

Oral Session Abstracts

103rd Annual International Conference of the American Society for Horticultural Science New Orleans, Louisiana

Presenting authors are denoted by an asterisk (*)

Oral Session 1—Genetics and Germplasm

27 July 2006, 2:00–3:15 p.m.

Bayside A

Moderator: James Nienhuis

Domestication of Vegetables as Illustrated in Renaissance Art

James Nienhuis*

University of Wisconsin, Horticulture, Madison, WI, 53706

An enigma in the process of domestication of many of our common vegetables is what they looked like and the speed of the process at which they were transformed from the wild progenitors to the modern cultivars. Many vegetables were either domesticated in antiquity or introduced into Europe, often by trade with Africa, the Middle East, or the Americas. Based on genetic information, we often know or can deduce center of origin and the progenitor species of our common vegetables, but we do not have a record of their early history once introduced into Europe. One window to the process of domestication of vegetables is still life art from the Renaissance period. The emphasis of the art form “natura morta” emphasized realism, which allows us to, in some cases, identify species and market classes based on accurate morphological details.

Efficiency of Recurrent Selection by Marker and Phenotype for Multiple, Quantitative Yield Components in Four Cucumber Populations

Matthew D. Robbins*, Jack E. Staub

University of Wisconsin Madison, Horticulture, Madison, WI, 53706

Four cucumber (*Cucumis sativus* L.) inbred lines were intermated then bulked maternally to create four base populations denoted as cycle 0 (i.e., Pop.1 C0, Pop.2 C0, Pop.3 C0, Pop.4 C0). Each of these populations underwent phenotypic selection (PHE; open-field evaluations), selection by marker (MAS; genotyping at 20 marker loci), and random mating (RAN; no selection) for three cycles. The four traits under selection, multiple lateral branching (MLB), gynoeious sex expression (GYN), earliness (EAR), and fruit length to diameter ratio (L:D), are quantitatively inherited, controlled by relatively few (two to six) QTL per trait and are directly related to yield. Using the same C0 populations and selection scheme allowed a direct comparison of the effectiveness of MAS and PHE. Because each C0 population varied for any given trait, the response to MAS and PHE was not the same for each population. In general, C0 populations that were inferior for a trait either responded favorably to selection or remained constant, while those with superior trait values either did not change or decreased. Both MAS and PHE provided improvements in all traits under selection in at least one population, with the exception of MAS for EAR. MAS and PHE were equally effective at improving MLB and L:D, but PHE was generally more effective than MAS for GYN and EAR. When considering all traits, responses to PHE were superior in three of the four populations. The population for which MAS was superior, however, showed the only increase in yield (fruit per plant), which was not under direct selection. These results indicate that both MAS and PHE are useful for multi-trait improvement in cucumber, but their effectiveness depends on the traits and populations under selection.

Detection of Genetic Variation in Wild Populations of Three *Allium* Species using Amplified Fragment Length Polymorphisms (AFLP)

Nathan C. Phillips*¹, Steve R. Larson², Daniel T. Drost¹

¹Utah State University, Plants, Soils, and Biometeorology, Logan, UT, 84322-4820; ²Utah State University, USDA-ARS Forage and Range Research Lab;

The genus *Allium* is distributed worldwide and includes about 80 North American species, with at least 13 occurring in Utah. Our study focuses on the population dynamics of three *Allium* species native to Utah; *Allium acuminatum*, *A. brandegei*, and *A. passeyi*. In conjunction with our studies of life history, growth characteristics, demographics, and habitat, we are interested in determining the levels of genetic variation in these species. This study examines amplified fragment length polymorphism (AFLP) within and among five *Allium acuminatum*, four *A. brandegei*, and three *A. passeyi* populations native to Utah. These species have contrasting abundance and distribution. The study populations were selected along an elevation gradient to represent within-species habitat differences. About 10–20 plants from each of the 12 populations were genotyped using six AFLP primer combinations, which detect DNA variation within and among all three species. These data will be used to compare levels of genetic variation and isolation among populations and species.

Relationships Among Reducing Sugar, Asparagine, and Chip Color in Wild *Solanum* Species

Leah C. McCann*¹, Phillip W. Simon²

¹University of Wisconsin, Department of Horticulture, Madison, WI, 53706; ²USDA-ARS, Vegetable Crops Research Unit, Madison, WI, 53706

When stored at temperatures less than 10 °C, tubers of all cultivated potatoes exhibit cold-induced sweetening (CIS) during which starch degrades to sucrose, glucose, and fructose. Upon frying at high temperatures, the reducing sugars (Fru, Glu) interact with free amino acids via the non-enzymatic Maillard reaction to form dark-colored chips that are unacceptable to consumers. In addition, scientists recently discovered that the toxic chemical acrylamide is also produced during frying. Although storage at warmer temperatures reverses CIS and circumvents dark chip production, the probability of storage loss due to shrinkage and disease increases. Wild *Solanum* species form the backbone of many potato-breeding programs. In this study, we evaluated 36 different plant introductions (PI) including 20 different species, grown in Madison and Rhinelander, Wis., to identify germplasm resistant to CIS for genetic analysis. After storage for 2–3 months at 4 °C, tuber sugar and amino acid content were analyzed via HPLC and slices were fried to determine chip color. Sugar and chipping data support previous research indicating CIS resistance in *S. okadae*, *S. raphanifolium*, and *S. phujera*. Interestingly, some germplasm selections with high reducing sugar content produced light-colored chips, indicating exceptions to the typical correlation between reducing sugar content and chip color. Genetic bases to these exceptions are under evaluation.

Using Prevosti’s Distance Coefficient for Direct Statistical Analysis of Population Differences

Theodore Kisha*¹, Richard Johnson¹, Dan Skinner¹, Stephanie Greene²

¹Washington State University, USDA-ARS, 59 Johnson Hall, Washington State University, Pullman, WA, 99164-6402; ²National Temperate Forage Legume Resources Unit, USDA-ARS, Prosser, WA, 99350

Three alfalfa populations were compared using four molecular marker

systems. Population differences were analyzed using Prevosti's distance coefficient, which is a measurement over all loci of the proportion of unshared alleles. The variance of this sample distance is related to the genetic diversities used in calculating F-statistics and can be easily generated using a spreadsheet. The simplicity of statistical testing using Prevosti's distance, and its accuracy at small distances compared with other coefficients, are unique and useful characteristics of this measurement.

Genetic Relationships of *Spathiphyllum* Cultivars Analyzed by AFLP Markers

Jianjun Chen^{*1}, Richard J. Henny¹, Pachanoor S. Devanand², Chih-Cheng T. Chao²

¹University of Florida, Mid-Florida Research and Education Center, Apopka, FL, 32703;

²University of California-Riverside, Department of Botany and Plant Sciences, Riverside, CA, 92521

Peace lily (*Spathiphyllum* Schott) is one of the most popular tropical ornamental foliage plants and is used worldwide for interiorscaping. However, little information is available on the genetic relationships of cultivars. Using amplified fragment length polymorphism (AFLP) markers with near-infrared fluorescence-labeled primers, this study analyzed genetic relatedness of 63 commercial cultivars and breeding lines. Forty-eight *EcoRI* + *2/MseI* + 3 primer set combinations were initially screened, from which six primer sets were selected and used in this investigation. All cultivars were clearly differentiated by their AFLP fingerprints, and the relationships were analyzed using the unweighted pair-group method of arithmetic average cluster analysis (UPGMA). The 63 cultivars were divided into four clusters. All commercial cultivars or breeding lines resulted from crosses of some of the cultivars, a total of 45, were positioned in cluster I with Jaccard's similarity coefficients between 0.61 and 0.88. There was only one cultivar in cluster II. Cluster III contained 16 cultivars; they are either species or breeding lines generated from interspecific hybridization. Cluster IV had one unknown species. This study provides genetic evidence as to why cultivars from cluster I and III are not readily crossable because the Jaccard's similarity coefficient between the two clusters was only 0.35. Results also indicate that commercial cultivars are genetically close. Strategies for increasing genetic diversity of cultivated peace lily should be sought for future breeding efforts.

Oral Session 2—

Consumer Horticulture & Master Gardeners

27 July 2006, 2:00–3:30 p.m.

Nottoway

Moderator: Richard Durham

Introduction to Landscape Design as Continuing Education for Master Gardeners

Kerrie B. Badertscher*

University of Nevada, Reno, Cooperative Extension, Reno, NV, 89502

Colorado currently has no licensure program for landscaping and many people applying to the Colorado Master Gardener program have indicated a desire to seek entry-level training in order to determine if a second career in horticulture is feasible. Alternatively, some each year who complete this basic training go on into the Green Industry either in basic design and/or maintenance. Colorado State University Cooperative Extension came together with Associated Landscape Contractors of Colorado and the Colorado Nursery Association (now CNGA) to create the Rocky Mountain Landscape Design Guide. The purpose of this publication was to inform the general consumer about the landscape design process. A review will be given using this publication with concurrent laboratory activities to Master Gardeners as a continuing education piece.

Innovative Teaching of Botany to Master Gardener Trainees

Linda McMahan*

Oregon State University, Department of Horticulture, OSU Extension, Yamhill County, McMinnville, OR, 97128

The science of botany is often daunting to people who are training to become Master Gardener volunteers. However, the range of natural diversity of plants as well as practical information about plant anatomy are essential foundations for other parts of Master Gardener training. I will present a botany module that I have developed over the past 5 years. The module focuses on relevance to the trainee and builds on basic information to examine more complex aspects of botany, all in the space of the 3–6 hours often allotted for basic botany training. It begins with a "tour" of the plant kingdom and plant relatives like algae and fungi, mosses, liverworts, and ferns. I follow this with basic morphology of stems, roots, and leaves; this basic morphology is used to answer the question of how water and minerals move from the soil into and throughout plants, even reaching the height of the tallest tree. A short segment on mycorrhizae reinforces water and mineral transport, while providing a link to the plant kingdom tour. The mycorrhizal section also reinforces or complements training on soils, which is often presented in another portion of the training schedule. Finally, a segment on flowers introduces basic terminology and winds up a discussion of how to recognize monocotyledons and dicotyledons. Several optional hands-on activities help active learners assimilate the information and provide needed reflective time for more traditional learners. The module has been adopted as the official OSU Extension Master Gardener™ Program botany module in Oregon.

Revamping a Master Gardener Curriculum for Use in Prison Job Readiness Programs

Angela M. O'Callaghan*, M.L. Robinson

University of Nevada, Reno, Cooperative Extension, Las Vegas, NV, 89146

University of Nevada Cooperative Extension (UNCE) faculty members have taught horticulture to inmates of correctional facilities for over 8 years. The training material used was the Master Gardener curriculum. Because inmates in Nevada have few opportunities to meet requirements for certification as Master Gardeners, this program was described simply as a horticulture class. Over the past 3 years, we have redirected it toward job readiness to assist inmates after release. The curriculum was first expanded to do intensive teaching on such topics as irrigation, landscape plant selection and maintenance, and problem solving. Even with these changes, horticulture jobs generally limited to low-paying, entry level ones. To improve employment opportunities, UNCE obtained the involvement of the Nevada Department of Agriculture. After inmates have passed the horticulture program, they may take the state pesticide applicator training and examination. This year, a mini course in "Developing a Business Model" will be added to the initial curriculum. To date, 36 inmates have received PAT certification. Conversations with potential employers indicate that this significantly enhances their likelihood of employment at a higher-than-entry level.

The Impact of the Louisiana Master Gardener Program on the Perceived and Actual Horticultural Knowledge of Program Participants

Bobby H. Fletcher, Jr.*¹, Michael F. Burnett², Krisanna L. Machtmes², Jeff S. Kuehny³

¹Louisiana State University Agricultural Center, Louisiana Cooperative Extension Service, Thibodaux, LA, 70301; ²Louisiana State University, School of Human Resource Education and Workforce Development, Baton Rouge, LA, 70803; ³Louisiana State University, Department of Horticulture, Baton Rouge, LA, 70803

The primary purpose of this study was to determine the impact of participation in the Master Gardener program on horticultural knowledge and practice. In 1972, the "Master Gardener" concept was initiated in Washington State due to the high demand to answer consumer horticultural questions. The main objective of this program is to increase

horticultural knowledge of program participants so they can transfer this information to consumer horticultural clientele. The program quickly spread throughout the United States. It reached Louisiana in 1994 and was expanded throughout most metropolitan areas by 1997. No formal evaluation has been conducted to determine the horticultural knowledge impacts of this program. All 257 participants in the 2004 Louisiana Master Gardener (LMG) program were surveyed before and after participation in this program. The survey used was a researcher-developed instrument designed to measure self-perceived knowledge, tested knowledge, and Best Management Practices (BMPs) used. Data were collected by master gardener coordinators and submitted to the researcher after each phase of data collection (pre and post). Results of the study revealed that the LMG participants were highly educated, mostly Caucasian, and mostly female. Significant improvements were identified in all of the knowledge and practice measurements included in the study. These included self-perceived knowledge, tested knowledge, and use of BMPs. It was concluded that the 2004 Louisiana Master Gardener program was effective in increasing the self-perceived horticultural knowledge and tested horticultural knowledge of program participants. In addition, the study concluded that the 2004 Louisiana Master Gardener program improved the use of BMPs among the participants.

The Relationship of Knowledge, Attitudes, and Perceptions Regarding Non-native Texas Invasive Plant Species

Sharon Frey*, Carolyn Robinson

Sam Houston State University, Agricultural Sciences, Huntsville, TX, 77340

Plants have been introduced into the United States intentionally as well as unintentionally as seeds and weeds. Technological advances, a mobile society, and our curiosity and desire to improve our landscapes have led to an ever-increasing invasive movement. These alien plants can jeopardize native populations, alter ecosystems, alter fire and water regimes, change the nutrient status, modify habitats, and cause significant economic harm. Today's public is unaware of the danger some non-native plants species pose to natural areas, thereby contributing to the lack of control for non-native invasive plants. This study looked at the knowledge and attitudes of Texas Master Gardeners as related to invasive species commonly used in landscaping. A web survey was made available to all Texas Master Gardeners that included pictures of plants along with their common and scientific names. Participants were asked to identify which they thought were invasive and contribute information regarding their knowledge of non-native invasive plants. Each of the invasive plants shown is on both the federal and the Texas Invasive Plant lists. Inquires were made concerning the occurrence of these plants in the participants' personal landscape and communities and their perceptions of each plant as an invasive threat. The purpose of the study is to determine if a relationship exists between knowledge, attitudes and perceptions of the participant and the occurrence of non-native invasive plants in the landscape. The results of this study will help determine factors that contribute to the lack of control for non-native invasive plants.

The eXtension Consumer Horticulture Community of Practice

Richard Durham*

University of Kentucky, Horticulture, Lexington, KY, 40546-0091

A Community of Practice (CoP) for consumer horticulture has been formed as part of the eXtension system. The CoP was organized at the National Consumer Horticulture Forum held Nov. 2005 at the Minnesota Landscape Arboretum. The meeting was attended by representatives of 24 states from all four Extension geographical regions. The attendees discussed project priorities and began to build a framework for working together across state lines on eXtension-sponsored activities and other efforts. Initial plans from the meeting include constructing a National Consumer Horticulture FAQ database, developing online learning modules that can be used for Master Gardener training, and develop-

ing marketing tools to better identify consumer horticulture resources available through local as well as national Extension activities. This presentation will provide additional details regarding the Consumer Horticulture Forum, an update regarding consumer horticulture activities within eXtension, and an opportunity for members of ASHS to learn how they can get involved in eXtension. Information regarding eXtension CoPs (including Consumer Horticulture) is continually being updated on the eXtension CoP Web site (cop.extension.org) and information regarding the Consumer Horticulture Forum has been posted on the Consumer Horticulture CoP Community Home page (cop.extension.org/wiki/Consumer_Horticulture_Community).

Oral Session 3—Floriculture 1

27 July 2006, 2:00–3:15 p.m.

Oak Alley

Moderator: Jonathan Frantz

Light, Fertilizer, and CO₂ Interact in *Petunia ×hybrida* Nutrient Uptake and Partitioning

Jonathan Frantz*¹, Peter Ling²

¹ARS, USDA, Toledo, OH, 43606; ²The Ohio State University, Department of Food, Agricultural, and Biological Engineering, Wooster, OH, 44691

Bedding plant petunia (*Petunia ×hybrida*) is often produced with high nutrient concentrations as a cool-season crop. How a plant uses the nutrients supplied will depend in large part on the environmental factors influencing growth rate, such as light and CO₂. Since more growers are considering using supplemental CO₂ to improve energy efficiency for plant production, it is important to understand light and fertilizer levels needed for efficient production of high-quality plants. Using a multi-chamber controlled environment system, petunia plants were grown from seed for 6–8 weeks after transplanting into different light and CO₂ environments and fed with either a low (7.1 mM N) or high (21.3 mM N) fertilizer regime. Plants were evaluated for appearance, harvested periodically, and separated into flower, stem, and leaf biomass. Biomass was then dried and analyzed with ICP-OES for essential macro- and micronutrients. Low-fertilizer-grown plants had consistently earlier and more flowers, but showed symptoms of nutrient deficiencies in the final few weeks of production at all light and CO₂ levels. There were significant interactions between light and fertilizer treatments for different nutrients. Calcium uptake was greatly influenced by light level, Fe, P, and K were influenced by the fertilizer supply, and Mg and B were inversely influenced by fertilizer supply at high light. These data suggest new management strategies are needed to improve fertilizer use efficiency in different environments.

Using SPAD-meter in Nitrogen Fertilization of *Rosa chinensis* Jacq. var. *mutabilis*

Giampaolo Zanin*, Paolo Sambo

¹University of Padova, Agronomy and Crop Science, Via dell'Università, Italy

Rosa chinensis Jacq. var. *mutabilis* plants were grown in a greenhouse to determine whether a hand-held chlorophyll meter (SPAD-meter) is suitable for the plant N status assessment. Therefore, plants were fertilized with increasing levels of N, applied through urea form as top dressing. The doses were: 0, 0.15, 0.3, 0.45, 0.6, and 0.75 g of N per liter of substrate. Periodically during the growing season, plant height and width, fresh and dry weight of different plant organs at 10, 20, and 30 weeks after planting, and their total N, plant P, and K were measured. Furthermore, six times along the growing cycle, the amount of chlorophyll in leaves was estimated using a SPAD-meter and analytically measured by chlorophyll extraction with ethanol and reading through a spectrophotometer. In the same leaves, N concentration was also determined. Treatments with 0.45–0.6 g of N per liter of substrate gave the tallest and widest plant. Plant weight and flower production were also the highest with these doses. The concentration of organic N in plant organs increased along with the N availability in

the substrate, which suggests that a “luxury consumption” took place. The SPAD values showed high correlation among chlorophyll and N concentrations. Values that ranged between 35–40 seemed to mean good nutrient status. A high correlation was also found among SPAD values and some of the productive characteristics, which indicates that a SPAD-meter is a suitable tool in the dynamic fertilization of rose.

Counter-anions Influence Greenhouse Rose (*Rosa* ×*hybrida*) Responses to Sodium-based Salinity

Alma R. Solis-Perez*, Raul I. Cabrera

Texas A&M University, Horticultural Sciences, Dallas, TX, 75252

Greenhouse rose plants, ‘Bull’s Eye’, budded on the rootstocks *Rosa manetti* and *R.* × ‘Natal Briar’, were grown in containers filled with a peat-based growing medium. The plants were irrigated with a 0.5× Hoagland solution salinized with a fixed 12-mM Na solution made up of seven ratios of NaCl, Na₂SO₄, and NaNO₃ (100:0:0, 50:50:0, 0:100:0, 0:50:50, 0:0:100, 50:0:50, and 33:33:33). The results after four flushes of growth and flowering showed higher dry weight productivities in *R. manetti* plants. Salt composition (i.e., counter-anion ratios) significantly affected the dry weight yield of ‘Natal Briar’ plants, with those irrigated with 100% Na₂SO₄ and NaNO₃ having the highest and lowest values, respectively. While the plants budded on *R. manetti* did not show significant responses to salt composition, there was a strong tendency for higher dry weight yields in binary salt (anion) compositions. Leachates collected throughout the study showed similar pH (7.5) and electrical conductivities (4.7 dS/m) for all salt treatments. Leachate Cl⁻ concentrations were linearly correlated with Cl⁻ application, whereas leachate Na⁺ concentrations remained similar among treatments. Plants on *R. manetti* accumulated less leaf Na⁺ and Cl⁻ than in *R.* × ‘Natal Briar’ plants, with lower values observed, in general, in plants irrigated with solutions containing Na₂SO₄.

Impact of Low Iron and Phosphorus Stresses on Acidification of Nutrient Solution by Geranium

Matthew D. Taylor*¹, Paul V. Nelson¹, Jonathan M. Frantz²

¹North Carolina State University, Department of Horticulture Science, Raleigh, NC, 27607; ²USDA-ARS, Toledo, OH, 43606

The cause of sudden substrate pH decline by geranium is unknown. Low Fe and low P have been shown to cause many plant species to acidify the substrate. Research was done to determine if low Fe or P stresses caused four geranium (*Pelargonium* ×*hortorum* Bailey) cultivars to acidify nutrient solution. Two cultivars were susceptible and two resistant to substrate acidification based on a grower survey. Rooted geranium cuttings were transferred to 4-L containers containing modified Hoagland’s solution with N supplied as 15% NH₄ and 85% NO₃. The plants were grown in a greenhouse for 44 days. Treatments consisted of a complete nutrient solution and two similar solutions devoid of either Fe or P. Solutions pH was set at 5.8, changed weekly, and tested 3 and 6 days after each change. Because all cultivars showed similar responses, results were combined. Twenty days after transplanting (DAT), plants in all treatments, including control, caused solution pH to fall below 5. At 37 DAT, the solution pH levels for control, minus Fe, and minus P treatments were 4.1, 3.7, and 3.6, respectively. Results indicated that geranium is an acidifying plant when N is supplied as 15% NH₄ and 85% NO₃. Additionally, low Fe and low P stresses increase the acidification rate. Total dry weights of minus-P plants were about half that of minus-Fe plants. This indicated that plants under P stress had a higher specific rate of acidification than plants under Fe stress.

Impact of Flower Removal and Light and Temperature Stresses on Acidification of Nutrient Solution by Geranium

Matthew D. Taylor¹, Paul V. Nelson*¹, Jonathan M. Frantz²

¹North Carolina State University, Department of Horticulture Science; USDA, ARS, Toledo, OH, 43606

The cause of sudden substrate pH decline by geranium (*Pelargonium*

×*hortorum* Bailey) is unknown. Published reports indicate that this response can be influenced in other plants by temperature and light extremes. The first of five experiments compared plants with all flowers removed to plants that were allowed to flower. Experiment 2 compared plants grown at four light levels (105, 210, 450 and 1020 μmol·m⁻²·s⁻¹). Experiment 3 compared plants grown at four temperatures (14/10, 18/14, 22/18 and 26/22 °C day/night). Experiment 4 was a repeat of Experiment 1 and Experiment 5 was a factorial combining the three highest light levels and the three highest temperature levels. Plants allowed to form flowers had a final substrate pH of 5.7 compared to 6.3 for plants where flowers were removed. With increasing increments of temperature, substrate pH declined from 6.8 to 4.6 and with increasing light intensity from 6.1 to 4.8. There was no effect of flower removal in Experiment 4. Light and temperature had no consistent effects in Experiment 5 throughout 46 days after planting, with most pH values remaining in the acceptable range of 5.6–6.1. By 60 days, temperature treatments began to segregate, with pH being highest in the low-temperature treatments and lowest, down to 5.5, in the highest-temperature treatments. High temperature stimulated geranium acidification in both experiments, with the effect more severe in the first experiment. The flowering and high light effects were not duplicated in the second trial. This indicates that an additional factor is involved in expression of the light, temperature, and flowering control of acidification.

Oral Session 4—

Water Utilization/Management & Pest Management

27 July 2006, 2:00–4:00 p.m.

Southdown

Moderator: Michael Compton

Potential of Anaerobic Digestion-derived Biosolids as an Organic Addendum in Horticultural Growing Media

Michael Compton*¹, Timothy Zauche²

¹University of Wisconsin–Platteville, School of Agriculture, Platteville, WI, 53818;

²University of Wisconsin–Platteville, Department of Chemistry and Engineering Physics, Platteville, WI, 53818

Soilless horticultural growing media are composed of organic matter, coarse aggregates, nutrients, and a wetting agent. Sphagnum peat has been the standard organic addendum to soilless growing media. However, recent shortages, escalating costs, and its acidity make sphagnum peat a sometimes less-than-desirable material. Alternatives such as composted bark dust, coconut coir, composted manure, and crop by-products have been proposed as substitutes for sphagnum peat, but none are a suitable general alternative. Anaerobic digestion-derived biosolids (ADB) has the potential to become a complete or partial substitute for sphagnum peat. ADB is a cellulosic product similar in appearance to sphagnum peat and is a product from the anaerobic digestion of cattle manure for 14 to 25 days at temperatures between 104 °F. and 140 °F. Bacteria from the animal’s rumen, present in the manure prior to anaerobic digestion, are used to breakdown excessive nutrients present in the manure. Following anaerobic digestion, the nutrient-rich liquid phase is removed to yield an odorless cellulosic fiber that is sterile, free of weeds, pests, and pathogens, as well as uniform and reproducible. The potential application of ADB to the horticulture industry, most specifically as an organic addendum to soilless media, is immense and will be discussed. Use of anaerobic digester-derived biosolids in horticultural growing media is a protected intellectual property and available for license through the WiSys Technology Foundation.

Roots Affect the Accuracy of Dual-probe Heat-pulse Method for Measuring Water Content in Plant Growth Media

Susan L. Steinberg*¹, Gerard J. Kluitenberg², Soheni Tanzeema¹

¹Universities Space Research Association, Division of Space Life Sciences; ²Kansas State University, Department of Agronomy

Little attention has been paid to how the presence of roots influences water content measurements obtained with water content sensors. This issue is especially important if sensors are deployed in densely rooted soil or growth media. This work addresses the impact of roots on water content measurements obtained with dual-probe heat-pulse (DPHP) sensors. In the DPHP method, the maximum temperature rise in response to heating (T_{max}) is used to calculate volumetric heat capacity, which in turn is used to calculate volumetric water content. The accuracy of DPHP sensors was evaluated in unrooted and rooted 0.25–1 mm baked ceramic aggregate. For both restricted and unrestricted volumes of aggregate the presence of roots caused DPHP sensors to consistently overestimate water content by 0.05–0.09 cm³·cm⁻³. Measured values of T_{max} were lower in the presence of roots, which resulted in over-estimation of volumetric heat capacity that was attributed to the high specific heat of water contained in roots in addition to that contained within the aggregate. Differences in water content and aggregate heating between unrooted and rooted aggregate equilibrated to the same matric potential were less distinct in unrestricted volumes, where the decrease in bulk density has the offsetting effect of lowering the heat capacity. Error in water content caused by the presence of roots and changes in bulk density was estimated by developing a theoretical mixing model for volumetric heat capacity that accounted for the heat capacity of all constituents, including aggregate, water, root water, and root tissue. Predicted errors in volumetric water content due to changes in bulk density or changes in heat capacity due to roots agreed well with direct measurement.

Non-irrigation in Fall and Winter Improves Florida Citrus Fruit Quality

Larry Parsons*, Ed Etcheberria

¹University of Florida, IFAS, Citrus Research & Education Center, Lake Alfred, FL, 33850

Moderate water stress applied to citrus trees can increase fruit °Brix. Florida citrus growers have been required to use less irrigation as competition for water increases. The goal of this study was to see if irrigation could be eliminated in the fall and winter with few negative consequences. Water stress was imposed over a 3-year period on ‘Hamlin’ and ‘Valencia’ oranges (an early and late variety, respectively) by stopping irrigation in late October and restarting it in March. ‘Hamlin’ fruit was harvested after 2 months of stress and ‘Valencia’ fruit was harvested after 4 to 5 months of stress. In most years, °Brix was increased by water stress. Over a 3-year period, ‘Hamlin’ yield was not affected by the water stress, but ‘Valencia’ yield decreased slightly in the 3rd year. The increase in °Brix is beneficial economically, and, over 3 cm of irrigation water per year can be saved.

Crop Simulation and Crop Evapotranspiration for Irrigation Management of Spinach

Giovanni Piccinni*¹, Thomas Gerik¹, Evelyn Steglich², Daniel Leskovar³, Jonghan Ko², Thomas Marek², Terry Howell⁴

¹Texas A&M University, Soil and Crop Sciences–TAES, Uvalde, TX, 78801; ²Texas A&M University, Texas Agricultural Experiment Station; ³Texas A&M University, Horticulture–TAES; ⁴USDA–ARS, Conservation and Production Research Laboratory

Improving irrigation water management for crop production is becoming increasingly important in South Texas as the water supplies shrink and competition with urban centers in the region grows. Crop simulators and crop evapotranspiration (ET) are appealing methods for estimating crop water use and irrigation requirements because of the low investment in time and dollars required by on-site (in-field) measurement of soil and/or crop water status. We compared the effectiveness of the Crop.m.an/EPIC crop simulator and Crop-ET approaches estimating the crop water use for irrigation scheduling of spinach. In-ground weighing lysimeters were used to measure real-time spinach water use during the growing season. We related the water use of the spinach crop to a well-watered reference grass crop to determine crop coefficients (K_c) to assist in predicting accurate crop needs using

available meteorological data. In addition, we ran several simulations of CropMan to evaluate the best management for growing spinach under limited water availability. Results show the possibility of saving about 61 to 74 million m³ of water per year in the 36,500 ha of irrigated farms of the Edwards aquifer region if proper irrigation management techniques are implemented in conjunction with the newly developed decision support systems. We discuss the implications of the use of these technologies for improving the effectiveness of irrigation and for reducing irrigation water requirements in South Texas.

Pre-emergence Weed Control in No-tillage Pumpkin Production

S. Alan Walters*¹, Bryan G. Young¹, Ronald F. Krausz²

¹Southern Illinois University, Plant, Soil, and Ag. Systems, Carbondale, IL, 62901-4415;

²Southern Illinois University, Plant, Soil, and Ag. Systems, SIUC Belleville Research Center, Belleville, IL, 62221-8615

A field study was conducted in 2002, 2003, and 2004 to evaluate various pre-emergence herbicides (ethafluralin & clomazone, ethafluralin & clomazone + halosulfuron, and ethafluralin & clomazone + imazamox) with or without a winter rye (*Secale cereale* L.) cover crop in tillage and no-tillage ‘Appalachian’ pumpkin (*Cucurbita pepo* L.) production. All herbicides were applied within two days of seeding, and no injury was observed with any of the herbicides evaluated at any time during the three growing seasons. Early- and late-season control of all weed species [giant foxtail (*Setaria faberi* Herrm.), common cocklebur (*Xanthium strumarium* L.), redroot pigweed (*Amaranthus retroflexus* L.), and common waterhemp (*Amaranthus rudis* Sauer)] were highly correlated ($0.47 \leq r \leq 0.86$, $P \leq 0.01$) with pumpkin yield and fruit size. The winter rye + no-tillage system provided greater weed control compared to the tillage systems and the no cover crop + no-tillage production system. Although winter rye alone had little influence on pumpkin yield, the no-tillage system improved pumpkin yield and fruit size compared to the tillage system. The two herbicide combinations (ethafluralin & clomazone + halosulfuron and ethafluralin & clomazone + imazamox) improved weed control and pumpkin yields compared to only ethafluralin & clomazone. Although this study indicated that the use of a high-residue winter rye cover crop in no-tillage pumpkin production will provide some weed control, the choice of pre-emergence herbicides is critical to maximize pumpkin productivity. No-tillage pumpkin production is feasible with proper herbicide use and timing, although current herbicide options will not provide optimal weed control.

Early Season Broadleaf Weed Control in Onion

Harlene M. Hatterman-Valenti*¹, Carrie E. Schumacher¹, Collin P. Auwarter¹, Paul E. Hendrickson²

¹North Dakota State University, Plant Sciences; ²North Dakota State University, Carrington Research/Extension Center

Field studies were conducted at Absaraka, Carrington, and Oakes, N.D., in 2005 to evaluate early season broadleaf weed control and onion (*Allium cepa* L.) injury with herbicides applied preemergence to the crop. DCPA is a common preemergence herbicide used in onion. However, DCPA can be uneconomical in most high-weed situations, or the usage may be restricted due to possible groundwater contamination. Potential substitutes evaluated were bromoxynil, dimethenamid-P, and pendimethalin. Main broadleaf weeds were redroot pigweed (*Amaranthus retroflexus* L.) and common lambsquarters (*Chenopodium album* L.). In general, all herbicides, except bromoxynil, provided acceptable broadleaf weed control 4 weeks after treatment. The highest herbicide rate provided greater weed control compared with the lowest rate for each herbicide. However, onion height was also reduced with the highest herbicide rate. In addition, the two highest rates of dimethenamid-P reduced the onion stand compared with the untreated. A postemergence application of bromoxynil + oxyfluorfen + pendimethalin to onion at the four- to five-leaf stage controlled the few broadleaf weeds that escaped the preemergence treatments and provided residual control of mid- and late-season germinating broadleaf weeds at two of the three locations. Intense germination

of redroot pigweed during July at the Oakes location reduced onion yield with all treatments compared with the hand-weeded check. In contrast, total onion yields with all herbicide treatments except the high rate of dimethenamid-P were similar to the hand-weeded check at Absaraka and Carrington.

Detection and Distribution of Viruses Infecting Field-grown Sweetpotato in East Africa

Douglas Miano*¹, Don LaBonte¹, Christopher Clark²

¹Louisiana State University, Dept. of Horticulture, Baton Rouge, LA, 70803; ²Louisiana State University, Dept. Plant Pathology & Crop Physiology, Baton Rouge, LA, 70803

Sweetpotato is an important staple food crop in Sub-Saharan Africa, with production being concentrated in East Africa, particularly around Lake Victoria. Productivity of the crop is greatly constrained by viral diseases. Four main viruses have consistently been detected from various surveys done in the region viz., sweetpotato feathery mottle virus (SPFMV), sweetpotato chlorotic stunt virus (SPCSV), sweetpotato mild mottle virus (Sp.m.MV), and sweetpotato chlorotic fleck virus (SPCFV). The most severe symptoms have been caused by co-infection with SPCSV and SPFMV, resulting in the synergistic sweetpotato virus disease (SPVD). Some local sweetpotato genotypes have been reported to recover from, or have localized distribution of SPVD, suggesting that the disease is not fully systemic. This has led to the suggestion that uninfected cuttings may be obtained from previously infected plants. Experiments were set to determine the possibility of obtaining cuttings long enough for propagation that are free from virus infection. This would form a basis for recommending to the local small-holder farmers of a way to reduce losses due to the disease. Field-grown sweetpotato vines were cut into three pieces (15, 15–30, and >30 cm from the apex) and tested for SPCSV and SPFMV. Nine genotypes were selected from a group of 21 local clones and used for this study. The two viruses were equally present in all the three sections of infected vines, indicating that it is not easy to obtain a virus-free cutting for field propagation from an infected vine. Virus assays in the past has mainly been limited to the use of serological methods. Use of PCR resulted in detection of begomoviruses infecting sweetpotatoes for the first time in the region.

Effect of Soil Solarization and Fumigation on Productivity and Fruit Quality of Strawberry

Mohamed Ragab*

Fac. of Agric., Ain Shams Univ., Horticulture, Hadayek Shobra 11241, Cairo, Egypt

A study of solarization and fumigation with methyl bromide (MB) on productivity and fruit quality of strawberry were investigated during two successive seasons of 2002–03. There were nine treatments: fumigation with methyl bromide (MB), solarization, their combination, and Nemaless. Results demonstrate that plant height, number of leaves per plant, average leaf area, root length, and crown diameter were significantly increased by fumigation with MB as compared with solarization or using Nemaless in the two tested seasons. Significant increments were obtained also in early and total yield, as well as total soluble solids and ascorbic acid when soil was fumigated with MB compared with solarization or using Nemaless. The highest total yield found with treatments was MB at 70 g/m², followed by MB at 50 g/m², 2-month solarization plus MB at 30 g/m², 1 month plus MB at 30 g/m², MB at 30 g/m², 2 months solarization, one month solarization, Nemaless, and control in the both tested seasons, respectively. Nemaless caused significant increments in early and total yield compared with the control in the two tested seasons. The results of this study provide evidence to suggest that a better understanding of different fumigation methods may aid us in the efforts to improve management of strawberry production.

Oral Session 5—Plant Biotechnology

27 July 2006, 4:15–5:45 p.m.

Borgne

Moderator: Jessica L. Boldt

Micropropagation Cultures for Genetic Transformation of Grapevine

Manjul Dutt*, Dennis J. Gray, Zhijian T. Li, Sadanand Dhekney, Marilyn M. Van Aman

University of Florida, Mid-Florida Research and Education Center, Apopka, FL, 32703

A major drawback to the use of embryogenic cultures for transformation of grapevine is that their ability to undergo genetic transformation is cultivar-dependent. Also, depending on cultivar, embryogenic cultures are difficult to impossible to maintain over time, reducing their utility for use in genetic transformation. An alternative to the use of embryogenic cultures for transformation of grapevine is the use of micropropagation cultures, which are easier to initiate from a wide range of grapevine cultivars and can be maintained over time without loss of function. *Vitis vinifera* ‘Thompson Seedless’ was used as a model for genetic transformation using micropropagation cultures. In vitro cultures were initiated from apical meristems of actively growing vines and maintained in C2D medium containing 4 μM of 6-benzylaminopurine (C2D4B). Shoot tips and nodes were collected from proliferating in vitro cultures for transformation studies. A variety of wounding techniques, including nicking, sonication, and fragmenting of meristematic tissues was employed in order to enable *Agrobacterium* infection. We used a construct containing a bidirectional 35S promoter complex with a marker gene composed of a bifunctional fusion between an enhanced green fluorescent protein (EGFP) gene and a neomycin phosphotransferase (NPTII) gene in one direction and a hybrid lytic peptide gene in the other. Transgenic shoots growing in C2D4B medium containing 200 mg·L⁻¹ each of carbenicillin and cefotaxime and 20 mg·L⁻¹ of kanamycin were selected based on GFP fluorescence. Transgenic shoots were rooted and transferred to a greenhouse. To date, 18 transgenic lines have been generated. Details on the transformation procedure will be discussed.

Comparison between Protoplast Transformation and Co-transformation in ‘Hamlin’ Sweet Orange [*Citrus sinensis* (L.) Osbeck]

Ahmad A. Omar*¹, Wen-Yuan Song², James H. Graham³, Jude W. Grosser¹

¹University of Florida, Horticulture Science, Citrus Res. and Education Center, Lake Alfred, FL, 33850; ²University of Florida, Plant Pathology; ³University of Florida, Soil and Water Science

Citrus canker disease caused by the bacterial pathogen *Xanthomonas axonopodis* pv. *citri* is becoming a worldwide problem. *Xa21* gene is a member of the *Xa21* gene family of rice, which provides broad spectrum *Xanthomonas* resistance in rice. ‘Hamlin’ sweet orange [*Citrus sinensis* (L.) Osbeck] is one of the leading commercial cultivars in Florida because of its high yield potential and early maturity. ‘Hamlin’ also has a high regeneration capacity from protoplasts and is often used in transformation experiments. Since the citrus canker pathogen is in the same genus, this gene may have potential to function against canker in citrus. The wild-type *Xa21* gene contains an intron, and there are some questions whether dicot plants can process genes containing monocot introns (the cDNA is intron-free). Plasmids DNA, encoding the non-destructive selectable marker *EGFP* (Enhanced Green Fluorescent Protein) gene and the cDNA of the *Xa21* gene were transformed or co-transformed into ‘Hamlin’ orange protoplasts using polyethylene glycol. More than 200 transgenic embryoids were recovered. More than 400 transgenic plants were developed from 75 independent transgenic events. PCR analysis revealed the presence of the cDNA of the *Xa21* and the *GFP* genes in the transgenic plants.

Some of the plants have the *GFP* only. Southern analysis is showing integration of the cDNA into different sites ranges from one to five sites. Western analysis is showing the expression of the cDNA of the *Xa21* gene in the transgenic citrus plants. This is the first time that a gene from rice has been stably integrated and expressed in citrus plants. Canker challenge assay is in progress.

