layer		
chromatography	TLC	second and subsequent uses
transmission electron		
microscopy	TEM	second and subsequent uses
ultraviolet	UV	second and subsequent uses
variance ratio	F	statistical reporting (in an analysis of variance)
volume (mix ratio)	v/v	with numerals only
volume (space)	vol	table column heads only; no period
weight	wt	only in tables and graphs
wettable powder	WP	second and subsequent uses, with percents
year	yr	table column heads only

## SI Units and Prefixes

Word/unit	Abbrev./symbol	Accepted usage
bar		do not use; convert to SI unit: 1 bar = 0.1 MPa = 100 kPa
Becquerel	Bq	derived SI unit for radioactive disintegrations per second
Brix	°Brix	with numerals only; use only with syrups, use soluble solids concentration (%) for juices extracted from plant tissues
Celsius	°C	all uses
centimeter	cm	with numerals only
cubic centimeter	cm <sup>3</sup>	with numerals only, equivalent to 1 mL
cubic decimeter	dm <sup>3</sup>	equivalent to 1 L
cubic meter	m <sup>3</sup>	with numerals only
Curie	Ci	do not use; convert to GBq (1 Ci = 37 GBq)
Dalton	Da	use the SI unit u, the unified atomic mass unit, which is exactly equivalent to the Dalton; define u at first use
day	d	all uses, not abbreviated in abstract
degree (angular)	°	with numerals only
decisiemens	dS	with numerals only
decimeter	dm	SI unit for 10 <sup>-1</sup> m
diameter	diam	table column heads only
disintegrations per minute	dpm	do not use, see Becquerel
eigen volt	eV	with numerals only
Einstein	E	a discarded unit for mole of photons; use $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$
gram	g	with numerals only
grams per cubic centimeter	g·cm <sup>-3</sup>	Preferably use g·mL <sup>-1</sup> or g·L <sup>-1</sup>
gravity	<i>g<sub>n</sub></i>	force of gravity, average of earth's surface (italicize <i>g</i> only); no times (×) needed; use for centrifugation
Gray	Gy	SI-derived unit for absorbed radiation dose (J·kg <sup>-1</sup> ); 1 Gy = 100 rads (an obsolete unit)
hectare	ha	with numerals only
hertz	Hz	with numerals only
hour (unit)	h	with numerals; not abbreviated in abstract
joule	J	with numerals only
Kelvin	K	SI base unit for temperature; note not °K

kilodalton	kDa	with numerals only
kilogram	kg	with numerals only
kilolux	klx	with numerals only
kilometer	km	with numerals only
kilovolt	kV	with numerals only
krad		do not use; see Gray
liter(s)	L	with numerals only
lux	lx	with numerals only
megagram	Mg	with numerals only
meter	m	with numerals only
metric ton (tonne)	t	with numerals only
microequivalent	μeq	with numerals only
microgram	μg	with numerals only
microliter	μL	with numerals only
micrometer (formerly, micron)	μm	with numerals only
micromolar	μM	with numerals only
micromole	μmol	with numerals only
milliequivalent	meq	with numerals only
milligram	mg	with numerals only
milliliter	mL	with numerals only
millimeter	mm	with numerals only
millimolar	mM	with numerals only
millimole	mmol	with numerals only
millivolt	mV	with numerals only
minute (time)	min	may be used with SI, but use the second whenever appropriate; use only with numerals and in table column heads
molar	M	with numerals only; use for growth regulators
mole	mol	with numerals only
nanoliter	nL	with numerals only
nanometer	nm	with numerals only
	nm <sup>-1</sup>	spectral irradiance (moles of photons) per unit wavelength within a specified range
nanosecond	ns	with numerals only
Newton	N	with numerals only; derived SI unit for force; do not use kg per unit area (1 kg mass exerts a force of 9.8 N on earth's surface)
normal (gram-equivalents per liter)	N	with numerals only

pascal	Pa	with numerals only
rad		obsolete unit for radiation; see Gray
revolution(s)	r	with numerals only
rotations per minute	rpm	for all legitimate uses. Do not use for centrifuge rotations—use $g_n$ (force of gravity)
second (time)	s	SI base unit of time; use with numerals only; square
centimeter	cm <sup>2</sup>	with numerals only
square meter	m <sup>2</sup>	with numerals only
tonne (metric)	t	with numerals only
volt	V	with numerals only
watt	W	with numerals only
week	week	acceptable non-SI unit for long periods; always spell out; may be used with a negative superscript (e.g., g·week <sup>-1</sup> )

### Common SI prefixes:

10 <sup>6</sup> mega	M	10 <sup>3</sup> kilo	k	10 <sup>2</sup> hecto	h
10 <sup>-1</sup> deci	d	10 <sup>-2</sup> centi	c	10 <sup>-3</sup> milli	m
10 <sup>-6</sup> micro	μ	10 <sup>-9</sup> nano	n	10 <sup>-12</sup> pico	p

## Air Flow

According to Savage (1979, p. 495), wind speed has the units  $m \cdot s^{-1}$ ,  $mm \cdot s^{-1}$ , or  $\mu m \cdot s^{-1}$ . The  $km \cdot h^{-1}$  unit is not preferred. State the height above surface when reporting results in field studies because wind speed varies with this value. In controlled environments, reference to the volume of air movement per unit time or the volume rate of air movement is more meaningful. The unit of this quantity is  $m^3 \cdot s^{-1}$ .

## Application Rates

Application rates are reported in kilograms (or grams, milligrams, or micrograms if more appropriate) per square meter ( $kg \cdot m^{-2}$ ) for applications of dry materials (such as seed, pesticide, and fertilizer) in small experimental plots. For large-scale applications, report kilograms per hectare ( $kg \cdot ha^{-1}$ ), although the hectare ( $10^4 m^2$ ) is not a recommended multiple of a basic SI unit. For liquid applications to small and large plots, report liters per square meter ( $L \cdot m^{-2}$ ) or liters per hectare ( $L \cdot ha^{-1}$ ), respectively. When volume may be important, report liters per cubic meter ( $L \cdot m^{-3}$ ).

## Centrifugation

Use  $g_n$ . Italicize the “g” only. Example: The sample was centrifuged at 20,000  $g_n$ .

## Concentration

Expressing concentration in parts per million (ppm) or parts per billion (ppb) is acceptable, but not preferred, because the terms are ambiguous. When the molecular mass of a substance is known, report concentration as moles per kilogram ( $\text{mol}\cdot\text{kg}^{-1}$ ), moles per cubic meter ( $\text{mol}\cdot\text{m}^{-3}$ ), or moles per liter ( $\text{mol}\cdot\text{L}^{-1}$ ). When molecular mass is unknown, report concentrations as milligrams per kilogram ( $\text{mg}\cdot\text{kg}^{-1}$ ), milligrams per cubic meter ( $\text{mg}\cdot\text{m}^{-3}$ ), or milligrams per liter ( $\text{mg}\cdot\text{L}^{-1}$ ). Use the small capital letters  $N$  and  $M$  (indicated by double-underscoring) to indicate normal and molar concentrations, respectively (e.g.,  $2\ \underline{N}\ \text{NaSO}_4$ ). For dilute solutions, use  $\mu M$  (e.g.,  $1.0\ \mu M$ ), rather than  $10^{-6}\ M$ . Use the decimal system, or multiplier of 10, for units of concentration (e.g.,  $0.1\ M$  or  $0.1\ \text{mol}\cdot\text{L}^{-1}$ , not  $M/10$ ). Avoid percentage expressions, but when using solution percentages, indicate v/v or w/v.

## Exchange Capacity

Give exchange capacity and exchangeable ion composition in equivalents (eq) or milliequivalents (meq) per gram (these are preferred.). If the cation exchange capacity is determined by the single ion saturation technique, the ion used should be specified because it can affect the cation exchange capacity measured.

## Frequency

Frequency may be expressed as the hertz (Hz) or the reciprocal second ( $\text{s}^{-1}$ ), which are equivalent. Hertz is preferred for frequency of light or other electromagnetic radiation, whereas the reciprocal second is preferred for rotational frequency. Revolutions per second ( $\text{r}\cdot\text{s}^{-1}$ ) is preferred to revolutions per minute (rpm) because minute is not a basic SI unit.

## Gauge

Always give actual dimension (e.g., “the wire was 0.13 mm thick”). Gauge numbers are meaningless to many readers, as there are several systems.

## Heat Quantities

Express specific latent heat as joules per kilogram ( $\text{J}\cdot\text{kg}^{-1}$ ). Express heat flux as joules per second ( $\text{J}\cdot\text{s}^{-1}$ ) or the watt (W). Heat flux density is the rate of energy of change per unit area  $\text{J}\cdot\text{s}^{-1}\cdot\text{m}^{-2}$ ; however, watts per square meter ( $\text{W}\cdot\text{m}^{-2}$ ) is used more often in the United States.

## Length

The SI unit of length is the meter (m). The micron and the millimicron have been replaced by the micrometer ( $\mu\text{m}$ ) and the nanometer (nm), respectively.

## Light

See “Photosynthetic radiation.”

## Magnification

The multiplication sign should precede the level in expressions of power of magnification with no space between (e.g.,  $\times 400$ ).

## Mass

See “Weight.” Weight varies with the force of gravity, whereas mass is independent of gravity. However, many journals, including ASHS publications, continue to use weight.

## Mix Ratios

Do not use slant lines to express ratios (e.g., “3/2” should be expressed as “3:2” with no spaces before or after the colon). There is an exception to this rule: the mix ratios “w/v” and “v/v” are permissible when describing quantity-to-quantity amounts). When giving the media mix ratio for containers, use the following style: “1 sand : 1 clay : 1 sphagnum peat (by volume).” Note the spaces on either side of the colons. Use “by volume,” not “v/v/v.” Use “w” and “v” (for weight and volume, respectively) in mix ratios only.

## Monetary

If monetary units are necessary to report crop yield values, the value in U.S. dollars should be reported first, with the local equivalent following in parentheses. Express values less than \$1 decimally (e.g., \$0.80)—although 80¢ is permissible.

## Percent

The percent sign (%) is used with numerals only; otherwise, the term “percent” is written out, as one word. Use the percent sign in a series of percentages (e.g., “tested at the 1%, 5%, 10%, and 20% levels.” Use the percent sign with each of a series of numbers if they precede the object (e.g., “There was no change when plants were sprayed with the 5% or the 8% solutions.” Repeat the percent sign when giving a range (e.g., “30% to 50%”). Do not average data expressed in percentages.

## Photosynthetic Radiation

While commonly used as a unit for photosynthetically active radiation (*PAR*), the einstein (E) is not an SI unit. SI units of micromoles per square meter per second ( $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ ) are equivalent and should be used. Photosynthetic photon flux (*PPF*) is photon flux in the 400- to 700-nm waveband. For studies with other wavebands, the waveband should be specified.

## Precipitation

Should be in millimeters (water depth).

## Pressure

The SI unit of pressure is the pascal (Pa) or newtons per square meter ( $\text{N}\cdot\text{m}^{-2}$ ). Do not use kilograms per meter ( $\text{kg}\cdot\text{m}^{-1}$ ) or pounds per square inch (psi) for pressure readings. Instruments do not measure or test pressure and should not be called “pressure testers”; they should be referred to as penetrometers or firmness testers.

## Relative Humidity

Relative humidity is the ratio of specific humidity to the saturation specific humidity, expressed as a percentage. The unit of relative humidity is the percent. If the term “specific humidity” is preferred, then the units  $\text{g}\cdot\text{kg}^{-1}$  may be used.

## Sieve Size

Give pore dimension or the number of pores per unit area.

## Temperature

Generally, the term “temperature” is meaningless—an adjective must accompany the word. For example, we speak of “leaf temperature,” “soil temperature,” or “air temperature.” Each of these temperatures is defined carefully so as not (in the case of air and leaf temperatures) to include the heating effects of the sun’s radiation. Report the type of sensor and location used for temperature readings. Temperatures may be “high” or “higher,” “low” or “lower,” but not “warm” or “warmer,” “cool” or “cooler.”

The ASHS-preferred unit of temperature is in degrees Celsius ( $^{\circ}\text{C}$ ), not the SI unit the kelvin (K, not  $^{\circ}\text{K}$ ). Do not use the synonym “centigrade.”

Use the symbol  $^{\circ}\text{C}$ , with a degree sign, each time a temperature is mentioned. When reporting temperature in a series or in a range, use the symbol  $^{\circ}\text{C}$  at the end (e.g., “20, 40, and 50  $^{\circ}\text{C}$ ” or “18 to 24  $^{\circ}\text{C}$ .” When temperatures are separated in the sentence, use the symbol  $^{\circ}\text{C}$  with each (e.g., “at 32.2  $^{\circ}\text{C}$  than at 21.1  $^{\circ}\text{C}$ ”). Report day and night temperatures when needed (e.g., “27  $^{\circ}\text{C}$  day/13  $^{\circ}\text{C}$  night”).

To avoid confusion with temperatures below 0  $^{\circ}\text{C}$ , do not use the range (en) dash with temperature readings (e.g., use “8 to 10  $^{\circ}\text{C}$ ,” not “8–10  $^{\circ}\text{C}$ ,” or use “–4 to –2  $^{\circ}\text{C}$ ,” not “–4–2  $^{\circ}\text{C}$ ”).

## Thickness

While used conventionally to give the thickness of plastic sheeting, mils are not SI units. Instead, use millimeters to give thickness of plastic or any other thin material.

## Time

Two time systems are appropriate, depending on how the author wishes to designate time:

- The 24-h system is indicated by four digits, the first two for hours and the last two for minutes. The day begins at midnight denoted 0000 HR, and the last minute of the day is 2359 HR. Thus, 0830 HR is the same as 8:30 AM, 1245 HR is the same as 12:45 PM, and 2315 HR is the same as 11:15 PM. Use the small capitals HR to designate clock hours, as distinguished from the abbreviation used for quantitative hours (h).
- The 12-h AM/PM system sometimes leads to confusion; e.g., “12:00” can mean noon or midnight. Use the small capitals AM and PM to designate before and after noon, respectively. Indicate the time in minutes following the colon, even if it is zero; e.g., “3:00 AM” is correct, rather than “3 AM.” Do not use the contraction “o’clock” with abbreviations of time.

The abbreviations for time zones (GMT, EST, CDT, etc.) are irrelevant to most studies. If daylength is critical, do not imply it through time-zone abbreviations. Give daylength in quantitative hours (e.g., “11 h 22 min” with no comma) along with quality of daylight.

Abbreviate the terms “hour(s),” “minute(s),” and “second(s),” (h, min, and s, respectively) in table column headings and when used with a number in the text, but spell out in the abstract. Abbreviate the terms “year(s),” “month(s),” and “week(s)” (yr., mo., and wk., respectively) in table column headings only, but spell them out when used with a number in text (e.g., “the project was completed in 4 months and 3 weeks”).

## Transpiration

Express transpiration as kilograms per square meter per second ( $\text{kg}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ ) on a mass basis and as cubic meters per square meter per second ( $\text{m}^3\cdot\text{m}^{-2}\cdot\text{s}^{-1}$  or  $\text{m}\cdot\text{s}^{-1}$ ) on a volume basis.

## Volume

The SI unit of volume is the cubic meter ( $\text{m}^3$ ). The unit cubic centimeter ( $\text{cm}^3$ , not cc) is acceptable. Give the volume of all containers used in an experiment. Other dimensions can be added if relevant.

## Water Potential

According to Savage (1979, p. 495), volumetric water potential is the potential (energy) needed to move a unit volume of water from the system under consideration to the reference position, normally taken to be that of pure free water at the same temperature as the water in the system and at a pressure of one standard

atmosphere, namely 101.3 kPa. Hence, the units of volumetric water potential are  $\text{J}\cdot\text{m}^{-3}$ ,  $\text{N}\cdot\text{m}^{-2}$ , or Pa. Alternatively, the term “specific water potential” has the same meaning as volumetric water potential, except that a unit mass of water is moved to the reference state and the unit is  $\text{J}\cdot\text{kg}^{-1}$ . Volumetric water potential =  $\pi_w(T) \times$  specific water potential where  $\pi_w$  is the density of water at temperature T. Many authors state incorrectly that  $\pi_w = 1000 \text{ kg}\cdot\text{m}^{-3}$ , implying that it is a constant for all temperatures.