Meristem Identity Genes and the Control of the Reproductive Development in *Brassica oleracea*

Denise Duclos*, Thomas Björkman

Cornell University, Horticultural Sciences, Hedrick Hall, NYSAES, Geneva, NY, 14456

The genetic factors that control reproductive development in *B. oleracea* remain a mystery. Broccoli differs from cauliflower in its floral development stage at harvest. We are studying the role of meristem identity genes (MIGs) in the transition from inflorescence meristem (cauliflower) to floral buds (broccoli). The objectives are to determine stage-specific roles of MIGs during reproductive development and to check whether expression of flowering genes in heading *B. oleracea* is as predicted by the *Arabidopsis* flowering model. We tested a model of arrest in *B. oleracea* that incorporates FUL, a redundant gene of AP1 in controlling inflorescence architecture and floral meristem identity, the meristem gene TFL1, the flowering gene LFY, and AP1/CAL, and genes involved in flower transition. Conclusions. 1) Arrest at the inflorescence meristem stage is highly correlated with a decrease in LFY to TFL1 ratio, given by a decrease in TFL1 expression. 2) Transcription of AP1c is stimulated at the time of floral primordium initiation, suggesting a role in floral transition but not in floral organ specification. Plants recessive for AP1a, AP1c, and CAL formed normal floral buds containing all four whorls of organs, and did not necessarily form curd. We suggest that their ability to flower could be related with the ectopic expression of FUL by affecting TFL1 expression. FUL paralogs were highly expressed at all stages of development of the triple mutant plants. 3) The lack of upregulation in AP1 transcripts at the floral bud stage, and the absence of an A-function mutant phenotype imply that other genes act redundantly with AP1 in the specification of sepal identity and questions the role of AP1a and AP1c as A-function genes in *B. oleracea*.

Characterization of Physiological Resistance to White Mold and Search for Molecular Markers Linked to Resistance via Advanced Backcross QTL Analysis in an Interspecific Cross between *Phaseolus coccineus* and *P. vulgaris*

J. Erron Haggard*, James R. Myers

Oregon State University, Horticulture, Corvallis, OR, 97331-7304

White mold, caused by *Sclerotinia sclerotiorum* (Lib.) de Bary, causes major losses in dry and snap bean (*Phaseolus vulgaris*) production. With little genetic variation for white mold resistance in common bean, other potential sources for resistance must be investigated. Accessions of scarlet runner bean (*P. coccineus*) have been shown to have partial resistance exceeding any to be found in common bean. Resistance is quantitative with at least six QTL found in a *P. coccineus* intraspecific resistant × susceptible cross. Our goal is to transfer high levels of resistance from *P. coccineus* into commercially acceptable common bean lines. We developed interspecific advanced backcross populations for mapping and transfer of resistance QTL. 111 BC₂F₃ lines from a cross between OR91G and PI255956 have been tested in straw tests and oxalate tests, as well as in a field trial. The data show that the OR91G × PI255956 population carries a high level of resistance, but because of the quantitative nature of resistance, it may be necessary to intercross individuals to achieve higher levels. SSR, RAPD, and AFLP markers are being tested in the population to construct a linkage map for placement of QTL. QTL identified from each type of test (straw, oxalate, and field) may provide additional

information about the genetic architecture of white mold resistance. Three other populations are from advanced backcrosses of the recurrent parents G122, OR91G, and MO162, with PI433251B as the donor parent in each. Analyses and advance of these populations will follow, the results of which should confirm QTL identified in the OR91G × PI255956 population, as well as possible additional resistance QTL from PI433251B.

Water Potential Characteristics of Transgenic *Petunias* Over-expressing Two *Arabidopsis* C-repeat Binding Factor cDNAs

Jessica L. Boldt*, James E. Barrett, David G. Clark

University of Florida, Environmental Horticulture, Gainesville, FL, 32611

Petunia × *hybrida* 'Electric Purple' plants, genetically transformed (Selecta Klemm Co.) via *Agrobacterium tumefaciens* to constitutively express the Cauliflower Mosaic Virus 35S promoter (CaMV35S) fused to two separate *Arabidopsis* c-repeat binding factor cDNAs (CBF3 & CBF4), were utilized to evaluate water relations. Non-stressed plants followed a classical stomatal conductance pattern, with maximum conductance between 1000 hr and 1400 hr. CBF3 and CBF4 plants showed an increase in transpiration rates and a decrease in stomatal resistance at 1230 hr, compared to 'Electric Purple'. Transpiration rates (per unit leaf area) were similar in CBF3 and 'Electric Purple' plants, but CBF4 plants were 12% less than 'Electric Purple'. Xylem water potentials at visible wilt were between -1.4 and -1.5 MPa and there were no significant differences between line or irrigation treatment. A fourth experiment observed differential plant responses to stress cycles. Under non-stress irrigation conditions, CBF4 plants showed an increase in stomatal resistance and a decrease in transpiration rate compared to 'Electric Purple' plants. There were no differences in the xylem water potential at visible wilt for the first and third stress cycles, but, for the second cycle, xylem water potentials at wilt were -1.9, -1.7 and -1.4 Mpa for CBF4, 'Electric Purple' and CBF3 plants, respectively. CBF3 and CBF4 plants showed small differences in performance as compared to 'Electric Purple' and under mild stress conditions as imposed in these experiments apparent heterologous overexpression of the *Arabidopsis* CBF3 & 4 transgenes may not be sufficient for conferring drought tolerance in petunia.

Optimization of the RAPD Marker Techniques in *Camellia*

Lianghong Chen*¹, Mack Nelson²

¹Fort Valley State University, Agricultural Research Station, Fort Valley, GA, 31030;

²Fort Valley State University, College of Agriculture

Randomly amplified polymorphic DNA (RAPD) technique is based on DNA amplification by polymerase chain reaction (PCR) of random DNA segments using single arbitrary nucleotide sequences. It has been widely used for genetic mapping, plant and animal breeding programs, and DNA fingerprinting. However, there is no single set of RAPD-PCR conditions that can be applied to all situations. In order to adjust reaction component concentrations within suggested ranges for efficient amplification during the use of RAPD in detection of genetic variation of genus *Camellia*, crucial factors, such as concentrations of MgCl₂ and DNA, annealing temperature (37 to 44 °C), and the use of an AmpliTaq[®] DNA polymerase and Stoffel fragment were examined. Five camellia cultivars, 'Winter's Beauty', 'Pink Icicle', 'Polar Ice', 'Winter's Hope', and 'Snow Flurry', were under investigation. Clear and reproducible amplification products were produced with 3.0 μM MgCl₂ and 30 ng template DNA/25 μL reaction mixer at annealing temperature 37 °C and 40 °C, compared with MgCl₂ at 1.5, 2.0, and 2.5 μM. When annealing temperature increased, the RAPD-PCR stringency was increased, as expected. Stoffel fragment was found to provide highly reproducible results.

Increasing Teaching Effectiveness through Collaborative Learning Activities

Elsa Sanchez*, Richard Craig

Pennsylvania State University, Horticulture, University Park, PA, 16802

The Plant Systematics course at Penn State University was reformatted in 1995 based on a three-dimensional model. It now includes several collaborative learning activities: a learning fair hosted by the enrolled students for elementary school students; applied laboratory exercises; and applied laboratory examinations. Each activity has a specific objective and was constructed to strengthen teaching effectiveness and to aid students in developing useful skills for future employment. A survey was administered to students enrolled in the course from 2003 through 2005 in part to assess the collaborative learning activities. Most students “strongly agreed” or “agreed” that they liked working in collaborative groups and learned from other group members. Students preferred working in groups for laboratory examinations more than for the Asteraceae Fair and learned more from their peers while completing the laboratory exercises than in laboratory examinations. Student participation in the lecture portion of the course increased as collaborative learning activities were completed. Camaraderie with peers through group work may have created an atmosphere conducive to participation and/or involvement during lectures. Organization and planning were vital to the success of these activities, as were using small groups and providing adequate incentives for completing activities. These activities engaged students to become active participants in the teaching and learning process.

Pre- and Post-course Assessment of Knowledge by Students in an Introductory Horticulture Course

James N. McCrimmon*

Southeast Missouri State University, Department of Agriculture, Cape Girardeau, MO, 63701

The Introduction to Horticulture course in the Department of Agriculture at Southeast Missouri State Univ. provides an overview of the principles of various horticulture crops. It is a lower-level course comprised primarily of freshmen and sophomores. Although many of the students that take the course are majors in the horticulture option, there are some students taking the course that are not horticulture majors, since the course is a requirement for all majors in the department. The objective of this study was to have students assess their knowledge of various types of horticultural plants before and after the course. During the first day of class, a pre-course student profile and survey was given to each student in order to determine their background and to assess their knowledge of certain horticultural plants. They were asked their knowledge of these topics; and, they rated their knowledge as follows: excellent, good, average, fair, or poor. Throughout the semester, these topics and plants were discussed or demonstrated in either the lecture or the laboratory. At the end of the semester, students were given a post-course survey to assess their knowledge of the same topics and horticultural plants which they rated their knowledge of the first day of class. Comparisons between pre- and post-course student assessment of their knowledge of topics and plants will be discussed.

Assessing a Garden-based Curriculum for First Graders in Iowa: Parental Perceptions of Change

Cynthia Haynes*¹, Kimberly Hilgers², Joanne Olson¹¹Iowa State University, Horticulture, Ames, IA, 50011; ²South Dakota State University, Horticulture, Forestry, Landscape, and Parks, Brookings, SD, 57007; ³Iowa State University, Curriculum and Instruction, Ames, IA, 50011

The interest, use, and recognized benefits of gardens as educational

tools for youth has increased in recent decades and has prompted the development of garden-based curricula for use in schools. Iowa State University Extension developed Growing in the Garden (GITG), a curriculum designed for use in kindergarten through third grade classrooms. This study examined the impact of the GITG curriculum on the awareness and interest of first graders in the areas of science, nutrition, and the environment. A survey was used to determine parental perceptions of their child's interest and awareness after experiencing three lessons from the GITG curriculum. Forty-seven parents (60.2% response rate) of first graders from four classrooms in Iowa completed the survey. A significant number of parents surveyed noted an increased awareness and interest of their children in the areas of science and the environment. Factors such as socio-economic status, ethnicity, and gender did not influence the outcomes.

An Interactive Online Case Study to Improve Problem-solving Skills of Landscape Horticulture Students

Ann Marie VanDerZanden*¹, David R. Sandrock*¹¹Iowa State University, Horticulture, Ames, IA, 50011; ²Oregon State University, Horticulture, Corvallis, OR, 97331

Horticulture graduates entering the landscape industry will be faced with a multitude of complicated management decisions where they will need to integrate their understanding of plant science, site constraints, state and federal environmental regulations, and the human impact on the built landscape. To help students develop and refine their problem-solving skills, an interactive online case study was created. The case study was used in two different landscape horticulture courses at Iowa State University and Oregon State University. The case study centers on a residential backyard with eight landscape problem scenarios. Each scenario is identified on the clickable landscape map of the area and contains links to audio files, PDF documents, images, and Internet links. After investigating each scenario, students submit an analysis, diagnosis, and recommendation about the landscape problem via WebCT or Blackboard, depending on the institution. Student evaluation of the case study as a teaching tool was positive (3.5, where 1 = poor; 5 = excellent). Students answered additional questions using a scale where 1 = strongly disagree and 5 = strongly agree. As a result of using this teaching tool, students felt that they were able to summarize the data (3.9), diagnose the landscape problem (3.9), and make a recommendation to the homeowner (3.6). Further, they felt this teaching tool was an effective way to deliver information (3.9); the interactive format aided their learning (3.7); that they were comfortable using a web-based format (4.2); and they liked learning using case studies (4.1). Our goal is to make the case-study framework available to other teaching colleagues who can then add their own data.

OASIS: An Experiential Learning Class in Organic Production

Erin Silva*¹, Connie Falk²¹New Mexico State University, Plant and Environmental Sciences, Las Cruces, NM, 88003;²New Mexico State University, Agricultural Economics and Agricultural Business, Las Cruces, NM, 88003

New Mexico State University has designed a course in Organic Vegetable Production centered on a working CSA (Community Supported Agriculture) Farm. This project, named “OASIS” (Organic Agriculture Students Inspiring Sustainability), was funded by a 3-year USDA Hispanic Serving Institutions (HSI) grant from 2002–05. The project has multiple objectives, including: to provide students with a multi-disciplinary experiential educational opportunity; to investigate the feasibility of small-scale organic drip-irrigated farming in the Chihuahuan desert; to demonstrate the CSA model to the local community; and to trial vegetable varieties. The class is co-listed in the Department of Plant and Environmental Sciences and the Department of Agricultural Economics and Agricultural Business. Recently, the class was adopted in the Honors College and also became part of the General Education (G) program at NMSU. The course meets twice a

week during two 2-h class periods. In-class time is divided between lectures, active learning projects, and work at the 0.26-ha field plot. The class content covered by the instructors includes organic regulations, history of CSAs and organic agriculture, evaluating the profitability of CSAs, the production of specific vegetable crops, planting and harvesting procedures, and postharvest requirements. Guest speakers are also part of the regular class structure and have discussed various topics such as beneficial insects, tillage, cover cropping, and weed management. The “living classroom” allows for these lectures to draw upon the experiences of students working on the farm. Although the course presents several challenges, the hands-on experience gained by the students is considered to be invaluable.

International Opportunities in Horticulture at Auburn University

Amy N. Wright*, Jeff L. Sibley, Luther Waters, Dave Williams, Joe Eakes

Auburn University, Horticulture, Auburn, AL, 36849

International undergraduate study programs give students an advantage in the job market, broaden their understanding of and experience with other cultures, and allow them to develop professional international contacts. Since 2003, faculty and administrators in the Department of Horticulture at Auburn University have been providing horticultural study tours for faculty and undergraduate and graduate students in horticulture. In 2003 and 2004, undergraduate students and faculty participated in an about 10-day non-credit study tour of gardens in London and southeastern England. In 2005, undergraduate students, a graduate student, and faculty participated in an 8-day non-credit study tour of gardens, horticultural production facilities, and natural ecosystems in Costa Rica. All of these tours in 2003 to 2005 occurred during the break between spring and summer semesters. In 2005, a 6-week study abroad program (1 June to 15 July) was offered at a college in northwestern England. Students received 13 hours of credit for four classes: Landscape Gardening, History of Garden Design, International Agriculture Seminar, and Herbaceous Plant Materials. In addition to class time, trips were arranged each week to regional gardens and retail and production facilities. Plans for 2006 include a week-long non-credit study tour of gardens and production areas in The Netherlands during the break between spring and summer semesters, a 2-week study tour of government, university, and agricultural production areas in Hungary in July (offered in conjunction with the College of Agriculture), and a repeat offering of the study abroad program in England.

Hurricanes Rita and Katrina: Impact on Louisiana's Green Industry Professionals

Allen Owings*¹, Ginger Fortson², Edward Bush¹, Jeff Kuehny¹

¹LSU AgCenter, Horticulture, Baton Rouge, LA, 70803; ²LSU AgCenter, Jefferson Parish, Metairie, LA, 70003

Hurricane Katrina (Aug. 2005) and Hurricane Rita (Sept. 2005) were devastating to the central U.S. Gulf Coast region. Hurricane Katrina caused an estimated \$10–11 million in wholesale nursery crop damage in Louisiana, while Hurricane Rita caused an estimated \$5 million in damages. Average wholesale nursery crop sales in Louisiana account for about \$120 million annually. 317 wholesale growers in Louisiana (49% of the state total) suffered damages due to Hurricane Katrina, while 158 wholesale growers (24% of the state total) suffered damages due to Hurricane Rita. Louisiana's retail plant dealers affected by Hurricane Katrina numbered 367 (28% of the state total). Louisiana's retail plant dealers affected by Hurricane Rita numbered 329 (24% of the state total). Retail plant dealers accounted for \$511 million in sales in 2002, the year for which figures are most recently available. In the landscape and horticultural services segment of Louisiana's green industry, 703 (36%) were impacted by Hurricane Katrina and 450 (23%) were impacted by Hurricane Rita. While growers and retailers experienced economic hardships ranging from 1 month to permanent, most landscape contractors and horticultural service providers rebounded quickly and were actively involved in storm cleanup and recovery. Some, however,

lost equipment, office structures, storage buildings, and vehicles. It is estimated that at least 20,000 of the 56,600 green industry employees in Louisiana were affected by Hurricanes Katrina and/or Rita to some degree. Louisiana's green industry overall provides about \$2.2 billion in economic contributions annually.

Oral Session 7—Controlled Environments

28 July 2006, 8:00–9:00 a.m.

Southdown

Moderator: Chieri Kubota

Effect of Volatile Ethanol Exposure on the Growth and Development of Three Radish Cultivars

Gary Stutte*, Ignacio Eraso

Dynamac Corp, Space Life Sciences Lab, Kennedy Space Center, FL, 32899

NASA has intensively studied the use of plants to regenerate the atmosphere, purify water, and produce food within a bioregenerative life support system for many years. A unique aspect of growing plants in a controlled environment is chronic exposure to low levels of atmospheric volatiles. Alcohols are one of the most common classes of atmospheric contaminants currently detected onboard the International Space Station. A series of experiments were performed in specialized volatile organic compound analysis (VOCA) chambers in order to determine sensitivity of three *Raphanus sativus* L. to atmospheric exposures of ethanol. Three radish cultivars, Sora, Cherry Belle, and Cherry Bomb Hybrid II, were grown under continuous exposure to 0, 50, 100, 300, 500, or 1000 ppm ethanol for 21 days in the VOCA chambers with environmental setpoints of 23 °C, 75% relative humidity, and 18/6 photoperiod under T8 triphosphor fluorescent lamps at 300 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ PAR and 1200 $\mu\text{mol}\cdot\text{mol}^{-1}$ CO₂. These concentrations corresponded to 5%, 10%, 30%, 50%, and 100% of the human exposure limits established by NASA and OSHA. Exposures to less than 10% of the legal exposure limit resulted in a 30% reduction in total biomass, 12% reduction in leaf area, and a 6% reduction in harvest index. Extreme stunting, chlorosis, and plant death were observed at only 50% of the exposure limit. All three cultivars were sensitive to ethanol exposure, with Cherry Bomb Hybrid II being slightly less sensitive than either Sora or Cherry Belle.

Reconfigurable LED Lighting System Development: Potential Energy Savings for CEA

Gioia D. Massa*¹, Jeffery C. Emmerich², Robert C. Morrow², C. Michael Bourget², Cary A. Mitchell¹

¹Purdue University, Horticulture and Landscape Architecture, West Lafayette, IN, 47907-2010; ²Orbital Technologies Corporation, Electrical Projects, Space Center, Madison, WI, 53717

Electrical cost, primarily for lighting, is one of the largest factors inhibiting the development of “warehouse-based” controlled environment agriculture (CEA). In a jointly sponsored collaboration, we have developed a reconfigurable LED lighting array aimed at reducing the electrical energy needed to grow crops in controlled environments. The lighting system uses LED “engines” that can operate at variable power and that emit radiation only at wavelengths with high photosynthetic activity. These light engines are mounted on supports that can be arranged either as individual intracanopy “lightsicles” or in an overhead plane of lights. Heat is removed from the light engines using air flow through the hollow LED strip mounts, allowing the strips to be placed in close proximity to leaves. Different lighting configurations depend on the growth habit of the crops of interest, with intracanopy lighting designed for planophile crops that close their canopy, and close overhead lighting intended for erectophile and rosette crops. Tests have been performed with cowpea, a planophile dry bean crop, growing with intracanopy LED lighting compared to overhead LED lighting. When crops are grown using intracanopy lighting, more biomass is produced, and a higher index of biomass per kW-h is obtained

than when overhead LEDs are used. In addition, the oldest leaves on intracanopy-grown plants are retained throughout stand development, while plants lit from overhead drop inner-canopy leaves due to mutual shading after the leaf canopy closes. Research is underway to increase the energy efficiency and automation of this lighting system. This work was supported in part by NASA: NAG5-12686.

Application of 1-MCP for Quality Preservation of Tomato (*Lycopersicon esculentum*) Seedlings during Long-distance Transportation

Chieri Kubota*, Mark Kroggel

The University of Arizona, Department of Plant Sciences, Tucson, AZ, 85721-0036

Increasing numbers of vegetable growers purchase their seedlings from specialized transplant producers. However, early yield reduction due to abnormal first fruit truss development was often observed after long-distance transportation of seedlings. 1-Methylcyclopropene (1-MCP), an inhibitor of ethylene-mediated reactions, is widely used for postharvest management. If ethylene accumulated in trailers causes such abnormal first truss fruit development, application of 1-MCP to seedlings may prevent such problems. To test this hypothesis, 'Durinta' tomato seedlings with visible flower buds were placed in chambers for 4 days under one of the following conditions: 1) conventional transportation air temperature of 18 °C without 1-MCP, 2) 18 °C with 1-MCP, 3) 12 °C without 1-MCP, and 4) nonstored control. The target initial 1-MCP concentration was 1 $\mu\text{mol}\cdot\text{mol}^{-1}$ inside the chamber, and the concentration was estimated to reach 0.2 $\mu\text{mol}\cdot\text{mol}^{-1}$ after 96 h. Three weeks after transplanting, 81.3% of first trusses on the plants treated at 18 °C without 1-MCP exhibited an abnormal, delayed fruit development. Both 1-MCP application and 12 °C air temperature successfully reduced the symptom to 4.7% and 3.1%, respectively; not significantly different from the nonstored control (1.6%). The average first truss yield was the lowest for 18 °C without 1-MCP (223 g per truss), followed by 18 °C with 1-MCP (582 g), and was the greatest (609–637 g) for 12 °C without 1-MCP or the control. Ethylene accumulation was the primary cause of the delayed fruit development causing yield reduction. Application of 1-MCP during transportation was shown to prevent such undesirable yield loss, although lowering temperature was the most effective under the present experimental conditions.

Measurements of Ambient Ozone Concentrations Show Elevated Levels within Commercial Greenhouses

Hazel Y. Wetzstein*¹, S. Edward Law²

¹University of Georgia, Horticulture Department, Athens, GA, 30602-7273; ²University of Georgia, Biological and Agricultural Engineering, Athens, GA, 30602

Ozone is a highly oxidizing phytotoxic air pollutant, whose effects are documented to adversely affect crop growth and productivity. In contrast to the large body of published work investigating the effects of atmospheric ozone on outdoor agronomic and forestry crops, relatively few studies have addressed the effects of ozone exposure on greenhouse-grown crops. Outdoor concentrations of ozone can commonly attain concentrations in the 50–150 ppb range, which are known to detrimentally impact plant growth. The objective of this study was to characterize ozone exposure in commercial greenhouses as a prelude to the determination of dose–response effects on specific greenhouse crops and the development of ozone abatement methods, if appropriate. This study documented the levels and diurnal fluctuations in atmospheric ozone concentrations over two annual June–October "ozone seasons." Measurements were taken every 10 min. for both indoor and outdoor ozone concentration, solar radiation, and temperature. Unexpectedly, indoor ozone concentrations often exhibited elevated levels that were 25% to 35% higher than outdoor concentrations, even in well-ventilated houses. These findings suggest that additional ozone production may occur within the greenhouse environment. Evaluations of causative factors and ozone effects on commercial crop production are warranted.

Oral Session 8—Nursery Crops 1

28 July 2006, 8:00–9:15 a.m.

Bayside A

Moderator: Hannah M. Mathers

Bark Splitting and Other Cold Hardiness Effects of Ornamental Herbicides

Hannah M. Mathers*, Michele M. Bigger

The Ohio State University, Horticulture and Crop Science, Columbus, OH, 43210

Many nurseries within Ohio and northeastern, southeastern, and western United States, and Canada have reported severe bark splitting and scald-type problems in 2005. The amount and severity of damage seen in 2005 has been unlike anything seen before. At Ohio State University, samples from across the state started appearing in 2003–04 and increased in incidence in 2005. Growers' reports of exceeding losses of 5% of their inventory or 3000 to 4000 trees per nursery are not uncommon. At an average cost of \$125 per tree and with the number of nurseries reporting problems, the stock losses in Ohio have been staggering, in excess of several million dollars. The trees that we have seen problems on in 2005 have been callery pears, yoshino cherry, kwanzan cherry, crab apples, sycamore, serviceberry, hawthorn, mountain ash, black gum, paper bark maple, japanese maples, norway maple 'Emerald Queen', red maples, kousa dogwood, magnolia 'Elizabeth' and the yellow magnolias such as 'Butterflies', 'Sawada's Cream', 'Yellow Bird', and 'Yellow Lantern'. It has long been observed that the actual cause of a bark crack was "preset" by a wound such as the improper removal of a basal sprout, herbicide, leaving of a branch stub, or lack of cold hardiness. Cold and frost may be contributing to the increase in bark splitting across the United States; however, new research results at Ohio State University regarding the effects of DNA preemergent herbicides in the reduction of root hardiness and regrowth potential, sprout removal and other mechanical injuries, and postemergent herbicide application will reveal these are more the causal agents.

Taxodium Growth Under Different Substrate Moisture Levels

Jon Sammons*, Daniel K. Struve

The Ohio State University, Horticulture and Crop Science, Columbus, OH, 43210

Water is quickly becoming one of the world's most precious resources. Micro- and cyclical irrigation are two effective ways that reduce irrigation volume without reducing plant quality. Development of a control mechanism to deliver timely and appropriate irrigation volumes combined with the advantages of micro- and cyclical irrigation will allow maximum water conservation and plant quality. For container-grown nursery plants, the interaction of container geometry and media physical properties dictate the volume of water available for plant uptake. The maximum amount of water a container substrate can hold under gravity is container capacity (CC). We managed season-long irrigation volumes by maintaining CC at three levels; 100% CC; 80% CC; and 60% CC, and used a set irrigation as a commercial control. The results showed similar plant growth for the 100% and set irrigation control groups through the growing season. However, the scheduled regime applied 50% more water than the group maintained at 100% CC. Our system increased water use efficiency without decreasing plant quality.

The Use of Cyclanilide to Promote Lateral Branching in Container-grown Whips

Petra Sternberg*, Daniel K. Struve

The Ohio State University, Horticulture and Crop Science, Columbus, OH, 43210

In nursery production, increased branching is desirable, especially when growing stock that will be marketed at smaller sizes. Typically,

branching is increased by pruning, which reduces growth potential. As an alternative to mechanical pruning, a chemical branching agent, Cyclanilide, has been evaluated for its ability to increase branching in container-grown whip production systems. Cyclanilide sprays of 0, 50, 100, and 200 mg·L⁻¹ were applied to elongating shoots of *Acer ×freemanii* 'Jeffsred', *Cercis canadensis*, *Diospyros virginiana*, *Eucommia ulmoides*, *Malus ×*'Prairie Fire', *Malus ×*'Harvest Gold', and *Quercus rubra* whips. Branching was increased in all taxa except *Eucommia* at concentrations >100 mg·L⁻¹, without significantly reducing plant dry weight. For *Diospyros*, branching was increased when combined with pruning before Cyclanilide application.

Manipulating Light Intensity and Fall Fertilization to Influence Photosynthesis and Freeze Resistance of Azaleas

Frank Henning*, Timothy J. Smalley, Orville M. Lindstrom, John M. Ruter

The University of Georgia, Department of Horticulture, Athens, GA, 30602

On 1 May 2004, a 4 × 2 split-plot experiment was initiated in Athens, Ga., on *Rhododendron ×kurume* 'Pink Pearl'. The four main-plot treatments were low irradiance, low irradiance May–October, low irradiance November–May, and high irradiance (high and low correspond to average daily PPF of 23.6 and 10.4 mol·m⁻²·d⁻¹). The two subplot fall fertigation treatments were 75 mg·L⁻¹ of nitrogen (N) and 125 mg·L⁻¹ N. Plant stem tissue was harvested monthly from November to March, and analyzed for freeze resistance (LT₅₀). Maximum quantum efficiency of PSII (Fv/Fm) was analyzed monthly with a Mini-pam photosynthesis yield analyzer. No interactions existed between fertilizer application and light intensity and the 125 mg·L⁻¹ N fertilizer treatment reduced freeze resistance of azalea stems throughout the study. Fall fertilization had no effect on fluorescence and no interactions existed between fertilizer and irradiance treatments. In November, plants that received low irradiance May–October were less freeze-resistant than plants from the high-irradiance treatment. However, in January, plants that received low irradiance throughout the study were more freeze-resistant than plants that received the high-irradiance treatment. In November, Fv/Fm was higher in the low irradiance and low irradiance November–May treatments. In February and March, Fv/Fm was lower in the low May–November treatment that received low irradiance during summer than the low November–May treatment that received low winter irradiance. The use of shade to reduce irradiance may delay the acquisition of freeze resistance in fall. However, shade may reduce photosystem damage and increase a plants ability to acquire and maintain greater freeze resistance.

Evaluation of Container Media and Cyclic Irrigation on *Ilex ×meserveae* Growth and Nutrient Concentration in Leachates

Gladis Zinati*

Rutgers University, Plant Biology and Pathology, New Brunswick, NJ, 08901

Ilex ×meserveae 'Blue Princess' plants were grown in a pot-in-pot using container media consisting of pine bark-peat-sand at 90:0:10, 75:15:10, and 60:30:10 by volume. During the summer season, plants were irrigated using a cyclic irrigation regime consisting of two and three irrigation applications and were compared to a traditional irrigation regime with one irrigation application that equaled the total volume applied in the cyclic regime. Nitrate concentrations in leachates were three times lower, whereas ortho-phosphate levels were two times lower in three irrigation application than those in one irrigation application. Increasing the percentage of bark in container media increased nitrate levels and reduced ortho-phosphate levels in leachates. There was no significant difference in growth index among treatments.

Oral Session 9—

Postharvest Physiology/MCP/Ethylene

28 July 2006, 9:30–11:30 a.m.

Southdown

Moderator: Jeffrey K. Brecht

Gene Expression Associated with Apple Aroma Biosynthesis

Nobuko Sugimoto*¹, Steve van Nocker¹, Schuyler Korban², Randy Beaudry¹

¹Michigan State University, Department of Horticulture, East Lansing, MI, 48824;

²University of Illinois, Department of Natural Resources and Environmental Sciences, Urbana, IL, 61801

A microarray containing over 10,000 gene fragments was used to link changes in gene expression with changes in aroma biosynthesis in ripening apple (*Malus ×domestica* Borkh). The microarray was probed with fluorescent-tagged cDNA derived from RNA extracted from 'Jonagold' apple skin and cortex tissue representing eight distinct physiological stages spanning 70 days during ripening and senescence. The ripening stages, in chronological order, were: 1) early preclimacteric; 2) late preclimacteric and onset of trace ester biosynthesis; 3) onset of the autocatalytic ethylene and rapidly increasing ester biosynthesis; 4) half-maximal ester biosynthesis and engagement of the respiratory climacteric; 5) near maximal ester biosynthesis, peak in respiratory activity, and the onset of rapid tissue softening; 6) maximal ester biosynthesis prior to its decline, the conclusion of the respiratory climacteric, and the completion of tissue softening; 7) midpoint in the decline in ester biosynthesis and maximal ethylene biosynthesis; and 8) postclimacteric minimum in ester production. Patterns in gene expression reflecting the rise and fall in ester formation were found in some putative genes for beta-oxidation (acyl-CoA oxidase, enoyl-CoA hydratase, and acetyl-CoA acetyl transferase), ester formation (aminotransferase, alcohol dehydrogenase, and alcohol acyl transferase), and fatty acid oxidation (lipoxigenase), but not fatty acid biosynthetic genes. A marked decline coinciding with the onset of ester production was detected in several putative genes for ADH.

Effect of AVG and MCP on Volatile Production of 'Gala' Apple

Valeria Sigal-Escalada, Douglas D. Archbold*

University of Kentucky, Horticulture, Lexington, KY, 40546

Our goal was to determine how aminoethoxyvinylglycine (AVG) and 1-methylcyclopropene (MCP) interact to influence postharvest storability and volatile production of 'Gala' apple. In 2004 and 2005, AVG was applied to 'Gala' apple trees 4 weeks before harvest. After harvest, control and AVG-treated fruit were treated for 20 h at 30 °C with MCP, and fruit were ripened at ambient temperature immediately after harvest, after MCP treatment, or after storage at 4 °C for 6 and 12 weeks. For both seasons, control fruit reached the highest internal ethylene concentration (IEC) during ripening at ambient temperature immediately after harvest. After storage, control fruit had very low IEC in 2004, but the highest in 2005. In general, the combined treatment repressed ethylene production the most for all harvest dates and lengths of storage. AVG plus MCP-treated fruit consistently had the highest flesh firmness (FF) but also had the lowest total volatile production (TVP) by flesh or peel after 6 and 12 weeks in cold storage following both harvest dates. The activity of alcohol acyltransferase was affected by the treatments, but could not explain all the variation found in TVP. TVP was lower for flesh than peel of control and treated fruit, but feeding alcohol substrates to the fruit resulted in a significant increase in TVP, regardless of tissue type or treatment. The results indicate that the combination of AVG plus MCP maintained apple fruit FF in cold storage better than the treatments used alone, but also substantially reduced TVP. Substrate availability seemed to be the most limiting factor affecting TVP by flesh and peel of 'Gala' apples treated with AVG plus MCP.

Sprayable 1-MCP Effects on Maturity and Quality of Apple Fruit at Harvest and After Storage: The New York Experience

Chris B. Watkins*, Jacqueline F. Nock, Tarek Wardeh
Cornell University, Horticulture, Ithaca, NY, 14853

A sprayable formulation of 1-MCP (250 $\mu\text{L}\cdot\text{L}^{-1}$) and 1% oil adjuvant was applied to 'McIntosh' and 'Empire' apple trees 24, 14, and 7 days prior to anticipated optimum harvest dates (early, mid-, and late-spray timings, respectively), and fruit harvested sequentially over 2 to 3 weeks from this date. At harvest, internal ethylene concentrations (IEC), percentage of blush, starch indices, firmness, and soluble solids concentration (SSC) were measured, as well as ethylene production of fruit maintained for 7 days at 20 °C. Additional fruit were stored in air (0.5 °C) with or without postharvest 1-MCP treatment. Preharvest drop of 'McIntosh' apples was also measured. Quality of these fruit was assessed at intervals for up to 4.5 months ('McIntosh') or 6 months ('Empire'). All spray timing resulted in marked delays of preharvest drop. For both cultivars, increases of IEC were inhibited or delayed by sprayable 1-MCP treatment, but effects on other maturity and quality factors were small. Ethylene production of treated fruit was lower than that of untreated fruit. The effects of sprayable 1-MCP on IEC and firmness were maintained during storage, but the longevity of these effects was affected by cultivar, spray timing, and storage period. Postharvest application of 1-MCP further inhibited IEC and maintained firmness of the fruit during storage. These experiments show that sprayable 1-MCP may be a valuable tool to manipulate both pre- and postharvest responses of apple fruit. However, with the formulation used in these experiments, phytotoxicity, primarily as damage around lenticel areas, was observed at harvest indicating that further development of the formulation is necessary for industry use.

Efficacy of Sprayable 1-MCP on Apple Quality at Harvest and after Storage: The Ontario Experience

Jennifer DeEll¹, Dennis Murr²

¹Ontario Ministry of Agriculture, Food and Rural Affairs, Crop Technology Branch, Simcoe, Ontario, N3Y 4N5, Canada; ²University of Guelph, Plant Agriculture, Guelph, Ontario, N1G 2W1, Canada

A sprayable formulation of 250 $\mu\text{L}\cdot\text{L}^{-1}$ 1-MCP and 1% oil adjuvant was applied to mature 'McIntosh', 'Empire', and 'Delicious' apple trees 1 week prior to anticipated optimum harvest. Other spray treatments included: none, 1% oil adjuvant alone, and a formulation of 125 $\mu\text{L}\cdot\text{L}^{-1}$ 1-MCP and adjuvant ('Empire' only). Unsprayed fruit were treated postharvest with or without gaseous 1-MCP (1 $\mu\text{L}\cdot\text{L}^{-1}$). At harvest, internal ethylene concentration (IEC), starch index, firmness, and soluble solids concentration were measured, as well as CO_2 , ethylene, and total volatile production of fruit samples over a 14-day period at 22 °C. Additional fruit samples for all preharvest and postharvest 1-MCP treatments were held 14 days at 22 °C and IEC and firmness measured for treatment efficacy. Fruit quality was assessed at 3 and 6 month storage intervals and over a 2-week ripening period at 22 °C. For all cultivars, the production rates of CO_2 , ethylene, and volatiles, as well as increases of IEC and decreases in firmness were inhibited or delayed by sprayable 1-MCP treatment. These effects were comparable to the postharvest 1-MCP treatment and were maintained during storage. The results of these experiments suggest that sprayable 1-MCP could be an additional tool for maintaining apple fruit quality. However, the sprayable formulation used in this study caused 100% incidence of skin damage to 'McIntosh' and a slight amount to 'Empire' (<5%). Lesions were halo-like, centered around lenticels, and tended to be more severe near the calyx. No skin damage was observed in 'Delicious' or in fruit treated with the adjuvant only or postharvest 1-MCP.

1-Methylcyclopropene, CO_2 , and Diphenylamine Interactions with External CO_2 Injury of 'Empire' Apples

Fanjaniaina Razafimbelo*, Jacqueline F. Nock, Chris B. Watkins

¹Cornell University, Horticulture

The 'Empire' apple cultivar is susceptible to external CO_2 injury, a

physiological disorder that is expressed as tan-colored, smooth, water-soaked areas that become irregularly shaped, rough, depressed, and wrinkled. 1-Methylcyclopropene (1-MCP) may increase susceptibility of fruit to external CO_2 injury during controlled atmosphere (CA) storage. We have investigated the effects of 1-MCP on external CO_2 injury of 'Empire' apple using several approaches. 1) Fruit were treated with 1%, 2.5%, and 5% CO_2 during storage. Higher injury levels were associated with exposure to higher CO_2 concentrations. 2) Fruit were exposed to 2.5% or 5% CO_2 for 3-week periods throughout storage, otherwise being kept at 1% CO_2 . Most injury occurred in fruit treated with elevated CO_2 during the first 3 weeks of storage, and 1-MCP did not extend the period of susceptibility to injury. 3) Exposure of fruit to CA with 5% CO_2 after harvest was delayed for up to 14 days. Susceptibility to injury remained high during the delay in 1-MCP-treated fruit in contrast to untreated fruit. 4) Fruit were treated with 250, 500, and 1000 $\mu\text{L}\cdot\text{L}^{-1}$ diphenylamine (DPA), an antioxidant applied for control of superficial scald that is known to prevent susceptibility of fruit to CO_2 injury at 1000 $\mu\text{L}\cdot\text{L}^{-1}$. The DPA eliminated injury in 1-MCP treated fruit, even at 250 $\mu\text{L}\cdot\text{L}^{-1}$. Our data show that 1-MCP increases susceptibility of 'Empire' apples to external CO_2 injury and extra care is therefore required to avoid fruit losses. Nonchemical means may reduce losses, but only DPA application has been shown to eliminate risk of injury.

Effects of 1-MCP and Ozone on Carrot Volatiles during Storage

Charles F. Forney*, Jun Song, Lihua Fan, Paul D. Hildebrand, Michael A. Jordan, Kenneth McRae, Sherry Fillmore, Willy Renderos

Agriculture and Agri-Food Canada, Atlantic Food and Horticulture Research Centre, Kentville, NS, B4N 1J5, Canada

Volatile compounds contribute to carrot (*Daucus carota*) flavor. However, effects of postharvest treatments on these compounds are not defined. To characterize treatment effects, fresh carrots (cv. Sunrise) were treated with 0 or 1.0 $\mu\text{L}/\text{L}$ 1-methylcyclopropene (1-MCP) at 10 °C for 16 h, then exposed to 0, 0.3, or 1.0 $\mu\text{L}/\text{L}$ ozone (O_3) at 10 °C for 1, 2, or 4 days, and subsequently stored at 0 °C for up to 24 weeks. Twelve terpenes were identified in the headspace over whole carrots, including dimethylstyrene (22.5%), alpha-pinene (19.1%), caryophyllene (15.8%), beta-pinene (9.1%), p-cymene (8.3%), limonene (7.7%), gamma-terpinene (6.7%), myrcene (4.7%), gamma-terpinolene (4.5%), camphene (1.0%), alpha-phellandrene (0.52%), and sabinene (0.03%). Most terpenes responded similarly to treatments and storage. Immediately after treatment with 1.0 $\mu\text{L}/\text{L}$ O_3 for 1, 2, or 4 days, total terpene concentrations were 45%, 85%, and 87% greater than concentrations in non-treated controls. Caryophyllene, beta-pinene, and sabinene did not increase in response to the O_3 treatment unlike the other terpenes. 1-MCP reduced terpene concentrations by an average of 18%. O_3 treatments also stimulated stress volatile production. Ethanol headspace concentrations were 8-, 21-, and 43-times greater than the nontreated controls immediately following treatments with 0.3 nL/L O_3 for 4 days or 1.0 $\mu\text{L}/\text{L}$ O_3 for 2 or 4 days, respectively. However, after 8 weeks, no differences among treatments were observed. Hexanal production also was stimulated by all O_3 treatments, being 2- to 11-times greater than controls immediately following treatment. 1-MCP reduced O_3 -stimulated ethanol and hexanal production by 23% and 8%, respectively.