## Weight

See also “Mass.” The unit of weight is the kilogram (kg). Weight can be expressed also in grams (g), milligrams (mg), micrograms ( $\mu\text{g}$ ), etc. [Weight technically is a measure of force produced by gravity, and the proper unit is the newton (N), or gravitational attraction]. Do not combine fresh weight and dry weight with SI units. State separately, such as “Data were recorded on a fresh weight basis ( $\text{g}\cdot\text{kg}^{-1}$ ).

## Whole Numbers

As a general rule, use Arabic numerals for whole numbers, but spell out numbers in the following cases: 1) when the number is below 10 and immediately precedes a non-SI unit of measure (e.g., “two plants” but “2 m,” “three trees” but “3 ha”), 2) when a number is used as a figure of speech (e.g., “a thousand times no”), 3) when numbers begin sentences (however, reword sentences to avoid starting with a number or a series of numbers, or end the preceding sentence with a semicolon), 4) when two numbers are adjacent to each other (e.g., write “thirty 10-L pots” instead of “30 10-L pots”), 5) in a series of three or more numbers all below 10 (e.g., “two, five, and nine cultivars,” but “6, 8, and 12 leaves,” and “three and 15 times”), 6) when a number is part of a proper name (except for cultivar names that include numbers), and 7) when the numbers 1 through 10 appear in titles of papers.

Use Arabic numerals with a unit or abbreviation of measure, including monetary units, proportions, rates, temperatures, percentages, dates, time, pages, and numerical designations such as “Expt. 3.” Use Arabic numerals for all mathematics where symbols are used (e.g.,  $3 \times 4$ ), where arithmetic function is discussed (e.g., “divide by 6”), and where exponents are used (e.g.,  $10^{10}$ ).

Use Roman numerals only in literature citations when the original used Roman numerals.

In numbers consisting of two to four digits (through the “thousandth place”), run the numerals together (e.g., 2000 or 6891), but in tables where there are numbers consisting of four or more digits, place commas between each group of three digits (e.g., 1,000; 10,000; or 1,000,000).

Change numbers having several zeros by substituting a word (e.g., 7.8 million, not 7,800,000), using exponents (e.g.,  $10^6$ , not 1,000,000), or changing the basic unit of measurement (e.g., 25 kg, not 25,000 g). You may use exponential functions to reduce numbers, particularly in tables and figures for space considerations.

Do not use full parentheses to list points numerically in a sentence or paragraph. Use closing parentheses only with numbers or lowercase letters to list points [e.g., “5)” or “d)”].

Plurals of numbers, such as years, are formed without apostrophes (e.g., “the 1890s” or “6s and 7s”). Numbers in a series are separated by commas, with a comma preceding the last conjunction (e.g., “57, 14, 115, and 56”).

#### DECIMALS

Round off all decimals to no more than three significant digits. The period (not the comma) is used for the decimal point. Decimal figures less than 1 carry a zero before the decimal point (e.g., 0.16, not .16).

#### FRACTIONS

Write fractions following a whole number or in a series with Arabic numerals and a slant line (e.g.,  $23 \frac{1}{2}$ , or  $1 \frac{1}{2} + 2 \frac{1}{2} + 2 \frac{1}{2}$ ). Spell out fractions when they stand alone (note hyphen) (e.g., “one-third,” “one-half,” and “two-fifths”). Use care in transposing common units such as one-half; e.g., if  $1\text{-}\frac{1}{2}$  pots of soil were used, do not write “1.5” unless measurement was accurate to one-tenth; conversely, if measurement was accurate, use decimals rather than fractions.

#### ORDINAL NUMBERS

Follow the same rules as for whole numbers when using ordinals (e.g., “third tree” but “3rd year,” and “thirteenth” is “13th,” but “first week” and “first year”). When enumerating parts of an argument, using the words “secondly” or “thirdly” is poor grammar; one does not say “firstly.” Begin progressive clauses with the words “second,” “third,” “fourth,” etc.

#### RANGE OF NUMBERS

When reporting ranges, “from 10 to 15” is preferred, but “range 10–15” (with en-dash) is acceptable.

#### ROUNDING OFF

Use the following procedure for rounding a number in which three significant digits are to be retained:

If the digit to the right of the third digit is less than 5, leave the third digit unchanged (e.g., 4.122 rounds to 4.12).

If the digit to the right of the third digit is more than 5, increase the third digit by 1 (e.g., 4.128 rounds to 4.13).

If the digit to the right of the third digit is exactly 5, followed only by zeros, and

the third digit is even, leave the third digit unchanged (e.g., 4.125 or 4.1250 rounds to 4.12).

If the digit to the right of the third digit is exactly 5, followed only by zeros, and the third digit is odd, increase the third digit by 1 (e.g., 4.135 or 4.1350 rounds to 4.14).

If the digit to the right of the third digit is 5 and there is at least one digit other than 0 to the right of the 5, increase the third digit by 1 (e.g., 4.1253 rounds to 4.13).

When rounding an inconveniently large number, follow a similar procedure (e.g., the number 2,845,492 can be expressed as 2.8 million).

### SIGNIFICANT FIGURES

In reporting a number, the number of significant digits (those known to be reasonably reliable) must be commensurate with the precision of the experimental method. More than three significant digits rarely are justified in horticultural measurements. If the quantity must be converted to SI units, multiply the quantity by the exact conversion factor and then round to the appropriate number of significant digits.

A recorded value of 37 mL represents two significant digits (3 and 7). If this same volume were written as 0.037 L, it would still contain only two significant digits. Zeros appearing as the first digits of a number are not significant since they merely locate the decimal point; thus, the two zeros in the value 0.037 are not significant. The values 0.0370 L and 0.370 L, however, represent three significant digits (3, 7, and the last zero), the value 1.037 L represents four significant digits (1, 0, 3, and 7), the value 1.0370 L represents five significant digits (1, 0, 3, 7, and 0), and the value 37.00 L represents four significant digits (3, 7, and the two zeros).

Use only the number of significant figures that is justified by the precision of the least precise measurement and that is meaningful in the context of use (e.g., leaf area was 137.6 mm may be justified, but it is not meaningful. Use 138 mm).

Avoid exaggerated precision in statistical reporting. When reporting means, more than three significant digits rarely are justified. Also avoid exaggerated probability statements: computers can be programmed to provide probability statements with many significant digits, but these are based on assumptions that are never met exactly in actual practice.

### Yield

Report crop yields in kilograms per hectare ( $\text{kg}\cdot\text{ha}^{-1}$ ), megagrams per hectare ( $\text{Mg}\cdot\text{ha}^{-1}$ ), or tonnes per hectare ( $\text{t}\cdot\text{ha}^{-1}$ ).

## PUNCTUATION

Proper punctuation marks emphasize the relationship among words and word groups. Although the current tendency is to avoid unnecessary punctuation, overpunctuation is preferred to ambiguity. Often sentences can be rewritten or divided into two or more sentences.

The following sections describe proper usage of punctuation in ASHS publications but are not meant to be a full treatment of punctuation in English usage.

### Apostrophe

Do not use an apostrophe to indicate the omission of a letter or letters in contractions (e.g., use “Assn.,” not “Ass’n”). Most contractions (can’t, rec’d, he’s) are undesirable in scientific writing.

Do not use an apostrophe with a personal pronoun in the possessive case (e.g., “its” and “hers”).

Do not use an apostrophe or an “s” when making symbols plural (e.g., “SDs” for standard deviation(s), not “SD’s”).

Do not use apostrophes for prime and minute symbols.

### Brackets

Use brackets for the following:

- To enclose material (such as an editor’s note) that has been inserted in a quotation.
- To enclose material that already contains material in parentheses, such as a scientific name with more than one authority; e.g., “peach [*Prunus persica* (L.) Batsch] has the ...”.
- To enclose equation numbers:  $x + y = z$  [1]
- For additional brackets, use the following order: { [ ( ) ] }

### Capitals

Capitalization should follow standard English usage [e.g., for the first word of each complete sentence, for proper nouns (names), and for the first word of an independent clause following a colon].

In addition, use initial capitals for the following:

- The first word and proper nouns and adjectives in the title of an article or book when cited in the text; but only the first word of the title when listed in literature citations.
- A professional, civil, military, or religious title that immediately precedes a personal name (e.g., Senator Jackson, Captain Hornblower).