Harvest Maturity Affects Response of Beit-alpha Cucumber Fruit to Postharvest Ethylene Exposure

Brandon M. Hurr¹, Donald J. Huber¹, Stephen T. Talcott²

¹University of Florida, IFAS, Horticultural Sciences Department, Gainesville, FL, 32611-0690; ²University of Florida, IFAS, Department of Food Science and Human Nutrition, Gainesville, FL, 32611-0370

The present study was conducted to explore the process of watersoaking seen previously in beit alpha-type cucumber fruit treated with ethylene. Fruit were harvested at four levels of maturity: Immature (4 to 8 days after anthesis, DAA), Mature (10 to 14 DAA), Breaker (16 to 20 DAA), and Yellow (35 to 40 DAA). Fruit were then stored at 13 °C in

the presence of air (control) or either 10 $\mu\text{L}\cdot\text{L}^{-1}$ ethylene or 1300 $\mu\text{L}\cdot\text{L}^{-1}$ propylene for up to 12 days. The physiological response to ethylene treatment varied with fruit maturity. Immature-stage fruit treated with ethylene for 9 days had mesocarp water soaking, epidermal sloughing, and lower hue (118°, control 124°), endocarp pH (4.4, control 5.4), and whole fruit firmness (23 N, control 46 N). Mature-stage fruit behaved similarly to Immature-stage fruit, but lacked mesocarp water soaking. In contrast, after 9 days of ethylene exposure, the Breaker- and Yellow-stage fruit exhibited no water soaking, accumulated beta-carotene in peel tissue (13.6 $\mu\text{g}\cdot\text{g}^{-1}$ F.W, control 0.35 $\mu\text{g}\cdot\text{g}^{-1}$ F.W.) and had a “melon”-like aroma. Ethylene exposure for all maturities increased respiration rate and decay incidence compared to air-treated fruit. Ethylene evolution was only detectable in fruit with visible decay. Decay incidence in response to ethylene treatment was inversely proportional to maturity at harvest. Water soaking, exhibited exclusively in Immature fruit, spread inward from the epidermis starting after about 6 days of ethylene treatment. Cells in water soaked tissue stained negatively for viability with fluorescein diacetate and cells proximal to water soaked cells stained weakly compared to air-treated controls. Current work is focused on identifying the mechanism of cell death.

Interaction of Water Loss and Fruit Ripening Promote Postharvest Cluster Tomato Fruit Abscission

Jeffrey K. Brecht*, Kimberly M. Cordasco

University of Florida, Horticultural Sciences, Gainesville, FL, 32611-0690

Abscission of cluster tomatoes commonly limits product marketability in the retail environment. Ripening and exogenous ethylene exposure are assumed to play important roles in cluster tomato fruit abscission. ‘Clarence’ and ‘DRW7229’ fruit harvested at either mature green or partially ripened stages did not abscise during storage for 2 weeks at 20 °C and 95% to 100% relative humidity (RH), although respiration and ethylene production indicated that all fruit reached the postclimacteric stage. Exogenous ethylene (1 or 10 ppm) exposure for 8 days at 20 °C and 95% to 100% RH also did not induce fruit abscission for either cultivar, although pedicel and sepal yellowing were observed. Fruit from clusters stored at 20 °C and 20% or 50% RH abscised if sepal shrivel became noticeable before the fruit reached the full red ripeness stage, while no abscission occurred in fruit that reached the full red stage prior to the appearance of sepal shrivel; no fruit stored in 95% to 100% RH abscised. Fruit that ripened prior to the appearance of sepal shrivel were “plugged” (i.e., tissue underlying the stem scar was pulled out) if manual fruit detachment from the pedicel was attempted. These results indicate that there is an interaction of water loss and fruit ripening in promoting abscission zone development in cluster tomatoes.

Oral Session 10—Floriculture 2

28 July 2006, 10:00 a.m.–12:00 p.m.

Bayside A

Moderator: Ying-Tung Wang

Physical Properties of Whole Fresh-ground Parboiled Rice Hulls for Use as a Horticultural Root Substrate

Johann S. Buck*¹, Michael R. Evans¹, Paolo Sambo²

¹University of Arkansas, Department of Horticulture, Fayetteville, AR, 72701; ²University of Padova, Department of Environmental Agronomy and Crop Production, Italy

Horticultural root substrates are designed to provide the optimal physical properties for plant growth. These properties include bulk density ($\text{g}\cdot\text{cm}^{-3}$), air-filled pore space (% v/v), total pore space (% v/v), water-filled pore space (% v/v), water-holding capacity (% v/v and w/w), and wettability. Whole, fresh parboiled rice hulls were ground to produce four grades with varying particle size distributions. Particle sizes for the four

grades ranged from <0.25 to >2.80 mm. Additionally, discrete particle sizes of <0.25, 0.50, 1.00, 2.00, 2.80, and >2.80 mm were produced. For all grade distributions and particle point sizes, physical properties were determined and contrasted against Canadian sphagnum peat. As the proportion of smaller particle sizes in the distributions increased or as the particle point sizes decreased, total pore space (% v/v) and air-filled pore space (% v/v) decreased, while, bulk density ($\text{g}\cdot\text{cm}^{-3}$) and water-holding capacity (% v/v and w/w) increased. Additionally, as the proportion of particle sizes from <0.25–0.50 mm increased, the wettability of the whole fresh parboiled rice hull material decreased. Particle sizes ranging from 1.00–2.80 mm possessed the physical properties most suitable for plant growth in containerized greenhouse crop production and were most similar to peat.

Growth of Geranium Plants in Soilless Media Containing Sphagnum Peat and Anaerobic Digestion-Derived Biosolids

Michael Compton*¹, Timothy Zauche²

¹University of Wisconsin-Platteville, School of Agriculture, Platteville, WI, 53818;

²University of Wisconsin-Platteville, Department of Chemistry and Engineering Physics, Platteville, WI, 53818

Anaerobic digestion-derived biosolids (ADB) has the potential to become a complete or partial substitute for sphagnum peat in the greenhouse and nursery industry. Bedding plant production being one of the largest segments of the floriculture industry may possess the greatest application for this new organic addendum to soilless media. An experiment was conducted in which geraniums (*Pelargonium × hortorum* ‘Red Elite’) were grown in potting mixes formulated with vermiculite and perlite plus various concentrations and combination of anaerobic digestion-derived biosolids (ADB) and sphagnum peat to determine if ADB could be used as a partial or complete replacement for sphagnum peat in soilless horticultural growing media. Plants were grown during June and July 2003–05 in the greenhouse at 75 ± 5 °F and normal light and photoperiod. Plant growth was assessed by measuring the dry weight of stem tissue. Plants were harvested when at least 50% of the total number of plants produced at least one inflorescence. Floriferousness was measured by counting the number of visible inflorescences per plant. Dry weight of plants grown in media containing ADB was greater than those grown in media containing sphagnum peat as the sole organic addendum. Plants grown in media containing ADB were also more floriferous. This study demonstrates that ADB has great potential for use as an organic addendum to horticultural growing media as a partial or complete replacement for sphagnum peat. Use of anaerobic digester-derived biosolids in horticultural growing media is a protected intellectual property and available for license through the WiSys Technology Foundation.

The Effect on Substrate Silica Incorporation on Post-germination Damping Off of Vinca

Michael R. Evans*¹, Bernard W. Krumpelman¹, Ramsey Sealy¹, Craig S. Rothrock²

¹University of Arkansas, Department of Horticulture, Fayetteville, AR, 72701; ²University of Arkansas, Department of Plant Pathology

Vinca (Catharanthus roseus) is a common annual bedding plant species that is susceptible to root and stem rot caused by *Phytophthora nicotianae*. The experimental design was a 6×2×1 factorial with a total of 12 treatment combinations that had five replications and was repeated twice. *Vinca* seeds were planted in the middle nine plugs of a 5×5 five-milliliter round plug tray filled with sphagnum peat (control) or peat amended with 2.1 kg/m³ calcitic lime, 5.9 and 7.3 kg/m³ potassium silicate alone and combined with 3.0 kg/m³ calcium sulfate. A peat control drenched with metalaxyl after inoculation was also included. After germination, when the seedlings had one true leaf, half of the treatments were inoculated with 500 cfu of *Phytophthora nicotianae* per plug cell while the other half remained uninoculated. The percentage of germination for the potassium silicate combined with calcium sulfate (KSCS) (79% and 78%) was similar to the control (86%) and

the metalaxyl treatment (83%), whereas the potassium silicate alone had poorer germination (69% and 71%) and plant growth. The percentage of mortality for the KSCS treatment (6% and 14%) was similar to the metalaxyl treatment (9%) but was significantly less than the control (100%). The average dry shoot and root weights for the KSCS treatments (4.4 and 4.9 mg; 2.7 and 2.2 mg) were similar to the metalaxyl treatment (5.0 and 3.6 mg) and the uninoculated control (5.0 and 3.2 mg), but were higher than the potassium silicate treatment alone (2.1 and 1.6 mg; 0.7 and 0.6 mg).

Effect of Potassium Concentration on a Hybrid *Phalaenopsis* Grown in a Bark Mix or Sphagnum Moss

Yin-Tung Wang^{*1}, Amy Ching-Jung Tsai²

¹Texas A&M University, Horticultural Sciences, Weslaco, TX, 78596; ²Texas A&M University, Dept. of Horticultural Sciences, College Station, TX, 77843

Vegetatively propagated plants (15-cm in leaf spread) of a white-flowered *Phalaenopsis* Taisuco Kaaladian clone were imported bare-root in late May and planted in a mix consisting of three parts of medium-grade fir bark and one part each of perlite and coarse Canadian peat (by volume) or in Chilean sphagnum moss. All plants were given 200 mg·L⁻¹ each of N and P, 100 mg·L⁻¹ Ca, and 50 mg·L⁻¹ Mg. K concentrations were 0, 50, 100, 200, 300, 400, and 500 mg·L⁻¹. After 7 months, plants grown in moss produced an average of two more leaves than those in the bark mix (4 to 5 vs. 2 to 3 leaves), regardless of K rates. In any given medium, K rate did not alter the rate of leaf production. The K rate did not affect the size of the top leaves when grown in the bark mix. However, plants grown in moss had increasingly longer and wider top leaves as K rate increased. The lower leaves on plants in the bark mix receiving no K showed deficiency symptoms of purple tinting, yellowing, necrosis, and even death. Yellowing and necrosis started from the leaf tip and progressed basipetally. The K at 50 mg·L⁻¹ reduced and 100 mg·L⁻¹ completely alleviated the symptoms of K deficiency. Plants grown in moss and receiving no K showed limited signs of K deficiency. Flowering stems started to emerge (spiking) from plants in the bark mix up to 4 weeks earlier than those planted in sphagnum moss. For plants receiving no K, all plants in the bark mix bloomed, whereas none planted in sphagnum moss produced flowering stems. Overall, at least 200 mg·L⁻¹ K (~250 mg·L⁻¹ K₂O) is recommended to produce quality plants with maximum leaf growth and early spiking.

N, P, and K Requirements of a Hybrid Noble *Dendrobium*

Rebecca G. Bichsel^{*1}, Terri W. Starman¹, Yin-Tung Wang²

¹Texas A&M University, Horticultural Sciences, College Station, TX, 77843-2133; ²Texas Agricultural Research and Extension Center, Horticultural Sciences, Weslaco, TX, 78596

Three experiments were conducted to determine how nitrogen (N), phosphorus (P), and potassium (K) rate and nutrient termination date would affect the growth of *Dendrobium nobile* Red Emperor 'Prince'. For each experiment, 150 one-year-old liner plugs, each with a single pseudobulb, were potted on 4 Feb. 2005. Each of the factorial experiments had five rates of the nutrient and three termination dates. The rates for N and K were 0, 50, 100, 200, and 400 mg·L⁻¹. P rates were 0, 25, 50, 100, and 200 mg·L⁻¹. Termination dates for all experiments were 1 Sept., 1 Oct., and 1 Nov. 2005. Ten months after planting when plants had ceased growing, data were collected for plant height, node number, number of leaves remaining, chlorophyll readings for the lower, middle, and upper leaves, and pseudobulb width and thickness. With one exception, interactions between fertilizer rate and termination date were nonsignificant for the variables measured. For all nutrients, terminating fertilization on 1 Oct. or 1 Nov. resulted in decreased pseudobulb thickness compared to 1 Sept. Prolonged fertilization with N resulted in slightly thinner pseudobulbs. Pseudobulbs grew taller as N rate increased, reaching its peak at 100 and 200 mg·L⁻¹, and declined as N further increased to 400 mg·L⁻¹. Plants had increasing chlorophyll readings in the middle leaves with increasing N rate. All

P rates resulted in taller plants with equally more nodes compared to 0 mg·L⁻¹. As K rate increased from 0 to 100 mg·L⁻¹, height and node number increased, but there were no further increases in height at high rates. Number and percentage of leaves remaining increased as N and K rates increased.

Nutrient Ranges in *Pelargonium ×hortorum* and *Pelargonium* Species

Jonathan Frantz^{*1}, Dharmalingam Pitchay², David Tay³, Jennifer Ehrenberger³, John Gray², Scott Heckathorn⁴, Scott Leisner²

¹ARS, USDA, Toledo, OH, 43606; ²University of Toledo, Department of Biological Sciences, Toledo, OH, 43606; ³USDA/Ohio State University, Ornamental Plant Germplasm Center, Columbus, OH, 43210; ⁴University of Toledo, Department of Earth, Ecological, and Environmental Sciences, Toledo, OH, 43606

Zonal geranium (*Pelargonium ×hortorum*) and scented geranium (*Pelargonium* sp.) together are among the top-selling floriculture plants in the United States today, with several hundred cultivars and species available each year. With such diversity in appearances, growth habits, and developmental traits, we hypothesize a correspondingly wide range of nutritional uptake and partitioning characteristics. Mature leaves from 55 cultivars or breeding lines of zonal geranium and 60 species of *Pelargonium* sp. were sampled from paired plants twice throughout the year from the Ornamental Plant Germplasm Center. Their tissue was analyzed for essential macro- and micronutrients using ICP-OES. Generally, macronutrients varied by a factor of 3–5, whereas micronutrients varied by up to 100-fold. The micronutrient boron was a notable exception with variation across the samples of only about a factor of 5. With this information, attempts will be made to correlate tissue nutrient concentrations with genetic source (cultivars and breeding lines) and environmental conditions from the origin of the different *Pelargonium* species from South Africa. This work illustrates the challenges in associating specific sufficiency or deficiency values for nutrient concentrations in tissue of plants based on only a few cultivars, species, or locations.

Growth of *Cypripedium* Orchids in Soilless Media Containing Anaerobic Digestion-derived Biosolids

Michael Compton^{*1}, Timothy Zauche²

¹University of Wisconsin-Platteville, School of Agriculture, Platteville, WI, 53818; ²University of Wisconsin-Platteville, Department of Chemistry and Engineering Physics, Platteville, WI, 53818

Lady slipper orchids have great potential as a perennial bedding plant in temperate-zone climates. Unfortunately, many gardeners fear these species because of their high cost and perceived difficulties associated with growing plants outdoors. The former factor can be addressed by improving the production of plants at the wholesale level. Growers contest that sphagnum peat and coconut coir are poor organic addenda for these species due to their natural acidity. Anaerobic digestion-derived biosolids (ADB) are not acidic like sphagnum peat or coconut coir, and may be the perfect organic addendum for the culture of lady slipper orchids. Hence, 3-year-old plants of showy (*Cypripedium reginae*) and yellow lady slipper (*Cypripedium parviflorum* var. *pubescens*) orchids were grown in soilless potting mixes containing vermiculite and perlite plus various concentrations and combinations of ADB and coconut coir. Plants were grown in the greenhouse at 70 ± 10 °F and received normal light and photoperiod during Summer 2005. Growth, as assessed by the dry weight of dormant stem tissue, of showy lady slipper potted in media containing ADB was three- to four-times greater than those grown in media containing coconut coir. Growth was similar among yellow lady slippers grown in media containing ADB or coconut coir due to the fact that these plants had produced all their stem growth for the season before the experiment was initiated. ADB has great potential as an organic addendum to horticultural growing media used for the culture of *Cypripedium* species. Use of anaerobic digester-derived biosolids in horticultural growing media is a protected intellectual property and available for license through the WiSys Technology Foundation.

Costs and Returns of Producing Outdoor Cut Flowers

Robin Brumfield*

Rutgers University, Agriculture, Food, and Resource Economics, New Brunswick, NJ, 08901-8520

Field-grown cut flower production, in general, is a low-overhead business. This is both good news and bad news. Good—because it doesn't require a lot of capital to get started in this business. Bad—because competition can develop rapidly, sometimes from marginal producers for whom profitability is a low priority. Thus, it is important for producers to know the costs of growing each product so that they can make profitable production and marketing decisions. A cost accounting program was developed to help producers calculate the cost of each crop. In addition, a series of benchmark budgets were developed for specialty cut flowers. These budgets are on the Rutgers University Farm Management Website (<http://aesop.rutgers.edu/~farmmgmt>).

Oral Session 11—

Vegetable Crops Culture & Management

28 July 2006, 10:30 a.m.–12:00 p.m.

Bayside B

Moderator: Alan Walters

Can Cover Crop-based Systems Reduce Vegetable Crop Fertilizer Nitrogen Requirements in the Southeastern United States?

Laura Avila*¹, Johannes Scholberg², Lincoln Zotarelli², Robert McSorely³

¹University of Florida, School of Natural Resources and Environment; ²University of Florida, Agronomy; ³University of Florida, Entomology and Nematology

Poor water- and nutrient-holding capacity of sandy soils, combined with intense leaching rainfall events, may result in excessive N-fertilizer losses from vegetable production systems. Three cover cropping (CC) systems were used to assess supplemental N-fertilizer requirements for optimal yields of selected vegetable crops. Fertilizer N-rates were 0, 67, 133, 200, and 267; 0, 131, and 196; and 0, 84, 126, 168, and 210 kg N/ha for sweet corn (*Zea mays* var. *rugosa*), broccoli (*Brassica oleracea*), and watermelon (*Citrullus lanatus*), respectively. Crop rotations consisted of sunn hemp (*Crotalaria juncea*) in Fall 2003 followed by hairy vetch (*Vicia villosa*), and rye (*Secale cereale*) intercrop or a fallow. During Spring 2004, all plots were planted with sweet corn, followed by either cowpea (*Vigna unguiculata*) or pearl millet (*Pennisetum glaucum*), which preceded a winter broccoli crop. Hairy vetch and rye mix benefited from residual N from a previous SH crop. This cropping system provided a 5.4 Mg/ha yield increment for sweet corn receiving 67 kg N/ha compared to the conventional system. For the 133 N-rate, CC-based systems produced similar yields compared to conventional systems amended with 200 kg N/ha. Pearl millet accumulated 8.8 Mg/ha—but only 69 kg N/ha—and potential yields with this system were 16% lower compared to cowpea system. For a subsequent watermelon crop, trends were reversed, possibly due to a delay in mineralization for pearl millet. Because of its persistent growth after mowing, hairy vetch hampered initial growth and shading also delayed fruit development. Although CC may accumulate up to 131 kg N/ha actual N benefits, N-fertilizer benefits were only 67 kg N/ha, which may be related to a lack of synchronization between N release and actual crop demand.

Interaction Between Water and Nitrogen Application on Yields and Water-use Efficiency of Tomato and Pepper in Sandy Soil

Lincoln Zotarelli*¹, Johannes Scholberg¹, Michael Dukes², Hannah Snyder¹, Rafael Munoz-Carpena², Eric Simonne³

¹University of Florida, Agronomy, Gainesville, FL, 32611-0965; ²University of Florida,

Agricultural and Biological Engineering, Gainesville, FL, 32611-0570; ³University of Florida, Horticultural Science, Gainesville, FL, 32611-0690

Several practices have been adopted to minimize water use and potential N leaching of vegetable production systems, including use of drip irrigation, plastic mulch, and fertigation. However, these practices may not be adequate on sandy soils with poor water and nutrient retention capacities. The objectives of this study were to evaluate the interactive effects of irrigation practices and fertilizer rates on yield, fertilizer requirements, and N-leaching of pepper and tomato production systems. Bell pepper and tomato were planted on plastic mulched to evaluate the effects of three nitrogen (N) fertilizer rates (154, 192, 288 kg·ha⁻¹ N for pepper vs. 166, 208, and 312 kg·ha⁻¹ N for tomato) and three irrigation scheduling methods were evaluated. Depending on sensor readings, soil moisture sensor (SMS) irrigation treatments allowed up to five watering events per day where as for the fixed duration treatment irrigation was applied once a day. For tomato, the effect of subsurface drip irrigation (SDI) was also evaluated. Compared to TIME, use of SMS control system reduced water use by 29% to 44% and 37% to 66% for tomato and pepper, respectively. Tomato yield was significantly higher on SMS and SDI treatments compared to TIME treatments. For pepper yield and biomass accumulation were not affected by irrigation treatments. The average yields were 24.6 and 27.8 Mg·ha⁻¹ of fresh marketable fruits for pepper and tomato, respectively. Nitrogen rate did not affect yield and optimal yield N rate did not affect yield for either crop. On average, SMS treatments increased irrigation water use efficiency 2–3 times compared to TIME treatments for both tomato and pepper.

Performance of Bell Pepper Cultivars in a Commercial Field Infested with *Phytophthora capsici*

Jamie R. Stieg*¹, S. Alan Walters¹, Jason P. Bond¹, Mohammad Babadoost²

¹Southern Illinois University, Plant, Soil, and Agricultural Systems, Carbondale, IL, 62901-4415; ²University of Illinois, Department of Crop Science, Urbana, IL, 61801

Phytophthora blight, caused by *Phytophthora capsici*, is a widespread problem of many vegetables including bell peppers. Four bell pepper cultivars marketed as resistant/tolerant to *P. capsici* include 'Paladin' (resistant), 'Alliance' (tolerant), 'Aristotle X3R' (tolerant), and 'Revolution' (tolerant). These cultivars, along with four other widely grown cultivars ('Commandant', 'King Arthur', 'Legionnaire', and 'Red Knight X3R') and a susceptible control ('California Wonder'), were evaluated for their performance in a commercial field highly infested with *P. capsici*. 'Paladin' had the lowest incidence of Phytophthora blight and the greatest yield compared to all other cultivars. 'Alliance', 'Aristotle X3R', and 'Revolution' (the tolerant cultivars) also had lower Phytophthora blight incidence and greater yields compared to the other five cultivars evaluated. Results indicated that in fields that historically have high incidence of Phytophthora blight, 'Paladin' could be a reliable choice for commercial production.

Influence of Slow Release Methylene Urea Products on Tomato Yield, Quality, Nutrient Uptake, and Economics

Douglas C. Sanders, Luz M. Reyes*

NCSU, Hort. Sci., Kilgore Hall, Raleigh, NC, 27695.

Two formulations of a new methylene urea product on tomato were evaluated. Applications of 150, 200, 250 lb/acre of N in eastern North Carolina and 175 and 250 lb/acre of N in western North Carolina of both liquid and dry formulation of the material were made. The liquid was applied the first 6 weeks of growth and the dry applied at planting. These treatments were compared with 200 lb/acre of N (standard) and 300 lb/acre of N, which were fertigated throughout the season. In eastern North Carolina, all rates of the liquid and high rate of dry formulations produced more yield of larger fruit than the standard. In western North Carolina, all methylene urea sources out-performed the standard. Soil and foliar nitrate was somewhat greater than the standard throughout the season, but, at end of season in the west, only the 250 dry material had more N in the soil. Methylene urea treatments took up more N than

the control. All methylene urea except 200 dry produced more dollars per acre than the standard.

Effect of Root Substrates and Nutrient Solution Electrical Conductivity on Tomato Transplant Characteristics

Paolo Sambo¹, Franco Sannazzaro*¹, Michael Evans²

¹University of Padova, Agronomy and Crop Science, Via dell'Università 16, Legnaro, Padova, 35020, Italy; ²University of Arkansas, Horticulture, Fayetteville, AR, 72701

In order to evaluate alternative rooting media as a substitute to sphagnum peat in tomato transplant, fresh rice hulls (2 and 4 mm particle size), perlite, and peat were compared. In the same experiment, four nutrient solutions differing in electrical conductivity [(EC) 2.5, 3.5, 4.5 and 6.0 mS/cm], but not in nutrient content, were used. Seed of tomato (*Lycopersicon esculentum* L.) 'Brigade' (ASGROW) were sown in 55 × 35 × 6.5 cm polystyrene transplant trays containing 336 cells (15 mL) and filled with the root substrates. The trays were placed in a glass-glazed greenhouse. Trays were kept under intermittent mist for 6 days and then fertilized twice per week with 2.6 L per tray of solution. A split-plot design with three replications was used with nutrient solution serving as the main plot and root substrates serving as the subplots. During the growing cycle (once a week) and when plants were ready to transplant (16 cm tall, with an average of five to seven true leaves), stem diameter, hypocotyl length, plant height, number of true leaves, fresh shoot weight, and dry shoot weight were measured. Also at transplant, root fresh and dry weight and above- and below-ground biomass were analyzed to determine N, P, K, Ca, Mg, Fe, and Mn content. Plants grown in rice hulls were as marketable as those in peat, but showed a higher content in N, K, and Mn. Increased nutrient solution affected not only dry matter accumulation, but also stem diameter and plant height, which were greater in plants grown with high EC.

Optical Tools, a Suitable Means to Reduce Nitrogen Use in Fertigated Tomato Crop

Giorgio Gianquinto¹, Paolo Sambo¹, Francesco Orsini², Marco Sciortino³, Valente Forte*¹

¹University of Padova, Agronomy and Crop Science; ²University of Napoli, Agronomy and Agriculture Engineering; ³University of Bologna, Department of Agronomy and Environmental Technology;

Technology provides new tools for agriculture to be able to optimize fertilization. Optical instruments are becoming valid tools for farmers in making decisions about fertilization, even though they need to be calibrated for specific crops. Chlorophyll meters and multispectral radiometers have been tested on rice, corn, and wheat and afterwards on vegetables, in timing fertilization. Today, threshold lines that are able to detect crop N status in tomato crops are available. These thresholds, obtained in experiments carried out at Padova University, were validated in three open-field experiments. The first experiment was carried out in 2004 at the University experimental farm on tomato cv. Perfect Peel. The second and third experiments were conducted in a commercial farm at Codigoro (Ferrara) in 2004–2005. Tomato cultivars used were 'UGX 822' and 'Precocix' in 2004, in 2005 'Jet' was also used. In all trials, a "standard fertilization" management was compared with fertigation guided using SPAD and/or CropScan. Optical tools were used to manage fertigation adopting both "threshold method" and "reference plot method". In general "guided fertigation" resulted in less nitrogen application (N supply reduced between 18% and 45%), especially when "threshold method" was adopted. Yields were comparable to "standard fertilization" treatments, showing a better efficiency of "guided fertigation". In some cases, guiding fertigation by means of optical instruments allowed higher fruit fresh weight, although dry matter content and °Brix were not influenced. Guided fertigation reduced also the number of damaged fruit and the percentage of nonmarketable product.

Oral Session 12—Pomology 1

28 July 2006, 2:00–3:15 p.m.

Oak Alley

Moderator: Esmail Fallahi

Irrigation and Rootstocks Affect Water Use, Growth, Nutrition, Yield, and Fruit Quality of 'Fuji' and 'Gala' Apples

Esmail Fallahi*, James R. McFerson, Bahar Fallahi

¹University of Idaho, Parma Research and Extension Center, Parma, ID, 83660; ²Washington Tree Fruit Research Commission, Wenatchee, WA, 98801; ³University of Idaho, Parma Research and Extension Center, Parma, ID, 83660

Many fruit growers in the Pacific Northwest region prefer to use a sprinkler system to produce high-quality fruit and to establish a cover crop in the orchard. However, water shortage mandates the use of more efficient methods of irrigation, such as drip. In this long-term experiment, the effects of seven irrigation systems for 'Fuji' and two irrigation systems for 'Gala' on five rootstocks on tree growth, water use, fruit quality, and mineral nutrients were studied. All forms of drip systems used less water than full micro-sprinkler (SP). Partial root drying sprinkler (PS) used 50% less water than SP. Trees with partial root drying drip and deficit drip had to receive 65% of full drip to survive. Each 'Fuji' tree with SP used about 5397 L of water in 2004 and 5833 L in 2005, while each tree with full drip used 2403 L in 2004 and 3438 L in 2005. Thus, trees with full drip used 41% to 55% less water than those with SP system without any reduction in fruit quality. This leads to a major savings in the cost of fruit production. Fruit weight in trees with full drip was always greater than those with PS or deficit drip. Fruits with SP system had lower soluble solids than those with PS. Fruits from trees with partial drip had a higher starch degradation than those with other systems. Leaf minerals, particularly N and K, were affected by irrigation systems. 'Pacific Gala' trees on B.9 rootstock were more precocious than those on Supporter-4 rootstock. In general, 'Pacific Gala' on RN-29 had better tree performance and fruit quality than those on other rootstocks. The calculation of water requirements on a tree-use basis provided an excellent guide for drip irrigation.

Optimum Fruit Size and Yield to Maximize Crop Value of Gala Apple

Terence Robinson*

Cornell University, Dept. of Horticultural Sciences, Geneva, NY, 14456

Field thinning studies were conducted in two orchards at Geneva and Milton, N.Y., over 3 years (2003–05) using mature Gala/M.9 trees. A range of final croploads was achieved with various chemical thinning treatments, including, benzyladenine combined with carbaryl, or naphthaleneacetic acid combined with carbaryl. The most-aggressive thinning treatments in the year with high rainfall achieved an average fruit size of 190–200 g; however, the yield was reduced considerably, resulting in a reduced farm gate crop value compared to less-aggressive thinning. In a dry year, the fruit sizes were smaller even with aggressive thinning. The optimum yield for maximum crop value varied for each orchard block for each year. The optimum croploads varied less than the optimum yield, since cropload normalizes the tree size between blocks. Optimum fruit size to maximize crop value varied narrowly between 155–170 g (113–100 count size) across blocks and years. This was true despite a substantial price difference between large, 80-count fruits and the moderate-size 113-count fruits. If lower prices received for processed apples were used in the analysis, then the optimum yield was significantly higher than with fresh fruit prices. In New York State, it appears that achieving 80-count fruit requires too large of a reduction in yield, which causes a reduction in crop value.

Promotion of Flowering in Apple with NAA and Ethrel

Steven J. McArtney*, Dick Unrath

¹North Carolina State University, Horticultural Science, Mountain Horticultural Crops Research and Extension Center, Fletcher, NC, 28768; ²NCSU, retired

Experiments were carried out in the southeastern United States between 1998 and 2006 to evaluate the potential for applications of NAA, Ethrel, or both, in the on-year of a biennial bearing cycle to increase return bloom in apple. Four bi-weekly applications of 5 ppm NAA beginning in mid June (summer NAA) increased return bloom, measured as the percentage of floral spurs in the year after treatment. The level of return bloom on trees receiving a summer NAA program was more than 2-fold higher than on untreated control trees, averaged across seven different experiments. Four applications of 5 ppm NAA at weekly intervals leading up to harvest (August/September) increased return bloom also. Combining 150 ppm Ethrel with summer NAA sprays resulted in an additive effect on return bloom compared to NAA or Ethrel alone. The effect of flower cluster density on return bloom the following year was more negative on control trees than it was on trees sprayed with Ethrel in the previous year. Treatment effects on fruit maturity at harvest were generally neutral, although flesh firmness was reduced in some experiments. NAA or Ethrel sprays in the on-year of a biennial bearing cycle may provide a strategy for achieving more consistent flowering and cropping in apple.

Developmental Anatomy of Russet of ‘McIntosh’ Apple Fruit Induced by the Fungus *Aureobasidium pullulans*

Martin C. Goffinet*, Thomas J. Burr, Mary Catherine Heidenreich, Mary Jean Welsler

Cornell University-NYSAES, Horticultural Sciences, Geneva, NY, 14456

The fungus *Aureobasidium pullulans* is ubiquitous and can cause russet of fruit in New York orchards. The details of russet induction by this fungus are not well known. We inoculated ‘McIntosh’ apple fruits with a suspension of *A. pullulans* spores (10 million colony-forming units/mL) 1–2 weeks postbloom or later at about 30 days postbloom. We dropped inoculum into plastic “microwells” attached to the fruit surface. The cuticle of uninoculated fruit (wells filled with water only) had no russet by autumn. Skin susceptibility to russet diminished with fruit age. The cuticle of inoculated young fruit began to break down in a few days, likely through direct cuticular digestion. Further erosion and breaching of the protective cuticle caused underlying epidermal cells to die. Within 1–2 weeks, cuticle disruption and epidermal cell death were widespread. This stimulated the fruit to initiate a repair process that involved periderm formation (russet), where many rows of cells were produced in nearby tissue to seal off the injury. This type of repair is not stretchable, so as young fruit expanded, additional skin splits and checks developed. This breakdown–repair process repeated itself, which created a scurfy skin. Older fruit did not expand as much after inoculation as did young fruit, and so they developed few obvious leathery patches of periderm. Older cuticle also resisted digestion better than did the young fruit cuticle, but we do not know if resistance resulted from increased cuticle thickness in older fruit or a change in cuticular compounds during fruit growth. Regardless, *A. pullulans* applied to older fruit did not progress beyond the early phase of cuticle digestion, even after 3 weeks postinoculation.

Growth and Yield Improvement of Newly Planted ‘Honeycrisp’ Apple Trees with Preplant Soil Amendments and Rootstocks

Renaee Moran*

¹University of Maine, Plant, Soil and Environmental Sciences, Monmouth, ME, 04259

Preplant soil-incorporated compost, mycorrhizal inoculation (MI) at planting, and the combination of the two were tested for growth and yield increase of ‘Honeycrisp’ apple trees on two rootstocks, M.26 and G.16. Compost was added at a rate of 0.51 m³ per tree. Within each

main plot of compost or no compost were planted four trees with two on each rootstock. Noncompost plots were fertilized with N in year 1 and N, K, and Mg in year 4. The MI had no effect on growth until the third and fourth years after planting when annual trunk growth and tree height were greater than the untreated control. Compost increased trunk growth in the third and fourth years, but decreased growth in the fourth year when combined with MI. G.16 had greater trunk growth and tree height than M.26 in years 3 and 4. Fruiting was delayed by pruning at planting, so trees fruited for the first time in the fourth year. Bloom and yield were not increased by MI. There was more bloom and yield on G.16 than on M.26. Yield of G.16 was increased by compost from 0.08 to 1.2 kg/tree. The combination of MI and compost increased bloom compared to the control, but not yield, which was 0.3 kg/tree. Compost increased bloom but not yield of M.26, since this rootstock had low yield when planted in compost, 0.2 kg/tree, and none when planted without compost.

Oral Session 13—Floriculture 3

28 July 2006, 2:00–3:30 p.m.

Southdown

Moderator: Rebecca Schnelle

Influence of Indolebutyric Acid Potassium Salt on Propagation of Semi-hardwood Stem Cuttings of *Bougainvillea*

Christopher B. Cerveny*, James L. Gibson

¹University of Florida, West Florida Research and Education Center, Environmental Horticulture Department, Milton, FL, 32583; ²University of Florida, West Florida Research and Education Center, Environmental Horticulture Department, Milton, FL, 32583

Bougainvillea glabra is a tropical species with reportedly difficulty to propagate. Previous research has shown the importance of talc-based rooting hormones when propagating *Bougainvillea*, yet little has been published on the efficacy of liquid-based formulations. Therefore, our objective was to determine the optimum concentration of indolebutyric acid potassium salt (KIBA) needed to effectively root semi-hardwood stem cuttings of *Bougainvillea* ‘California Gold’ and ‘Helen Johnson’. Sub-terminal cuttings measuring 6.5 cm were harvested from stock plants of *Bougainvillea* on 3-week intervals from 6 June to 8 Aug. and repeated 6 Sept. to 8 Nov. 2005. Cuttings were dipped 0.5 cm in a solution of 0, 1500, 3000, or 6000 mg·L⁻¹ KIBA or in a 1500-mg·L⁻¹ solution containing indolebutyric acid (IBA) 1% : naphthaleneacetic acid (NAA) 0.5% and propagated under mist. Cuttings were evaluated for percent survival, rooting quality (1 = poor; 5 = best), and number of primary and lateral roots 5 weeks after planting (WAP). Differences in ‘California Gold’ for percent survival, average rank, and number of roots were determined not significant at $P \leq 0.05$. However, application of rooting hormone to ‘Helen Johnson’ increased rooting quality, number of primary roots, and number of lateral roots by up to 24%, 53%, and 50%, respectively. Results indicated rooting performance was generally improved with application of KIBA; therefore, cuttings of *Bougainvillea* may benefit from a 1500-mg·L⁻¹ solution. KIBA was also found to be as effective as the industry standard liquid formulation. Growers will have to consider the availability and cost of KIBA when propagating *Bougainvillea*.

Response of Coleus (*Solenostemon scutellarioides*) to Plant Growth Regulators Applied during Propagation

Jennifer K. Boldt*, James E. Barrett

University of Florida, Environmental Horticulture, Gainesville, FL, 32611

A daminozide plus chlormequat chloride tank mix spray was applied to six *Coleus* cultivars or breeding lines at different times during propagation. For UF 03-8-10 and ‘Coco Loco’, plants sprayed on day 7 or day 10 were shorter than control plants at transplant, but plants sprayed on day 13 were not. Other cultivars did not respond to single applications. Five of the six cultivars responded to application on days 7 and 13.

Plants of UF 03-8-3 and 'Coco Loco' were significantly shorter than control plants at transplant. Plants of UF 03-8-10, UF 03-6-1, and UF 03-17-8 were shorter than control plants at 3 weeks after transplant. 'Hurricane Louise' did not respond to the tank mix. A second study found a cultivar specific response to three chemical treatments applied as a spray on day 10 of propagation. At transplant, UF 03-8-10, UF 03-8-3, UF 03-6-1, and 'Coco Loco' plants sprayed with the tank mix at 2500 plus 1500 mg·L⁻¹, respectively, were significantly shorter than the control plants. A uniconazole spray at 2 mg·L⁻¹ reduced elongation in UF 03-8-10, UF 03-8-3, and UF 03-6-1, compared to control plants. Ethephon at 250 mg·L⁻¹ reduced elongation in UF 03-8-10, UF 03-8-3, and 'Coco Loco' plants. None of the chemical sprays reduced elongation in 'Hurricane Louise' at the concentrations applied. Ethephon increased axillary branching in all cultivars, and induced lower leaf abscission in UF 03-17-8 and 'Hurricane Louise'; leaf malformation in UF 03-6-1 and 'Coco Loco'; and color alteration in UF 03-6-1, UF 03-8-3, and 'Coco Loco'.