- Do not** use initial capitals for the following:
- Names of subject fields for which a degree is given (unless the subject is a language).
  - Words derived from proper names but now in common usage (e.g., bunsen burner, petri dish).
  - Seasons of the year (e.g., spring) unless referring to a specific season (e.g., Spring 1997).
  - Professional titles when not preceding a name (e.g., assistant professor). Second and/or subsequent words of a hyphenated term when the first word is capitalized.
- See sections on Geography, Trade names, and Taxonomy for specific examples in those areas.**

## Colon

Use a colon to mean “note what follows,” especially after expressions like “as follows” or “the following.” A colon should fall at the end of, not in the middle of, a thought. **A colon should not precede a verb or preposition.**

**YES** We collected several plant parts: leaves, shoots, and stems.

**NO** We collected: leaves, shoots, and stems.

Use a colon to separate the parts of ratios (except for quantity-to-quantity mix ratios, where the slant line is used), proportions, and dilutions (e.g., “1:3” for “1 part to 3 parts” or “1 part in 3 parts”). There is a space before and after the colon when the number precedes the ingredient (e.g., “1 sand : 1 clay : 1 sphagnum peat”).

A colon should fall outside a closing parenthesis or closing quotation mark.

## Comma

Use a comma for the following:

To separate the elements (words, phrases, or clauses) of a simple series of three or more items, including the element preceding the conjunction (e.g., “apples, peas, or oranges” and “the tomatoes wilted, the beans died, and the peppers bore no fruit”). If any of the elements contain internal punctuation, separate them with semicolons.

Use a comma also to set off a conjunctive adverb (such as “therefore,” “thus,” “since,” “however,” and “accordingly”) or a transitional phrase (such as “in fact,” “after all,” and “on the contrary”) that introduces a distinct break in continuity of thought.

Commas belong outside a closing parenthesis and inside a closing quotation mark, unless the quoted material is the name of a cultivar.

Use a comma inside the closing quotation mark when a sentence continues beyond the end of a quotation, even though the comma is not part of the quotation.

Do not use a comma for the following:

Between the month and year (e.g., “June 1983,” not “June, 1983”).

In numbers of four digits (e.g., “6981,” not “6,981”).

## Dash, em

The em-dash is used (sparingly) to indicate an abrupt break in thought within a sentence (e.g., “Federal funds allocated to the states—except for funds reserved for cooperative region research—are determined by a formula based on the size of the rural population in each state”).

## Dash, en

The en-dash is used to indicate range (e.g., “p. 7–13”), joining of two nouns (e.g., “soil–air interaction”), compounding of capitalized names (e.g., “Chicago–Moscow night”), and fertilizer components (e.g., “10N–3P–83K”).

Do not use a minus sign or the word “from” with an en-dash (e.g., use “–3 to –6 °C,” not “–3—6 °C,” and use “from page 8 to 11,” not “from page 8–11”).

## Diacritical Marks

Retain diacritical marks in authors’ names, street addresses, and literature citations. Do not use them for names of cities and countries, unless there is no English equivalent (e.g., use “Spain,” not “España,” or use “Cologne,” not “Köln”).

## HYPHENATION, COMPOUND TERMS

### Compound Terms

A compound term is a combination of two or more words that, through use together, have acquired a special meaning. Use a hyphen for noun–adjective expressions, such as “on a per-gram basis” and when it adds clarity. Avoid over-use—if clear without a hyphen, leave out (e.g., dry weight basis).

### Adverbs

Never use a hyphen for a two-word modifier if the first word ends in “ly” or if the word is “very” (e.g., “freshly harvested tomatoes” and “very high frequency”).

### Modifiers

Hyphenate compound adjectives before the word they modify but not after the word (e.g., “split-plot design,” but “each split plot,” or “a winter-hardy plant,” but “it is winter hardy,” or “a 5-mL drench,” but a “drench of 5 mL,” or “a 12-h cycle,” but “every 12 h.” A compound modifier containing a numeral or spelled-out number usually is hyphenated (e.g., “two-thirds majority,” “a 4-min exposure,” and “5-year-old field.”)

## Open compound nouns

Open compound nouns that are well established and widely used in a field usually are not hyphenated (e.g., “stem rust control” or “red kidney bean”).

Use a hyphen (which is not as long as an en-dash) for the following:

- Between a prefix and a proper noun or name (e.g., “pre-Renaissance”).
- Between elements of a unit modifier in attributive position to avoid ambiguity (e.g., “he is a small-business entrepreneur”—to avoid the connotation that he is a business entrepreneur of small stature).
- Suspend the first part of a hyphenated, compound modifier when used with another hyphenated, compound modifier (e.g., “a 6- or 8-d interval”—note the space following the hyphen after “6”). Also, the elements in a series carry a hyphen if they are modifiers (e.g., “20-, 30-, and 40-cm depths”).
- Between the numerator and denominator of a spelled-out fraction (e.g., “one-third”).
- To break a chemical name at the end of a line, only if the hyphen is a part of the name.
- For place keeping in tables where data have been excluded (use three hyphens).

Do not use a hyphen for the following:

- To divide a word at the end of a line in a typed manuscript—go to the next line.
- After adverbs ending in “ly” or before words preceded by the adjective “very.”
- In measurements where the preposition “of” is understood (e.g., do not write “5-mL water” for “5 mL [of] water”).
- With prefixes such as “re-,” “non-,” “pre-,” “post-,” and “sub-,” except in the cases of multiple prefixes or where the meaning of the word would be understood (e.g., re-cover a canopy vs. recover from an illness). When it is necessary to break a chemical name between lines in a manuscript (instead, use the close-up symbol).

**air-conditioning** air-condition (verb), air-conditioned (adjective), and air conditioner (noun).

**by-product**

**clear-cut**

**cool-white**

**co-worker**

**-fold** denotes multiplication by the root. It is hyphenated and roots are given in Arabic numerals [e.g., “12-fold” (“twelve-fold” and “12fold” are incorrect)].

**4-H**

**-like** not hyphenated, unless the suffix follows a word ending in “ll” (e.g., “shell-like”), a long word (e.g., “picuropucumonia-like”), a proper name (e.g., “June-like”), a hyphenated word (e.g., “half-ape-like”), or when it is used as a modifier (e.g., “doll-like appearance,” “animal-like behavior”).

**one-half, two-thirds, etc.**

**peat-lite**

**root-knot nematode**

**water-holding capacity**

**year-round**

## Italics

Use italics for the following:

- The scientific name of a genus, species, or subspecies, but not for the names of higher taxa. Italicize all scientific trinomials of plants and organisms (but not the authorities).
- The titles of books, journals, or other published works when they are mentioned in the text or footnotes, but not when they are listed in literature citations.
- Latin and foreign words and descriptive phrases that have not been naturalized in English (see “Foreign Words,” page 33).
- A word or phrase given stress or emphasis. Overuse of italics for this purpose, however, destroys the emphasis. Where italics are added for stress within quotations, include a parenthetical note between the end of the quotation and the period [e.g., “‘Only results of *original* research are acceptable’ (italics mine)”]. A word or phrase discussed as a term or introduced for specific discussion is not italicized but is enclosed in double quotation marks.
- An unknown or a constant in mathematical equations, some statistical variables or functions, and symbols for certain physical properties (e.g., *g* for gravity, *P* for probability, and *r* for sample coefficient of linear correlation).
- Prefixes, symbols, or letters designating configurations of the chemical structure of organic compounds used for pesticides. Examples include: hyphenated prefixes (*cis-*, *trans-*, but not *bis-* and *tris-*), elements that occur as locants (*O-*, *S-*, *N-*, *H-*), and configurational relationships (*R*, *S*).
- Names of genes and gene descriptions (e.g., *af* and *rin*). Also, the symbols when referring to chromosome number (e.g., somatic number ( $2n = 56$ ), gametic number ( $n = 28$ ), and genomic number ( $x = 7$ )).

Do not use italics for complete quotations in a foreign (non-English) language.

## Parentheses

Use parentheses to enclose the name of the author of the original taxonomic description when a species is transferred to a genus other than the one to which it was assigned originally.

Use a closing parenthesis to enumerate points in a sentence [e.g., “a)...b)...c)...” or “(1)...(2)...(3)...” or to set off the number or letter of an enumerated paragraph that begins a line. Do not label enumerations unless the

labels are necessary for clarification or speed of reading.

Do not use parentheses within parentheses; use em-dashes or parentheses within brackets instead.

## Period

Periods are used to end a sentence or indicate an abbreviation. They belong inside of quotation marks, unless the quoted material is the name of a cultivar.

Use a period for the following:

- To abbreviate the name of a state (but not with official ZIP code abbreviations) (e.g., “Conn.,” but “CT”).
- To abbreviate a Latin term (e.g., “e.g.” and “sp.nov”).
- In an abbreviation in which omission of the period might cause confusion (e.g., “Fig.” and “ed.”).
- At the end of paragraph side heads.

Do not use a period for the following:

- After elements of abbreviations for academic degrees (e.g., “BA” and “PhD”).
- With a lowercase contraction or abbreviation (except Latin) commonly acceptable in scientific or technical writing (e.g., “concn.,” “diam,” “mm,” and “g,” but “Expt.” and “cv.”).
- After main headings in the text.
- After table subentries and table column headings (unless the entry or heading is, or ends with, an abbreviation that requires a period).
- After an item in a list (unless the item completes a sentence whose beginning is the heading of the list or ends with an abbreviation that requires a period).

## Quotation Marks

USE DOUBLE QUOTATION MARK FOR THE FOLLOWING:

Around text that is a direct, literal quotation from a published source. Do not italicize direct quotations. Personal communication is considered unpublished material and does not require quotation marks.

Around the title of an article, the title of a chapter, or other part of a book, and the title of a series when referred to in the text or footnotes (such titles are neither italicized nor enclosed in quotation marks in the literature cited).

Around the first appearance of a term or word that is being a) coined or introduced for the first time; b) defined or discussed as a term or word; or c) adopted from another field, applied in a new or unusual sense, or given a special meaning.

USE SINGLE QUOTATION MARK FOR THE FOLLOWING:

For cultivar names in the text, footnotes, table headnotes and footnotes, and figure captions (except where the abbreviation “cv.” or the word “cultivar” immediately precedes the name), but not in table headings, table fields, or bodies of

figures, except where omission of the single quotes would reduce comprehension.

Reproduce quotations of material that contain factual or typographical errors with those errors intact, drawing attention to the error or correcting it within the quote in brackets. When material has been combined from a quotation for clarity, use the ellipsis (...) to show the deletion.

Place commas and periods within quotation marks, even if they are not part of the quotation, except when the quoted material is the name of a cultivar. Place semicolons and colons outside quotation marks.

## Small Capitals

Small capitals give typographic variety or help distinguish certain abbreviations from others having identical letters. Use small capitals for the following abbreviations: SE (standard error of the mean of a sample), SD (standard deviation of a sample), LSD (least significant difference), HSD (honestly significant difference), NS (nonsignificant), CV (coefficient of variation), HR (24-h time), AM (before noon), PM (after noon), BC (before Christ), AD (anno Domini), N (normal concentration), and M (molar concentration). Rotation of the chemical structure of organic substances used for pesticides is shown with small capitals D and L.

## Soil Identification and Terminology

Identify the soil used in field experiments at the lowest possible taxonomic level. As a general guideline, identify soils at the series and family levels (e.g., “the soil was Pullman clay, a mixed thermic Torretic Pauleustoll”). For experiments using containers, state the texture of the soil material (e.g., “sandy loam” or “silty clay loam”). If uncertain about soil names or texture, consult a soil specialist at your institution or check the soil survey map of the country where the experiment was conducted.

For details on soil terminology, consult the *Glossary of Soil Science Terms* (Soil Science Society of America, 1984), which contains a basic list of 1200 terms, plus appendixes covering obsolete terms, tillage terminology, and new designations for soil horizons and layers.

## Statistical Reporting

A report that involves the collection of experimental data should include an appropriate statistical analysis to aid the author and the reader in the interpretation of the results. Include sufficient summary data to enable the reader to interpret the statistical analysis. Give a complete description of the experimental design in the Materials and Methods section, as well as the treatments used and the statistical analyses performed. An explanation as to why a particular set of treatments was

chosen in light of the objectives of the experiment may be advisable in some cases. Also, in the Materials and Methods section, the statistical software package(s), procedure(s), and option(s) used to analyze data should be included. Indicate the type of Sums of Squares used (sequential or partial) to test hypotheses. If a model has more than one source of error, then state which error term was used to determine significance of model terms.

Where multiple regression is used, including polynomial models, indicate the criteria used to select the most appropriate model and present the  $P$  value and coefficient of determination for the best model. Indicate which terms were tested in the full model, including squared or cubed terms, indicator variables, and interaction terms. Many authors present  $P$  values for the linear, quadratic, and cubic models, but do not indicate which model best fits the data. Because the author is the most qualified to select the best model, information for only the best model should be presented. Include information such as the  $P$  value, coefficient of determination, and number of observations ( $n$ ), to enable readers to evaluate the model. Use of polynomials beyond quadratic is discouraged, unless the additional inflection points can be justified.

Although asterisks and the abbreviation NS have long been used to indicate the level of significance in tables and figures, presenting the  $P$  value is encouraged because it is much more informative and today most software packages can accurately calculate exact values.

When means within a column or row are separated with a multiple comparison, at the bottom of each column also include a  $P$  value from the analysis of variance to indicate the level of significance for treatment differences.

Plant biologists often measure the same plant or plant part several times during the course of an experiment (plant height, trunk circumference, fruit diameter, etc.). In such cases repeated measures analysis may be most appropriate. Researchers not familiar with repeated measures analysis may want to consult with a statistician.

Whenever an unusual statistical procedure is used, the author should briefly describe why that procedure is superior to more commonly used procedures, and provide a reference for the procedure.

Whether or not a mean separation procedure is used, including an analysis of variance (ANOVA) table may be helpful to the reader. Use of ANOVA tables is considered desirable by some reviewers and associate editors. Such a table gives a clear picture of the structure of the experiment and the contribution of each source of variation to the total sum of squares. In addition, it provides the necessary variance estimates for determining the standard errors of means (SE) and confidence intervals. In the interest of saving space, these tables need to contain only the sources of variation, the degrees of freedom, and the mean squares for each of

the response variables. Figures are often presented with means and  $SE$ s of the means. The  $SE$  of the mean only provides information about the variation around each mean and is not useful for comparing means. Because  $SE$  of the mean often tend to clutter a figure and provide limited information, presenting the pooled  $SE$  of the treatment difference (obtained from using the mean square error from the analysis of variance) is suggested. Standard error of means should be presented only where the author wishes to show the magnitude of variation around the means or that the variances are not homogenous.

If data are being transformed before analysis, then state the transformation that was used and the reasons for choosing it. Furthermore, clarify whether the means being reported are based on the raw data or are the correctly back-transformed weighted means derived from the transformed data.

Referencing of texts or papers from which the author obtained a particular statistical procedure is desirable when such a procedure is one not commonly found in most standard texts. A statistician consulted in the preparation of the manuscript may be recognized either as a coauthor or in a footnote, but do not then make any revisions in the statistical presentation without the knowledge of the statistician involved. Many problems in data analysis can be avoided by consulting a statistician before the experiment is set up. Data collected from experiments with incorrect or unconventional designs often cannot be analyzed statistically.

## Taxonomy and Nomenclature

### COMMON NAMES

Although generic names should be used whenever possible, many plants are known also by their vernacular (provincial or common) names. Common names are given in Roman type and are not capitalized, even though they may have been named after people or places (e.g., japanese maple, virginia pine, colorado potato beetle, brussels sprouts, douglas fir, bermudagrass, st. augustinegrass). A generic name used as a common name is neither italicized nor capitalized (e.g., *Camellia*, camellia or *Rhododendron*, rhododendron). Common names of well-known crops (apple, pear, rose, tomato, etc.) can be used—indeed, are often preferred—in titles of papers, except where their use is ambiguous (e.g., bean). If the common name is given in the title, the scientific name must be listed in the additional index words (without the authority) and in the abstract (with the authority).

For diseases caused by specific organisms, capitalize and italicize when referring to the organism *Phytophthora cinnamomi* or *Phytophthora* as a genus or *Verticillium aloratum* or *Verticillium* as a genus on the second reference; however, “phytophthora root rot” or “verticillium wilt” (in Roman type) when referring to the disease.