The Effects of Several Key Factors on the Efficacy of Paclobutrazol Liner Dips for the Control of Stem Elongation in Bedding Plants

Rebecca A. Schnelle*, James E. Barrett

University of Florida, Environmental Horticulture, Gainesville, FL, 32611

The paclobutrazol liner dip is a plant growth regulator application technique that is becoming widespread in the commercial bedding plant industry. This technique, in which plug trays are dipped in a solution of paclobutrazol before transplant, is an efficient method for applying this growth regulator to a large number of plants. In previous studies, significant variability in size control was documented following liner dip treatments with identical solution concentrations. To elucidate the causes of this variability, three bedding plant species with varying levels of paclobutrazol sensitivity (*Petunia ×hybrida*, *Impatiens wallerana*, and *Scaevola aemula*) were treated with paclobutrazol liner dips under various conditions. Four factors identified in previous studies that may impact the efficacy of paclobutrazol liner dips were evaluated in this study. The age of the cuttings at the time of treatment ranged from 2 to 4 weeks after propagation. The light intensity incident to the plants from 2 h before through 2 h following the time of treatment ranged from about 1000 μmol·m⁻²·s⁻¹ in a greenhouse to 5 μmol·m⁻²·s⁻¹ indoors. The relative moisture content of the plug media before the treatment was saturated or at 25%, 50%, or 80% dry down by weight, based on air-dried media. The amount of time the plug media remained in the paclobutrazol solution was 10 s, 30 s, or 2 min. Data were collected on stem elongation 3 weeks after transplanting and again 2 weeks later. The results confirm that all four factors tested interact with the concentration of paclobutrazol in the dip solution to determine the control in stem elongation achieved by the treatment.

Responsible Plant Growth Recommendations from Greenhouse-grown Bedding Plant Experiments Must Integrate Data from Postharvest Landscape Evaluations

Michael Arnold*, Garry McDonald

Texas A&M University, Horticultural Sciences, College Station, TX, 77843-2133

Multiple experiments conducted over the past 5 years suggest that greenhouse-grown bedding plants, particularly fall-propagated cool-season annuals, may exhibit reductions in vegetative growth and flowering in response to plant growth regulators (PGRs) applied at rates commonly used by growers. Studies using *Viola ×wittrockiana* Gams as a model system indicated that paclobutrazol applied at production stages and rates reportedly used by growers could result in significant postharvest residual responses that adversely impacted landscape performance. Most of these rates were also included within the recommended ranges on the agricultural chemical labels. Multiple applications to the same plants during production increased the severity of the residual responses and decreased the rates at which residual responses were detectable

in landscape plantings. Tests with additional taxa, *Brassica oleracea* L. var. *acephala* DC., *Calendula officinalis* L., *Ipomoea carnea* Jacq. subsp. *fistulosa* (Mart. ex Choisy) D. Austin, *Lantana urticoides* Hayek 'L.S. Red', *Lupinus texensis* Hook., *Plumbago auriculata* Lam., *Salvia greggii* Gray, and *Verbena canadensis* Kunth 'Homestead Purple', PGR formulations and at various times of the year indicate that the postharvest landscape responses to PGRs vary among taxa and seasons. These results strongly suggest that in order for researchers to make responsible recommendations on PGR use, studies must include not only greenhouse or nursery production data, but also subsequent testing for residual responses to the PGRs in landscape settings.

The Influence of Plant Growth Regulators on Budbreak and Shoot Growth from Large Stem Segments of *Acer saccharinum* L.

Katayoun Mansouri, John E. Preece*

Southern Illinois University, Department of Plant, Soil and Agricultural Systems, MC4415, Carbondale, IL, 62901

A factorial combination of gibberellic acid (GA₃) and benzyladenine (BA) was applied in 20% white exterior latex paint to large (40 cm long, >2.5 cm diameter) stem segments of *Acer saccharinum* L. (silver maple) to determine the effects on forcing new softwood shoots in the greenhouse or laboratory and the subsequent growth of these new shoots in vitro. Stem segments were harvested from 10-year-old field-grown coppice shoots. The GA₃/BA-paint mixes were applied to the entire stem segments that were forced in plastic flats filled with 1 perlite : 1 vermiculite (by volume) and watered with care so as not to wet the new softwood shoots. The flats and stem segments were drenched weekly with Zeritol (0.18% H₂O₂). The softwood shoots were harvested when they were at least 3 cm long. After disinfecting and rinsing, the nodal and shoot tip explants were established aseptically in vitro on DKW medium with no cytokinin or with 10-8M thidiazuron. Coppice shoots were harvested, cut, and painted on 9 Sept., 28 Oct., and 12 Dec. 2005. Although there were no significant differences in shoot production among stem segments painted with various combinations of GA₃/BA, stems treated with plant growth regulators produced a mean of 2.7, 1.8, or 0.5 shoots for the three harvest dates compared to 0.5, 0.0, or 0.25 shoots on control stem segments. It is well-known that shoot forcing is poor from September through January; however, use of GA₃/BA resulted in growth of dormant epicormic shoots. Shoot tip explants produced the most shoots in vitro after 8 weeks if they were harvested from stem segments treated with 0.03 mM GA₃, whereas nodal explants produced the most shoots if harvested from segments that had been treated with 0.01 mM GA₃.

Different Developmental Stages of Mother Plants Induct Different Morphogenesis Pathways in In Vitro Culture of *Fritillaria imperialis* and *Fritillaria persica*

Ahmad Khalighi*¹, Manijeh Mohammadi Dehcheshmeh¹, Esmaeil Ebrahimi², Manoochehr Sardari³, Rohangiz Naderi¹, Rohangiz Naderi¹

¹University of Tehran, Horticulture, Bolvar Emamzade Hasan, Faculty of Horticulture, Karaj, Tehran, 31587-11167, Iran; ²University of Tehran, Agronomy and Plant Breeding, Bolvar Emamzade Hasan, Faculty of Agronomy and Plant Breeding, Karaj, Tehran, 31587-11167, Iran; ³Agriculture and Natural Resources Center, Natural Resources Center, Farokhshahr Road, Shahrekord, Chahar Mahal va Bakhtiari, 11, Iran

Fritillaria imperialis and *Fritillaria persica* are important medicinal and ornamental plants that are native to Iran. Wild populations of *Fritillaria* are at risk of extinction. For the first time, capability of developmental stages in respect to induction of different morphogenesis pathways from petal tissue was studied in detail. The developmental stages were green unopened flowers, colored unopened flowers, and open flowers. Direct bulblet regeneration and direct somatic embryogenesis were observed from green unopened flowers in both *F. imperialis* and *F. persica*. More bulblet regeneration was produced in *F. imperialis* in contrast with *F. persica* in colored unopened flowers.

Somatic embryogenesis via callus was established in green unopened flowers of *F. persica* with cold pretreatment. The effect of light on induction of different morphogenesis pathways was nonsignificant except for green unopened flowers of *F. persica* with cold treatment. Our results showed that the developmental stages of petal explants play a significant role in micropropagation of *Fritillaria* and induction of different morphogenesis pathways.

Oral Session 14—Fruit Breeding

28 July 2006, 4:15–5:15 p.m.

Bayside A

Moderator: David Byrne

Studies with Crisp-textured Blueberries

Les Padley, Jr., Paul Lyrene*

University of Florida, Horticultural Sciences, Gainesville, FL, 32611-0690

Over the past two decades, selections that produce crisp-textured blueberries have been noted by breeders. Research was conducted to determine how these selections differ from standard cultivars. Four blueberry clones with crisp texture were compared, using firmness, with 94 advanced selections from the University of Florida blueberry breeding program. The clones, tested for berry firmness with an Instron machine, produced a normal distribution. The crisp clones were at the high end of the distribution, but were not qualitatively different from other firm-fruited selections. Firmness was tested during final stages of berry development to determine if crisp clones softened more slowly than standard cultivars. In both 2003 and 2004, firmness decreased greatly from the white to pink stages of development, with slower loss of firmness thereafter. Crisp and commercial clones were similar in the timing of firmness loss. Berries from six crisp clones and four firm commercial cultivars were subjected to shear cell tests to see if the two groups could be distinguished. Shear cell tests from early and late harvests in the same year showed good agreement. Three of the four crisp clones were much higher in shear force than the other clones tested. A consumer sensory panel was conducted to determine if the average person could distinguish between the berries of crisp and standard cultivars. Ninety-five subjects were given two samples each of crisp and non-crisp blueberries, and asked to designate the one sample they thought the most crisp. Seventy-five subjects chose one of the two crisp clones and 20 chose one of the standard clones. This research indicates that crisp texture in blueberry exists and is recognizable and repeatable, but is difficult to objectively define.

Progress in Selection for Cold-hardiness, Adaptation, and Quality in *Vaccinium ashei* and *Vaccinium ashei/V. constablaei* Derivatives and the Potential for Northern-adapted Rabbiteye Cultivars

Mark Ehlenfeldt*, Lisa Rowland²

USDA-ARS, Beltsville, Fruit Laboratory, Beltsville, MD 20705

In recent years, the U.S. Department of Agriculture has generated *V. ashei* and *V. constablaei* derivatives to provide late-flowering, early-ripening rabbiteye germplasm for the southern U.S.; however, this germplasm has also performed well in New Jersey, and could potentially provide northern-adapted rabbiteye types. When combined, these germplasms complement each other in many respects. Crosses with varying percentages of *V. constablaei* germplasm ranging from 100% to 0%, in 25% increments, were evaluated for mid-winter cold-hardiness using a detached twig assay. Hybrids with 50% or more *V. constablaei* germplasm were hardy to -25°C or lower. Further backcrosses to *V. ashei* resulted in dramatic segregation for hardiness, but still yielded some progeny as hardy as typical northern highbush. Assays of rabbiteye cultivars have been recently completed to enhance the ability to generate cold-hardy hybrids. Recombination and selection have begun to yield hybrids improved for critical commercial characteristics, and further rapid progress is expected.

Molecular Marker Use in Tree Fruit and Woody Ornamental Plant Breeding

David Byrne*

Texas A&M University, Horticultural Sciences, College Station, TX, 77843-2133

Fruit and ornamental breeders were surveyed about their use of molecular markers in either their breeding programs or in their related research programs. Responses were obtained from over 100 fruit and ornamental breeding programs from throughout the world. Of these, less than 50% used molecular markers in their programs. The two most common uses of these markers were for studies in plant identification and diversity. These were followed by the use of markers in developing molecular maps, in discovering molecular tags and/or trying to identify the genes for specific plant traits, for marker assisted selection, and finally, for the elucidation of plant taxonomy. In conclusion, although there is much research in this area, few programs are actually using markers in the context of an applied breeding program. The major reason for this situation is the lack of available markers and the cost of using these markers to screen large numbers of progeny. Those that use markers in their breeding tend to use them to verify the genotype of the parents or confirm the genotype of selected seedlings rather than screen unselected seedlings.

A Fresh Look at Avocado Pollination

Thomas L. Davenport*, Zhentu Ying¹, Raymond J. Schnell²

¹University of Florida, Tropical Research and Education Center, Homestead, FL, 33031; ²USDA/ARS, Subtropical Horticulture Research Station, Miami, FL, 33158

The synchronously dichogamous flowering behavior of avocado has historically been assumed to promote cross-pollination. Preliminary studies in southern California have revealed that self-pollination is more typical. The primary objective of the California research is to determine the paternity of individual fruit sampled during early and late fruit development using SSR markers. Cultivars included Hass as the primary cultivar and Bacon, Ettinger, Fuerte, Harvest, Lamb Hass, Marvel, Nobel, SirPrize, and Zutano serving as cross-pollinating cultivars. We were able to: 1) estimate proportions of self- and cross-pollinated 'Hass' fruit with cultivars planted in rows of varying proximity to the 'Hass' rows; determine if the proportion of outcrossed fruit increased during maturity due to preferential abscission of self-pollinated fruit; and 2) determine if there is preferential retention of fruit cross-pollinated by a specific cultivar during maturation. On average, cross-pollination by any individual cultivar in 2004 was 6% or less in marble-sized fruit. Over 70% of the fruit were self-pollinated. This is greater than the proportion of self-pollination (about 30%) observed in near-mature fruit harvested in the previous year, 2003. Proportions of marble-sized fruit pollinated by each cultivar within each row were compared to the proportions of self or cross-pollinations in fruit harvested from the same trees at near-maturity. We observed about a 10% increase in proportion of self-pollinated fruit and a concomitant decrease in retained fruit derived from cross-pollination. Self-pollination appears to be the dominant mode of pollination. These preliminary results indicate that trees benefit from it, perhaps in preference over cross-pollination.

Oral Session 15—

Vegetable Crops Culture & Mangement 3

28 July 2006, 4:15–5:45 p.m.

Southdown

Moderator: Dean Kopsell

Rapid Reconnaissance Method to Assess Hurricane Damage to Horticultural Crops in Miami-Dade County

Mary Lamberts*, Donald Pybas¹, Carlos Balerdi¹, Joseph Garofalo¹, Charles LaPradd²

¹University of Florida, Miami-Dade County Extension, Homestead, FL, 33030-2309;

²Miami-Dade County, Office of the County Manager

The University of Florida Miami-Dade County Extension, as a member

of the USDA's County Emergency Board, is required to assess damage to commercial horticultural crops (tropical fruit, ornamentals, and vegetables) immediately following natural disasters. While trying to determine dollar values following a freeze in Jan. 1997, Extension and the Farm Service Agency (FSA) developed a spreadsheet that lists all the major crops by commodity along with average yield per acre and price based on how the crop is sold. Acreage is another component, as is the percentage of each crop that was "lost" during the disaster in question. These components are multiplied to give a dollar value of the loss for each individual crop and are totaled to give losses for the major commodities in Miami-Dade. While acreage is relatively stable for ornamental and tree fruit crops, it fluctuates considerably for vegetables, depending on the time of year. Within roughly 24 h of a disaster, the committee assesses actual damage to different crops by conducting a windshield survey of the local growing area. This allows staff to calculate the percentage of damage experienced by each sector and current acreage. Then, acreage and crop loss figures are plugged into the equation and dollar values are generated. Crop loss can also be translated into lost jobs, which can assist migrant service providers with funding requests. This presentation will review the different types of damage experienced during hurricanes Katrina and Wilma in 2005 and their effects on the local economy. Katrina caused extensive flooding, with some structural damage, while damage from Wilma was primarily due to high winds and micro-bursts.

Impact of Hurricanes on Vegetable Crops in South Florida

Kent Cushman*¹, Monica Ozores-Hampton¹, Eric Simonne², Eugene McAvoy³, Darrin Parmenter⁴, Teresa Olczyk⁵

¹University of Florida, Southwest Florida Research & Education Center, Immokalee, FL, 34142; ²University of Florida, Horticultural Sciences Department; ³University of Florida, Hendry County Extension; ⁴University of Florida, Palm Beach County Extension; ⁵University of Florida, Miami-Dade County Extension

Vegetable producers in south Florida suffered the effects of four major hurricanes during 2004 and two during 2005, causing damage to crops and farms estimated at well over 1 billion dollars each year. Producers were quick to respond by replanting or nursing damaged crops back to health. Green beans and leafy crops appeared least likely to recover or produce acceptable yields after exposure to high winds and driving rains. Young tomato plants up to the second or third string were at times completely stripped of leaf material, yet recovered surprisingly quickly. A replant study showed no benefit in replanting compared to keeping damaged plants in the field. Older tomato plants were marginal in their ability to recover with 10% to 60% reductions in yield for first and second harvests when compared to yields common in the region. As much as 100% of Palm Beach County's 2005 early fall bell pepper planting was destroyed by storms. Other peppers in the region were affected by flooding and subsequent development of root diseases such as phytophthora. Damaged eggplant recovered slowly. Research plantings located in commercial fields and at Research and Education Centers were devastated. In addition to loss of crops, costs to vegetable growers included labor to remove damaged plastic and reset stakes, installation of replacement plastic mulches, replanting, and structural damage to buildings and packing facilities. Some transplant houses and greenhouses for specialty peppers were completely destroyed. Removing plastic coverings before a storm's arrival saved structures and crops. Transplants of all crops were in short supply. Labor was lacking due to reconstruction efforts in New Orleans and the Gulf Coast. Successful and not-so-successful recovery efforts will be shown.

The Transition of the California Processing Industry from Direct-seeding to Transplanting

Mike Murray*

University of California, Cooperative Extension, Colusa, CA, 95932

The California processing tomato industry continues to utilize transplants as a primary method of obtaining final plant stands. About 75% of the anticipated 2006 acreage will be transplanted, up from 0% a scant 20 years ago. This trend is being driven by increasing hybrid seed costs,

the desire to utilize the land for multiple crops per year, potential water savings, and enhanced weed management options. The history of this transition will be traced, identifying positive and negative impacts of reliance on transplants. An economic evaluation suggests that stand establishment using transplants costs at least \$250 per acre more than direct-seeding. A cost-benefit analysis is considered. The movement to transplants has reduced seed sales and many hybrid seed variety prices are tripling in 2006, as seed companies attempt to recoup R&D costs with declining markets. This "differential seed pricing," and its implications, are discussed in detail.

Crop Strategies Impact on Yield and Head Quality Components of Globe Artichoke in Southwest Texas

Daniel Leskovar*¹, Smiljana Goreta², Kil Sun Yoo³, Giovanni Piccinni⁴, Shinsuke Agehara¹

¹TAES, Texas A&M University, Horticulture, Uvalde, TX, 78801; ²Institute for Adriatic Crops, Vegetable Crops, Put duilova 11, Split 21000, Croatia; ³Texas A&M University, Vegetable and Fruit Improvement Center, College Station, TX; ⁴Texas A&M University, Soil and Crop Sciences

Introduction of artichokes in the Wintergarden of Texas, an area with mild winters and hot summers, depends on the development of strategies that will overcome limiting climatic conditions for bolting, earliness, and length of harvest. Cultivars with different bolting requirements were evaluated at two planting times and irrigation rates. The cultivars Emerald, Experimental Red, Imperial Star, Green Globe, and Purple Romagna were transplanted in the field on 27 Sept. and 3 Dec. 2004, and evaluated at 100% and 75% crop evapotranspiration rates (ETc) at Uvalde, Texas (29°1' N; 99°5' W). Harvests started on 24 Mar. and 21 Apr. 2005 for the first and second planting dates, respectively. Yield increased more than 3-fold for the first compared to the second planting date. Irrigation rates did not affect yield, water use efficiency, or head quality. The cultivars Emerald, Imperial Star, and Experimental Red were earlier than Green Globe and Purple Romagna. The highest yield was measured for cv. Imperial Star, while the largest head weight was for cv. Green Globe. Total fibers, crude protein, and phenolic compounds concentration depended on cultivar, whereas the total sugar concentrations in the edible part of the head were similar among cultivars. Head weight, percentage of heart, and crude protein concentration decreased, whereas total fiber content increased as the harvesting season progressed. Integrating environmental and cultivar strategies aimed at earliness, large head size, and enhanced level of health-promoting compounds, will contribute to the potential production of globe artichokes in the region.

Yield and Isoflavone Content of Edamame Varieties at Different Planting Dates and Densities

Allison E. Stewart*, Debra J. Carpenter, Vincent R. Pantalone, Carl E. Sams

The University of Tennessee, Plant Sciences, Knoxville, TN, 37996

Consumer interest in Edamame (edible soybean) is increasing due to reported health benefits associated with diets high in soy. The purpose of this study was to compare four varieties of edible soybean grown at four plant spacings on three planting dates. The lines were grown at the Plateau Research and Education Center in Crossville, Tenn. They were analyzed for horticultural traits and isoflavone content. All lines were at the R6 stage. Fresh weight of pods, weight of 200 pods per plot, the number of seeds per 200 pods, and the weight of 100 seeds were recorded from two-row plots (6.10 m x 1.52 m). A significant ($P < 0.001$) difference was found for fresh weight among planting dates. The May planting had the highest mean fresh weight (3118 g/plot), followed by the June (3068 g/plot) and July (2131 g/plot) dates. The weight per 100 seeds was significantly different ($P < 0.001$) for planting date and genotype. May seed weight was highest at 49 g, followed by June at 45 g, and July at 42 g per 100 seeds. 'Gardensoy-43' was the highest-yielding variety, with a mean of 3253 g/plot. It was followed by 'TN00-60' and 'TN03-349', with mean fresh weights of 2730 and 2723 g/plot, respectively. The line 'TN5601T' had the lowest mean fresh weight of 2389 g/plot. Both fresh weight ($P < 0.001$) and weight

per 100 seeds ($P < 0.05$) were significantly different among plant spacings. Twenty-six plants per meter within rows yielded the highest total fresh weight per plot (3071 g), but had the lowest mean weight per 100 seeds (43 g). Spacing three plants per meter within rows resulted in the highest weight per 100 seeds (48 g), but the lowest fresh weight per plot (2122 g). Isoflavone content will be measured for each variety, planting date, and spacing.

Response of Seed Potato (*Solanum tuberosum*) Cultivars to Glyphosate

Harlene M. Hatterman-Valenti*, Collin P. Auwarter, Paul G. Mayland

North Dakota State University, Plant Sciences

Field trials were initiated during 2004 at a dryland site near Prosper, N.D., to evaluate the effects of simulated drift from glyphosate to 'Russet Burbank' and 'Red Lasoda' seed potato during the early senescence stage. Glyphosate was applied at rates 1/3, 1/6, 1/12, 1/24, and 1/48 the use rate for spring wheat desiccation on 10 Sept. 2004 with a CO₂ pressurized sprayer operated at 280 L/ha and 276 kPa. The amount of a.m.S added to the spray solution was also reduced accordingly. Following harvest, samples from each plot were placed into cold storage until the following March. A subsample from each plot was slowly warmed to initiate sprout formation. Remaining samples were cut into 57-g pieces, dusted with a seed piece treatment, and stored at 18 °C with about 90% RH until planted. Plots consisted of two 3-m rows at 91 cm-row spacing with a border row on each side and three spacer plants between plots. The trial was arranged as a randomized complete block with four replications. Plots were desiccated on 12 and 19 Sept. and harvested 11 Oct. Tubers were hand-graded shortly after harvest. Results indicated that glyphosate at 70 g ae/ha or more inhibited tuber budbreak by 75% or more compared to untreated. In the field, injury was observed as delayed emergence and, in several instances, no plants emerged. Total yield for 'Red Lasoda' was 34.8 Mg/ha for the untreated, which was significantly greater than glyphosate treatments of 280, 140, and 70 g ae/ha. 'Russet Burbank' total yield was considerably less at 23.5 Mg/ha for the untreated. Both the untreated and glyphosate at 18 g ae/ha had significantly greater total yields compared with glyphosate treatments of 280, 140, and 70 g ae/ha.

Oral Session 16—

Vegetable Crops Culture & Management

29 July 2006, 8:00–9:30 a.m.

Bayside A

Moderator: Teresa Olczyk

Root Development of Chile Peppers Under Two Different Irrigation Regimes

Erin Silva*¹, Mark Renz², Stephanie Walker²

¹New Mexico State University, Plant and Environmental Sciences, Las Cruces, NM, 88003;

²New Mexico State University, Extension Plant Sciences, Las Cruces, NM, 88003

Chile pepper (*Capsicum annuum*) production in the southwest can be impacted by many factors. In particular, factors that alter root growth and development can be critical to pepper productivity. Several factors can cause less-than-optimal taproot formation, including irrigation practices, planting method (seeds vs. transplants), climatic conditions, and competition from weed species for limiting resources. The goals of this research were to quantify the root development of chile peppers established from either seeds or transplants under furrow and drip irrigation. Research was conducted in 2005 at Artesia Plant Science Research Center in Artesia, N.M., using a state-of-the-art drip irrigation system. Differences in root development between both irrigation types and planting methods were measured using of the mini-rhizotron image capturing system. Measurements occurred at a weekly basis to document location, root length density, and pattern of root formation. At the time of harvest, yield and fruit quality were evaluated. Direct-seeded chile plants yielded more fruits than transplanted chile under

both irrigation regimes. Patterns of root development differed over time for direct-seeded vs. transplanted and furrow vs. drip-irrigated chile peppers. Planting and irrigation method affected root growth differently at various points in the season. These data can aid in the optimization of management strategies for specific production practices.

Organic Garlic Research in Colorado; Winter Mulching, Irrigation Systems, Spacing, Scape Removal, and Flame Cultivation

Debra Guenther, Frank Stonaker*

Colorado State University, Horticulture and Landscape Architecture, Fort Collins, CO, 80523-1173

The Specialty Crops Program at Colorado State University conducted research of hardneck garlic (*Allium sativum ophioscorodon*) production on certified organic land at the Horticulture Field Research Center northeast of Fort Collins, Colo., during the garlic growing seasons of 2002–03 and 2003–04. Winter mulches and irrigation treatments were studied during the first season. It was found that garlic that was covered by any type of winter mulch (grass hay, single or double layers of floating row cover) resulted in better yields (higher average bulb weight) than garlic which was not covered at all (ANOVA, $F = 2.93$, $P = 0.034$). Yields from sprinkler and furrow irrigation were essentially the same; however, furrow irrigation used nearly 30% more water. Too little water was applied to the drip-irrigated treatment and yield suffered. Our findings suggest that yields are negatively impacted when less than 12 inches of combined precipitation and irrigation are received. During the second season, clove planting spacings of 3, 4.5, and 6 inches, and flame weeding and scape removal effects on yields were studied. The bulbs that grew at a 6-inch spacing were significantly larger than those grown at 3 and 4.5 inches (ANOVA, $F = 46.5$, $P < 0.001$). Flame weeding had no significant effects on yields (t -test, $P = 0.6$) and may be more economical compared to hand weeding depending on fuel costs. Removing the scapes did result in slightly higher bulb weights (t -test, $P = 0.06$). Removing scapes takes extra labor and may not be worth the time for only slightly higher bulb weights; however, selling the edible scapes may offset the cost and generate extra income.

Reducing Phosphorus Use for Sweet Corn Grown on Calcareous Gravelly Soils

Teresa Olczyk*¹, Yuncong Li², Xing Wang², Eric Simonne³

¹University of Florida IFAS, Miami-Dade County Extension Service, Homestead, FL, 33030; ²University of Florida IFAS, Soil and Water Science, Homestead, FL; 33031,

³University of Florida IFAS, Horticultural Sciences, Gainesville, FL

Sweet corn (*Zea mays*) is a major cash crop produced on calcareous soils in Miami-Dade County. Applications of large amounts of phosphorus (P) fertilizer for many years resulted in the accumulation of high levels of P in these soils. Accumulated P is slowly released into the soil solution to become available for plant roots. Previous studies conducted in this area showed little or no yield and crop quality response to P fertilizer applications. Large-scale field trials with reduced P applications were conducted in a grower's field. The treatments were: 1) no P; 2) 50% grower's rate; and 3) 100% grower's rate with six replications. The data collected included: plant stand, height, nutrient concentrations in leaf tissue, leaf chlorophyll, tip fill, number, and weight of marketable ears/acre. Reduced rates of P fertilizer did not significantly reduce yield and quality of sweet corn.

Integrating Root Interception Capacity and Crop Nitrogen Demand into BMPs for Vegetable Crops

Johannes Scholberg¹, Kelly Morgan*², Lincoln Zotarelli¹,

Eric Simonne³, Michael Dukes⁴

¹University of Florida, Agronomy; ²University of Florida, SW Florida REC; ³University of Florida, Horticultural Science; ⁴University of Florida, Agricultural and Biological Engineering

Most strategies used to determine crop N fertilizer recommendations do not address potential environmental issues associated with agricul-

tural production. Thus, a more holistic approach is required to reduce N loading associated with vegetable crops production on soils that are prone to N leaching. By linking fertilizer N uptake efficiency (FUE) with irrigation management, root interception capacity, and N uptake dynamics, we aim to improve FUE. Nitrogen uptake for peppers, tomato, potato, and sweet corn followed a logistic N accumulation patterns. Up to 80-85% of N uptake occurred between 4 to 7 weeks (sweet corn) vs. 6 to 12 weeks (other crops), while N uptake during initial growth and crop maturation was relatively low. Maximum daily N accumulation rates occurred at 5 weeks (sweet corn) vs. 8-10 weeks (other crops) and maximum daily N uptake rates were 4-8 kg N/ha. Overall FUE for most vegetables may range between 23% and 71%, depending on production practices, soil type, and environmental conditions. Maximum root interception capacity was typically attained 3 to 5 weeks prior to crop maturity. It is concluded that, during initial growth, root interception may be the most limiting factor for efficient N use. Although recent uptake studies have shown that FUE may be highest toward the end of the growing season, this may not coincide with the greatest crop demand for N, which occurs during the onset of the linear growth phase. As a result, yield responses to N applied later in the season may be limited. Integration of these results into best management practices and expert systems for vegetable production can minimize the externalities associated with commercial vegetable production on vulnerable soils in the southeastern United States.

Maturity, Yield, and Quality Modeling for Processing Carrots

Rajasekaran Lada*, Azure Adams, Arumugam Thiagarajan
Nova Scotia Agricultural College, Plant & Animal Sciences, Truro, NS, B2N 5E3, Canada

Carrot processing demands a continuous supply of uniform root grades for various product lines. Consequently, producers frequently harvest carrots with disregard to optimum maturity and quality, resulting in reduced yields, recovery, and profits. Beyond management inputs, weather conditions influence carrot growth and maturity through their intrinsic processes connected with carbon fixation and utilization. Establishing the relationship between the weather parameters and crop maturity, bulking, and quality of various processing carrot varieties would help in predicting crop growth, maturity, yield, and quality; thus leading to better harvest planning. Accordingly, experiments were conducted during the growing seasons of 2002–04, using seven carrot varieties in commercial plots at various locations in Nova Scotia. Weather stations were installed at each location to constantly record air temperature, rainfall, solar radiation, relative humidity, soil temperature, wind speed and direction, from which degree days and evaporation were calculated. Crop measurements included plant stand, leaf biomass (top growth), root girth and length, and gross yield. Recovery of marketable grades was arrived after the final yield was determined. Cumulative data was compiled for all of the weather parameters measured to coincide with the sampling dates. Multiple regression analyses were performed to quantify the association between cumulative weather parameters and maturity traits. All varieties, in all locations, showed strong correlations between bulking and various cumulative weather parameters. Field trials were repeated at three adjacent locations for all varieties during the 2005 growing season and the data obtained will be used to validate the fitness of the proposed model.

Nitrate Leaching, Yields, and Water-use Efficiency of Zucchini Squash (*Cucubita pepo*) under Different Irrigation and Nitrogen Rates and Methods in a Sandy Soil

Lincoln Zotarelli*¹, Johannes Scholberg¹, Michael Dukes², Hannah Snyder¹, Eric Simonne³, Michael Munoz-Carpena²
¹University of Florida, Agronomy Department, Gainesville, FL, 32611-0965; ²University of Florida, Agricultural and Biological Engineering, Gainesville, FL, 32611-0570; ³University of Florida, Horticultural Science, Gainesville, FL, 32611-0500

On sandy soils, potential N contamination of groundwater resources associated with intensively managed vegetables may hamper the sus-

tainability of these systems. The objective of this study was to evaluate the interaction between irrigation system design/ scheduling and N fertilization rates on zucchini production and potential N leaching. Zucchini was planted during Fall 2005 using three N fertilizer rates (73, 145, 217 kg/ha) and four different irrigation approaches. Irrigation scheduling included surface-applied drip irrigation and fertigation: SUR1 (141 mm applied) and SUR2 (266 mm) using irrigation control system (QIC) that allowed time-based irrigation (up to five events per day) and a threshold setting of 13% and 15% volumetric water content (VWC), respectively; Subsurface drip irrigation (SDI) using a QIC setting of 10% VWC (116 mm) combined with surface applied fertigation; and a control treatment with irrigation applied once daily (424 mm). Leachate volumes were measured by drainage lysimeters. Nitrate leaching increased with irrigation rate and N rate and measured values ranged from 4 to 42 kg N/ha. Use of SDI greatly reduced nitrate leaching compared to other treatments. SDI and SUR1 treatments had no effect on yields (29 Mg/ha). However, SDI had a 15% and 479% higher water use efficiency (WUE) compared to SUR1 and the fixed irrigation duration treatment. Application of N in excess of intermediate N-rate (standard recommendation) did not increase yield but yield was reduced at the lowest N-rate. It is concluded that combining sensor-based SDI with surface applied fertigation resulted similar or higher yields while it reduced both water use and potential N leaching because of improved nutrient retention in the active root zone.

Oral Session 17—Postharvest Quality/Disease

29 July 2006, 10:00–11:45 a.m.

Nottoway

Moderator: Wilhelmina Kalt

Effects of Postharvest Storage and UV-C Irradiation on the Phenolic Content and Antioxidant Capacity of Cranberries

Wilhelmina Kalt*¹, Agnes M. Rimando², Michele Elliot³, Charles F. Forney³

¹Agriculture & AgriFood Canada, Food Chemistry, Nova Scotia, B4N 1J5, Canada; ²USDA, Natural Products Utilization Research Unit, University, MS, 38677; ³Agriculture & AgriFood, Post Harvest, Nova Scotia, B4N 1J5, Canada

Recent interest in the human health-promoting properties of fruit phenolics, and especially fruit flavonoids, has stimulated research on how these secondary metabolites may be affected by pre- and postharvest horticultural factors. Resveratrol, although a minor phenolic in many fruit, possesses potent bioactivities, and is therefore of particular interest. To study the effects of postharvest storage and UV-C irradiation on selected phenolic components and antioxidant capacity of cranberry (*Vaccinium macrocarpon*), fruit of cv. Pilgrim, Stevens, and Bergman, were irradiated with UV-C at levels between 0 and 2.0 KJ·m⁻², followed by storage at 9 °C for 7 and 17 d. Total phenolic content did not change during storage. However, resveratrol content was higher and antioxidant capacity (ORAC) was lower at 7 days of storage compared to 17 days. There was no main effect of UV-C on total phenolics, anthocyanins, resveratrol, or ORAC. However, there was an interaction between storage time and UV-C irradiation. Anthocyanin content was lower at 7 days, and higher at 17 days, at UV dosages of 1.0 or 2.0 KJ·m⁻². Resveratrol content was higher in UV-C irradiated fruit at 7 days, while at 17 days there was no difference between UV-treated and untreated fruit.

Phenolic Composition and Antioxidant Activity of Minimally Processed Sweetpotatoes

Malkeet S. Padda*, David H. Picha
Louisiana State University, Horticulture

Three different style cuts of minimally processed sweetpotatoes (shredded, French-fry, and sliced) were stored at 0 °C and 5 °C for 4 and 8 days. Total phenolic content, individual phenolic acids, and

free radical scavenging activity were determined using Folin-Denis reagent, reversed-phase HPLC, and 1,1-diphenyl-2-picrylhydrazyl (DPPH) methods, respectively. Total phenolic content in sliced cut sweetpotatoes held at 5 °C was higher than in the shredded cut. Both sliced and French-fry cut sweetpotatoes held at 5 °C had significantly higher antioxidant activity than shredded cut sweetpotatoes. All treatments, except shredded sweetpotatoes held at 0 °C, had significantly higher total phenolic content and antioxidant activity after 4 and 8 days of storage. Minimally processed sweetpotatoes held at 5 °C accumulated more phenolic compounds and had a higher antioxidant activity than sweetpotatoes held at 0 °C. Chlorogenic acid followed by 3,5-dicaffeoylquinic acid were the predominant phenolic acids present in sweetpotatoes. The rate of increase in individual phenolic acid content with storage time was higher at 5 °C than at 0 °C. No tissue browning was observed in any of the cuts after 8 days of storage and the products were considered to be marketable.

Physiological Changes in Cantaloupe during Development and in Stored Fresh-cuts Prepared from Fruit Harvested at Various Maturities

John Beaulieu*¹, Jeanne Lea²

¹USDAARS, Food Processing & Sensory Quality, New Orleans, LA, 70124; ²USDAARS, Food Processing & Sensory Quality

Cantaloupe (*Cucumis melo* Var. *reticulatus*, Naudin) were evaluated during development and then fresh-cuts were stored after preparation from various maturities to track quality changes during storage. Flowers were anthesis tagged one morning and developing fruit were harvested weekly at 13, 20, 27–28, and 34–35 days after anthesis (DAA). Mature fruit were harvested at 37–38 DAA with five distinct maturities: 1/4-, 1/2-, 3/4-slip, full-slip and over-ripe. Hunter L* and a* color values indicated change from pale green to light orange that occurred after 28 DAA. There were significant decreases in L*, a* and b* by day 9 in storage as fresh-cuts. After 28 DAA, sucrose dramatically increased, and this was positively correlated with increases in both total sugars ($r = 0.882$, $P = 0.084$) and °Brix ($r = 0.939$, $P = 0.041$). Gradual subjective deterioration occurred during storage, which was independent of maturity. There was a negative linear trend over the length of storage in hand-held firmness for each maturity level and the slopes decreased significantly with increasing maturity; indicating the effect of storage duration decreased as maturity increased. Vitamin C had a significant increasing trend (P -value = 0.042) during development from 12 through 35 DAA, then losses were greater in fresh-cuts prepared from full-slip fruit (65%) than in less mature fruits, quarter-slip 40%, half-slip 48%, and three quarter-slip 50%. The pH of mesocarp tissue dropped to the lowest value (5.25) just prior to physiological maturity, then peaked after harvest (6.51–6.79), and generally declined by the end of fresh-cut storage. In sum, considering other publications on this study, and herein, fruit should be harvested at greater than or equal to 1/2-slip to attain optimum quality and storability.

Cold Storage Effects on Pawpaw Fruit Ripening and Quality

Federica Galli*¹, Douglas D. Archbold¹, Kirk W. Pomper²

¹University of Kentucky, Horticulture, Lexington, KY, 40546; ²Kentucky State University, USDA Clonal Germplasm Repository for *Asimina* Species, Frankfort, KY, 40601

Pawpaw [*Asimina triloba* (L.) Dunal] has significant potential as a new fruit crop. During ripening, loss of firmness is extremely rapid, and this trait may be the biggest obstacle to the development of a broader market. Cold storage of pawpaw fruit seems limited to 4 weeks at 4 °C, though fruit softening merely slows during storage. A study of several cultivars with commercial appeal has shown that none have superior cold storage life. Extending the cold storage beyond 4 weeks resulted in increasing loss of fruit firmness, poor poststorage ripening, and development of quality traits, and many fruit exhibiting flesh and peel discoloration. Cold storage duration affected fruit volatile production. By 4 weeks of cold storage, ethyl hexanoate and ethyl octanoate were the major volatiles produced, replacing methyl hexanoate, which was the major

volatile produced by ripe fruit after harvest. By 8 weeks of cold storage, volatile ester production was generally low and ethyl hexanoate became the only major volatile. This loss of volatile production was accompanied by a decrease in alcohol acetyl transferase activity. Also, during cold storage, there was an increase in total phenolic content, lipid peroxidation products, and polyphenol oxidase activity. These changes may contribute to the black discoloration that developed in fruit cold-stored for 8 weeks or more. It is apparent that cold storage alone may not be sufficient to extend the storage life of most, if not all, current pawpaw cultivars beyond 4 weeks.

Influence of Commercial Packing and Storage on Navel Orange Flavor, Quality Constituents, and Juice Ethanol Concentration

David Obenland*¹, Paul Neipp¹, Sue Collin², Jim Sievert², Kent Fjeld², Margo Toyota², Julie Doctor³, Mary Lu Arpaia²

¹USDA-ARS, Commodity Protection and Quality, Parlier, CA, 93648; ²University of California, Kearney Agricultural Center, Parlier, CA, 93648; ³Sunkist Growers, Research/Technical Services, Lindsay, CA, 93247

It is commonly believed within the citrus industry that handling, waxing, and storage of navel oranges may have undesirable effects on flavor. However, the effect of each potential influencing factor under commercial conditions is not completely understood. The purpose of this study was to systematically investigate these potential influences on navel orange flavor. Navel oranges were harvested on two separate dates, using three grower lots per harvest date, and the fruit run on a commercial packing line. Fruit were sampled at four different stages of the packing process: in the field bin; after the washer; after the waxer; and after packing into standard cartons. Fruit quality, flavor, and juice ethanol concentration were evaluated immediately after sampling and following 3 and 6 weeks of storage at 5 °C. The overall hedonic score, a measure of flavor, significantly declined from 6.5 to 5.7, as a result of 6 weeks storage. Fruit selected from field bins, from after the washer, and after the waxer were all judged by the taste panel to be equivalent in flavor. The packed fruit were judged to be slightly inferior in flavor. Titratable acidity declined while soluble solids increased as a result of storage; the stage of the packing process influenced neither. Waxing and storage both were associated with higher ethanol levels in the fruit.