## CULTIVARS

Give the name of a cultivar in Roman type after the name of the species and set it off with single quotes (e.g., ‘Green Ice’ cucumber or *Cucumis melo* L. ‘Green Ice’) in the text, table headnotes, and figure captions. Do not use single quotation marks in the body of tables (especially under the heading “Cultivar”) or within figures, except where their absence leads to ambiguity. Regardless of the origin of the name of a cultivar, capitalize its initial letter (with rare exceptions, depending on requirements of a modern language). Do not use the word “cultivar” (or the abbreviation “cv.”) and single quotation marks at the same time.

## INTERSPECIFIC CROSSES

The name of an interspecific hybrid consists of the generic name followed by a single Latin epithet (“collective” epithet), the latter immediately preceded by the math × (multiplication sign) (e.g., *Fragaria* × *ananassa* Duchesne, *Pelargonium* × *hortorum* L.H. Bailey, or *Canna* × *generalis* L.H. Bailey (note that the × is flush against the species name, with no space between). This format is prescribed by the *International Code of Botanical Nomenclature*.

## ROOTSTOCK NOMENCLATURE

Use the full alphanumeric designations for a clone or cultivar in the abstract; e.g., ‘Malling 22’ or ‘Malling–Merton 112’, with the diminutive following in parentheses; e.g., (‘M.22’) or (‘MM.112’). Subsequent references may use the diminutive without parentheses. When several stocks of the same series appear in sequence, give the diminutive for each (e.g., ‘M.2’, ‘M.9’, and ‘M.27’). Clonal rootstocks are cultivars and should be set off by single quotation marks.

Seedling rootstocks usually are not cultivars and should not be set off by single quotation marks. Seedling rootstocks become clones when increased in number asexually, which usually follows a naming process, which then produces a cultivar.

When graft combinations are listed, separate the components by slashes with the scion listed first, interstock (if present) next, and rootstock last, with single quotation marks around each where appropriate (e.g., ‘Fairchild’/’Cleopatra’).

## SCIENTIFIC NAMES

See also the ASHS website ([www.ashs.org/resources/plant\\_names](http://www.ashs.org/resources/plant_names)) and Germplasm Resources Information Network (GRIN) web site ([www.ars-grin.gov/npgs](http://www.ars-grin.gov/npgs)).

Give the full scientific names of plants, disease organisms, and insects, along with their authority (and, if important, the cultivar name). (NOTE: Effective July 2008, reporting authorities for genera and lesser taxonomic classifications is optional in JASHS.) Style of providing scientific and cultivar names should conform to *The New Royal Horticultural Society Dictionary of Gardening* [A. Huxley and M. Griffiths (eds.). 1992]. For scientific and common names of edible fruit crops, consult Magness et al. (1971). For citrus species and relatives, the authority to use is Swingle and Reece (1967); see especially Swingle’s system (p. 358–363, 368–406) and Tanaka’s system

(Table 3-3, p. 364–367). Many species' names in the citrus literature are actually synonyms of those listed in these two systems; refer to these synonyms to get appropriate species or to give a reference for the epithet used.

The basic groups, categories, or taxa (singular, taxon), in descending order, are division, class, order, family, genus, and species. Treat the scientific names of all taxa as Latin, regardless of their derivation. Names of genera and higher ranks may stand by themselves, but the scientific name of a species is a two-word (binary) combination, called a “binomial,” consisting of a generic name followed by a specific epithet—*Dianthus caryophyllus* L. Italicize the generic name and the specific epithet, but not the authority.

Capitalize the name of a genus or taxon of higher rank (phylum, order, class, family, or genus and abbreviation of the genus) and of the name or abbreviation of the authority, but not of a specific epithet, even if it is derived from the name of a person or place (e.g., use *Cephalotaxus harringtonia*, not *Cephalotaxus Harringtonia*). Give the names of taxa before the rank of genus in Roman type; they are always plural in form and, therefore, require a plural verb (e.g., “the Orchidaceae are...”). A generic name that is followed by a specific epithet must be spelled out the first time it is used in the text or at the beginning of a sentence; subsequently, the generic name may be abbreviated to a single letter.

Never abbreviate specific epithets. A specific epithet is part of the binomial and should not appear as a monomial except, perhaps, when used in a table devoted to a single genus. Specific epithets are always lowercase, regardless of the name's origin.

The person who first published the scientific name for a species is its author. Include the authority (in Roman type) with the scientific name of any organism; it needs to appear only once in an article, preferably in the abstract. The authority should not appear in the additional index words. If the name of the organism is changed subsequently, place the name of the original author in parentheses, followed by the name of the author responsible for the change [e.g., *Prunus persica* (L.) Batsch]. Use brackets to set off parenthetical use of the name of an organism that has an authority enclosed in parentheses {e.g., “[*Prunus persica* (L.) Batsch]}”}.

Avoid hyphenation or line-splitting of plant names; if splitting is unavoidable, however, a guide to hyphenation may be found in Smeal (1979).

The following scientific names are preferred by ASHS to those from other sources:

<i>Carya illinoensis</i> (Wangenh.) C. Koch	pecan
<i>Lycopersicon esculentum</i> Mill.	common tomato
<i>Malus ×sylvestris</i> (L.) Mill. var. <i>domestica</i> (Borkh.) Mansf.	apple

## PROOF CORRECTION

### Proofreading

Authors will be asked to carefully proofread their **page proofs**. Accuracy in the proofreading stage is the responsibility of the author. This is the last time the author will see the article before it is published, so thoroughness is essential.

Page proofs are sent via e-mail as PDF files. Look for an email message from “Sheridan.com” with the manuscript number and “e-proof” in the subject line.

The author is entirely responsible for the correct spelling of proper names; the accuracy of quotations and literature citations; proper alignment and chemical formulas and mathematical equations; and the accuracy of all facts, dates, and data. Pay attention to references to tables, figures, and literature citations; the content of tables; abbreviations and symbols; and end-of-line breaks, as well as typographical errors, misspellings, and the omissions of full lines or paragraphs.

Check carefully for any symbols that may not have been translated properly from PC to Macintosh: chi ( $\chi$ ), mu ( $\mu$ ), alpha ( $\alpha$ ), beta ( $\beta$ ), etc.

Avoid unnecessary changes. Correct errors, but do not make trivial changes. Excessive additions or changes that did not appear in the original, approved manuscript cost more than initial composition, may introduce new errors, and delay production. Any extra cost incurred by excessive changes will be added to the author’s publishing fee.

If the author has made or learned of observations that should be reported in or with the article in the proof stage, then this material can be added only with the approval of the Associate Editor or Science Editor. Adding new material in an article under an old “received for publication date” is unethical.

## TRADE OR BRAND NAMES

Trade or brand names are not permanent; try to refer to the generic form of what you are using (e.g., “We used a tissue to wipe the thermometer.” instead of “We used a Kleenex to wipe the thermometer.”). If you must use brand names,

avoid using them without clarification. In general, refer to trade or brand names only parenthetically with the active ingredient, chemical formula, purity, and diluent or solvent stated clearly in the text and emphasized in preference to the commercial product; also, include the name, city, and state/country of the company that produces the product. Capitalize the first letter of trade or brand names. Do not capitalize adjectives made from trade names (e.g., petri dish). Avoid use of trade names in titles. If using trade names is unavoidable, include a footnote that disclaims endorsement of similar products of like properties (this is mandatory in some agencies and institutions). **Capitalization replaces the use of trademark symbols. ASHS does not use trademark symbols.**

## WORD USE

The following list contains words or terms commonly misused or misspelled, jargon to avoid, trade names, and ASHS conventions. **For hyphenated words, see Hyphenation. For nomenclature, see Taxonomy.**

**about** An adverb of “approximately” or “circa.” The approximate symbol ( $\approx$ ) should immediately precede Arabic numerals.

**aboveground** One word.

**accommodate** Note spelling.

**according to** A phrase reserved for documents and written opinions or procedures. Use “said” for conversations.

**affect** As a verb, to cause a change or to have an effect. Almost never used as a noun. Compare “effect.”

**afterward** Do not use “afterwards.”

**among** A preposition used in relating three or more things. Compare to “between.”

**and/or** A conjunction that indicates that two entities are to be considered together or individually. It is best to avoid the term (e.g., “apple, peaches, or both” is preferable to “apples and/or peaches”).

**Anjou** Use instead of d’Anjou.

**apex** Plural is “apices.”

**approximately** Use “about” or use the approximate symbol ( $\approx$ ) immediately before Arabic numerals.

**arcsin** One word. Note spelling.

**at this point in time, at the present time** Use “now.”

**between** 1) A preposition used in relating two things; however, the phrase “to examine the relationship between application rate and fruit set, seed number,

and acid” is correct. Compare “among.” 2) A preposition paired with “and” when giving a range (e.g., between 8 and 10 mm.” The phrase “between 8 to 10 mm” is incorrect. Compare “from.”

**budbreak** One word.

**budline** One word.

**by means of** “By” or “with” is sufficient.

**bypass** One word (no hyphen).

**cannot** One word. Do not use “can not.”

**cantaloupe** Use “muskmelon.”

**carefully** A term that is not necessary when describing procedure. Most techniques are performed “carefully” in research.

**caused by** Use “incited by” for a disease.

**check** Use “control.”

**Clorox** Capitalized trademark (note spelling). The generic term is “chlorine bleach” or “5.25% sodium hypochlorite solution.” It is suggested that the actual chemical dilution be given and the use of the trademark be avoided.

**coldframe** One word.

**compare** A verb followed by “to” when a similarity is stated or suggested, as in “he compared Bailey to Washington” (i.e., one the father of horticulture, the other the father of his country). “Compare” is followed by “with” when details of dissimilarity are stated or suggested, as in “he compared Bailey with Darwin” (i.e., pointing out details in which the two scientists were dissimilar).

**comprise** To include or contain (e.g., “the series comprises six bimonthly issues” but six issues do not “comprise” the volume). Avoid “comprised of.”

**concentration** One says “high or low concentration,” not “large or small concentration.” One says “various concentrations (5, 10, 15 mg·m<sup>-1</sup>), not “varying concentrations.”

**continual** Going on in time without interruption.

**continuous** Going on in time or space without interruption.

**control** Use instead of “check.”

**correlated** A term to be restricted to use in statistics. Use “related” for nonstatistical descriptions.

**cultivar** A cultivated variety. Use the term “cultivar.”

**data** Plural form of “datum.” When used in a collective sense, “data” takes a plural verb (e.g., “the data from the experiment are presented in Table 4”).

One says “many data” or “few data,” not “much data” or “little data.”

**daylength** One word.

**daylight** One word.

**desiccate** Note spelling.

**despite the fact that** Use “although.”

**determined** Use when indicating that measurements were taken (e.g., “growth was determined by counting nodes”). See also “measured,” “compare,” and “recorded.”

**dieback** One word.

**different from** Preferred to “different than.”

**disease** Symptom of the destructive effects of one or more biotic agents.

**disorder** Symptom of an abiotic (physiological) disturbance; need not be preceded by the word “physiological.”

**dissertation** An extended, written treatment of a subject; specifically, one submitted for a doctorate. The term, however, now is reserved generally for a work that includes an exhaustive review of the literature. Compare “thesis.”

**Douglas fir** Capitalize. Do not hyphenate.

**drip irrigation** Do not hyphenate.

**dry weight** Do not use dry mass. Do not hyphenate except when used as a modifier (e.g., “the dry-weight figures in column 3”).

**due to** Not to be used automatically as a substitute for “because of.” The phrase “yields fell due to severe frost” is incorrect; the correct form is “the decrease in yield was due to severe frost.”

**due to the fact that** Use “because.”

**Duncan’s multiple range test** Only “Duncan’s” is capitalized.

**Du Pont** The company’s style is to capitalize the name as shown when it stands alone. The full name is E.I. du Pont de Nemours & Co.

**each** When “each” is the subject of a sentence, it takes a singular verb (e.g., “Each of the limbs was sprayed”).

**Earth** Capitalize when referring to the planet.

**effect** As an adverb, to bring about or to cause to come into being. As a noun, the result of an action. Compare “affect.”

**either...or** When singular and plural nouns are linked with the “either/or” combination, the verb follows the number of the closest noun (e.g., “either sulfur alone or its derivatives are recommended as mild mildewcides”). Do not use commas to set off a phrase beginning with “or” if it is preceded by “either.” Compare “neither/nor.”

**endpoint** One word.

**end result** Use “result.”

**ensure** To make certain or guarantee that a desired event occurs. Compare “insure.”

**erlenmeyer flask** Note spelling.

**estimated** Use when a phenomenon is not easily measured by a single criterion or when the process is not a direct measure of the phenomenon or object (e.g., “growth was estimated by measuring leaf area”). Include the basis or means of

the estimation.

**far red** Two words and lowercase.

**federal** Do not capitalize, unless part of an official name, such as “Federal Trade Commission.”

**feel** Avoid the term, unless sensory perceptions are relevant in describing certain qualities of a product.

**fewer** Use when dealing with specific numbers of units that can be counted individually. Antonym is “more.” Compare “less,” “lesser,” “small,” and “smaller.”

**Fiberglas** Capitalized trademark. The generic term is “fiberglass” or “glass fiber.” Note the spelling.

**finalize** Use “end.”

**Fraser fir** Capitalize. Do not hyphenate.

**fresh** Acceptable as a collective noun when referring to produce or flowers destined for fresh market.

**fresh weight** Do not use fresh mass. Do not hyphenate except when used as a modifier (e.g., “the fresh-weight figures in column 2”).

**from** A preposition paired with “to” when giving a range (e.g., “from 8 to 10 mm”). The phrase “from 8–10 mm” is incorrect. Compare “between.”

**fruit** Acceptable as a collective noun when referring to one or more of the same species (e.g., “10 apple fruit were collected each week”). Use the plural when referring to two or more species, e.g., “lemon and orange are citrus fruits.”

**fruit set** Two words.

**F test** No hyphen, unless used as a modifier (e.g., “F-test results”).

**Fusarium** Capitalize and italicize when referring to the organism *Fusarium oxysporum* or *Fusarium* as a genus on the second reference; however, “fusarium rot” (in Roman type) when referring to the disease.

**gauge** Do not use “gage.”

**germplasm** One word.

**greater** Use when referring to quality, worth, or significance. Antonym is “lesser.” Compare “higher,” “more,” and “larger.”

**groundcover** One word.

**groundwater** One word.

**half-life** Hyphenated as noun or adjective. Plural is “half lives” (no hyphen).

**held** Use “kept” unless contained in hand (e.g., “apples were kept in storage”).

**higher** Use when referring to position, rank, order, scale, or yield. Antonym is “lower.” Compare “greater,” “more,” and “larger.”

**honeybee** One word.

**hopefully** Due to constant misuse of this word, it is preferable to delete it completely. Proper use is “he hopefully anticipated the outcome.” It should not be

used as a substitute for “We hope” or for “it is to be hoped.”

**horticulturist** Do not use “horticulturalist.”

**illinoensis** Do not use *illinoensis*.

**-ic, -cal** Suffix endings used in adjectives. The “-ic” form is preferred, although the two endings sometimes convey different meanings (e.g., “economic botany,” but “economical process”).

**impact** Not a verb. Use “affect.”

**imply** To intimate or suggest a meaning not expressed or a conclusion to be drawn from allusion or reference, in contrast to a direct statement. Compare “infer.”

**incited by** Use instead of “caused by” for a disease.

**index** Plural is “indices” for measurable quantities, but “indexes” for a book.

**infer** To derive by reasoning; to declare or to conclude from facts or premises. Compare “imply.”

**infrared** One word.

**initiate** Use “begin” or “start.”

**in order to** Use “to.”

**input** An overworked word. Confine usage to computers or crops.

**in situ** Do not italicize.

**insure** To assure against loss; to take out insurance. Compare “ensure.”

**interaction** A term often used physiologically—and ambiguously. Reserve use of the term in its statistical sense for two effects that are not parallel in terms of the responses evoked.

**in vitro** Do not italicize.

**in vivo** Do not italicize.

**it is suggested that** Use “I (we) suggest.”

**kiwifruit** One word.

**Kjeldahl** Note spelling and capitalization.

**larger** Use when referring to dimension or size. Antonym is “smaller.” Compare “greater,” “higher,” and “more.”

**less** Use when dealing with amounts in a collective sense (time or distance). Antonym is “more.” Compare “fewer,” “lesser,” “lower,” and “smaller.”

**lesser** Use when referring to quality, worth, or significance. Antonym is “greater.” Compare “less,” “fewer,” “lower,” and “smaller.”

**LI-COR** Hyphenated and all uppercase.

**lima bean** Do not capitalize.

**lower** Use when referring to position, rank, order, scale, or yield. Antonym is “higher.” Compare “fewer,” “less,” “lesser,” and “smaller.”