Some Biochemical Changes in Carrot Roots Induced by *Erwinia carotovora* var. *carotovora*

Parthiban Valnaickenpalayam Kumaresan*¹, Prakasam Velappan², Prabakar Kuppusami², Thangaraju Muthu³

¹Agricultural Engineering College and Research Institute, Tamil Nadu Agricultural University, Post Harvest Technology Centre, Coimbatore, Tamil Nadu, 641 003, India; ²Tamil Nadu Agricultural University, Plant Pathology, Coimbatore, Tamil Nadu, 641 003, India; ³Tamil Nadu Agricultural University, Department of Agricultural Microbiology, Coimbatore, Tamil Nadu, 641 003, India

Carrot is a rich source of nutrients. Carrots contains carotene and lycopen, which gives bright color to the roots. The quality of the carrots was assessed based on the carotene, lycopen, and other biochemical constituents such as sugars, starch, and protein. To study the effect of various isolates of the *Erwinia carotovora* var. *carotovora* on the above biochemical constituents, the pathogens were inoculated and the contents were analyzed separately at 1, 2, 3, 4, and 5 days after inoculation. The contents of β-carotene increased significantly due to all the three isolates of the pathogen and the Coimbatore isolate recorded highest of 36.03%. The same trend was also observed in the lycopen content, with 93.55% increase over control. The contents of total and reducing sugars were found to significantly increase due to inoculation with the pathogen. The starch content showed a decreasing trend in all the isolates tested. The maximum reduction of 62.98% was observed in the roots inoculated with Coimbatore isolate. The protein content showed a decreasing trend up to 5th day of inoculation, and further reduction of about 25.45% was recorded with Coimbatore isolate on the 5th day. The total phenol content in the roots of carrot decreased significantly, and reached the least on 5th day due to the infection by all

the three isolates and the maximum reduction of 22.79% was observed in roots treated with Coimbatore isolate.

Encapsulation of Naturally Occurring Antifungal Compound into β -cyclodextrins: A New Technology for Reducing Postharvest Losses

Eva Almenar*, Rafael Auras, Maria Rubino, Bruce Harte
Michigan State University, School of Packaging, East Lansing, MI, 48824-1223

The United States is the world's largest producer of blueberries and strawberries. Successful marketing for both of them requires fruit of the highest quality and appearance. However, these fruits have a relatively short postharvest life, mostly due to the incidence of molds such as *Colletotrichum acutatum*, *Alternaria alternata*, and *Botrytis cinerea*. At present, several natural occurring plant volatiles have been shown to be effective against fungal growth, but, even so, those compounds could not be maintained at constant concentration during the whole postharvest period due to their volatility. In this work, two naturally occurring aldehydes (acetaldehyde and hexanal) were tested and compared against the growth of the above mentioned fungi at 23 °C. After that, the most effective antifungal compound for each fungus was encapsulated in β -cyclodextrins (β -CD) and tested during storage period. Both aldehydes were effective in reducing and avoiding fungal proliferation depending on concentration. Fungal proliferation depended on daily, and not initial, volatile concentrations. Volatiles encapsulated in β -CD showed higher antifungal activity compared to that obtained using the pure volatile during storage. Tested volatiles showed both fungicidal and fungistatic capacities after storage of fungal cultures in air. Results suggested β -CD-acetaldehyde and β -CD-hexanal complexes can be used as a new technology to release a naturally occurring antifungal compound during storage against several fungal diseases.

Oral Session 18—Vegetable Breeding

29 July 2006, 8:00–9:15 a.m.

Nottoway

Moderator: Linda Wessel-Beaver

Investigation of Doubled Haploid Performance and Combining Ability in Short-day Onion

Ryan L. Walker*¹, Sunggil Kim¹, Javier F. Betran², Kilsun Yoo¹, Leonard M. Pike¹

¹Texas A&M University, Department of Horticultural Sciences, College Station, TX, 77843-2119; ²Texas A&M University, Soil and Crop Sciences

Onions suffer from severe inbreeding depression, which has inhibited the development of homozygous inbred lines in breeding programs. The creation of doubled haploid (DH) lines in onion provides a unique opportunity to evaluate the utility of such lines as parents in a breeding program. For this purpose, two diallele cross experiments were conducted. The first consisted of a six-parent diallele cross using six DH lines developed at Texas A&M University. The second, a four-parent diallele cross performed with two DH lines and two inbred lines from the breeding program. Bulbs from the various crosses were evaluated for diameter, height, centers/bulb, ring thickness, number of rings/bulb, bulb weight, soluble solids content, and pungency. For some traits, general combining ability (GCA) effects explained most of the variation. However, for other traits, specific combining ability (SCA) effects predominated. For all traits, GCA and SCA were always larger than the reciprocal effects (divided into maternal and nonmaternal components). The GCA and SCA effects show an inverse correlation between the number of centers/bulb and ring thickness.

Heterosis for Horticultural Traits in Broccoli

Anna L. Hale*, Mark W. Farnham

U.S. Vegetable Laboratory, USDA/ARS, Charleston, SC, 29414

Over the last 3 decades, broccoli (*Brassica oleracea* L., Italica Group)

hybrids made by crossing two inbred lines replaced open-pollinated populations to become the predominant type of cultivar. The change to hybrids evolved with little or no understanding of heterosis or hybrid vigor in this crop. Therefore, the purpose of the present study was to determine levels of heterosis expressed by a set of hybrids derived by crossing relatively elite, modern inbreds ($n = 9$). A total of 36 hybrids formed by crossing nine parents were evaluated for horticultural characters, including head weight, head stem diameter, plant height, plant width (in a row), and maturity (e.g., days from transplant to harvest) in four environments. When averaged across all four environments, roughly half of the hybrids exhibited high parent heterosis for head weight (1 to 30 g) and stem diameter (0.2 to 3.5 cm). Almost all hybrids showed high parent heterosis for plant height (1 to 10 cm) and width (2 to 13 cm). Unlike other traits, there was negative heterosis for maturity, indicating that heterosis for this character in hybrids is expressed as earliness. With modern broccoli inbreds, heterosis for head characteristics appears less important than for traits that measure plant vigor.

The Inheritance of Bacterial Soft Rot Tolerance through Stem Scar Water Infiltration in Tomato

Sarah M. Smith*¹, John W. Scott¹, Jerry A. Bartz²

¹University of Florida, Horticultural Sciences, Wimauma, FL, 33598; ²University of Florida, Plant Pathology, Gainesville, FL, 32611

When tomato (*Lycopersicon esculentum* Mill.) fruit come in contact with water at the packing house dump tanks, they can infiltrate water through the stem scar. If the water is infested with *Erwinia carotovora*, the fruit can infiltrate the bacteria, which will later develop into bacterial soft rot. To determine the inheritance of low water infiltration and thus tolerance to soft rot, a complete diallele was produced using six parents that infiltrate different amounts of water. The parents and hybrids were grown in a completely randomized block design with three blocks and 10 plants per block. The amount of water infiltrated by the fruit was measured by the change in weight after the fruit were immersed in water in a pressure cooker for 2 min. Both general combining ability (GCA) and specific combining ability (SCA) were significant, with GCA having a higher significance than SCA. There appeared to be a cytoplasmic effect on water uptake, where less water was taken up when the low-uptake parent was used as a female. When orthogonal contrasts were performed on reciprocal hybrids from parents that were significantly different, 33% of them were significantly different.

Variation for Tipburn Resistance in Lettuce

Ryan Hayes*

U.S. Department of Agriculture, Agricultural Research Service, Crop Improvement and Protection Unit, Salinas, CA, 93905

Tipburn (TB) is a physiological disorder that results in necrosis along the margins of lettuce leaves. The disorder is objectionable to consumers and reduces the shelf life of whole and minimally processed lettuce. The objectives were to 1) determine the variation for tipburn resistance in iceberg, romaine, green leaf, and red leaf cultivars; and 2) determine the genotype \times location interaction for tipburn resistance. Tipburn incidence was recorded on 10 plants in each of three repetitions in Salinas, Calif., and Yuma, Ariz., trials with 20 iceberg, 21 romaine, 11 green leaf, and six red leaf cultivars. Data were analyzed using analysis of variance type statistics of ranked data. Variation for TB resistance was found in all lettuce types at both locations, although iceberg cultivars (average percentage of TB = 31% Salinas; 77% Yuma) had significantly ($P < 0.01$) higher levels of resistance at both location than romaine (58% Salinas, 81% Yuma), green leaf (52% Salinas; 88% Yuma), and red leaf (43% Salinas, 89% Yuma). The Yuma, Ariz., trial was more conducive for TB, and had less variation (range of percentage of TB = 33% to 100% Yuma, 0% to 100% Salinas). Four iceberg, one green leaf, and one red leaf genotype with industry acceptable levels of TB ($\leq 5\%$) were identified in the Salinas environment. Genotype \times location interaction was present ($P < 0.01$), and included rank order changes within all lettuce types. The correlation between the locations was low, 0.26, but significant ($P = 0.045$). A need exists for romaine, green leaf,

and red leaf germplasm with improved TB resistance, particularly in the Yuma environment. The presence of variation within each lettuce type and genotype \times location indicates that genetic improvement should be possible using within type crosses followed by selection in the Yuma or Salinas target environment.

A New Dominantly Inherited Source of TSWV Resistance in Tomato Derived from *L. chilense*, which Resists Isolates that Overcome *Sw-5*

Mikel R. Stevens*¹, John W. Scott², John J. Cho³, Bradley D. Geary¹, Frederic D. Memmott¹

¹Brigham Young Univ., Plant & Animal Sciences, Provo, UT, 84602; ²Univ. of Florida, Gulf Coast Research & Education Center, Wimauma, FL, 33598; ³CITAHR-Maui County Research, Univ. of Hawaii, Dept. of Plant Pathology, Kula, Maui, HI, 96790

Tomato spotted wilt virus (TSWV), a tospovirus, is a thrips-vectored disease infecting more than 1000 species of both monocots and dicots, including many species of agriculture importance. TSWV is the limiting factor for tomato (*Lycopersicon esculentum* Mill.) production in several areas of the world. For a number of years, the *Sw-5* gene (derived from *L. peruvianum* Mill.) has provided acceptable control of this disease. Recently, *Sw-5* derived resistance has been overcome by virulent pathogen isolate(s) in tomato production areas such as Spain and Italy. In earlier studies, we identified a potential new source of resistance to TSWV derived from *L. chilense* Dun. accession LA 1938. In a set of recent field studies, it was demonstrated that this putative new source of resistance was highly resistant to TSWV in Hawaii, Florida/Georgia, and South Africa. Furthermore, greenhouse screening trials have clearly demonstrated that the *L. chilense* source of TSWV resistance is resistant to isolates that overcome tomatoes homozygous for *Sw-5*. In these same greenhouse and field studies, there is uniform evidence that this resistance is dominant. Subsequent greenhouse studies suggest that this resistance is controlled by a single gene. Studies have been initiated to verify the inheritance of the gene(s) and to develop linked molecular markers. Furthermore, studies are under way in Australia to test this resistance on non-TSWV tospoviruses. If the data demonstrate that this is a single dominant gene we suggest this gene be designated *Sw-7*.

Assessment of Cowpea Genotypes for Use as a Weed-suppressing Cover Crop

Howard F. Harrison*¹, Judy A. Thies¹, Richard L. Fery¹, J. Powell Smith²

¹U.S. Vegetable Laboratory, USDA/ARS, Charleston, SC, 29414; ²Edisto Res. and Educ. Center, Clemson Univ., Entomology, Blackville, SC, 29817

A preliminary screening experiment was conducted to evaluate 47 cowpea [*Vigna unguiculata*, (L.) Walp.] genotypes for use as a weed-suppressing cover crop. Lines evaluated in this study included forage varieties, PI accessions, experimental breeding lines, and land races of unknown origin. Of these, 11 were selected for further testing on the basis of vigorous growth and weed-suppressing ability. In a field experiment repeated over 4 years, the selected genotypes were not different from the leading cover crop cultivar, 'Iron Clay', in biomass production. Vigor ratings, vine growth ratings, and canopy widths of some genotypes exceeded those of 'Iron Clay'. Vigor ratings and canopy measurements were efficient selection criteria that could be useful for breeding cover crop cowpea cultivars. All selections except an African cultivar, 'Lalita', were highly resistant to southern root knot nematode [*Meloidogyne incognita* (Kofoid and White) Chitwood], and the genotypes varied in seed size, photoperiod, and response to diseases.

The National, All-crops Plant Breeding Coordinating Committee

Linda Wessel-Beaver*¹, Ann Marie Thro²

¹Univ of Puerto Rico, Dept. Agronomy & Soils, Mayaguez, PR, 00681-9030; ²CSREES, USDA, Plant and Animal Systems, Washington, DC, 20024

The Plant Breeding Coordinating Committee will be a forum for

leadership regarding issues, problems, and opportunities of long-term strategic importance to the contribution of plant breeding to national goals. The committee will create the only regular opportunity to provide such leadership across all crops. The nature of plant breeding as an integrative discipline par excellence will be reflected in multidisciplinary committee membership. The past decade has brought major changes in the U.S. national plant breeding investment. In order for administrators and other decisionmakers to understand the implications of the changes and respond most effectively for the future, there is need for a clear analysis of the role of plant breeding for meeting national goals. Although recent changes in investment are the impetus for this committee, the need to articulate the role of plant breeding in meeting national goals is likely to be on-going, regardless of immediate circumstances. This presentation will describe recent progress on organizing this committee, and will ask all plant breeders to begin thinking about the questions to be addressed at the upcoming national workshop.

Oral Session 19—Floriculture 4

29 July 2006, 10:15–11:45 a.m.

Southdown

Moderator: Allan M. Armitage

The Influence of Cold on the Greenhouse Forcing of Woody Shrubs

Allan M. Armitage*, Natalia K. Hamill, Stephanie L. Anderson
University of Georgia, Horticulture, Athens, GA, 30602

As part of the New Floriculture Crop Program at the University of Georgia, a research project was initiated in Fall 2004 to determine the suitability of woody shrubs for forcing in the greenhouse. This paper will provide an overview of the research, indicating plants that were determined to be suitable for greenhouse forcing and sales in the retail area and those that were discarded from the program. About 15 taxa were initially selected for the program based on habit, foliar qualities, and flowering (if present). All plants were subjected to 1.7 °C to 4.4 °C for 0, 6, or 10 weeks in a controlled temperature cooler. Based on growth and visual characteristics, *Leptodermis oblonga*, *Indigofera pseudotinctoria* 'Rose Carpet', *Forsythia \times intermedia* 'Golden Peep', and *Philadelphus coronaria* 'Manteau d'Hermaine' were discarded. *Caryopteris \times clandonensis* 'Sunshine Blue', *Leycesteria formosa* 'Golden Lanterns', *Sambucus nigra* 'Black Lace', *Philadelphus coronaria* 'Variegata', and *Physocarpus oblongifolius* 'Summer Wine' were investigated further. Data presented for *Physocarpus* suggested that cooling was not necessary for growth; however, 10 weeks of cooling resulted in the least time to finish in the greenhouse. Zero, 6, and 10 weeks cold resulted in 17, 10, and 7 weeks finish time, respectively. Additional work on *Kolkwitzia*, *Buddleia*, and *Wegelia* conducted in 2005 and future research will be discussed.

The Influence of Cooling on Growth of Three Shrubs for Greenhouse Forcing

Natalia K. Hamill*, Allan M. Armitage, Stephanie L. Anderson
University of Georgia, Horticulture, Athens, GA, 30602

As part of the New Floriculture Crop Program at the University of Georgia, a research project was initiated in Fall 2004 to determine the suitability of 12 taxa of woody shrubs for forcing in the greenhouse. In this study, the influence of cooling on greenhouse forcing of (*Caryopteris \times clandonensis* 'Sunshine Blue', *Leycesteria formosa* 'Golden Lanterns' and *Sambucus nigra* 'Black Lace') was evaluated. Dormant rooted liners were cooled for 0, 6, or 10 weeks at 1.7 °C to 4.4 °C. With 0 and 6 weeks cooling, *Caryopteris* never reached an acceptable finish stage. With 10 weeks cooling, plants finished in 7 weeks in the greenhouse. With 0 weeks cooling, *Leycesteria* was

salable in 13 weeks. With 6 and 10 weeks cooling, plants finished in 7 and 8 weeks, respectively. With 0 weeks cooling, *Sambucus* never reached a salable stage. With 6 weeks cooling, plants were salable in 11 weeks; with 10 weeks cooling, plants finished in 6 weeks. The data suggest that cold is necessary to force *Caryopteris* and *Sambucus* in the greenhouse, and that 10 weeks of cold resulted in the shortest production time for both taxa. Data show that 6 weeks cooling of *Leycesteria* resulted in the shortest production time, but cooling is not necessary. This experiment was repeated in 2005–06 and will be compared to the 2004 findings. Additional experiments conducted in 2006 will also be discussed.

Short Days or Vernalization Promote Flowering in *Aquilegia* × *hybrida* Sims ‘Origami Blue and White’

Catherine M. Whitman, Erik S. Runkle*, Arthur C. Cameron
Michigan State University, Horticulture, East Lansing, MI

Flowering of *Aquilegia* is generally considered to require vernalization, while photoperiod has little or no effect. The cold treatment is most effective when plants have passed the juvenile stage (often 12 to 15 leaves) prior to vernalization. We performed experiments on a cultivar reported to have a reduced vernalization requirement. Seedlings of *Aquilegia* × *hybrida* Sims ‘Origami Blue and White’ in 128-cell plug trays with four or five leaves were either placed directly into a 5 °C cooler or transplanted to 13-cm containers. Plants were grown (bulked) for 0, 3, or 6 weeks at 20 °C under 9-h short days (SD) or 16-h long days (LD) provided by incandescent lamps at 1 to 3 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$. Plants had seven or eight leaves after 3 weeks bulking and 13 or 14 leaves after 6 weeks bulking. They were then cooled at 5 °C for 0, 5, or 10 weeks and placed in a common forcing environment of 20 °C under an LD provided by high-pressure sodium lamps. *Aquilegia* plants placed directly into the forcing environment flowered in 89 and 97 days in years 1 and 2, respectively. Flowering percentage of plants cooled in the plug tray decreased with increasing duration of cold treatment, and only 15% flowered after a 10-week cold treatment. All plants bulked for 3 or 6 weeks prior to cold treatment flowered, and in 26 to 35 days. Surprisingly, all plants that were moved directly from bulking treatments to the forcing environment (no cold treatment) flowered, and flowering was most rapid (36 days) in plants exposed to 6 weeks of SD before forcing. Therefore, our data indicate that SD can at least partially substitute for a cold treatment in this *Aquilegia* cultivar.

Photoperiod, Irradiance, and Cool Temperature Effects on *Gymnocalycium*, *Rebutia*, *Lobivia*, and *Sulcorebutia* sp. Growth and Flowering

John Erwin*, Esther Gesick, Ben Dill, Charles Rohwer
University of Minnesota, Department of Horticultural Science, St. Paul, MN, 55108

A study was conducted to determine if photoperiod, irradiance, and/or a cool temperature impacted flowering of selected species in five cactus genera. *Gymnocalycium*, *Rebutia*, *Lobivia*, and *Sulcorebutia* plants were grown for 4 months under natural daylight conditions (August–November) in a greenhouse maintained at 26 ± 2 °C. Plants were then placed in either of two greenhouses: 1) a greenhouse maintained at 22 °C day/18 \pm 1 °C night temperature with an 8-h daylength (SD) or natural daylight plus night interruption lighting (NI; 2200–0200 HR), or 2) a greenhouse maintained at 5 ± 2 °C under natural daylight conditions (8–10 h). After 12 weeks at 5 °C, plants were moved to the SD and NI lighting treatments in the before mentioned greenhouse and additional lighting treatment [natural daylight plus supplemental high-pressure sodium lighting ($85\text{--}95 \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$; 0800–0200 HR)]. In all cases, plants were moved out of lighting treatments after 6 weeks and were then grown under natural daylight conditions in a greenhouse maintained at constant 22 ± 1 °C. Data were collected on the approximate date growth commenced, the date when each flower opened (five flowers only), flower number per plant, and individual flower longevity (five flowers only). Species were classified into photoperiodic and irradiance response groups where appropriate and whether species exhibited a vernalization requirement was reported.

Lastly, whether dormancy occurred and what conditions overcame that dormancy was reported.

Photoperiod, Irradiance, and/or Cool Temperature Effects on *Lobivia* × *Chamaecereus* Hybrid ‘Rose Quartz’ Flowering

John Erwin*, Esther Gesick, Ben Dill, Charles Rohwer
University of Minnesota, Department of Horticultural Science, St. Paul, MN, 55108

Photoperiod, irradiance, and/or a cool temperature effects on *Chamaelobivia* hybrid ‘Rose Quartz’ flowering was studied. Two- to 3-year-old plants were grown for 4 months under natural daylight (DL; August–November) in a greenhouse maintained at 26 ± 2 °C. Plants were then placed in either of two greenhouses: a cool temperature house (5 ± 2 °C; natural daylight), or a lighting treatment house (22 ± 1 °C day/18 \pm 1 °C night temperature, respectively). The lighting treatment house had eight light environments: 1) short day (SD; 8 h; 0800–1600 HR); 2) SD+25–35 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$; 3) SD+45–50 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$; 4) SD+85–95 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$; 5) DL plus night interruption lighting (NI; 2200–0200 HR; 2 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ from incandescent lamps); 6) DL+25–35 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ (lighted from 0800–0200 HR); 7) DL+45–50 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$; and 8) DL+85–95 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$. Supplemental lighting was provided using high-pressure sodium lamps. Plants were placed in the cool temperature environment for 0, 4, 8, or 12 weeks before being placed under lighting treatments. All plants received a 6-week lighting treatment and were then placed in the finishing greenhouse (22 ± 2 °C). Data were collected on the date when each flower opened (five only), the flower number per plant, and flower longevity (five only). Vernalization interacted with photoperiod to affect flowering. Unvernalized plants exhibited an obligate long-day requirement for flowering. Vernalized plants exhibited a facultative long-day requirement for flowering. The impact of vernalization, photoperiod, and irradiance on flower number, time to flower, and longevity will also be discussed.

Floating System Production of *Liatis* *spicata* (L.) Willd.

Giampaolo Zanin*, Paolo Sambo
University of Padova, Agronomy and Crop Science, Viale dell’Università 16, Legnaro, Padova, 35020, Italy

Liatis is an ornamental plant cultivated as a garden perennial for more than 70 years. Since the early 1970s, *Liatis spicata* has gained importance as a cut flower because of its long-lasting flowering and its peculiar downward flowering succession. This species is usually cultivated in beds both outdoors and in greenhouses. However, in order to improve yield and quality production, some research has been carried out on soilless cultivation. In particular, floating systems seem to provide the best performances, although only different nutrient solutions or their concentrations have been studied. In this research, in addition to two different concentrations of Hoagland solution [full-strength (H) and a half-strength (1/2H)], three corm circumferences (8/10, 10/12, and 12+) and three plant densities (36, 48, and 60 plants/m²) were also evaluated. The full-strength solution gave the best performance from both qualitative and quantitative standpoints. This nutrient solution also showed, at the end of the experiment, very high residual nitrate-N, which could induce environmental pollution during disposal. Furthermore, the management of the solution appeared more difficult and time-consuming. All these aspects should be taken into account by growers in making choices. Corm size also affected production. Increasing circumference from 8/10 to 12+ increased marketable stems per plant and their quality traits, but, because of the highest mortality of plants observed with the bigger corms, yield per square meter did not increase over corm size of 10/12. Finally, rising plant density from 36–60 plants/m², the biomass of the single plant decreased. However, it resulted also in the enhancement of sellable production per square meter.

American–Japanese Expedition to Hokkaido to Collect Berry Crops in 2004

Kim E. Hummer*¹, Tom Davis², Hiroyuki Iketani³, Hiroyuki Imanishi⁴

¹USDA ARS, National Clonal Germplasm Repository, Corvallis, OR, 97333-2521; ²University of New Hampshire, Plant Biology/Genetics, Durham, NH, 03824; ³National Institute of Fruit Tree Sciences, Department of Genetics and Breeding, National Agriculture and Bio-oriented Research Organization (NARO)2-1 Fujimoto, Tsukuba, Ibaraki, 305-8605, Japan; ⁴Akita Prefectural College of Agriculture, Experimental Farm, Ogata, Akita, 010-0451, Japan

Genetic resources of temperate berry crops were collected 7 to 27 July 2004 in Hokkaido, Japan, under a bilateral agreement between the United States and Japan. This expedition was a collaborative effort between the United States Department of Agriculture (USDA), the Japanese Ministry of Agriculture, Forestry and Fisheries (MAFF), the University of New Hampshire, and Akita Prefectural College of Agriculture, Japan. Additional assistance was provided by the Hokkaido Governmental Plant Genetic Resources Center, several Forest Research Stations of the Hokkaido University, and private botanists. The expedition obtained 100 accessions encompassing eight genera and 29 species. In all, 84 seedlots, and 23 plants were obtained. The genera collected included: *Actinidia*, *Fragaria*, *Lonicera*, *Morus*, *Ribes*, *Rubus*, *Sambucus*, and *Vaccinium*. Plant and seed accessions from this trip are preserved and distributed from the USDA ARS National Clonal Germplasm Repository in Corvallis, Ore., and from MAFF. The target genus for this expedition was *Fragaria*, so the trip was planned for July. Multiple samples of the two Japanese diploid strawberry species, *Fragaria iinumae* Makino and *F. nipponica* Makino (synonym = *F. yezoensis* H. Hara) were obtained during their prime ripening time. *Ribes*, *Rubus*, and *Vaccinium* fruits ripened later in the summer, but were collected when fruit were observed. Unfortunately, seeds of some of these accessions proved to be immature or nonviable upon extraction. We suggest that expeditions to collect these genera should be planned for late August. Morphological and molecular evaluation of collected germplasm is underway at the USDA ARS Corvallis Repository and at the University of New Hampshire.

Microsatellites are Used to Examine Apple and Pear Identities and Genetic Relationships

Nahla Bassil*, Kim Hummer, Joseph Postman
NCGR, USDA/ARS, Corvallis, OR, 97333

Simple Sequence Repeat (SSR) markers developed in apple and pear were used to determine genetic relationships among heritage apple and pear cultivars from Portugal's Azore Islands, and to develop identity fingerprints for European and Asian pear accessions at the USDA–ARS National Clonal Germplasm Repository (NCGR). We used 11 SSR markers (six from apple and five from pear) to examine 18 heritage apple and 9 heritage pear cultivars from the Azores. Eight additional Portuguese and economically important cultivars of apple and eight of pear were used as standards. Cluster analysis separated the apple and pear accessions into two distinct groups. Among apple genotypes, 12 unique accessions and five groups of synonyms were identified, while, in pear, seven unique genotypes and three pairs of synonyms were found. None of the accessions obtained from the Azores corresponded to widely grown standard Portuguese apple or pear cultivars. To examine 144 NCGR pear accessions, we used nine polymorphic SSR loci that were developed from GenBank sequences. Cluster analysis identified five sets of synonyms (four in *P. communis* L. and one in *P. ussuriensis* Maxim.) and four pairs of homonyms (three in *P. communis* and one in *P. pyrifolia* Burm. f. Nakai), and confirmed three clonal sets. Morphological evaluations and additional SSR markers will be used to confirm these results, and to genetically document the identities of

pear genotypes. SSR markers will greatly assist the management of ex situ pome fruit germplasm collections by helping to eliminate duplicate accessions and expanding the genetic diversity represented.

Construction of a cDNA Library of *Vitis pseudoreticulata* Native to China Inoculated with *Uncinula necator* and the Analysis of Potential Defense-related Expressed Sequence Tags

Yan Xu, Yuejin Wang*

Key Laboratory of Northwest Horticulture Plant Germplasm and Genetic Improvement of Ministry of Agriculture, Northwest A&F University, College of Horticulture, Yangling, Shaanxi, 712100, P.R. China

Expressed sequence tags (ESTs) constitute a rapid and informative strategy for studying gene-expression profiles of specific stages of annual and perennial plant species. Compared with annual plants, the NCBI database has very little sequence information from perennial plant species. To date, only ~145 ESTs of *Vitis pseudoreticulata* W.T. Wang have been deposited in databases. This is insufficient to understand the biology and development of this species. In this report, a cDNA library constructed from young leaf inoculated with powdery mildew pathogen [*Uncinula necator* (Schw.) Burr.] of Chinese wild *Vitis pseudoreticulata*. Leaf was harvested at various times after inoculation for total RNA extraction, which was used to generate ESTs. In our study, 107 cDNA clones were sequenced either from 5' or 3' end of the cDNAs. Among them, 60 unigenes (56%) were functionally characterized by the BLASTX matches to known function proteins, and 20 unigenes (18.6 %) matched significantly with those having unknown function in the public databases. The remaining 27 unigenes (25.2%) failed to show significant homology to any proteins in the public databases, suggesting that they represent novel sequences. Some functional genes identified from the cDNA library to be potentially associated with plant defence-related responses are discussed.

Mango Genetic Diversity Analysis and Pedigree Inferences for Florida Cultivars using Microsatellite Markers

Raymond Schnell*¹, J. Steven Brown¹, Cecile Olano¹, Alan Meerow¹, Richard Campbell², David Kuhn³

¹SHRS USDA-ARS, Plant Genetics, Miami, FL, 33158; ²Fairchild Tropical Botanical Garden, Botany, Coral Gables, FL, 33156; ³Florida International University, Biological Sciences, Miami, FL, 33199

Mangifera indica L. germplasm can be classified by origin with the primary groups being cultivars selected from the centers of diversity for the species, India and Southeast Asia, and those selected in Florida and other tropical and subtropical locations. Accessions have also been classified by horticultural type: cultivars that produce monoembryonic seed vs. cultivars that produce polyembryonic seed. In this study, we used 25 microsatellite loci to estimate genetic diversity among 203 accessions. The 25 microsatellite loci had an average of 6.96 alleles per locus and an average PIC value of 0.552. The total propagation error in the collection, i.e., plants that had been incorrectly labeled or grafted, was estimated to be 6.13%. When compared by origin, the Florida cultivars were more closely related to Indian than to Southeast Asian cultivars. Unbiased gene diversity (H_{nb}) of 0.600 and 0.582 was found for Indian and Southeast Asian cultivars, respectively, and both were higher than H_{nb} among Florida cultivars (0.538). When compared by horticultural type, H_{nb} was higher among the polyembryonic types (0.596) than in the monoembryonic types (0.571). Parentage analysis of the Florida cultivars was accomplished using a multistage process based on introduction dates of cultivars into Florida and selection dates of Florida cultivars. Microsatellite marker evidence suggests that as few as four Indian cultivars, and the land race known as 'Turpentine', were involved in the early cultivar selections. Florida may not represent a secondary center of diversity; however, the Florida group is a unique set of cultivars selected under similar conditions offering production stability in a wide range of environments.

Methylation Sensitive Amplification Polymorphism in Date Palms and Their Offshoots

Jingui Fang, ChihCheng T. Chao*

Univ. of California-Riverside, Dept. of Botany & Plant Sciences, Riverside, CA, 92521-0124

DNA methylation plays an important role in the regulation of gene expression in eukaryotes. The extent and patterns of DNA methylation were assessed in the date palm (*Phoenix dactylifera* L.) mother plants and their offshoots using the methylation sensitive amplified polymorphism (MSAP) technique. Three types of bands were generated using 12 pairs of primers. Type I bands were present in both EcoR I + Hpa II and EcoR I + Msp I lanes; type II bands were present in EcoR I + Hpa II lanes, but not in EcoR I + Msp I lanes; and type III bands were present in EcoR I + Msp I lanes, but not in EcoR I + Hpa II lanes. The total numbers of these three types of bands were 782, 55, and 34. Among these three types of bands, the polymorphic bands were 34, 10, and 0, respectively. The distribution of polymorphic bands among mother-plants and offshoots could suggest the methylation variation occurred to the mother plants and offshoots. The methylation variation during offshoot growth of date palm was characterized as a process involving mainly of demethylation. Hypomethylation of DNA in offshoots compared with mother plants reflects the marked expression of this molecular feature, which may related to gene expression during development of offshoots. The methylation or demethylation status of specific loci in the mother plants and their offshoots might not relate their lineage but occurred randomly.

Screening the U.S. National Fig Collection for Potential Fresh Fruit Genotypes

Ed Stover*¹, Malli Aradhya¹, Carlos Crisosto², Louise Ferguson²

¹USDA/ARS, National Clonal Germplasm Repository, Davis, CA, 95616; ²University of California, Plant Sciences Dept., Davis, CA, 95616

Currently, 94% of California fig production is dried or otherwise processed, but there is interest in expanding fresh fig sales. Since cultivars dominating the industry were largely selected for dried fig use, the fig collection of the National Clonal Germplasm Repository (NCGR) in Winters, Calif., was screened for traits of interest in fresh fruit production. For some traits, the bearing collection of 137 accessions was screened, while for most traits, data was collected on a core group of 30 accessions. While current commercial cultivars feature flavors of honey or caramel, some NCGR accessions have bright fruity flavors, reminiscent of berries or citrus, as well as noticeable acidity. Considerable variation was observed for time of maturity. Breba (figs on previous year's wood ripe in June/July) production was markedly greater in 'King' than in any other core-group genotype, with $\approx 3\times$ more fruit per branch than the next most breba-productive variety and $8\times$ higher than the commercial standards. Earliness of ripening in the large collection was most pronounced in 'Yellow Neches', 'Orphan', and 'Santa Cruz Dark', with $3\times$ as many ripe fruit per tree in early August as the earliest commercial standard. Several commercial standards scored among the varieties with greatest late-season production (≈ 200 fruit per tree ripe after mid-September), comparing favorably with 'Zidi', 'Panachee', and 'Ischia Black', among others. The SSC at commercial ripeness ranged from 13% to 19%, and SSC at tree-ripeness averaged 30% higher than in commercially ripe fruit. Several accessions were observed to have fruit traits that might also contribute to sustained quality through market channels.

Oral Session 21—Cross Commodity Nutrition

29 July 2006, 9:30–10:30 a.m.

Bayside A

Moderator: John M. Smagula

Response of Lowbush Blueberry to Several Organic Fertilizers

John M. Smagula*, Ilse W. Fastook

University of Maine, Plant, Soil, and Environmental Sciences, Orono, ME, 04469-5722

Four organic fertilizers were evaluated in a commercial lowbush blueberry

field with a history of N and P deficiency. In nonorganic production, diammonium phosphate (DAP) is the standard fertilizer for correcting N and P deficiency. Nitrogen a rate of $67 \text{ kg}\cdot\text{ha}^{-1}$ [Renaissance (8-2-6), Pro-Holly (4-6-4), Pro Grow (5-3-4), Nutri-Wave (4-1-2), or DAP (18-46-0)] was applied preemergent to $1.8\text{-m} \times 15\text{-m}$ treatment plots. Leaf N and P were deficient ($<1.6\%$ and 0.125% , for N and P, respectively) in the unfertilized plots that served as controls. DAP and Pro-Holly raised leaf N to satisfactory levels ($>1.6\%$). Only DAP raised leaf P concentrations (0.144%), compared to controls (0.122%). Leaf K was not deficient, but was raised by Pro-Holly. Soil pH was slightly lowered by Renaissance (4.2) and raised by Pro-Holly (4.4), compared to the control (4.3). Soil P concentrations were raised by DAP and soil S by Pro-Holly. Soil K was raised by all fertilizers except DAP, compared to the control. Pro-Holly and DAP were equally effective in increasing stem height, branching, branch length, flower bud formation, and yield, compared to the control and the other organic fertilizers. Pro-Holly could effectively substitute for DAP in organic wild blueberry production.

Genotypic Variability of Iron and Zinc in Sweetpotato

Michael W. Courtney*, Don La Bonte

Louisiana State University, Horticulture Department, Baton Rouge, LA, 70803

Sweetpotato [*Ipomoea batatas* (L.) Lam.] is a major subsistence crop in southern Africa, where iron and zinc deficiency in humans is an important health problem. A cultivar of sweetpotato that is suited for subsistence farming in this region and that is high in iron and zinc could be an important means of combatting these deficiencies. As part of a program of the HarvestPlus program, under the auspices of the International Potato Center (CIP) to develop such a cultivar, we are working to identify the high and low range of iron and zinc in sweetpotato cultivars grown throughout the world by testing a number of cultivars for these nutrients. Subsidiary objects include determining the heritability of iron and zinc levels and surveying the variability in the levels of these nutrients from root to root on the same plant, from plant to plant of the same cultivar, from the proximal to the distal end of a given root, and from cambium to cortex. For the roughly 80 cultivars in the genotypic variability study, results showed a three-fold difference between the high- and low-yielding cultivars on a fresh weight basis and a two-fold difference on a dry weight basis, for both iron and zinc.

Update on Nitrogen BMP Efforts with Tomato Production in Florida

Monica Ozores-Hampton*¹, Eric Simonne², Eugene McAvoy³, Phil Stansly⁴, Sanjay Shukla⁵, Fritz Roka⁶, Tom Obreja⁷, Kent Cushman¹, Phyllis Gilreath⁸, Darrin Parmenter⁹

¹University of Florida/SWFREC, Horticulture, Immokalee, FL, 34142; ²University of Florida, Horticulture, Gainesville, FL, 32611; ³University of Florida, Hendry Co. Coop. Ext. Office, Labelle, FL, 33975; ⁴University of Florida, Entomology, Immokalee, FL, 34142; ⁵University of Florida/SWFREC, Agricultural and Biological Engineering, Immokalee, FL, 34142; ⁶University of Florida/SWFREC, Food and Resource Economics, Immokalee, FL, 34142; ⁷University of Florida, Soil and Water Sciences, Gainesville, FL, 32611; ⁸University of Florida, Manatee County Extension Service, Palmetto, FL, 34221; ⁹University of Florida, Palm Beach County Ext. Service, West Palm Beach, FL, 33415-1395

Florida tomato growers generate about \$600 million of annual farm gate sales. The *Florida Vegetable and Agronomic Crop Water Quality/Quantity Best Management Practices Manual* was adopted by rule in the Florida Administrative Code in 2006 and describes cultural practices available to tomato growers that have the potential to improve water quality. By definition, BMPs are specific cultural practices that are proven to optimize yield while minimizing pollution. BMPs must be technically feasible, economically viable, socially acceptable, and based on sound science. The BMP manual for vegetables endorses UF-IFAS recommendations, including those for fertilization and irrigation. Current statewide N fertilizer recommendations for tomato provide for a base rate of 224 kg/ha plus provisions for supplemental fertilizer applications 1) after a leaching rain, 2) under extended harvest season, and 3) when plant nutrient levels (leaf or petiole) fall below the sufficiency range. An on-farm project in seven commercial fields was conducted in 2004 under cool and dry growing conditions, to compare grower practices (ranging from 264 to

468 kg/ha of N) to the recommended rate. Early and total extra-large yields tended to be higher with growers' rate than with the recommended rate, but these differences were significant only in one trial. The first-year results illustrated the need for recommendations to be tested for several years and to provide flexibility to account for the reality of local growing conditions. Working one-on-one with commercial growers provided an opportunity to focus on each farm's educational needs and to identify specific improvements in nutrient and irrigation management.

Wool and Hair Waste as Nutrient Source for High-value Crops

Valtcho Zheljazkov (Jeliazkov)*¹, Ekaterina Jeliazkova², Nedko Nedkov³

¹Mississippi State, North MS Research and Ext Center, Verona, MS, 38879; ²Nova Scotia Agricultural College, Environmental Sciences, Truro, NS, B2N 5E3, Canada; ³Research Institute of Roses and Medicinal Plants, Institute of Roses and Medicinal Plants, Kazanluk, 6100, Bulgaria

Container and field experiments were conducted to evaluate sheep wool wastes and human hair wastes as soil amendments and nutrient sources for high-value crops. Overall, wool-waste or hair-waste additions to soil increased yields from basil, garden sage, peppermint, valerian, thorn apple, marigold, foxglove, and swiss chard; increased the amount of secondary metabolites (such as essential oils and alkaloids); increased NH₄-N and NO₃-N in the soil; and increased total N (and protein) content in plant tissue. The wool-waste or hair-waste additions did not affect soil microbial biomass, but decreased mycorrhizae colonization of plant roots. Scanning electron microscopy (SEM) and Energy Dispersive X-ray (EDX) analyses indicated that some of the wool and hair in soil from the container and field experiments (after two field seasons and several harvests) retained its original structure, a significant amount of S, some N, and was not fully decomposed. Results from this study suggest that wool and hair wastes can be used as soil amendment and nutrient source for high-value container or field crops.

Oral Session 22—

Fruit/Small Fruit Crops Physiology/Production

29 July 2006, 10:00–11:45 a.m.

Borgne

Moderator: Kitrin Glozer

Chemical Blossom Thinning on *Prunus* in New York

Jason L. Osborne*, Terence L. Robinson

¹Cornell University, Horticulture, Geneva, NY, 14456

In 2004, we conducted a chemical thinning field study in Appleton, N. Y., on 5-year-old 'Rising Star' peach trees on Lovell rootstock. Treatments included soybean oil or petroleum oil applied at 8% about 30 days before budbreak. Ammonium thio-sulfate (ATS) 3.5 gal/acre, ATS 5.0 gal/acre, lime sulfur (1%, 3%) plus Crockers fish oil 2 gal/acre, and Wilthin 6 pt/acre were applied at FB; and the grower standard hand-thinning treatment at 45 DAFB. Trees treated with thinning agents were not given supplemental hand thinning. The high rate of ATS, 5.0 gal/acre and Wilthin 6 pt/acre had the greatest thinning effect and reduced fruit set by 55% and 61%, respectively, compared to the untreated control. The high rate of ATS also increased fruit size 25%, but reduced yield by 45%. Soybean and petroleum oil treatments did not significantly reduce fruit set. Lime sulfur plus fish oil treatments 1% and 3% also did not significantly reduce fruit set. Although a significant reduction in yield was observed in the high rate ATS and Wilthin treatments, a greater proportion of the crop was in the larger size categories. In 2005, treatments included soybean oil 8% plus Latron B 1956 applied 18 days and 25 days before FB, Lime sulfur (2%, 4%) plus Crockers fish oil (2%) applied at FB, Ammonium thio-sulfate (ATS) 3.5%, 5.0%,

Wilthin 1.9, 2.8 L (Entek, Inc.), plus Regulaid 473 mL per 935 L/ha applied at FB, Entry 1.5, 3.0%, Tergitol TMN-6 0.75, 1.5%, hand-thin flowers to a crop load of seven fruits per cm² at FB and hand-thin fruit to 7 fruits per cm² applied 45 days after FB.

Predicted Crop Value for a Cling Peach and Three Nectarines of Different Harvest Seasons as a Function of Crop Load

Gabino Reginato*¹, Terence Robinson², Victor Garcia de Cortazar¹

¹Universidad de Chile, Facultad de Ciencias Agronomicas, Santiago, Chile; ²Cornell University, Dept. of Hort. Sciences, Geneva, NY, 14456

Several field experiments to assess the effect of tree size and crop load on fruit size and yield were conducted in a 'Ross' cling peach orchard and in three nectarine orchards of different harvest seasons in Chile. Trees were randomly selected in each orchard and then hand-thinned at the beginning of pit hardening to a wide range of crop loads. The fraction of above-canopy photosynthetically active radiation intercepted by the canopy (PARI) was determined at harvest and all fruits were counted, weighted, and average fruit weight calculated. Cropload and yield were expressed in terms of fraction of PARI. Data on farm gate prices for export fruit of different sizes and export dates were obtained from a Chilean export company. For each orchard, the relationship between cropload and fruit size or cropload and yield efficiency was assessed by regression analysis. Fruit size distribution was calculated from adjusted fruit size assuming a normal fruit size distribution and valued according to shipment date and price. Using crop load as a covariate, fruit size adjusted for cropload was calculated for each nectarine orchard. Differences in adjusted fruit size and yield efficiency were detected among cultivars. Predicted crop value, normalized in terms of PARI intercepted, was calculated for all the cultivars. Large differences in predicted crop value were found for early, mid-season, and late-ripening nectarines. The early and late ripening cultivars showed the highest predicted crop value, especially at lower crop loads and larger fruit sizes. On the other hand, 'Ross' cling peach showed its highest crop value at a medium crop load with high yield and relatively small fruit size. (Funded by FONDECYT grant 1930695.)

Mechanical Thinning in Cling Peach

Kitren Glozer*, Janine Hasey

¹University of California, Davis, Plant Sciences, Davis, CA, 95616; ²University of California, Cooperative Extension, Yuba City, CA, 95991-5593

Production of extra-early cling peach varieties in California typically results in a \$988 per hectare loss for Sacramento Valley growers, based on a 2004 University of California cost analysis study. This net loss is due to a number of factors, including lower yields than late-harvested peaches; and pruning, thinning, and harvest labor. The estimated cost per hectare to hand-thin extra-early varieties is \$1515, which is 31% of all cultural costs. A conservative estimate for machine thinning with transportation costs would be \$136 per hectare, a cost savings of about 90%. Machine thinning operates at about 200 trees per hour with two persons (operator and supervisor), compared to four to six trees per hour with two hand-thinners. In recent years, equipment to mechanically thin and harvest has become more sophisticated. We evaluated different types of equipment and settings in two experimental orchards trained in two pruning systems in 2005. We compared effects of crop load and variability in fruit development at time of shaking, as well as the timing of shaking with respect to fruit growth after bloom and compared mechanical and hand thinning. We found an optimum "window" for mechanical thinning based on fruit size and crop load, with tree architecture less important than these factors. Machine-thinning with follow-up hand-thinning reduced the thinning time by 30% to 41%. When machine thinning without follow-up hand-thinning was compared to hand-thinning alone, total yield was improved by 22% and salable yield was improved by 18% in the machine-thinned trees. The net increase in undersized yield in the machine-thinned only treatment was less than 6%.

Selective Summer Pruning as a Tool to Develop Compact ‘Sweetheart’ Sweet Cherry Trees on Mazzard Rootstock

Roberto Nunez-Elisea*, Lilia Caldeira

Oregon State University, Mid-Columbia Agricultural Research and Extension Center, Hood River, OR, 97031

We tested two severities and four timings of summer pruning in 2-year-old ‘Sweetheart’ (*P. avium* L.) trees on seedling mazzard (*P. avium* L.) rootstock to evaluate growth and precocity responses. Trees were planted at 3.6 m × 5.6 m (497 trees/ha). Canopies consisted of three to four scaffolds and about 20 current-season shoots. All shoots on summer-pruned trees (n=6) were either headed or tipped on 24 June, 9 July, 26 July, or 9 Aug. 2004. Control trees were trained as steep leaders, with comparative current season shoots left intact. Trees had no bloom in 2004 and negligible bloom or fruiting in 2005. All 2005 shoots were headed in late July, except for controls, where only leaders were headed. By late Fall 2005, controls were 3.4 m tall with a canopy diameter of 3 m, while headed and tipped trees were about 65% and 75% the size of controls, respectively. Growth modules consisting of the original shoot and subsequent growth showed distinct responses to summer pruning treatments. Control shoots did not branch in 2004 and modules had an average of 17 spurs. Headed shoots branched in 2004 (except those headed 9 Aug.) and produced compact modules with a similar amount (24 June) or about 25% fewer (later heading treatments) spurs than controls. Shoots tipped in 24 June or 9 July branched in 2004 and produced modules with about 50% more spurs than controls. Shoots tipped in 26 July or 9 Aug. produced no new growth in 2004 and modules had about 30% the spurs of controls. Selective summer pruning produced compact trees which are expected (based on spur number) to yield at least 15 kg of fruit in 2006 (4th year) and appear suitable for densities of about 750 trees/ha. Yields, fruit quality, and future canopy management will be discussed.

Biomass and Total Nonstructural Carbohydrate Partitioning in Relation to Nursery Digging Date, and Subsequent Growth, Development and Fruiting Pattern of Strawberry Runner Plants Propagated in California High-latitude Nurseries

Daniel S. Kirschbaum¹, Kirk D. Larson², Steven A. Weinbaum³, Theodore M. DeJong³

¹INTA Famaillá, Frutihorticultura, Ruta Prov. 301, Km 32., Famaillá, Tucumán, 4132, Argentina; ²University of California South Coast Research & Extension Center, Plant Sciences, Irvine, CA, 92618; ³University of California, Plant Sciences, Davis, CA, 95616

The pattern of total nonstructural carbohydrate [starch and soluble sugars (TNC)] accumulation in strawberry (*Fragaria × ananassa* Duch.) nursery runner plants, cv. Camarosa, was determined for three growing seasons. A similar study was conducted on ‘Selva’, but for only one year. Growth, development and fruit production patterns of plants transplanted to growth chambers (GC) or fruiting fields were also evaluated. The experiments were carried out on plants propagated in high latitude (41°50’ N) nurseries in California (Siskiyou County). Plants were sampled beginning late summer through early autumn and analyzed for dry mass (DM) and TNC. Plants from different digging dates were established in GC or fruit evaluation plots in Irvine, Calif. (33°39’N). Initial TNC concentration in storage tissues at the time of nursery digging increased steadily from the second week of September to the third week of October. Crown and root TNC concentration and content were correlated positively with the accumulation of chilling units (CU = hours ≤7.2 °C) in the nursery. Root TNC concentration consistently increased from 6% to 10% DM in ‘Camarosa’ (a short-day cultivar), and from ~4% to 14% DM in ‘Selva’ (a day-neutral cultivar) from mid-September to the first week of October. The root TNC content increased ~2.5 times in ‘Camarosa’ and ~3.7 times in

‘Selva’ during the same period. Transplant growth, development, and fruiting pattern were affected by digging date. Root TNC concentration and content were more sensitive to CU accumulation than crown TNC concentration and content. Therefore, root sampling appeared to be more appropriate than crown sampling for assessing the carbohydrate status and optimal digging dates of strawberry nursery runner plants early in the fall.

Application of Hydrated Lime to Hydrogen Cyanamide-treated Grapevines Reduces Lemon Leaf Abscission in Neighboring Lemon Orchards

Anwar G. Ali*, Carol J. Lovatt

University of California, Riverside, Department of Botany and Plant Sciences, Riverside, CA, 92521-0124

Previous research in our laboratory provided evidence that hydrogen cyanamide (HC) applied to grapevines (*Vitis vinifera*) to stimulate budbreak resulted in ethylene production, which, in addition to HC drift at application, caused abscission of leaves in neighboring ‘Eureka’ lemon [*Citrus limon* (L.) Burm. F.] orchards. Foliar-applied hydrated lime [Ca(OH)₂] at 140 kg per 2337 to 2807 L·ha⁻¹ to commercial ‘Thompson Seedless’, ‘Perlette’, ‘Red Flame’, or ‘Princess’ vineyards 2–48 h after HC treatment reduced leaf abscission from 2-year-old ‘Eureka’ lemon trees placed inside the vineyards, with no negative effects on budbreak or yield of any grape cultivar. Hydrated lime is an effective inexpensive tool that grape growers can use to protect neighboring lemon orchards.

Automatic Detection of Fine Roots in Minirhizotron Images

Guang Zeng¹, Stanley Birchfield¹, Christina Wells^{*2}, Desmond Layne²

¹Clemson University, Electrical and Computer Engineering, Clemson, SC, 29634; ²Clemson University, Horticulture, Clemson, SC, 29634

Minirhizotrons and specialized camera equipment have been widely adopted for in situ observation of fine root dynamics in horticultural settings. However, the laborious nature of data collection from minirhizotron images limits the number and size of experiments that can reasonably be analyzed. Here we present an algorithm for the automatic detection and measurement of roots in minirhizotron images, including the discrimination of light-colored roots from bright background objects. First, two-dimensional matched filtering and local entropy thresholding are used to produce binarized images from which roots are detected. Next, a strong root classifier based on geometric and intensity features is used to discriminate roots from unwanted background objects. A labeling algorithm identifies each individual root in the image, and root lengths and diameters are measured using Dijkstra’s algorithm and the Kimura–Kikuchi–Yamasaki method for obtaining the length of a digitized path. This approach allows us to identify and measure fine roots as individuals, rather than simply measuring the aggregate root length in an image. Experimental results from a collection of 250 peach (*Prunus persica*) root images demonstrate the effectiveness of the approach. The algorithm is able to detect and measure a variety of roots of different shapes, sizes, and orientations, with a detection rate of 92%, a false-positive rate of 5%, and an average measurement error of 4.1% and 6.8% for length and diameter, respectively. Current work involves improving the efficiency of the algorithm and incorporating it into an application. We are also exploring algorithms for tracking the location of a root over time as it grows darker in color and blends with the surrounding soil.

Oral Session 23—Organic Horticulture

29 July 2006, 3:30–5:30 p.m.

Oak Alley

Moderator: Matthew Kleinhenz

Liquid Effluent from Poultry Waste Bioremediation as a Nutrient Source for Hydroponic Cucumber Production

Barbara E. Liedl*, Kristen Wilfong, Christina Taylor, Kari Mazzaferro

West Virginia State University, Agricultural and Environmental Research Station, Institute, WV, 25112-1000

Fertilizer costs and increased awareness of point-source pollution are amplifying the pressures on farming, economics along with public demand for sustainable production methods and organically grown produce. Our research focuses on using effluent from thermophilic anaerobic digestion of poultry litter as an alternative fertilizer. Cucumbers (*Cucumis sativus* L.) were grown hydroponically using a bato bucket system to evaluate the effects of liquid effluent as a nutrient solution versus a commercial nutrient solution. Seeds of the beit alpha cultivar 'Manar' were started in Horticultubes and transplanted into buckets containing a perlite/coir media. The effluent fertilizer consisted of effluent diluted to the same ppm nitrogen found in the commercial fertilizer based on ammonium measured in the effluent. Hydroponic solutions were monitored twice a day to maintain a pH of 5.6–6.0. Fruit was harvested three times a week and graded on size and shape. Fruit of each grade were counted, weighed, and recorded. Average fruit weight and fruit number produced was statistically significant between the two fertilizer regimes with the commercial fruit, averaging 84 g compared to 75 g for effluent fruit. The effluent treatment produced a greater percentage of grade 1 fruit (33%) compared to the commercial treatment (26% grade 1 fruit). Thus, 74% of the commercial harvest was grade 2 or cull fruit compared to only 66% of the effluent harvest. Correlating grade with average fruit weight analysis identified statistical differences between treatments for the grade 1 fruit, but not the grade 2 or the culls. While effluent from thermophilic anaerobic digestion shows promise as an alternative hydroponic fertilizer, it is not better than the commercial fertilizer regime.

The Changing Needs with Time for Mineral Nutrition of an Organic Stone Fruit Orchard Under Mediterranean Conditions

Michael Raviv*¹, Ido Aviani¹, Yael Laor²

¹Agricultural Research Organization, Environmental Horticulture, Newe Ya'ar Research Center, Ramat Yishay, 30095, Israel; ²Agricultural Research Organization, Soil and Water, Newe Ya'ar Research Center, Ramat Yishay, 30095, Israel

Fruit growers apply fertilizer at high rates with soil organic matter (SOM) below 2.0%. As organically certified fertilizers are costly, our objective was to compare the effects of two modes of organic nitrogen nutrition to conventional control on plum tree yield and soil properties. The orchard is located on a Vertisol soil, and planted to plums in 1998. The tested treatments were: A) conventional control, receiving an average of 350 kg of N/ha per year; B) fertilization using cattle manure compost (15 tons/ha per year) + feather meal (1 ton/ha per year); and C) a combination of the same amount of compost + 500 kg of feather meal/ha per year + leguminous cover crop (alfalfa, *Medicago sativa* cv. Gilboa). By 2003, the SOM of treatment A remained stable and that of treatments B and C increased by 36% and 91%, respectively. As a result, soil bulk density of treatments B and C declined with no change in A. During the first year, levels of soil nutrients were lower in treatments B and C than those in A, but they became higher after 2 to 3 years. Nitrification capacity of the soils of treatments B and C was higher than that of treatment A. This enabled a drastic reduction of the application rates of organic amendments without resulting a decline in the soil's nutrient content in the organic treatments over the next 3 years, due to continued mineralization of the SOM pool. Various soil

microbial characteristics (microbial counts, total hydrolytic activity, functional richness, and diversity) were determined. In all these parameters the organic treatments showed higher levels than treatment A. Stem circumferences and yields were similar for all treatments. It can be concluded that soil productivity is affected by SOM, so that after achieving a threshold level of SOM, fertilization needs are reduced considerably.

Effect of Ground Floor Management Systems on Root Architecture of Pacific Gala on M.9 NAKB 337 under Organic Protocol

Dario Stefanelli*, Ronald L. Perry

Michigan State University, Horticulture, East Lansing, MI, 48824

One of the main problems facing organic horticulture is orchard ground floor management. Several works report that ground floor management affects root architecture of fruit trees, changing the position and depth of the roots. The purpose of this work is to study the effects of orchard ground floor management systems (GFMS) in an apple orchard under organic protocol in Michigan. The research was conducted at the Clarksville Horticultural Experimental Station of Michigan State University, in the organically certified (by OCIA) orchard of 'Pacific Gala' grafted on M9 NAKB 337, established in May 2000. The GFMS being studied are: 1) mulch (MU) made of alfalfa hay on the tree rows, with a width of 2 m; 2) "Swiss Sandwich System" (SSS) that consists in superficial tillage of two strips 90 cm wide at each side of the tree row, leaving a 40-cm strip in the middle (under the canopy) where volunteer vegetation is allowed to grow; 3) flaming (FL) of the weeds in a 2-m strip underneath the tree canopy by a propane burner. Root architecture was studied in Sept. 2005 through the frequency of roots by the profile wall method. Trenches (3.36-m long × 1.32-m deep) were dug in the soil 45 cm from the tree trunk. Two 158 cm × 130 cm metal grid frames divided by strings into a 28 cm × 22 cm grid were placed against the profile faces to facilitate the counting and mapping of the root distribution. The GFMS did affect the root distribution of the two classes of roots under study (<2 mm and >2mm). In the FL and MU treatments, roots were noticed to be superficial and their frequency was higher close to the tree. In SSS, root frequency was similar until 80 cm deep in the soil profile and they extended farther from the tree.

Nutrition Management in No-till Organic Cling Peaches

Janine Hasey*¹, Roland Meyer², Karen Klonsky³, Pete Livingston³, Anil Shrestha⁴

¹University of California, Cooperative Extension Sutter & Yuba Counties, Yuba City, CA, 95991; ²University of California, L.A.W.R., Davis, CA, 95616; ³University of California, Agriculture & Resource Economics, Davis, CA, 95616; ⁴University of California, UC IPM, Parlier, CA, 93648

Growing tree crops organically is gaining in popularity as growers seek ways to protect the environment and retain economic viability. Five row middle nutritional treatments were established and costs recorded following the 2001 planting of a cling peach [*Prunus persica* (L.) Batsch cv. Klamt] orchard transitioning to organic production. Treatments were: subclover; soft ches + 45 kg·ha⁻¹ N compost; subclover/soft ches; resident vegetation + 45 kg·ha⁻¹ N compost; and resident vegetation + 90 kg·ha⁻¹ N compost. The compost was chicken manure in 2002–03 and yard waste in 2004–05. Compost analysis showed lower nitrogen (N) than expected in 2003, and high moisture content in 2005. The self-reseeding subclover and soft ches remained stable over 4 years. Burclover populations peaked in 2004 in the treatments receiving compost. Subclover treatments showed a trend for higher cover crop dry matter yield and nutrient content. Tree leaf N levels at 2.67% or higher were maintained in the subclover treatment. All compost treatments received sodium nitrate in 2004 and 2005 when leaf analysis showed borderline N deficiency (<2.5%) in several plots. The subclover and the 90 kg·ha⁻¹ N compost treatments had the most rapidly growing trees: 94.4 and 90.0 cm² in 2005 and 116.1 and 114.5 cm² in 2006, respectively. There were no significant differences in yields, fruit size, or firmness in

2004–05; however, more brown rot damage was seen in the treatment receiving the most compost and sodium nitrate. Annualized cost per hectare for row middle nutrition, ranked from lowest to highest, was: subclover/soft chess = \$50; subclover = \$53; resident vegetation + 45 kg N = \$134; soft chess + 45 kg N = \$138; and resident vegetation + 90 kg N = \$204.

Integrative Approaches for Weed Management in Organic Citrus Orchards

Jose Linares*¹, Johannes Scholberg¹, Carlene Chase², Robert McSorley³, James Fergusson²

¹University of Florida, Agronomy, Gainesville, FL, 32601; ²University of Florida, Horticultural Science; ³University of Florida, Entomology and Nematology

Lack of effective weed control may hamper organic citrus establishment. Cover crop/weed biomass (CCW) indices were used to assess the effectiveness of annual and perennial cover crops (CC) in reducing weed growth. The CCW values for perennial peanut (PP) were 0.06, 0.14, 0.4, and 0.5 during 2002, 2003, 2004, and 2005, respectively (very poor to poor weed control). Initial PP growth was slow and repeated mowing was required, but, over time, PP became more effective in controlling weeds. Weed biomass with sunn hemp was 0.3 Mg/ha in 2002 (CCW = 25, outstanding weed control) compared to 1.4 Mg/ha with use of cowpea (CCW = 1) in 2004. In 2004, the dry weights (Mg/ha) for different summer CC were: hairy indigo = 7.6, pigeon pea = 7.6, sunn hemp = 5.3, cowpea = 5.1, alyce clover = 2.9, velvet bean = 1.3, and lablab bean = 0.8. Corresponding 2005 values were: 9.5, 3.7, 12.6, 1.0, 1.9, and 1.4. Respective CCWI values were: 7, 4, 2, 16, 28, 0.6, and 0.3 (2004) vs. 17, 2, 64, 80, 0.5, 2, and 14. In 2004, winter CC production (Mg/ha) was radish (R) = 3.2, crimson clover (CR) = 1.7, oats (O) + lupine = 1.6, and rye (WR)/vetch (V) mix = 1.1. Results for 2005 were: CR + R + WR = 8.0, WR = 6.0; CR + WR = 5.3, CR = 5.0, CR + O + WR = 5.0, R = 4.3, and O = 3.6 Mg/ha. Corresponding values for CCW-indices were 15, 2, 1, and 3 (2004) and 100, 25, 76, 35, 62, 11, and 16 (2005). Although OMRI-approved herbicides showed up to 84% weed injury for selected species, none of these products provided long-term weed control. Combination of repeated tillage, use of compact/reseeding CC mixes in tree rows, more vigorous annual CC and/or perennial PP in row middle and repeated use of organic herbicides near sprinklers and tree trunks are thus required to ensure effective weed suppression in organic citrus.

Living Mulches for Weed Suppression and Enhanced Water Infiltration in Fall Broccoli

Carlene A. Chase*¹, Odemari S. Mbuya², Danielle D. Treadwell¹

¹University of Florida, Horticultural Science, Gainesville, FL, 32611-0690; ²Florida A&M University, Agronomy Program & Center for Water Quality, Tallahassee, FL, 32307-4100

The effect of living mulches (LM) on weed suppression, crop growth and yield, and soil hydraulic conductivity were evaluated in broccoli in North Central Florida at Citra and in North Florida at Live Oak, using organic production methods. 'Florida 401' rye, 'Wrens Abruzzi' rye, black oat, and annual ryegrass, were either mowed or left untreated and compared with weedy and weed-free controls. Cover crop biomass was highest with 'Florida 401' at both locations, intermediate with black oat and 'Wrens Abruzzi', and lowest with ryegrass. The greatest weed infestation occurred with the weedy control. In Citra, ryegrass decreased weed biomass by 21% compared with ~45% by the other LM with no differences due to mowing. However, at Live Oak, mowed LM and the weedy control had similar amounts of weed biomass; whereas unmowed LM had 30% to 40% less weed biomass than the weedy control. At both locations, broccoli heights were greatest with the weed-free control, intermediate with the cover crops, and lowest with the weedy control. Total above-ground broccoli biomass and marketable weight of broccoli at Live Oak, and number of marketable heads at both locations, were unaffected by the LM. At Citra, total broccoli biomass with LM and the weedy control decreased in a similar manner, so that total broccoli biomass was highest with the weed-free control. Ryegrass and the weedy control suppressed marketable broccoli weight by 24%; however, greater

decrease in marketable weight (39% to 43%) occurred with 'Florida 401', 'Wrens Abruzzi', and black oat. At both locations, mowing of LM had no effect on broccoli growth or yield. There was no difference in saturated hydraulic conductivity among treatments.

Vegetable Crop Yield and Quality following Differential Soil Management (Compost Versus No Compost Application) in Transitional- and Certified-organic Systems in Ohio

Matthew Kleinhenz*, Annette Wszelaki, Sonia Walker, Senay Ozgen, David Francis

The Ohio State Univ., Ohio Agricultural Research and Development Center, Horticulture and Crop Science, Wooster, OH, 44691-4096

Successful organic farming requires synchronizing soil-based processes affecting nutrient supply with crop demand, variable among and within crops. We report here on two studies conducted in transitional- (TO) and certified-organic (CO) systems containing subplots that, annually, were either amended with compost or not amended prior to vegetable crop planting. Dairy-manure compost was added at rates providing the portion of a crop's anticipated nitrogen requirement not provided by a leguminous rotation crop and/or carryover from previous compost application. In the TO study, potato (2003), squash (2004), green bean (2005), and tomato (2006) were planted in main-season plots in open fields and high tunnels, and beet, lettuce, radish, spinach, and swiss chard were planted in high tunnels in early spring and late fall. Long-term CO open-field plots (\pm compost) were planted to multiple varieties of lettuce, potato, popcorn, and processing tomato in 2004–2006. Drip irrigation was used in all TO plots and CO lettuce and processing tomato plots. Treatment effects on crop physical and biochemical variables, some related to buyer perceptions of crop quality, were emphasized in each study. Yield in TO, compost-amended plots exceeded yield in unamended plots by 1.3 to 4 times, with the greatest increases observed in high-tunnel-grown mesclun lettuce and the smallest response observed in potato. Similar results were found in CO plots, although compost effects differed by crop and variety. The data suggest that: 1) compost application and the use of specific varieties are needed to maximize yield in organic vegetable systems in temperate zones, regardless of age; and 2) production phase management may influence buyer-oriented aspects of crop quality.

Summer Squash Planting Systems Following a Rye Cover Crop

James W. Shreffler*¹, Warren Roberts¹, Charles Webber², Jonathan Edelson¹, Merritt Taylor¹

¹Oklahoma State University, WWAREC, Lane, OK, 74555; ²USDA-ARS, SCARL, Lane, OK, 74555

Commercial organic vegetable production requires using soil improvement practices and effective weed control measures. Rye (*Secale cereale*) cover crops are known to suppress annual weeds. Research was begun in 2004 to measure crop yield, annual weed infestation, and weed control requirements for vegetable planting systems that begin with a rye cover crop. Poultry litter was used to supply nutrients and was applied based on a soil test and commercial vegetable recommendations. Rye 'Elbon' was seeded 21 Oct. 2004 on beds with 1.8-m centers. Zucchini squash (*Cucurbita pepo*) 'Revenue' was planted the following year using three crop establishment dates, such that transplanting occurred on 6 May, 3 June, and 29 June. Planting system treatments included: conventional tillage (CT), CT and plastic mulch (P), CT with stale seedbed, mow, mow and burn-down, mow and shallow till (ST), ST and burn-down. Following field preparation, squash was transplanted in a single row at the bed center with 0.77-m plant spacing. Drip irrigation was used in all plantings. Emerging weeds were removed by hoeing. Squash was harvested from each planting over approximately 3 weeks and total marketable fruit counts were determined. Marketable yields with P were approximately double those of the CT and ST treatments in the 6 May transplanting. Yields were comparable for CT and ST in the 3 June transplanting, but were significantly lower for the P treatment.

There were no significant differences among the treatments that received tillage in the 29 June planting. However, the non-tilled treatments had significantly lower yields compared to tilled treatments.

Oral Session 24—Environmental Stress Physiology

29 July 2006, 3:30–4:45 p.m.

Southdown

Moderator: Marc W. van Iersel

Within-crown Variation in the Development of Photosynthetic Capacity Is Proportional to Growth Temperature in Temperate Deciduous Trees

William L. Bauerle*¹, Joseph D. Bowden¹, Geoff G. Wang²

¹Clemson University, Horticulture, Clemson, SC, 29634; ²Clemson University, Forest and Natural Resources

This study set out to test the hypothesis that the development in the capacity for the maximal rate of ribulose-1,5-bisphosphate carboxylase/oxygenase (VC_{max}) and the maximum regeneration rate of ribulose-1,5-bisphosphate (J_{max}) per unit mass is proportional to the growth temperature under which the leaf develops and to investigate whether the capacity for photosynthetic acclimation to temperature varies genetically within a species by testing genotypes that originated from diverse thermal environments. *Acer rubrum* L. (red maple) genotypes were subjected to short-term and long-term temperature alteration to investigate the photosynthetic response. We minimized the variation of within-crown light gradients by growing trees in open grown field conditions and controlled temperature on a crown section basis. Thus, we singled out the temperature acclimation effects on the photosynthetic temperature optimum. In response to temperature acclimation, the genotype from the northern United States downregulated both VC_{max} and J_{max} and had a 5 and 3 °C lower temperature optimum than the genotype native to the southern United States. The activation energy increased and was higher for J_{max} than for VC_{max} in both genotypes. With respect to respiration, both genotypes downregulated about 0.5 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$. Although respiration was lower, the increased energy of activation in response to growth temperature resulted in a decrease in maximum net photosynthetic rate (A_{max}) under saturating light and CO_2 . The results illustrate that the photosynthetic capacity adjusted in response to growth temperature but the temperature optimum was different among genotypes.

Assessment of Kentucky Bluegrass Salt Tolerance with Remote Sensing

James A. Poss*¹, Catherine M. Grieve¹, Walter B. Russell¹, Stacy A. Bonos²

¹USDA-ARS-PWA George E. Brown, Jr., Salinity Laboratory, Plant Sciences, Riverside, CA, 92507; ²Rutgers, The State University of New Jersey, Plant Biology and Pathology, Brunswick, NJ, 08901

Six cultivars or selections of Kentucky bluegrass (*Poa pratensis* L.) exposed to salinity stress were evaluated with ground-based remote sensing plant reflectance (R) measurements at wavelengths ranging from 350 nm to 2500 nm. Cultivars Baron, Brilliant, Cabernet, Eagleton, Midnight, and the selection A01-856, a Texas \times Kentucky bluegrass hybrid (*Poa arachnifera* \times *P. pratensis*), were grown outdoors from vegetative clones in a gravelly-sand medium from Apr. to Sept. 2005, in Riverside, Calif., at soil water salinities ranging from 2 to 22 dSm^{-1} . Two Normalized Difference Vegetation Indices (NDVI) were developed based on: 1) canopy reflectance in the visible domain at 695 and 670 nm and 2) an average of eight wavelengths in mid-infrared [$R_{avg} = (R:1500, R:1680, R:1740, R:1940, R:2050, R:2170, R:2290, \text{ and } R:2470 \text{ nm}/8)$] and the reference wavelength (670 nm). Both NDVIs were significantly sensitive to salinity-induced changes in grass canopies and were able to discriminate significantly between the salt-tolerant cultivars ('Baron', 'Brilliant', and 'Eagleton') and salt-sensitive cultivars ('Cabernet', 'Midnight', and A01-856). Another remotely sensed index, based on the derivative of the absorbance (1/R) in the red-edge region between 600 and 800 nm, also generated a similar ranking to the NDVIs and

biomass for the six cultivars. These findings indicate that remote sensing of canopy reflectance may represent an additional tool to evaluate and explain the biophysical or physiological differences among Kentucky bluegrass cultivars related to salt tolerance.

NaCl Stress in Hydroponic Tomatoes Can Be Alleviated by Calcium

Francesco Montesano¹, Marc W. van Iersel*²

¹University of Bari, Dipartimento Di Scienze Delle Produzioni Vegetali, Via Amendola 165, Bari, Italy; ²University of Georgia, Department of Horticulture, Athens, GA, 30602

The availability of good quality irrigation water is decreasing worldwide, and salinity is an increasingly important agricultural problem. To determine whether detrimental effects of NaCl can be minimized by additional Ca^{2+} , tomato (*Lycopersicon esculentum* Mill.) 'Super-sweet 100' was grown hydroponically. The basic nutrient solution contained 11.9 mM NO_3^- and 3.2 mM Ca^{2+} . We added 14.1, 44.4 and 70.4 mM of NaCl to this solution to determine the effect of NaCl and there were treatments with 70 mM NaCl and 10 or 20 mM Ca^{2+} to look at Ca^{2+} effects. We also included three treatments in which all nutrient concentrations were increased (without NaCl) to distinguish between osmotic and ion-specific effects. 70.4 mM NaCl reduced leaf photosynthesis, chlorophyll content, gas phase conductance for CO_2 diffusion, carboxylation efficiency, and dark-adapted quantum yield of photosystem II. The inclusion of 20 mM Ca^{2+} prevented these effects of NaCl. NaCl also decreased leaf size and elongation rate, but this could not be prevented by adding extra Ca^{2+} to the nutrient solution; these were caused by osmotic effects, rather than Na^+ specifically. Likewise, plant dry mass was negatively correlated with solution EC, suggesting an osmotic effect. Our results indicate that leaf area development, which was inhibited by high EC, is more important for dry matter accumulation than leaf photosynthesis, which was inhibited by high Na^+ . Adding 20 mM Ca^{2+} to the 70 mM NaCl solution reduced the Na^+ concentration in the leaf from 79 to 24 $\text{mg}\cdot\text{g}^{-1}$, which may explain why Ca^{2+} alleviates Na^+ toxicity.

Water Stress and Growth of Native and Introduced Shrub Species as Influenced by Irrigation Regime

Sloane M. Scheiber*, Richard C. Beeson, Heather Bass

¹University of Florida, Environmental Horticulture, Apopka, FL, 32703

Native plants are often promoted as an approach for water conservation in urban landscapes. However, information regarding plant water needs is based primarily upon anecdotal observations of plant performance. Direct comparisons between native and introduced species using physiological measures of plant water stress are unavailable to support or refute such recommendations. *Ligustrum japonicum* and *Myrica cerifera*, representing an introduced and native species, respectively, were transplanted into a fine sand soil to evaluate establishment rates and growth characteristics under two irrigation regimes. Each species was irrigated either daily or every 3 days and received 1.3 cm of irrigation per event for 8 months after transplant. Predawn, midday, and dusk water potentials were recorded on three consecutive days monthly, with cumulative stress intervals calculated. Height, growth indices, shoot dry mass, root dry mass and leaf area were also recorded. Water potential was significantly influenced by day of water stress level. On days without irrigation, water stress was generally greater and affected growth. *Myrica* irrigated daily had the greatest growth, yet plants receiving irrigation every 3 days had the least growth and greater leaf drop. In contrast, for *Ligustrum* there were no differences between irrigation regimes in growth responses except for growth index.

Variation in Leaf Anatomical Traits of Pecan Cultivars

Madhulika Sagaram*, Leonardo Lombardini, Larry Grauke

Texas A&M University, Dept. of Horticultural Sciences, College Station, TX, 77843

An assessment of anatomical traits of pecan cultivars ('Pawnee', 'Mohawk', and 'Starking hardy giant') collected from three locations

(Tifton, Ga.; Chetopa, Kans.; and Stillwater, Okla.) was conducted at Texas A&M University. The objective of the study was to provide an understanding of patterns of geographic variation within the natural range for anatomical (stomatal density, stomatal index, and epidermal cell density) traits. Microscopy using acetate casts was used as the means to investigate the patterns of variation in the epidermal characteristics of pecan leaf. 'Starking hardy giant' had the greatest number of stomates/cm² (46,229, 47,807, and 45,990 at Tifton, Chetopa, and Stillwater, respectively) while 'Mohawk' had the least (37,397, 36,217, and 35,305). 'Pawnee' had the greatest number of epidermal cells/cm² (251,806, 250,098 and 254,883 at Tifton, Chetopa, and Stillwater, respectively) while 'Starking hardy giant' had the least (141,699, 138,405, and 142,155). Differences in stomatal index were observed between the three cultivars at Tifton and Stillwater. No differences in stomatal index were observed between 'Pawnee' and 'Mohawk' at Chetopa. The study showed that stomatal density as well as epidermal cell density of all the tested cultivars were significantly different ($P < 0.05$) at a particular location but no differences were observed in a given cultivar grown at different locations.

Oral Session 25—

Produce Quality, Safety, & Health Properties

29 July 2006, 4:45–6:00 p.m.

Southdown

Moderator: G.K. Jayaprakasha

Phenolics and Carotenoids Contribute to Antioxidant Activity in Navel Orange

G.K. Jayaprakasha*, Clark Wilson, Bhimanagouda S. Patil
Texas A&M University, VFC, Department of Horticultural Sciences, College Station, TX, 7784-2119

Consumption of fruits and vegetables has been associated with reduced risk of disease, such as neurodegenerative disorders and certain forms of cancer, and aging. Antioxidants prevent the damage to macromolecules and cells by interfering with the free radicals. Several natural compounds that possess antioxidant activity have been reported from plant sources and are commercially promoted as nutraceuticals. Citrus fruits contain certain bioactive compounds such as phenolics, flavonoids, limonoids, carotenoids, and ascorbic acid. In this context, navel oranges were freeze-dried and extracted with five different solvents, such as hexane, ethyl acetate, acetone, methanol, and 8 methanol : 2 water. The extracts were dried under vacuum and screened for their radical scavenging activity using the 1,1-diphenyl-2-picrylhydrazyl method at 250, 500, and 1000 ppm. The methanol : water and methanol extracts of navel orange were found to be maximum (92.9%) and minimum (63.89%) radical scavenging activity at 1000 ppm. Furthermore, the antioxidant capacity of all extracts was assayed through the phosphomolybdenum method and expressed as equivalent to ascorbic acid ($\mu\text{mol/g}$ of the extract). The order of antioxidant capacity for navel orange extracts was found to be ethyl acetate > acetone > methanol : water > methanol > hexane. It seems that the antioxidant capacity of the extracts is in accordance with the amount of phenolics/lycopene present in each fraction and may provide a good source of antioxidants. This project is based upon work supported by the USDA–CSREES under Agreement USDA IFAFS #2001-52102-02294 and USDA #2005-34402-14401 "Designing Foods for Health" through the Vegetable and Fruit Improvement Center.

A Nuclear Magnetic Resonance Spectroscopy-based Approach to Profile Biologically Active Plant Metabolites Using Black Raspberry Inhibition of Colon Cancer Cell Proliferation as a Model System

Faith J. Wyzgoski¹, A. Raymond Miller*², Joseph C. Scheerens², Peter L. Rinaldi³, Bert L. Bishop⁴, R. Neil Reese⁵, Mustafa Ozgen⁶, Artemio Z. Tulio, Jr.², M. Monica Giusti⁷, Joshua A. Bomser⁸

¹The Ohio State University-Mansfield, Chemistry, Mansfield, OH, 44906; ²The Ohio State University, Horticulture and Crop Science, Wooster, OH, 44691; ³University of Akron, Chemistry, Akron, OH, 44325; ⁴The Ohio State University, Computing and Statistical Services, Wooster, OH, 44691; ⁵South Dakota State University, Biology and Microbiology, Brookings, SD, 57007; ⁶Gaziosmanpasa University, Horticulture, Tasliciflik, Tokat, 60240, Turkey; ⁷The Ohio State University, Food Science and Technology, Columbus, OH, 43210; ⁸The Ohio State University, Human Nutrition, Columbus, OH, 43210

We have developed a Nuclear Magnetic Resonance (NMR)-based approach to metabolomics research that enables the identification of bioactive compounds in crude plant extracts. For this work, we used black raspberries, which are known to contain compounds that exhibit chemopreventive activity toward oral, esophageal, and colon cancers. To ascertain bioactive components and their interrelationships, NMR results for black raspberry samples from four cultivars grown on commercial farms in Ohio were examined using principal component analysis. Multivariate analysis that included anthocyanin content (HPLC), antioxidant activity (DPPH, ABTS, FRAP), total phenolics (Folin-Ciocalteu assay), and bioactivity as measured by inhibition of colon cancer HT-29 cell line proliferation showed correlations with specific regions of NMR spectra at 400 MHz. Correlations were also observed for major and minor groupings of the black raspberry samples. Replicate black raspberry samples were examined with a 750 MHz NMR spectrometer equipped with a cryoprobe that provided a 4- to 5-fold improvement in sensitivity. In this manner, even minor bioactive components in black raspberries could be examined to determine additive and synergistic effects.