**magnitude** See “order of magnitude.”

**Mason jar** Capitalize.

**measured** Use when indicating that measurements were taken by an instrument or scale (e.g., “length was measured by using a meter stick”). See also “determined.” Compare “recorded.”

**media** Plural of medium; do not use in the singular.

**microphotograph** A photograph on a greatly reduced scale, as on microfilm. Compare “photomicrograph.”

**midpoint** One word (no hyphen).

**midseason** One word.

**modifying** Use the term judiciously. “Modifying” effects are not necessarily “opposing” or in opposition to other effects.

**molal** Refers to molecular concentration per 1000 g of solvent.

**molar** Refers to molecular concentration per 1000 mL of solution.

**more** Use when dealing with a) specific numbers or units that can be counted individually (antonym is “fewer”) or b) amounts in a counted sense, such as time or distance (antonym is “less”). Compare “higher,” “greater,” and “larger.”

**muskmelon** Preferred term for “cantaloupe.” For specific types, use “netted muskmelons,” “‘Honey Dew’ muskmelons,” etc.

**needless to say** Leave out and consider leaving out whatever follows it.

**neither...nor** See “either...or.” “Neither” should be followed by “nor,” not by “or.”

**number of, a** Avoid this term. Use “several,” “many,” or “few.”

**nylon** Do not capitalize (no longer a trademark).

**o’clock** Do not use with abbreviations of time.

**opposing** See “modifying.”

**order of magnitude** Refers to a multiplication by a factor of 10.

**order to, in** Use “to.”

**Osmocote** Capitalized trademark. The generic term is “controlled-release fertilizer” or “slow-release fertilizer.”

**overall** One word (no hyphen).

**parafilm** Do not capitalize.

**parameter** A mathematical term. It should not be used as a substitute for “characteristic,” “attribute,” “feature,” or “quality.”

**peat** A generic term (for a mass of semicarbonized vegetative matter formed by partial decomposition of plant tissues in water, containing less than 10% sand or other matter and usually highly acid) that is used when the origin or source is unknown. “Peatmoss” or “moss peat” is of moss origin. “Sphagnum peat” is of sphagnum origin. “Reed-sedge peat” is of reed-sedge origin. Use “peat” except when the material is identified specifically.

**peatmoss** One word.

**percent** Noun, adjective, or adverb, spelled as one word. The symbol (%) and

not the term is used with numerals.

**percentage** A noun, indicating part of a whole expressed in hundredths, as in “percentage of leaf dry mass.” Often misused as an adjective (e.g., use “percent error” or “percentage of error,” not “percentage error”).

**petri dish/plate** Do not capitalize.

**phosphorous** An adjective. Resembling phosphorus, or used to designate a compound of phosphorus in which this element has a valance lower than that in phosphoric compounds.

**phosphorus** The element, as a noun. Sometimes used attributively, as in “phosphorus fertilizer.”

**photocopy** A generic term. Use instead of “Xerox.”

**photomicrograph** A photograph taken through a microscope. Compare “micro-photograph.”

**Plexiglas** Capitalized trademark. The generic term is “synthetic glass” or “plexi-glass.” Note the spelling.

**policymaking, policymaker** One word.

**pollinator** The agent of pollen transfer. Note spelling.

**pollinizer** The source of pollen. Note spelling.

**polymerase chain reaction** Spell out first mention, then abbreviate PCR.

**postharvest** One word.

**poststorage** One word.

**posttreatment** One word.

**preemergence** One word.

**preharvest** One word.

**prior to** Use “before.”

**Pyrex** Capitalized trademark. The generic term is “crack-resistant glassware.”

**quite** Do not use (e.g., the cultivar is “unique,” not “quite unique”).

**randomly amplified polymorphic DNA** Spell out first mention, then abbreviate RAPD. Do not use the plural (RAPDs), rather RAPD markers.

**rather** Do not use (e.g., the cultivar is “interesting,” not “rather interesting”).

**recorded** Use when gathering or posting data, with a writing or printing device, to make a record for future use (e.g., “the date was recorded on the leaf with indelible marker pen after the blade had expanded” or “temperature was recorded with a 7-d thermograph”). Compare “determined” and “measured.”

**‘Redchief Delicious’** A cultivar; incorrectly written ‘Red Chief Delicious’.

**relatively** The term implies comparison and should accompany a basis for comparison: “relative” to what?

**replicate** Verb; “This test was replicated three times.”

**replication** Noun; “We used three replications.”

**restriction fragment-length polymorphism** Spell out first mention, then

abbreviate RFLP.

**ringspot** One word.

**root ball, root rot, root zone** Two words. Hyphenate when used as a modifier (e.g., root-zone temperature”).

**rowcover** One word.

**runoff** One word.

**Saran** A trademark term for plastic products, such as “Saran Wrap” (a kind of plastic film) and “Saran Cloth” (a shade cloth).

**Scotch tape** Use “cellophane tape.”

**seedcoat** One word.

**separate** Avoid this term as an adjective. In the phrase “the procedure was used in 12 separate trials,” the word “separate” adds nothing.

**shade cloth** One word.

**shelf life** Two words. Do not hyphenate.

**sidedressing** One word (no hyphen).

**significant** Confine use of the term to statistical judgment. Do not use the term loosely for “important,” “noteworthy,” “distinctive,” or “major.”

**smaller** use when referring to dimension or size. Antonym is “larger.” Compare “fewer,” “less,” “lesser,” and “lower.”

**southernpea** One word. Do not capitalize. “Cowpea” is the preferred term, but “southernpea” is acceptable for edible cultivars.

**sphagnum** A moss that grows only in wet, acid areas (such as in ditches or along lake shores) where its remains become compacted to form peat and whose aerial portions are harvested and dried. Synonym: “sphagnum moss.” Do not use “sphagnum peatmoss.”

**sphagnum peat** Partially decomposed sphagnum.

**stepwise** One word (no hyphen).

**Student’s *t* test** “Student” is the pseudonym for British statistician W.S. Gossett and is capitalized.

**Styrofoam** Capitalized trademark. The generic term is “plastic foam.”

**subsequent to** Use “after.”

**sulfur** Preferred spelling of “sulphur.”

**sweetpotato** One word.

**terminate** Use “end.”

**that** A relative pronoun introducing a restrictive (defining, limiting) clause. For example, in the sentence—“The tree that survived the treatment developed fruit.”—the defining clause (“that survived the treatment”) is needed to identify the tree being discussed. Compare “which.”

**thermos** Do not capitalize (no longer a trademark) except when referring to the specific brand of vacuum bottle.

**thesis** A dissertation written by a candidate for an academic degree. Do not use the term “PhD thesis.”

**this** Do not use as a noun. After explaining a certain result, a sentence such as the following might appear: “This indicates an interaction of A with B.” This what? Determining what “this” means often is difficult in science. Use specific nouns (e.g., “This increase indicates...”).

**toward** Do not use “towards.”

**troubleshoot** One word.

***t* test** Lowercase and italicized *t*. Not hyphenated.

**Tukey’s Studentized range test** Note capitalization.

**turfgrass** One word.

**ultraviolet** One word.

**unaffected** Use instead of “not affected.”

**uniconazole** Note spelling.

**utilize** Use “use.”

**variety** See “cultivar.” Use the term cultivar exclusively when referring to a cultivated variety.

**versus** Spell out and do not capitalize in titles; otherwise, use “vs.” (including period).

**vesicular–arbuscular** Use en-dash. Capitalize both words if used in a title.

**Waller–Duncan** Use en-dash. Capitalize both words.

**wastewater** One word.

**wavelength** One word.

**whether or not** Use “whether.”

**which** A relative pronoun introducing a nonrestrictive (nondefining, descriptive) clause. For example, in the sentence—“The third tree, which survived the treatment, developed fruit.”—the nondefining clause (“which survived the treatment”) merely gives additional information about its subject, which has already been identified by the adjective “third.” Compare “that.”

**winterhardiness** One word.

**winter hardy** Two words, unless used as a modifier (e.g., “winter-hardy plant.”)

**worldwide** One word.

**Xerox** Capitalized trademark. The generic term is the noun “photo copy.” Do not use as a verb.

**X-ray** An acceptable jargon noun for “X-ray photograph” or “X-ray picture.” Adjective and verb are “X-ray.”