Planting Date Effects on Anthocyanin Concentrations in Nine Lettuce (*Lactuca sativa*) Varieties and Relationships among Anthocyanin Levels and Instrumented and Visual Assessments of Color

Aparna Gazula¹, Matthew Kleinhenz*¹, Peter Ling², Joseph Scheerens¹

¹The Ohio State Univ., Ohio Agricultural Research and Development Center, Horticulture and Crop Science, Wooster, OH 44691-4096; ²The Ohio State Univ., Ohio Agricultural Research and Development Center, Food, Agricultural and Biological Engineering, Wooster, OH, 44691-4096

Leaf samples collected from field plots of nine lettuce varieties established in the Early (ES) and Late (LS) Summer of 2002 and 2003 in Celeryville, Ohio, were subjected to spectrophotometric measurement of anthocyanin concentrations and/or color analysis based on colorimeter and spectroradiometer readings and human panelist ratings. Interactions between year (Y), planting date (PD), and variety (V) main effects for anthocyanin concentration were significant due to shifts in response magnitude, but not direction. Anthocyanin levels were higher following LS than ES planting, regardless of Y and V, and PD effects were pronounced in 2002, when differences in average daily temperature between ES and LS plantings tended to be larger. Also, regardless of Y and PD, anthocyanin levels followed the pattern 'Impuls' > 'OOC 1441' > 'Valeria' > 'OOC1426' > 'Lotto' > 'SVR 9634' > 'OOC 1434' > 'OOC 1310' > 'Cireo'. Treatment-based color differences were also evident in colorimeter and spectroradiometer readings. And, panelists differentiated field-grown samples based on red color intensity. Strong correlations between analytical and instrumented and human panelist-based measures suggest that instrumented assessments of red color intensity may serve as reliable proxies for direct measures of anthocyanin levels or human panelist ratings, particularly if the aim is to establish color differences between major experimental groups and assign a quantitative, repeatable value to red color intensity.

Fertilizer Source and High Tunnel Production Environment Affect Antioxidant Levels of Pac Choi

Xin Zhao*¹, Edward E. Carey¹, Takeo Iwamoto²

¹Kansas State University, Horticulture, Forestry, and Recreation Resources, Manhattan, KS, 66506; ²Kansas State University, Biochemistry, Manhattan, KS, 66506

An experiment was conducted at Olathe, Kan., in Spring 2004 to investigate the influence of organic and conventional fertilizer sources and application rates on antioxidant levels of pac choy (*Brassica rapa*

L. cv. Mei Qing) in open fields and poly-covered high-tunnel plots. Organic plots received pre-plant application of composted cattle manure and alfalfa (Hu-More 1-1-1) at 0 kg/ha N, 156 kg/ha N, or 314 kg/ha N, and conventional plots received preplant application of 13N-13P-13K at 0 kg/ha N, 78 kg/ha N, or 156 kg/ha N. Antioxidant levels were measured using the oxygen radical absorbance capacity (ORAC) assay. There were significant effects of fertilizer source and high-tunnel environment on the antioxidant capacity of pac choi. Organic fertilization significantly increased hydrophilic ORAC of pac choi in open field plots, but not in high tunnels. Regardless of the fertilizer source, pac choi grown in the open field had significantly higher hydrophilic ORAC than that grown in tunnels. Lipophilic ORAC was significantly increased by organic fertilization but was not affected by high-tunnel production. Total ORAC (hydrophilic + lipophilic) was significantly higher in pac choi from organic or open-field plots, compared to conventional and high-tunnel plots, respectively. Although fertilizer rate did not show significant impact on antioxidant level of pac choi, hydrophilic and total ORAC seemed to decrease as the fertilizer rate increased, especially under conventional fertilization, while lipophilic ORAC reached the highest level at the medium fertilizer rate. Differences in antioxidant levels were likely associated with the enhanced phytochemical content of pac choi from organically fertilized and open-field plots.

The Response of Basil Accessions to Date of Planting in North Alabama

Cedric A. Sims*, Srinivasa R. Mentreddy
Alabama A&M University, Plant and Soil Science

Basil (*Ocimum* sp.), belonging to the mint family, Lamiaceae (Labiatae), is a popular herb grown for the fresh market or for its dried aromatic leaves, which are used as a spice or in potpourris. In Asian countries, basil, particularly *O. tenuiflorum*, is better known as a medicinal plant species used for treating ailments ranging from colds to complex diseases such as cancers and diabetes. In the United States, however, it has a limited acceptance as a fresh-market herb. There is much potential for developing basil as a medicinal plant to cater to the growing herbal medicinal products industry. A field trial was therefore conducted to determine optimum date of planting basil in Alabama. Six-week-old seedlings were transplanted from the greenhouse into field plots arranged in a split-plot design with four replications. Planting dates at monthly intervals beginning in April were the main plots and three *Ocimum* accessions, Ames 23154, Ames 23155, and PI 288779 were sub-plot treatments. The accessions were compared for growth, leaf area development, light interception, canopy cover, and dry matter accumulation and partitioning pattern over planting dates. Ames 23154, with greater canopy cover (98.5%) and photosynthetically active radiation interception (96.1%), also produced higher total plant biomass than other accessions. Accession PI 288779 appeared to partition greater dry matter to leaves, which are the primary source of bioactive compounds in basil. Among planting dates, second (May) date of planting appeared to be optimum for both total biomass and leaf dry matter production. Genotypic variation for dry-matter partitioning and relationships among agronomic parameters as influenced by planting date will be discussed in this presentation.

Oral Session 26—Genetics & Germplasm 3

30 July 2006, 8:00–9:15 a.m.

Southdown

Moderator: Rose Palumbo

Genetic Variation and Relationships among Frangipani Cultivars

Alan W. Meerow*¹, Richard Criley², Raymond J. Schnell¹

¹USDA-ARS-SHRS, National Germplasm Repository, Miami, FL, 33158; ²Univ. of Hawaii, Dept. of Trop. Plant & Soil Sci., Honolulu, HI, 96822-2279

Plumeria is a small genus of succulent trees and shrubs in the Apocyna-

ceae native to tropical America. It is favored as a landscape ornamental in tropical and tropical regions due to its tolerance of hot, dry conditions, ease of propagation, and long season of bloom. Flowers of certain varieties are important components of leis in Hawaii. Numerous cultivars have been developed, chiefly from either seedling selections of *P. rubra*, a Mexican species, and *P. obtusa*, broadly distributed in the Caribbean basin, or hybrids between these species and among older cultivars. Little is known of the breeding behavior of the species in nature or cultivations, but very few of the cultivars set an abundant number of fruits. We used 21 microsatellite DNA (SSR) loci developed in our lab from *Plumeria rubra* to investigate the genetic relationships of 83 cultivars of *Plumeria* from a germplasm collection at the University of Hawaii, now duplicated in Miami. All 21 loci were highly polymorphic, with three to 15 alleles observed across the cultivar population. Six of the 21 loci exhibit heterozygote excess across the cultivars; the majority of the remaining 15 have an excess of homozygotes, suggesting that the cultivars are largely inbred. Clustering with Bayesian analysis suggests that there are five main groups represented among the cultivars, with varying degrees of admixture among the five. The data also suggest that identical genotypes have received different cultivar names at times. We are also analyzing seedling populations from fruits spontaneously set on several cultivars to determine if they are predominantly the result of self-pollination or out-crossing.

A Phylogeny of *Pelargonium* Based on TRAP Markers

Rose E. Palumbo*¹, Wai-Foong Hong¹, Jinguo Hu², Charles Krause³, James Locke⁴, Richard Craig⁵, David Tay⁶, Guo-Liang Wang¹

¹The Ohio State University, Plant Pathology, Columbus, OH, 43220; ²USDA-ARS Northern Crop Science Laboratory, Sunflower Research Unit; ³USDA-ARS, Application Technology Research Unit; ⁴The University of Toledo, Plant Pathology; ⁵Penn State University, Horticulture; ⁶The Ohio State University, Ornamental Plant Germplasm Center

Pelargonium is one of the priority genera collected by the Ornamental Plant Germplasm Center (OPGC). In order to protect future breeders from a loss of genetic diversity, the OPGC collects heirloom cultivars, breeding lines, and wild species. The current *Pelargonium* collection consists primarily of cultivars originating from *P. ×hortorum* and *P. ×domesticum*. Our project was designed to analyze the current collection in order to facilitate the maintenance of a more-diverse core collection. We have expanded our TRAP (Target Region Amplified Polymorphism) analysis from 120 plants with one primer set to include 780 plants with four primer sets. Each primer set consists of a labeled arbitrary primer paired with a gene-specific primer, and two different fluorescent labels were used to allow multiplexed PCR reactions. We scored about 90 markers in each of the first two primer sets and about 60 markers in each of the second two. In comparisons between the phylogeny and the morphology and taxonomy of these plants, we show some matching clusters that may be explained by the breeding history of the plants.

Techniques to Evaluate Caladium Cultivars for Host Resistance to Fusarium Tuber Rot

Fahrettin Goktepe*¹, Zhanao Deng¹, Brent K. Harbaugh¹, Teresa Seijo², Natalia A. Peres²

¹Gulf Coast Research & Education Center, Horticulture, Wimauma, FL, 33598; ²Gulf Coast Research & Education Center, Dept. of Plant Pathology, Wimauma, FL, 33598

Caladiums, widely used in containers and landscapes as ornamental plants for their bright colorful leaves, are generally forced or grown from tubers. Commercial production of these tubers in central Florida is through dividing “seed” tubers and growing them in fields. Tuber quality is therefore of critical importance to success in container forcing, landscape use, and tuber production. Fusarium tuber rot (*Fusarium solani*) has been recognized as the most-destructive disease that affects caladium tuber quality. There is anecdotal evidence from growers indicating the existence of resistance in commercial caladium cultivars. To identify and confirm the source of fusarium tuber rot resistance in caladium, *F. solani* isolates have been collected from rotting tubers grown under different soil conditions and from different locations. The pathogenicity of these isolates has been tested through artificial inoculation of fresh harvested and/or stored tubers, and a number of highly virulent isolates

have been identified. These isolates have been used to refine inoculation and disease evaluation techniques. Two techniques, spraying a conidial suspension onto fresh cut surfaces and inserting *Fusarium*-infested carnation leaf segments into artificial wounds, have proven to yield consistent resistance/susceptibility ratings among cultivars of known difference in resistance to fusarium tuber rot. Appropriate incubation temperatures and humidity seem to be very critical for disease development and evaluation. The two techniques have been used to evaluate 35 cultivars. Several cultivars, including 'Candidum', showed a high level of resistance to fusarium tuber rot, and may be good breeding parent for developing new resistant cultivars.

Determination of Seed Germination Requirements in *Nolana* sp.

Amy Douglas*, Rosanna Freyre

University of New Hampshire, Plant Biology, Durham, NH, 03824

Nolana is a diverse genus native to coastal deserts of Peru and Chile, with great potential for developing new ornamental cultivars. Low germination has been an obstacle to breeding efforts at the University of New Hampshire (UNH). *Nolana* fruits are comprised of unusual sclerified mericarps, each containing one or more embryos. Germination occurs with opening of funicular plugs on the mericarps. Under normal greenhouse conditions at UNH, germination success in eight *Nolana* species (*N. adansonii*, *N. aticoana*, *N. humifusa*, *N. laxa*, *N. ivaniana*, *N. plicata*, *N. elegans*, and *N. rupicola*) ranged from 0 to 0.05 seedlings/mericarp. We analyzed mericarp morphology, imbibition, and the effect of chemical and environmental germination treatments. SEM showed that soaking treatments create physical changes in mericarp morphology, exposing tracheid tubes in the funicular plugs. Mericarps were soaked in dye to track imbibition, confirming that this occurs through the tracheid tubes, and that additional scarification is not required. The following chemical treatments were unsuccessful in increasing germination: 0.1 N HNO₃, 0.2 KNO₃, conc. H₂SO₄, 10 mM or 1 μM ethephon. Gibberellic acid (1000 ppm) effectively increased germination in some species (up to 0.47 seedlings/mericarp). Mericarps stored dry for 2 years had significantly higher germination than fresh mericarps (0.55 seedlings/mericarp). Mericarps of *N. aticoana* were subjected to after-ripening treatments. Mericarps stored for 7 weeks at 35 °C and 75% RH showed significantly higher germination (0.36 seedlings/mericarp) than mericarps stored dry, or stored moist for 1-6 or 8-12 weeks. Our findings facilitate development of larger hybrid populations, thus increasing the efficiency of *Nolana* breeding programs.

Fritillaria Species Are at Risk of Extinction in Iran: Study on Effective Factors and Necessity of International Attention

Esmail Ebrahimie*¹, Manijeh Mohammadi-Dehcheshmeh², Manoochehr Sardari³

¹University of Tehran, Department of Agronomy and Plant Breeding, Faculty of Agriculture, Zoobe Ahan, Karaj, Tehran, 31587-11167, Iran; ²University of Tehran, Department of Horticulture, Bolvar Emamzade Hasan, Karaj, Tehran, 31587-11167, Iran; ³Research Center, Agriculture and Natural Resources, Farokhshahr Rd., Shahrekord, Chahar Mahal va Bakhtiari, Iran

The fascinating *Fritillaria* genus includes 100 species, of which 14 species are native to Iran. Iran is center of origin and genetic diversity of important species like *F. imperialis* and *F. persica*. Unfortunately, in recent years wild populations of these valuable plants, which have commercial value, are at risk of extinction in Iran. Effective factors on extinction of *F. imperialis* and *F. persica* were investigated in 2 years (2003 and 2004). The important factors were: 1) irregular grazing of *Fritillaria* stands (provenances); 2) in Iran, there is no protecting rule for saving *Fritillaria* from extinction; 3) changing of pastures to dry farms; 4) pest overflows that are related to destruction of pastures; and 5) *Fritillaria* are not commercially cultivated in Iran. Because of poverty, native people eradicate *Fritillaria* with their bulbs and transfer them to florists' shops. Prevention of this tragedy and conservation of *Fritillaria* require international attention. Because of these factors, *Fritillaria* will be removed rapidly from their place of origin.

Oral Session 27—Teaching Methods/Human Issues

30 July 2006, 8:00–9:45 a.m.

Gallier A/B

Moderator: Karen L. Panter

Horticultural Problem-solving Using Interactive Compressed Video

Karen L. Panter*

University of Wyoming, Plant Sciences, Laramie, WY, 82071

Interest in horticulture in Wyoming increases each year. The vast size of the state, coupled with its low population, make travel to individual sites around the state difficult. Distance education and communication are keys to a successful horticulture Extension education program. Every summer since 2000, the University of Wyoming Cooperative Extension Service has sponsored a series of horticulture question and answer sessions. These sessions are carried out using the Wyoming compressed video system, linking campus-based specialists with Extension educators, Master Gardeners, industry, and occasionally the public, around the state. The number of sites linked with campus has varied from six to 11, depending on the year. The number of sessions held each summer has also varied, from the current six to a high of nine in 2000. Each session is 50 minutes long. The objective of these sessions is to allow personnel off-campus to show samples, ask questions, and get assistance from campus-based specialists in diagnosing various plant problems. Evaluations are done annually to determine several things: if the programs should be run again the next year, which days of the week and time of the day are best, if attendees are utilizing the information learned in the sessions, and if they feel more comfortable with their own diagnoses after the sessions. Responses vary with year, but typically 100% say the programs should continue, and greater than 75% use the information they learn and are more comfortable with their responses and their abilities to solve plant problems.

Conversion of Introductory Plant Biology Course and Lab to Web-Based Distance Ed Course

Lucy Bradley*¹, Leslie Towill², Jean Stutz², Robert Roberson³

¹Arizona State University, Plant Biology, Phoenix, AZ, 85003-1150; ²Arizona State University, Plant Biology, Tempe, AZ, 85287-1601; ³Arizona State University, Cellular & Molecular Biosciences, Tempe, AZ, 85287-1601

Conversion of the introductory plant biology course for non-majors from a lecture/lab format to a web-based course was a collaborative project between the Department of Plant Biology and the Instructional Support group at ASU. This course provides an introduction to biology through the world of plants by including lectures and laboratory activities that examine plant systems. The project was undertaken to provide students with an asynchronous opportunity to participate in either the course, the lab, or both. There were three distinct phases of implementation of the multimedia website: Design, Development, and Delivery. The design phase was driven by the faculty, who, along with graduate assistants, developed the course outline and content. They gathered images, identified concepts to be animated, and created storyboards to layout the sequence in the animation. The development stage was driven by the Instructional Designers who selected the appropriate media for animations and worked with developers to create them. The delivery phase was again driven by the professors. They implemented the website as a teaching tool, gathered feedback from students and teaching assistants, and worked with instructional designers and multimedia developers to improve the site. A wide variety of on-line multimedia components were incorporated into the website, including illustrations, images, animations, interactive modules, video and text. Three separate media packages were used: MacroMedia Flash (Macromedia, 2000), Director Shockwave (Macromedia, 2000), and QuickTime (Apple, Inc. 2000). Findings from surveys of students, faculty, and staff identified positive regard for the site as a whole. Several technological and logistical challenges were encountered and addressed.

Virtual Field Trips for Improving Undergraduate Education in Greenhouse Management

Michael R. Evans*¹, Todd J. Cavins², Jeff S. Kuehny³, Richard L. Harkess⁴, Greer R. Lane⁴

¹University of Arkansas, Department of Horticulture, Fayetteville, AR, 72701; ²Oklahoma State University, Department of Horticulture; ³Louisiana State University, Department of Horticulture; ⁴Mississippi State University, Department of Plant and Soil Sciences

Economics and logistics have greatly reduced or eliminated the ability of horticulture instructors to use field trips or on-site visits as educational tools. This is especially problematic in the field of greenhouse management and controlled environment agriculture, since the facilities and technologies used are essential to the discipline. To address this problem, we developed 15 DVD-based virtual field trips (VFT's) that instructors may use to demonstrate to students the most up-to-date facilities, technologies, and management strategies used in greenhouse management (ornamental and food crops) and controlled environment agriculture (GCEA). Each VFT included a preface with background information about the company, a tour organized by subject chapters, self-examination, and a teacher's guide with additional information and case studies. Each land-grant institution with an instructional program in greenhouse management of controlled-environment agriculture will be provided a free copy of each VFT, which will benefit all instructors of GCEA in the United States.

Using Active Learning to Teach Irrigation Concepts in Greenhouse Management

Stephanie Burnett*, Donglin Zhang

University of Maine, Plant, Soil, and Environmental Sciences, Orono, ME, 04469-5722

In the past, horticulture students at the University of Maine have been taught to irrigate plants using only hand irrigation. It is becoming increasingly important to irrigate and fertilize efficiently in commercial greenhouses in order to reduce water waste and nutrient leaching. In 2004 and 2006, greenhouse management or plant production students were exposed to alternate methods of irrigating *Dendranthema × morifolium* (chrysanthemum) in greenhouses to train students more effectively in irrigation techniques. In 2004, students measured the quantity of water applied to chrysanthemums once they reached the permanent wilting point from 26 Sept. until 30 Oct. The irrigation frequency generally increased as crops grew, but, the quantity of water applied upon irrigation was not significantly different. This experience provided students with a tangible idea of how irrigation frequency and timing change as crops grow, which could be applied to irrigation timing decisions in the future. In 2006, students grew a crop of chrysanthemums using alternate methods of irrigation (hand watering vs. drip irrigation) and fertilization. Student surveys in 2006 indicated that only 25% of students with previous experience working in a greenhouse or nursery had grown crops using drip irrigation, but all students with prior experience had irrigated by hand. Expanding student experiences with irrigation in the greenhouse uses active learning to instill students with more knowledge of irrigation and provide them with practical skills for irrigating efficiently and conservatively in the future.

Advanced Teacher Training on Air Pollution Effects on Plants at the Air Quality Learning and Demonstration Center at the Arboretum at Penn State

Dennis Decoteau*¹, Jonathan Ferdinand², Jim Savage¹, Dick Stevenson³, Donald Davis³

¹Penn State University, Horticulture; ²Penn State University, Institutes of the Environment; ³Penn State University, Plant Pathology

Penn State's Air Quality Learning and Demonstration Center was completed and open to the public in 2003. The facility houses the State College air monitors for the Department of Environmental Protection and contains self-guided walkways through gardens of air pollution sensitive plants, innovative techniques for demonstrating the effects of air pollutants on plants, displays of recent research findings, industry-supported displays of pollution abatement technologies, and a teaching

pavilion. One of our outreach projects, funded by the US EPA and the PA Department of Environmental Protections, is to provide enhanced teacher training on air pollution impacts on the regional and specific vegetation through an in-service training for local science school teachers utilizing on-site and archived data on weather conditions and plant injury symptom development. The picture archive began to be developed during Summer 2005 using video cameras that are permanently mounted for the growing season inside the open-top chambers and focused on a plant (and a specific leaf or set of leaves). Once the teachers are trained to utilize these data sets appropriately, they will be able to access the data during the school year through the Learning Center website and conduct the same analysis with their students in their classroom during the school year. This use of archival information is important because the school year does not coincide with optimum times for observing air pollution symptoms on vigorously growing field-grown plants in Pennsylvania (which is best during the summer).

Food and Nutrition Security and Horticulture

Prem Nath*

Dr. P.N. Agricultural Science Foundation (PNASF), Chairman, #9, 1st Cross, 1st Main, 1st Block, Rajmahal Vilas Extension, 2nd Stage, Bangalore, Karnataka, 560094, India

The world produces adequate food for everyone, but unequal distribution has created a gap between the countries that produce more food than they consume and those countries with deficit production. About 815 million people suffer from hunger and malnutrition, mostly in the developing world. By 2020, the developing world is expected to face the overwhelming challenge of a 97.5% increase in population; moreover, developing countries will face serious challenges with the trend of a major shift in population from rural to urban areas, where 52% of the people will live in megacities—all asking for more food, land, and infrastructure. According to the World Health Organization, an estimated 334 million children in developing countries are malnourished. In 2020, one out of every four children in these countries will still be malnourished. It is recognized that modern agriculture must diversify production and achieve sustainable higher output to supplement food security. In order to reduce pressure on cereals as well as to improve human nutrition through the consumption of other nutritious crops, diversification in cropping patterns can provide better options. The increased production and consumption of fruits and vegetables, with their wide adaptation and providers of important nutrients (especially vitamins and minerals), offer promise for the future. Fruits and vegetables as food and diet supplements are gaining momentum in most countries. In addition, recent experimental evidence has shown the growing importance of fruits and vegetables in the prevention of noncommunicable diseases. Further, horticulture would play an important role in urban and peri-urban agriculture and development.

State Partnership Program: Mississippi and Bolivia

Christine E. Coker*¹, William Evans², Michael Collins³, Walter Blankenship⁴

¹Mississippi State Univ., Coastal Research & Extension Center, Biloxi, MS, 39532; ²Mississippi State Univ., Central MS Research & Extension Center, Crystal Springs, MS, 39059; ³Mississippi State Univ., Plant & Soil Science, Mississippi State, MS, 39762; ⁴MS National Guard, State Partnership Program, Joint Force HQ, Jackson, MS, 39202

The National Guard State Partnership Program seeks to link the National Guards of the United States with Ministries of Defense of emerging democratic nations in cooperative activities of mutual benefit. The Program aims to enhance those connections by bringing "Hometown America" onto the international stage through personal, sustained relationships. These associations could build a "Bridge to America," establishing and nurturing bonds of mutual understanding at the grass roots level. The focus of the program has shifted rapidly to the "citizen" aspects of the National Guard, with instruction, orientation, and personnel exchanges in areas such as economic development, small business administration, and entrepreneurship. Mississippi's program partner is Bolivia. Mississippi State University was called upon to participate in the program by providing Subject Matter Experts. Scientists spent seven days in Bolivia working with

the Bolivian military (made up of conscripted soldiers as young as 14 years of age), the Catholic University, and local villages, advising on greenhouse vegetable production and instructing program participants on cultural practices that would benefit their communities.

Oral Session 28—

Ornamentals, Landscape & Turf Management

30 July 2006, 10:30–11:30 a.m.

Oak Alley

Moderator: Jeffrey Norcini

Effect of Provenance on Alkalinity Tolerance of *Baldcypress*

Geoffrey Denny*, Michael A. Arnold, Donita Bryan

Texas A&M University, Horticultural Sciences, College Station, TX, 77843-2133

Seedlings from 15 open-pollinated families of *Taxodium distichum* (L.) Rich. native to the Gulf Coast, central and south Texas, and Mexico, were evaluated for growth and foliar chlorosis development on field sites in Texas with acidic to alkaline soils. Forty seedlings per family were rated for level of chlorosis, height, and trunk diameter after two growing seasons in the field. Families grown on acidic soils did not differ in chlorosis ratings. Families from Mexico and south Texas had the lowest levels of chlorosis in the field, followed by those from central Texas, and then those from the Gulf Coast. Additionally, eight of the families were subjected to a greenhouse screening experiment with four levels of KHCO_3 (0, 4, 8, 12 mM). These were evaluated for height, trunk diameter, shoot and root dry mass, and level of chlorosis and leaf necrosis. Family differences were less apparent during greenhouse screening experiments than in the field. Mexican families were significantly less chlorotic than other families at higher levels of alkalinity in the greenhouse. There was also a trend for height and shoot dry masses of western populations to be less adversely affected by higher alkalinity levels than more eastern populations.

Mid-season Pruning Affects Cold Tolerance of *Abelia* Cultivars in Central Georgia

Matthew Chappell*, Carol Robacker

University of Georgia, Horticulture, Griffin, GA, 30223

While the recommended time to prune abelia is before spring growth initiates, the actual pruning time is often variable and dependent upon labor and plant appearance. As abelia suffers from freeze damage north of zone 8A, pruning may have an impact on the level of freeze damage. Six *Abelia* genotypes were established in replicated field plots in Griffin, Ga., in 1999. On 3–4 July 2003, half the individuals of each genotype were severely pruned (75% of growth removed). Subsequently, 80 uniform-sized stem tips were randomly collected from plants of each genotype–treatment combination once per month from Oct. 2003 through Apr. 2004. Stem sections were exposed to predetermined temperatures ranging from $-3\text{ }^\circ\text{C}$ to $-27\text{ }^\circ\text{C}$ in a temperature bath. The number of stem sections killed in each of two replications out of four possible stem sections was recorded (0 = none dead; 4 = all dead). Data were analyzed with SAS using the Genmod procedure to acquire seasonal results as well as with PROC GLM and means separation to acquire monthly results. Using the Genmod procedure, all genotypes with the exception of ‘Canyon Creek’ were significantly more cold tolerant in unpruned compared to pruned treatments. In this study, Dec. 2003 was the first month with temperatures below freezing at the test site. Proc GLM analysis indicated a significant difference between the pruned and unpruned treatments in Dec. 2003–Feb. 2004. Results of the Proc GLM analysis for the months of Oct. and Nov. 2003 as well as Mar. and Apr. 2004 were nonsignificant ($P < 0.05$) due to an absence of cold acclimation. These results indicate that mid-season pruning of *Abelia* genotypes can significantly reduce cold hardiness and lead to serious stem dieback in pruned plants.

Growth, Flowering, and Survival of *Gaillardia pulchella* Foug. Based on Seed Source and Growing Location

Jeffrey G. Norcini*¹, Helen E. Danielson², Sandra B. Wilson³, Rick Schoellhorn⁴, Deborah L. Miller⁵

¹University of Florida/IFAS, North Florida Research & Education Center, Quincy, FL, 323251; ²University of Florida/IFAS, Department of Environmental Horticulture, Palm Beach Gardens, FL, 33418; ³University of Florida/IFAS, Indian River Research and Education Center, Fort Pierce, FL, 34945; ⁴Proven Winners, Director of New Products, Alachua, FL, 32615; ⁵University of Florida/IFAS, West Florida Research and Education Center, Milton, FL, 32583

Containerized *Gaillardia pulchella* Foug. derived from seed of natural populations in east Texas (ET), northeast Florida (NEF), central west Florida (CWF), central east Florida (CEF), and southeast Florida (SEF) were transplanted in early April to field sites located in northwestern, northern central, and southeastern Florida. During the 22-week study, plants were irrigated only during the first 2 weeks after transplanting to aid establishment. Plant growth was assessed by calculating growth indices (GI, a gauge of plant size based on height and width) at first and second flowering peaks, and by recording shoot dry weight at first flowering peak. Growth index varied among ecotypes and sites but ecotype \times site was nonsignificant. At 22 weeks, NEF and ET had GIs about 18% larger than CEF or SEF. Plants grew more at the two northern sites than in southeastern Florida, which was probably due to the loamy soils at the northern sites. Averaged over the entire study, visual ratings of vigor, flowering, and quality varied by ecotype; ecotype \times site interactions were nonsignificant. All ecotypes except CEF exhibited equally high vigor, flowering, and quality. Plants in southeastern Florida had lower vigor and flowering ratings than those at the two northern sites. Survival varied by ecotype and site, and ecotype \times site was significant. Within a site, survival of NEF, SEF, and ET was equally high (83% to 100%). Also, CWF had 100% survival at the two northern sites, yet no CWF plants survived past week 16 in southeastern Florida. There was no short-term home region advantage to necessitate using local *G. pulchella* ecotypes in residential or commercial landscapes. CEF and CWF performed poorly in southeastern Florida, which was probably related to excessive June rain.

Planting Technique Matters in Reducing Vinca Disease in Landscapes

Yan Chen*¹, Regina Bracy¹, Allen Owings²

¹LSU AgCenter, Hammond Research Station, Hammond, LA, 70403; ²LSU AgCenter, Horticulture, Baton Rouge, LA, 70403

Annual vinca, *Catharanthus roseus*, is exceptionally adaptive to the summer heat and the sandy loam or clay soil in the southeastern region and provides season-long blooms once established in landscape plantings. A wide variety of colors, sizes, and applications are available for landscape use. However, diseases such as alternaria leaf spot and phytophthora leaf blight are prevalent in this region in vinca plantings. Effective disease control requires frequent fungicide application that is expensive and may pose negative effects on the environment. Proper planting techniques including date of planting, fertilization rate at planting, and variety selection may improve plant growth, reduce disease severity, and save landscape service business labor in disease management. Plants of three varieties: open-pollinated ‘Cooler Hot Rose’, F_1 hybrid ‘Titan Rose’, and trailing variety ‘Mediterranean Lilac’ were planted on 1 Apr. or 1 May in landscape plots. Plants were at the same growth stage at the time of planting and were fertilized with Osmocote 14–14–14 (3 months) at 0, 35, 70, or 140 g·m⁻². Plant growth index indicates that plant growth increased significantly at increasing fertilization rates; however, plant overall quality ratings were not significantly different among fertilized plants. Disease incidence in July suggests that late planting may reduce alternaria leaf spot in open-pollinated and hybrid upright type vinca. Disease severity in August was more pronounced on trailing vinca and more severe when plants were not fertilized or fertilized with the highest fertilization rate. Tissue analysis indicates that trailing vinca ‘Mediterranean Lilac’ may require less fertilization than upright type.

Herbicide Drift Study on White Oak Seedlings

Jayesh B. Samtani*, John B. Masiunas, James E. Appleby

University of Illinois at Urbana-Champaign, Natural Resources and Environmental Sciences, Urbana, IL, 61801

In 2004 and 2005, potted white oak seedlings 0.6 m in height were treated with six herbicide treatments at three concentrations, 1/4, 1/10, and 1/100× of the standard field use rate. These herbicides and their standard field use rate of active ingredient (a.i.) included 2,4-D at 1.5 kg/ha, 2,4-D + glyphosate at 0.8 kg/ha + 1 kg/ha, acetochlor + atrazine at 3.5 kg/ha, dicamba at 0.7 kg/ha, glyphosate at 1.1 kg/ha and metolachlor at 2.0 kg/ha. The seedlings were treated at three growth stages: swollen buds, leaves unfolding, and expanded leaves. A compressed air spraying chamber delivering 187 L/ha was used to apply the herbicides. After treatment, the containers were placed in an open field plot in a completely randomized design. Oak seedlings were most susceptible to herbicide injury at all concentrations, at the leaves unfolding stage. Symptoms on seedlings treated with 2,4-D and dicamba at the leaves unfolding stage included leaf cupping and rolling, leaf curling, leaf rolling downward from leaf margin, and unusual elongation at leaf tip. Glyphosate + 2,4-D applications resulted in leaf cupping, yellowing, leaf rolling downward from leaf margin and abnormal leaf tips. Glyphosate symptoms ranged from leaf yellowing and browning, to slight browning of interveinal leaf tissues. Acetochlor + atrazine, or metolachlor alone caused the abnormality referred to as “leaf tatters” where in severe cases, only the main veins are present with limited amounts of interveinal tissues. Detailed description of the injury symptoms, supplemented with photographs are posted on a web site: http://www.nres.uiuc.edu/research/herbicide_research/index.htm

Oral Session 29—

Vegetable Crops Culture & Management 2

30 July 2006, 10:30–11:45 a.m.

Southdown

Moderator: Elizabeth Maynard

Stoller's Root Feed Applied to Drip-irrigated Cantaloupes Enhances Productivity and Pest Tolerance

Albert Liptay*, Jerry H. Stoller, Ron Salzman

Stoller Enterprises Inc., Research & Development, Houston, TX, 77043

Root Feed is a product developed by Stoller Enterprises, Inc., to enhance crop productivity and quality. Weekly application of Root Feed in drip-irrigated crops was found to be the most effective frequency of application. Root Feed increased the number of the largest melons and total melons by over 50% and also increased fruit °Brix (soluble solids). Moreover, it was observed that a number of pests were suppressed with Root Feed, namely, whiteflies, a cucurbit virus, and downy mildew.

Drip Irrigation Effect on Yield and Fruit Size of Jack-o-lantern Pumpkins

Elizabeth T. Maynard*

Purdue University, Horticulture and Landscape Architecture, Westville, IN, 46391

Benefits of drip irrigation for jack-o-lantern pumpkins (*Cucurbita pepo*) in the midwestern United States are not documented. Field trials were conducted on a sandy loam soil to compare yield and fruit size of unirrigated pumpkins (NONE) with pumpkins irrigated when in-row soil water tension (SWT) 30 cm deep reached 20 kPa (HIGH) or 60 kPa (MED). The 2004 trial included two planting methods, direct seed (SD) and transplant, and two cultivars, ‘Gold Medal’ (GM) and ‘Magic Lantern’ (ML). GM typically has larger and more vigorous vines than ML. In 2005 the trial included only SD ML. Rainfall June

through August totaled 38.4 cm in 2004 and 28.2 cm in 2005. In 2004 HIGH increased yield 13% compared to NONE (42.1 vs. 37.2 t·ha⁻¹). MED (39.0 t·ha⁻¹) did not differ from NONE. Neither planting method nor cultivar influenced the yield response to irrigation. The effect of irrigation on average weight per pumpkin depended on cultivar. In 2004, ML with HIGH averaged 7.76 kg per pumpkin, 16% heavier than NONE at 6.67 kg. MED averaged 7.17 kg. Irrigation did not affect average weight of GM: HIGH, MED and NONE averaged 12.6, 12.8 and 12.3 kg, respectively. For SD ML, combined analysis of 2004 and 2005 data showed an 18% increase in average pumpkin weight for HIGH vs. NONE (7.94 vs. 6.72 kg), but no significant effect of irrigation on yield (33.6, 29.8 and 28.4 t·ha⁻¹ for HIGH, MED and NONE, respectively). Irrigation did not affect the number of pumpkins produced per hectare for either cultivar in either year. Results suggest that compared to no irrigation, maintaining SWT less than 20 kPa with drip irrigation may lead to 1) yield increase on the order of 10% or less, 2) 16% to 18% increase in average pumpkin weight for ML.

Can Sunn Hemp Decrease Nitrogen Fertilizer Requirements of Vegetable Crops in the Southeastern United States?

Laura Avila*¹, Johannes Scholberg², Nancy Roe³, Corey Cherr¹

¹University of Florida, School of Natural Resources and Environment; ²University of Florida, Agronomy; ³Farming System Research, Research

Increased dependency of conventional agriculture on inorganic fertilizers and fossil fuels may hamper long-term sustainability of agricultural production. Sunn hemp (*Crotalaria juncea*) was tested during summer in a Community Supported Agriculture vegetable crop operation located in Southeast Florida, from 2003 to 2005. Farm system components included sunn hemp (SH) vs. a conventional fallow during summer, tomato (*Lycopersicon esculentus*) and pepper (*Capsicum annuum*) during winter and spring sweet corn (*Zea mays*). Tomato and pepper were fertilized with 0, 67, 133, 200 kg N/ha (2003) vs. 0, 100, 200 kg N/ha (2004/05). Sweet corn received 133 or 200 kg N/ha (2003) vs. 100 kg N/ha (2004/05). Average SH biomass was 3.7 Mg/ha. In 2003 tomato yields following SH without supplemental N were similar to fallow, with 200 kg N/ha. By the third year, tomato and pepper yields in SH plots were 25% and 26% higher, respectively. Conventional pepper amended with 200 kg N/ha had only 8% higher yields than treatments amended with 100 kg N/ha and CC. Overall, sweet corn had low yields, but yields increased if the preceding tomato/pepper crop received higher N rates. In 2003, sweet corn fertilized with 200 kg N/ha following a SH-fall vegetable crop produced 17% higher marketable yields compared to the fallow treatment. During 2004 and 2005, sweet corn within the SH-non-fertilized tomato system produced 29% higher yields compared to a similar conventional system. Results show that, in this rotation, both fall vegetable crops and sweet corn yield benefit from residual N fertilizer. Mineralization of SH may thus not only benefit the immediately following crop, but its effects can be seen later during the year.

Root Zone Temperature as Modified by Plastic Mulches Affect the Appearance of First Systemic Symptoms of Tomato Spotted Wilt and Fruit Yield in Tomato

Juan C. Diaz-Perez*¹, Ron Gitaitis², Bikash Mandal²

¹University of Georgia, Horticulture, Tifton, GA, 31793; ²University of Georgia, Plant Pathology, Tifton, GA, 31793

Tomato spotted wilt (TSW) is a serious constraint to tomato production in various regions of the world. The effect of TSW on tomato yield is largely influenced by time of infection. Early infection usually results in severe stunting of the seedling and even death of the plant. Plastic mulches have been found to affect both the incidence of TSW, and plant growth and yield of tomato. The objective of this study was to determine the effect of root zone temperature (RZT) as affected

by plastic mulch on the timing of appearance of first TSW symptoms, vegetative top fresh weight (FW) and fruit FW in tomato. Under natural TSW infection as well as in artificially inoculated plants, vegetative top FW and fruit FW were both linearly related with number of days after transplanting (DAT) the plants were free from TSW symptoms. The plants grown on black mulch during the fall showed earlier appearance of TSW symptoms, and had significantly reduced vegetative growth and fruit yields. The mean RZT during the first 42 DAT—the time before the plants reached full canopy closure—significantly affected the timing of first appearance of TSW symptoms, tomato plant growth and fruit yield. Vegetative top FW (optimal RZT = 24.1 °C) and fruit FW (26.9 °C) fitted the quadratic relationships with the mean RZT during the first 42 DAT. In conclusion, utilization of plastic mulches that created conditions of RZT stress, particularly heat stress, resulted in reduced plant growth and yield and may predispose the plants to earlier expression of TSW symptoms compared to plants grown under RZTs more favorable to tomato plant growth.

Are Optical Tools Suitable to Manage Phosphate and Potassium Fertigation in Tomato Crops?

Paolo Sambo, Giorgio Gianquinto, Valente Forte*

University of Padova, Agronomy and Crop Science, Via dell'Università, 16, Legnaro, Padova, 35020, Italy

Several experiments on multispectral radiometer showed its suitability in driving nitrogen fertigation in tomato crop. Nir-Green light ratio describes crop nitrogen status well, highlighting element deficiency or excess, which is a great help to farmers in choosing timing and intensity of fertilizer application. The scientific literature reports several studies about nitrogen management only, but not phosphorus and potassium. Because of the advantage obtained with N, it would be desirable to also adapt it to phosphorus and potassium management. For this purpose, a preliminary trial was carried out on the tomato cultivar Brigade grown in pots in a greenhouse. Four nutrient solution were supplied. Three were lacking in N, P, or K—the last had all elements needed for a balanced growth. Radiometer readings were taken once a week during the crop cycle, around noon. First results were encouraging. After some data elaboration, it appeared evident that, in some cases, it was possible to set the fertigation treatments apart by only having a look at the single wavelengths measured by the instrument. Through the Nir/green index, used in N management, phosphorus deficiency was identified as well. Potassium trend line was completely different from those of nitrogen and phosphorus, and very similar to that of the control. The utilization of the radiometer in handling potassium fertigation in tomato appeared somewhat difficult. Its application might be desirable, instead, for phosphorus fertigation in addition to nitrogen. The 560 and 710 nm wavelengths might be the especially more useful for this purpose, although a simple index or a combination of some simple indices able to identify phosphorus deficiency/excess and to screen them from those induced by nitrogen are needed.

Oral Session 30—Plant Biotechnology 2

30 July 2006, 10:30 a.m.–12:00 p.m. Grand Couteau

Moderator: Robert Griesbach

Molecular Evidence for an Asian Origin and a Unique Westward Migration of Species in the Genus *Castanea* via Europe to North America

Ping Lang¹, Fenny Dane*¹, Thomas L. Kubisiak², Hongwen Huang³

¹Auburn University, Horticulture, Auburn, AL, 36849; ²USDA-Forest Service, Southern Institute of Forest Genetics, Saucier, MS; ³Wuhan Institute, Botany, Wuhan City, Hubei, P.R. China

The genus *Castanea* (Fagaceae), which contains three sections and

seven species, is widely distributed in the deciduous forests of the Northern Hemisphere. The phylogeny of *Castanea* was estimated using DNA sequence data from five different regions of the chloroplast genome. Sequencing results support the genus *Castanea* as a paraphyletic group with *C. crenata*, the Japanese chestnut, representing an early divergence in the genus. The three Chinese species form a strongly supported sister clade to the North American and European clade. A unique westward expansion of extant *Castanea* species is hypothesized with *Castanea* originating in eastern Asia, an initial diversification within Asia during the Eocene, followed by intercontinental dispersion and divergence between the Chinese and European/North American species during the Oligocene and a split between the European and North American species in the early Miocene. The differentiation within North America and China might have occurred in late Miocene or early Pliocene. The North America species are supported as a clade with *C. pumila* var. *ozarkensis*, the Ozark chinkapin, as the basal lineage, sister to the group comprising *C. pumila* var. *pumila*, the Allegheny chinkapin, and *C. dentata*, the American chestnut. Morphological evolution of one nut per bur in the genus may have occurred independently on two continents.

Recent Developments in Primer Design for DNA Markers in Higher Plants

Xiaohan Yang¹, Brian E. Scheffler², Leslie A. Weston*³

¹University of Tennessee, Plant Sciences, Knoxville, TN, 37996; ²USDA-ARS-CGRU, MSA Genomics Laboratory, Stoneville, MS, 38776; ³Cornell University, Horticulture, Ithaca, NY, 14853

Primer design is a critical step in the application of PCR-based technologies in genetic diversity analysis of horticultural plants. As more plant genomes have been sequenced in recent years, the emphasis of primer design strategy has shifted to genome-wide and high-throughput direction. This poster summarizes recent advances in primer design for profiling of DNA polymorphism in higher plants, including new primers for the classical plant DNA marker system such as simple sequence repeat (SSR) and single-nucleotide polymorphism (SNPs), as well as newly developed DNA marker systems such as sequence-related amplified polymorphism (SRAP), sequence-specific amplification polymorphism (SSAP), target region amplification polymorphism (TRAP), and universal rice primer (URP). Although most of these primers were designed for agronomical crops, they could be applied to horticultural plants because plant genomes are evolutionarily related. Also, these new primer design strategies could help horticultural researchers develop better primers specifically for profiling of polymorphism in a variety of horticultural crops, invasive weeds, or medicinal plants. We will present examples of their utilization in these diverse systems.

Construction of Antisense ACC Oxidase Gene of *Lilium* and its Genetic Transformation

Yali Liu*, Fuling Hao, Rui Meng, Weirong Xu

Key Laboratory of Northwest Horticulture Plant Germplasm and Genetic Improvement of Ministry of Agriculture, Northwest A&F University, College of Horticulture, Yangling, Shaanxi, 712100, P.R. China

The enzyme ACC oxidase (ACO), encoded by a small multigene family in many plants, catalyzes the terminal step in the ethylene biosynthesis pathway. In this research, based on the total RNA isolated from the flowers of Asia hybrids 'Pollyanna' and Oriental hybrids 'Sorbonne', we obtained two cDNA fragments of ACO genes (Genbank accession DQ062133 and DQ062134) by RT-PCR technique. The two cDNA fragments were reversely inserted into plant expression vector pWR306 respectively, and constructed two antisense ACO gene expression binary vectors harboring hygromycin phosphotransferase (hptII), glucuronidase (uid A), and a green fluorescent protein (GFP) gene in the T-DNA region. We have developed a system to produce transgenic plants in *Lilium* via *Agrobacterium tumefaciens*-mediated transformation of calli. Transformants were subjected to GFP expression analysis, PCR assay, and Southern hybridization to confirm gene integration.

Duplication of the Phytoene Synthase Gene in the Carotenoid Biosynthetic Pathway of Watermelon

Haejeen Bang^{*1}, Sunggil Kim¹, Daniel I. Leskovar², Angela Davis³, Stephen R. King¹

¹Texas A&M University, Vegetable and Fruit Improvement Center, Horticultural Sciences, College Station, TX, 77843; ²Texas A&M University, Horticultural Sciences, Texas Agricultural Experiment Station, Uvalde, TX, 78801; ³USDA-ARS, SCARL, Lane, OK, 74555

Gene identification and characterization can be utilized for the identification of respective functions and their relationship to flesh color inheritance. Phytoene synthase (PSY), which converts two molecules of GGPP into phytoene, is the first committed step of the pathway. Previous phylogenetic analysis of PSY has indicated that PSY duplication is common in Poaceae, but rare in dicots. Degenerate PCR and RACE were used for PSY cloning. Three members of PSY gene family (PSY-A, PSY-B and PSY-C) were identified. PSY-A shared higher identity with PSY-C than PSY-B. PSY-C shared 96% identity with melon PSY. PSY-C also showed a high homology with tomato PSY1, even higher than PSY-A and PSY-B. It showed a similar gene expression pattern, so we propose that PSY-C is a homologue to PSY1. RT-PCR analysis indicated that PSY-B has a different transcriptional behavior from PSY-A, similar to tomato PSY2. Therefore, PSY genes appear to be under different regulatory mechanisms. Deduced protein sequence of PSY1 or PSY2 between species has higher homology than between PSY1 and PSY2 within species. Phylogenetic analysis indicated that watermelon PSY gene family is very distantly related. Watermelon and carrot PSY gene families did not appear to cluster as closely as in Poaceae or tomato. This indicates that watermelon and carrot PSY genes are not conserved as much as PSY in tomato or Poaceae. There was no particular pattern in phylogenetic relationship of dicots. Poaceae PSY genes showed a clustering into a PSY1 group and PSY2 group. PSY duplication in watermelon provides additional evidence that PSY duplication may be a common phenomenon in dicots. They are likely to be duplicated evolutionarily a long time ago, possibly even prior to the evolution of monocot and dicot divergence.

Gene Expression Affecting Spider Mite Herbivory: A Comparison of Sulfur-dusted and Nondusted Grapevines

Danielle Poor^{*}

CalPoly, Horticulture and Crop Science, San Luis Obispo, CA, 93407

Sulfur application is a common practice in viticulture fungus control. This application has been suspected to increase grape susceptibility to spider mites. We hypothesize that sulfur may initiate a pathway that increases spider mite infection. RNA was isolated from grape leaves with various sulfur applications. Evaluation of genes being expressed will allow us to determine if sulfur application is regulating grape leaf defense mechanisms.

Genetics of the Star Mutation in *Petunia ×hybrida*

Robert Griesbach^{*}, Ron Beck

USDA, ARS, BARC-W, U.S. National Arboretum, Beltsville, MD, 20705-2350

Differences in structural gene expression are responsible for a wide range of responses from human cancer to patterned flowers. Gene silencing is one of the ways in which gene expression is controlled. We have developed a model system to study gene silencing using a gene silencing mutation in *Petunia ×hybrida* (Star mutation) and the ability of certain viruses to reverse the silencing mutation. This model system was used to characterize how the Star flower color pattern was controlled.

Oral Session 31 —

Citrus Crops Physiology/ Production

30 July 2006, 2:00—3:15 p.m.

Southdown

Moderator: Kuo Tan Li

The Effects of Girdling on Root Respiration, Carbohydrate Concentration, and NaCl Uptake in Citrus Trees

Eran Raveh^{*}

Institute of Plant Science, Horticulture, D.N. Negev, Gilat Research Center, 85280, Israel

Carbohydrates are the energy source for most root activities, including membrane maintenance and osmotic adjustment. Yet, the relationship between root carbohydrate status and selective sodium chloride uptake remains unknown. The following study examined the effects of root carbohydrate starvation due to girdling on sodium and chloride uptake in mature citrus trees. Trees were girdled during the spring or during the autumn, when girdling is known to have more dramatic effects. In spring-girdled trees, 4 days after girdling, root total carbohydrate and starch decreased by 25% and 30%, respectively. The decrease in root carbohydrates was followed by a 20% reduction in root respiration rate. Based on root mineral analysis, spring-girdled trees were characterized by having 42% more sodium and 30% more chloride. The effects of girdling on shoot xylem sap mineral concentration were similar to trends in root mineral status; xylem sap from spring-girdled trees had 43% more sodium and 22% more chloride. Leaf chloride concentration measured 6 months after girdling was 74% higher in girdled trees and reached toxicity levels (0.65% vs. 0.37% dry mass, for girdled and nongirdled trees, respectively). The differences in leaf sodium, however, were nonsignificant (0.14% vs. 0.13% dry mass, for girdled and nongirdled trees, respectively). In autumn-girdled trees, the effects on leaf sodium and chloride concentration were more dramatic. Leaves from autumn-girdled trees (sampled 10 months later) had about two times more sodium and about five times more chloride in comparison to nongirdled trees (0.39 % vs. 0.20% dry mass sodium and 1.02% vs. 0.22% dry mass chloride, respectively). The above results link root carbohydrate status and selective sodium or chloride uptake in citrus trees.

Fine Root Growth in Late-season ‘Valencia’ Sweet Orange Trees Harvested by Trunk Shaker

Kuo-Tan Li^{*}, Jim Syvertsen, Jackie Burns

University of Florida, IFAS, Citrus Research and Education Center, Lake Alfred, FL, 33850

Mechanical harvesting using trunk shakers on late-season ‘Valencia’ sweet orange [*Citrus sinensis* (L.) Osb.] trees can remove young fruit for the next crop and occasionally cause root exposure or severe bark scuffing on the trunk. To evaluate the effects of these physical injuries on fine root growth and lifespan, we installed minirhizotrons in the root zone of 15-year-old fruiting ‘Valencia’ trees on Swingle citrumelo [*C. paradise* Macf. × *Poncirus trifoliata* (L.) Raf.] rootstocks. Images of roots against the minirhizotron tubes were captured biweekly with a custom-made video-DVD recorder system. Trees were harvested in early June by hand or with a linear-type trunk shaker in two consecutive years. Bark injury after trunk shaking was mimicked by removing part (42%) of the bark tissue from the main trunk with a sharp knife. Numbers of fine roots, root activity and lifespan as indexed by the color of the root, and the distribution of new fine roots after harvest were analyzed. Although root exposure was common with the normal operations during mechanical harvesting, few disturbances reached the major fine root zone. There was no clear correlation between root growth and trunk shaking with or without bark injury. The root system might benefit from less competition after the loss of young fruit from mechanical harvesting, as a greater availability of carbohydrates or other resources may compensate for any potential damage due to mechanical harvesting.

Effects of 5-chloro-3-methyl-4-nitro-1H-pyrazole and Ethephon on Citrus Leaf Function and Water Relations

Kuo-Tan Li*, Jackie Burns, Luis Pozo, Jim Syvertsen

University of Florida, IFAS, Citrus Research and Education Center, Lake Alfred, FL, 33850

To determine the effects of abscission compounds 5-chloro-3-methyl-4-nitro-1H-pyrazole (CMNP) and ethephon on citrus leaf function and water relations, we applied CMNP at 0, 200, 500, 1000, or 2000 ppm, or ethephon at 400 or 800 ppm, to canopies of fruiting potted and field citrus trees during the harvest season. Both compounds induced fruit and leaf drop after 3 days of application, especially at high concentrations. Low concentrations of CMNP (0, 200, or 500 ppm) or either ethephon treatments did not affect leaf photosystem II efficiency, as indicated by leaf chlorophyll fluorescence (F_v/F_m). High concentrations of CMNP (1000 or 2000 ppm) immediately reduced photosystem II efficiency in leaves and fruit peel. However, F_v/F_m of leaves remaining on the trees was gradually restored and close to the level of control after 4 days of treatment. Both compounds had little effect on chlorophyll content, ratio of chlorophyll a to chlorophyll b, leaf water content, and mid-day leaf water potential. The results suggest that CMNP at recommended concentrations (200 to 500 ppm) effectively reduced fruit attachment force with little herbicidal effect on leaves.

Yield of Citrus Trees with Foliar Urea as the Only N Source

L. Gene Albrigo*, James P. Syvertsen

University of Florida, Citrus Research and Education Center, Lake Alfred, FL, 33850

In order to evaluate possible reduced nitrate leaching while maintaining yield, 'Hamlin' orange and 'Flame' grapefruit trees on 'Carrizo' or 'Swingle Citrumelo' rootstocks were grown from planting using only foliar urea or soil-applied nitrate or ammonium N. An intermediate treatment of foliar and ground N was included also. From the 4th year, yields were recorded for 3 years. As previously reported, canopy growth was greater for the foliar urea treatment for the first 3 years. For 2 of the next 3 bearing years, the grapefruit trees in the foliar urea N treatment produced significantly less yield than the soil-applied treatment and the intermediate treatment was intermediate. The orange trees in the foliar urea treatment produced significantly less fruit than the soil N treatment in only 1 of 3 years, but the yields were numerically less every year. Results for fruit quality and nitrate leaching will be reported also. Foliar urea application alone was more costly and less productive than a soil N program.

Citrus Bioactive Limonoid Extraction using Environment-friendly Hydrotrophy

Deepak Dandekar*, G.K. Jayaprakasha, Bhimanagouda Patil

Texas A&M University, Vegetable & Fruit Improvement Center, Department of Horticultural Sciences, College Station, TX, 77843

Citrus consumption has been shown to promote human health due to presence of several bioactive compounds. In the process of understanding the health benefits of citrus, we need to isolate and characterize these compounds. Limonoids are one of such prominent, but lesser-known phytonutrients that have been shown to prevent cancers of the mouth, skin, lung, breast, and colon. With the growing interest in the health-promoting properties of citrus limonoids, the demand for these bioactives has significantly increased. It has been critical to explore environment-friendly extraction methods rather than using hazardous organic solvents. A water-based hydrotropic extraction of limonoid aglycones from sour orange (*Citrus aurantium* L.) seeds was developed. Two hydrotropes, sodium salicylate (Na-Sal) and sodium cumene sulfonate (Na-CuS), were studied for extraction efficiency using the Box Behnken experiment design method. The extraction efficiency of prominent aglycone limonin was observed depending on hydrotrope concentration, extraction temperature, and percentage of raw material loading. Response Surface Analysis (RSA) of data predicted the optimum conditions for maximum

yield. Recovery of aglycones from filtered extract is also easily achieved by mere dilution using water at pH 3 or 7 or by partitioning the extract with dichloromethane. At optimum conditions, limonin yield of 0.46 mg/g seeds in the case of Na-Sal extraction and 0.65 mg/g seeds in the case of Na-CuS extraction was achieved. The results demonstrated that the hydrotropic extraction process of limonoid aglycones has practical commercial importance. This project is based upon work supported by the USDA-CSREES IFAFS #2001 52102 02294 and USDA-CSREES #2005-34402-14401 "Designing Foods for Health" through the Vegetable and Fruit Improvement Center.

Oral Session 32—Ornamental/Landscape/Turf/Plant Breeding/Management

30 July 2006, 2:00–3:15 p.m.

Oak Alley

Moderator: Timothy Rinehart

Intergeneric Hybrids between *Weigela* and *Diervilla* (Caprifoliaceae)

Darren Touchell, Zenaïda Viloria, Thomas Ranney*

North Carolina State University, Horticultural Science, Mt. Hort. Crops Res. and Ext. Ctr., Fletcher, NC

Weigela Thunb. consists of 12 species distributed throughout Northeast Asia. *Diervilla* Mill. is a closely related genus containing three species endemic to North America. Taxa from both of these genera are important nursery crops. Hybrids between these genera could potentially combine the excellent cold hardiness and adaptability of *Diervilla* with diverse forms, foliage colors, and flower colors found in *Weigela*. Prior attempts to create intergeneric hybrids between these genera were unsuccessful and resulted in embryo abortion before seeds matured. To overcome this barrier, ovule culture and micropropagation procedures were used to develop intergeneric hybrids. Cleaved amplified polymorphic sequences (CAPS) analysis was used to verify hybrids. Intergeneric crosses, *D. lonicera* × *W. middendorffiana*, *D. sessilifolia* × *W. florida* (two clones), and *D. lonicera* × *W. florida* were attempted. Crosses of *D. lonicera* × *W. middendorffiana* did not produce viable hybrids. From the remaining three crosses, a total of 544 plants were obtained from 1278 ovules. About 85% of the 544 plants appeared very chlorotic or had low vigor, and senesced when transferred to multiplication medium. Only 80 of the 544 plants were successfully maintained in tissue culture, of which 10 have been successfully transferred *ex vitro*. CAPS analysis indicated that a majority of these plants were hybrids. Further studies are focused on improving tissue culture procedures and other methods to develop tetraploids to increase plantlet vigor and fertility.

Using SSR Markers to Verify Crapemyrtle Hybrids

Tim Rinehart*¹, Cecil Pounders¹, Brian Scheffler²

¹USDA-ARS, Southern Horticultural Laboratory, Poplarville, MS, 39470; ²USDA-ARS, MSA Genomics Laboratory, JWDSRC, Stoneville, MS, 38776

Crapemyrtles (*Lagerstroemia*) are deciduous shrubs or trees with prolific summer flowers. Their popularity is due in large part to low maintenance requirements in sunny climates, wide range of growth habits, disease resistance, and bark characteristics, as well as having a long flowering period (up to 120 days). Once well-established, they are extremely tolerant to heat and drought. *Lagerstroemia* was first introduced to the southern U.S. from southeast Asia more than 150 years ago, and is comprised of at least 80 known species. Most modern cultivars are *L. indica* and *L. fauriei* hybrids. *L. speciosa* is a tropical crapemyrtle with very large flowers, but lacks cold hardiness. It is a vigorous plant, but only when grown in Hardiness zones 9 or 10. We recently established microsatellite markers for *Lagerstroemia* and evaluated their utility for verifying interspecific hybrids. Here we verify F₁ hybrids between *L. indica* 'Tonto', 'Red River', and *L. speciosa*. We also genotyped two commercially available *L. speciosa* hybrids. Currently, we are using crapemyrtle SSRs for cultivar identification and germplasm conservation. Future research includes marker-assisted breeding to produce powdery

mildew and flea beetle resistant cultivars, as well as improved growth habit and fall foliage color.

Determining Water Use and Crop Coefficients in Five Woody Ornamental Plants

Genhua Niu^{*1}, Denise S. Rodriguez¹, Raul I. Cabrera², Cynthia McKenney², Wayne Mackay²

¹Texas A&M University, AREC-El Paso, Department of Horticultural Sciences, El Paso, Texas, 79927; ²Texas A&M University, AREC-Dallas, Department of Horticultural Sciences, Dallas, Texas, 75252

Relatively little work has been done to determine the water requirements of ornamental plants. To meet this need, five woody ornamental species including *Abelia grandiflora* 'Edward Goucher', *Buddleia davidii* 'Burgundy', *Ilex vomitoria* 'Pride of Houston', *Euonymus japonica*, and *Nerium oleander* 'Hardy Pink' were investigated to determine their water use and crop coefficients. Parallel experiments were conducted by growing the shrubs both in 56-L (15 gal) drainage lysimeters and in aboveground 10-L containers. Water use per plant, crop coefficients, and overall growth parameters differed by species and culture system. Of the five species tested, *Buddleia* and *Nerium* had higher water use per plant in the lysimeters than in the containers. There was no significant difference in water use per plant for *Abelia*, *Euonymus*, and *Ilex* between the two culture systems. Crop coefficients and growth indices of *Abelia*, *Euonymus*, and *Ilex* were statistically similar between the two systems. The growth index of *Buddleia* and *Nerium* was much higher in the lysimeters than in the containers. *Abelia* and *Euonymus* had more growth in the containers than in the lysimeters while *Ilex* had slightly larger leaf area in the lysimeters than in the containers. The culture system did not affect the water use per unit leaf area of all species. Therefore, our results indicated that by quantifying the leaf area, the plant water use in the two culture systems is convertible.

Irrigation Requirements and Drought Response of Two Ornamental Grass Species

Erin Alvarez^{*1}, Sloane M. Scheiber², David R. Sandrock³

¹University of Florida, Environmental Horticulture, Gainesville, FL, 32611; ²University of Florida, Environmental Horticulture, Apopka, FL, 32703; ³Oregon State University, Department of Horticulture, Corvallis, OR, 97331

Water use is the most important environmental issue facing the horticulture industry. As a result, many water management districts are recommending native plants for their putative low-water requirements. Numerous textbooks and trade journals claim native plants use less water than non-natives; however, previous research found no difference in water use efficiency in the field between native and non-native species. Furthermore, recommendations of ornamental grasses for use as low-maintenance and low-water-requiring landscape plants have recently escalated. This study evaluated non-native *Miscanthus sinensis* 'Adagio' and the native *Eragrostis spectabilis* for irrigation requirements and drought response in a landscape setting. To simulate maximum stress, both species were planted into field plots in an open-sided, clear polyethylene covered shelter. Each species was irrigated on alternating days at 0, 0.25, 0.5, or 0.75 L for a 90-day period. Growth index and height were recorded at biweekly intervals, and final shoot and root dry masses were taken at completion of the study. Significant treatment and species effects were found for height, growth index, shoot dry weight, and biomass. Plants receiving 0.75 L of irrigation had the greatest growth, and non-irrigated plants grew significantly less. Comparisons between species found growth was greatest among *Eragrostis spectabilis* plants for all parameters.

Drought Stress and Recovery in Green Ash

Greg Litus^{*}, James Klett

Colorado State University, Horticulture and Landscape Architecture, Fort Collins, CO, 80523

During Summer 2005, green ash (*Fraxinus pennsylvanica* 'Patmore') trees planted at the Colorado State University Agricultural Research Development and Education Center in 1996 were exposed to

simulated drought by restricting irrigation for 33 to 41 days. During this period, predawn leaf water potentials in drought-stressed trees progressively dropped to a low of -2.04 MPa, while the control plot was maintained with full irrigation such that predawn leaf water potentials did not fall below -0.5 MPa. On 24 Aug. 2005, 31 days into this drought cycle, mid-day leaf water potentials and stomatal conductance were measured at -3.0 MPa and 22.63 mmol·m⁻²·s⁻¹, respectively. Measurements in control trees collected at about the same time were -2.0 MPa and 169 mmol·m⁻²·s⁻¹. The dramatic reduction in stomatal conductance in the drought-stressed trees began at about 10:30 a.m. and continued into the evening. Once irrigation was resumed, drought stressed trees rebounded from depressed predawn leaf water potentials and mid-day leaf water potentials and stomatal conductance and reached levels similar to control trees in 2 to 5 days. Stem flow gauges indicate that, during this period, fully hydrated control trees used about 250 liters/day.

Oral Session 33—Pomology—Physiology

30 July 2006, 2:00–3:45 p.m.

Grand Couteau

Moderator: Paolo Sabbatini

Mechanism of Up-regulation of Starch Synthesis in Mature Leaves of Transgenic Apple Trees with Decreased Sorbitol Synthesis

Rui Zhou¹, Lailiang Cheng^{*1}, Abhaya Dandekar²

¹Cornell University, Horticulture, Ithaca, NY, 14853; ²University of California, Plant Science, Davis, CA, 95616

The reaction catalyzed by ADP-glucose pyrophosphorylase (AGPase) to form ADP-glucose is a regulatory and rate-limiting step in starch synthesis in plants. In response to decreased sorbitol synthesis, starch synthesis was up-regulated in the transgenic apple plants. In this study, we examined both redox and metabolite regulation of AGPase to understand the mechanism responsible for the up-regulation of starch synthesis. No difference in the monomerization/dimerization of apple leaf AGPase small subunits was observed between the transgenic plants and the untransformed control. NADP-dependent malate dehydrogenase, indicative of chloroplastic redox status, did not show significant change in the transgenic plants either. Determination of key metabolites with nonaqueous fractionation indicated that concentrations of hexose phosphates (mainly glucose-6-phosphate and fructose-6-phosphate) were higher in both the cytosol and chloroplasts of the transgenic plants than in the control, whereas 3-phosphoglycerate (PGA) concentration in the chloroplast was not higher in the transgenic plants. We conclude that accumulation of hexose-phosphates results in a decrease in inorganic phosphate (Pi) concentration and an increase in PGA/Pi ratio in the chloroplast, leading to up-regulation of starch synthesis via activating AGPase.

Regulation of Starch Degradation in Mature Leaves of Transgenic Apple Trees with Decreased Sorbitol Synthesis

Rui Zhou^{*1}, Lailiang Cheng¹, Abhaya Dandekar²

¹Cornell University, Horticulture, Ithaca, NY, 14853; ²University of California, Plant Science, Davis, CA, 95616

Considering starch synthesis was enhanced in leaves of transgenic apple trees with decreased sorbitol synthesis, we hypothesized that starch degradation must be up-regulated correspondingly to maintain carbon supply to sink tissues. Compared with the untransformed control, mature leaves of the transgenic plants had a larger drop in starch concentration between dusk and pre-dawn, higher maltose concentration, and higher activities of two key enzymes in starch degradation: α -amylase and cytosolic glucosyltransferase during the day and night. ¹⁴C-maltose and ¹⁴C-glucose were fed to the apple

leaves to study the fate of starch breakdown products in the synthesis of sorbitol and sucrose. Under light, a larger proportion of both ^{14}C -maltose and ^{14}C -glucose were converted to sorbitol than to sucrose in the untransformed control, whereas conversion of ^{14}C -maltose and ^{14}C -glucose to sucrose predominated over that to sorbitol in the transgenic apple leaves. The leaf samples fed with ^{14}C -maltose and ^{14}C -glucose in the dark are still being analyzed, but it appears that sucrose is the main product in both the untransformed control and the transgenic plants. These results support the hypothesis that starch degradation is up-regulated in the transgenic plants.

Yield, PFD Interception, and Crop Load Relationships in 'Royal Gala' Apples

Victor Garcia de Cortazar¹, Gabino Reginato²

¹Universidad de Chile, Ingeniería y Suelos, Santiago, Chile; ²Universidad de Chile, Producción Agrícola, Chile

Three different parameters were tested to estimate yield in 'Royal Gala' apples. These are: a) parameters related to crop load—fruits per tree, fruits per cm^2 of branch cross-sectional area, and fruits per hectare; b) parameters related with PFD interception: average fraction of PFD intercepted, total PFD intercepted during the season; and c) combination of the parameters a) and b). The data set was composed of measurements of PFD interception once a month and of yield components on various commercial apple orchards of the variety 'Royal Gala' in the central zone of Chile between 2003 and 2006. The orchards were managed for high production, but there were differences of plantation distance, age, and size between them. Also, inside the orchard there were differences between trees. For the trees studied, there were variations of a factor of 10 for crop load, branch cross-sectional area, and tree size estimated as fractional interception of PFD at the beginning of the season. In spite of the big differences between trees, simple equations were fitted between yield and load parameters with coefficients of determination >0.95 . Research funded by FONDECYT-Chile grant 1930695.

Observations on the Relationship Between Crop Load and Return Bloom in 'Honeycrisp' Apple

Philip G. Schwallier¹, Paolo Sabbatini², Martin J. Bukovac²

¹Michigan State University, Department of Horticulture, Clarksville Horticultural Experiment Station, Portland, MI, 48815; ²Michigan State University, Horticulture, East Lansing, MI, 48823

The 'Honeycrisp' apple has unique characteristics favored by consumers that has provided exceptional return to growers. This cultivar also has some traits that challenge plant management. There appears to be a strong inhibitory effect of crop load on flower initiation and thus annual cropping. We studied the relationship between fruit load, established by post-bloom hand and chemical thinning, and effect of ethephon and gibberellin (GA_{4+7}) on flower initiation and thereby annual cropping. Initially, return bloom (RB) was related to previous season's crop load in three thinning studies on 3- and 9-year-old 'Honeycrisp'/M 9, Pajam 1 trees. The RB density was rated 1–10 on trees ($n=172$), which produced 0–60 kg of fruit/tree. Return bloom ratings (RBR) on the 3-year-old trees ranged from 0–9. Percentage of trees with $\text{RBR} > 5$ for previous season's yield of < 5 kg, 5–10, 10–15, and 15–20 was 70, 9, 2.5, and 0, respectively. There was dramatic inhibition of flowering at a crop load of > 5 kg/tree. In the second study (9-year-old trees), crop load ranged from 15–60 kg/tree ($n=24$). RBR for trees in the 30–40 kg/tree class ranged from 0–8 with high variability. Thirty-one percent of trees with crop load between 20–30 kg had RBR of 5–8, and 26% between 0–5. Twenty-one percent of trees in the 30–40 kg/tree class flowered and all but one had a RBR of 5 or less. Yields ranged from 22–81 kg/tree in the third study ($n=60$); crop load was normally distributed among trees. Flower initiation was almost completely inhibited. Fifty percent of the trees did not flower; the remainder had a RBR of < 1 , i.e. $< 10\%$. In the ethephon/ GA study, RBR ranged 8–10 on trees producing < 12 kg/tree, then decreased rapidly to < 2 for yields of 25–50; greatest variation at 20–40 kg.

Effect of Varying Crop Load on Leaf Photosynthesis and Carbon Isotope Discrimination of 'Imperial Gala' Apple Tree

Paolo Sabbatini*, James Flore

Michigan State University, Horticulture, Plant and Soil Science Bldg., East Lansing, MI

Crop load (CL) is a critical regulator of production and quality on apple. It affects leaf photosynthetic rate and usually an increase is detected in leaves close to developing sinks. The objective of this work was to test if ^{13}C discrimination during photosynthesis could be an indicator of carbon sink limitation. The natural plant carbon isotope composition ($^{13}\text{C}/^{12}\text{C}$ ratio: $\delta^{13}\text{C}$) is an indicator of water use efficiency and it is an effective tool to study environmental stresses in plants. Seven-year-old trees of Imperial Gala/Bud 9 ($n=30$), field-grown at the Clarksville Horticultural Research Station in Michigan, were hand-thinned to five levels of CL manipulating the leaf to fruit ratio (LFR: 4, 8, 16, 32, 64) after June drop. Net photosynthetic rate (A) of leaves was monitored daily during the season and elevated rates were observed in low LFR. The A was inhibited in low CL trees (LFR 32 and 64) more in the afternoon (from 20% to 42% in relation to normal CL: LFR 16) than in the morning (from 5% to 20%), and stomatal conductance declined over the afternoon. Shoot and fruit growth were affected (fruit size $-11/+11\%$, shoot length $-13/+18\%$ from normal CL; LFR 16). Variations of the stable carbon isotope composition of leaves show a significant reduction of ^{13}C discrimination in low CL trees (-3.2% : $\delta^{13}\text{C} -25.82$) and an increase of ^{13}C discrimination ($+2.7\%$: $\delta^{13}\text{C} -27.38$) in relation to normal CL trees (LFR 15.63). The results were similar to those reported in 2004, which imply isotopic discrimination in relation to source limitation. This is the opposite of what you would expect under water stress conditions. Although trees were well-watered during the season, the effect of water stress on apple trees and its interaction with source limitation will be discussed.

Modeling Fruit Tree Architectural Growth, Source–Sink Interactions, and Physiology with L-PEACH

Ted M. DeJong¹, Romeo Favreau¹, Mitch Allen¹,

Przemyslaw Prusinkiewicz²

¹University of California, Davis, Plant Sciences, Davis, CA, 95616; ²University of Calgary, Computer Science, Canada

Modeling source–sink interactions and carbohydrate partitioning in plants requires a detailed model of plant architectural development, in which growth and function of each organ is modeled individually and carbohydrate transport among organs is modeled dynamically. L-PEACH is an L-system-based graphical simulation model that combines supply/demand concepts of carbon partitioning with an L-system model of tree architecture to create a distributed supply/demand system of carbon allocation within a growing tree. The whole plant is modeled as a branching network of sources and sinks, connected by conductive elements. An analogy to an electric network is used to calculate the flow and partitioning of carbohydrates between the individual components. The model can simulate multiple years of tree growth and be used to demonstrate effects of irrigation, crop load, and pruning on architectural development, tree growth, and carbon partitioning. Qualitative model outputs are viewed graphically as the tree "grows" on the computer screen while quantitative output data can be evaluated individually for each organ or collectively for an organ type using the MatLab software.

The Photoperiod Pathway in *Fragaria* (Rosaceae)

Philip J. Stewart*, Ashley R. Winslow, Kevin M. Folta

University of Florida, Horticultural Science, Gainesville, FL, 32611

The transition from vegetative growth to reproductive growth is carefully controlled by a number of independent signal transduction systems, one of which interprets photoperiod. Photoperiodic control of flowering time has been well-described in *Arabidopsis* and rice,

revealing the presence of a generally common network of regulatory proteins. Timely and appropriate progression to flowering is critical to profitable production of cultivated strawberry (*Fragaria × ananassa*), a species that includes long-day, short-day, and day-neutral cultivars. In an effort to characterize the photoperiodic flowering control mechanism in strawberry, the *Fragaria* orthologs of the photoperiod pathway genes were cloned and sequenced. Strawberry versions of *Constans*, *Constans-like*, *Leafy*, *Flowering Locus T*, and *Suppressor of Constans Overexpression 1* were identified by screening cDNA libraries and through degenerate PCR approaches. Expression of these transcripts in short-day and day-neutral cultivars was tested under long and short photoperiods. Functional complementation of Arabidopsis mutants was performed where appropriate, alleles were identified, genetic linkage was determined where possible, and relationships between the strawberry genes and homologs from other species were studied. These trials define the mechanistic elements of an agriculturally important pathway in this valuable crop, and lays the foundation for transgenic studies in strawberry to manipulate the floral transition.

Oral Session 34—

Viticulture and Small Fruit—Culture & Management

30 July 2006, 2:00–4:00 p.m.

Edgewood A/B

Moderator: Fumiomi Takeda

Spatial Variability of Grape Yield and Quality: Using GIS as a Precision Viticulture Tool to Optimize Vine Yield and Quality

Said Ennahli*, Sorkel Kadir

Kansas State University, Horticulture, Forestry, and Recreation Resources

Variability due to soil types, topography, and climate within a vineyard influences grapevine physiological parameters and fruit quality. Technical feasibility of using precision Geographic Information System (GIS) as a viticulture tool to improve vineyard management and increase wine quality will be investigated. The study was conducted in an experimental vineyard where rows consist of plots with 24 cultivars and selections randomly planted and managed similarly. Monitored vineyard parameters collected by Global Positioning System (GPS) location include soil characteristics, soil moisture, vine growth, crop load, and fruit characteristics. Geospatial maps are used to differentiate yield between the cultivars and selections as high, medium, or low. Production was determined from each variety/selection within the vineyard. Yield parameters were number of clusters, cluster weight, and weight of 50 berries; fruit composition (such as pH), titratable acidity, soluble solids concentration, and anthocyanins were measured. Maps for each factor will be derived via GIS tools and spatial analysis will be conducted to assess which spatial variability factor has more effect on grapevine physiology, yield, and fruit quality. This type of analysis can be used by grape growers to achieve specific wine characteristics in a large or small vineyard by controlling all sources of variability, leading to the ability to perform precision viticulture in the future, with low cost.

Effect of Cropload on Eastern European Grapevine Cultivars

Joseph Masabni*, S. Kaan Kurtural, Dwight Wolfe, Chris Smigell
University of Kentucky, Horticulture, Lexington, KY, 40546-0091

The effect of cropload (kg yield/kg pruning weight) on yield components and fruit composition of 17 eastern European grapevine cultivars was evaluated from 2000 to 2004 in a vineyard, at the research station in western Kentucky, characterized by a long and warm season. There was a cubic relationship between number of clusters retained per vine and the cropload ($R^2 = 0.6374$, $P < 0.0001$). Similar relationship was evident between yield per vine and cropload ($R^2 = 0.5908$, $P < 0.0001$). Of the observed variation in cluster weight, 28% was attributed to varia-

tion among predictions, based on the value of cropload in a quadratic relationship ($P < 0.0001$). As cropload increased, pruning weight per meter of row decreased ($R^2 = 0.4513$, $P < 0.0001$). However, there was very little effect of cropload on the percentage of total soluble solids and juice pH measured at harvest. Optimum cropload values fell in between 13–18 (kg yield/kg pruning weight) depending upon cultivar evaluated, based on optimum ranges for pruning weight per meter of row for optimum vine balance in the lower Midwest.

Physiological Responses of Three Grapevine Cultivars to Partial Root Drying

Said Ennahli*, Sorkel Kadir

Kansas State University, Horticulture, Forestry, and Recreation Resources

Partial root-zone drying (PRD) irrigation management has been developed for grapevines as an efficient method to control excessive growth, improve fruit quality, and save water without compromising yield. PRD is based on knowledge of the mechanisms that control transpiration and requires slow dehydration of half of the plant root system, whereas the other half is irrigated. A study was conducted in the field to evaluate the effect of PRD on physiological characteristics, growth, yield, and fruit quality of three grape cultivars. The wetting and drying cycle of the PRD-vine root system is alternated on a 10–14 day schedule. Significant reduction in vigor was observed in treated plants compared with control plants. Root biomass was not affected, but fine roots significantly increased in PRD-treated plants, compared with that of the control. This contributed to the ability of PRD-treated plants to maintain leaf water potential similar to that of the control. Stomatal conductance of PRD plants was significantly reduced when compared with that of the control plants. Abscisic acid (ABA) concentration in leaves of PRD vines increased significantly when compared to the control vines. PRD treatment significantly increased yield and fruit quality when compared with the control treatment. PRD significantly increased water use efficiency (pruning weight per unit of water applied). This study shows that PRD stimulated ABA production in the drying roots, which caused reduction in stomatal conductance and transpiration rate, leading to a substantial reduction in vegetative growth without compromising yield and fruit quality.

A Winter Protection Method for Blackberries

Fumiomi Takeda*¹, David Handley²

¹USDA-ARS, Appalachian Fruit Research Station, Kearneysville, WV, 25430; ²University of Maine, Agricultural Research Center, Monmouth, ME, 04259

A combination of simple cultural practices, a modified rotatable cross-arm (RCA) trellis system, and covering plants with insulation material in winter overcame the lack of cold hardiness in trailing blackberries that have been established at Kearneysville, W.Va. After tying canes to trellis wires and rotating the cross-arms to below horizontal, tied canes were close to the ground, allowing them to be covered with protective materials, such as floating rowcover and polyethylene plastic during winter. Covers were removed in early spring and the canes remained in the horizontal orientation until bloom, which promoted flowering laterals to grow upright. After bloom, the cross-arm was rotated beyond vertical to position the fruit on one side of the row and improve harvest efficiency. In Jan. and Feb. 2005, the daily minimum temperatures under the FRC+PE covers were about 3 °C higher than in the open. The covers also provided protection against the wind. Tissue damage in protected trailing blackberries was significantly less than for unprotected plants. ‘Siskiyou’ plants in covered plots produced 3 to 5 times more fruit than plants in the open. Harvesting of ‘Siskiyou’ fruit occurred during the red raspberry harvest season or 2 to 3 weeks earlier than for eastern blackberries. Our findings suggest that trailing blackberries can grow satisfactorily and produce fruit if the adverse effect of low temperatures and winds is mitigated with our trellis system and winter protection method. If practical cultural techniques for improving their winter survival become available, there is a potential for early-season high-quality blackberry production in the mid-Atlantic coast region.

Pre-plant Dipping of Strawberry Transplants for Control of *Colletotrichum acutatum*

Oleg Daugovish*¹, Doug Gubler²

¹University of California, UCCE, Ventura, CA, 93003; ²University of California, Plant Pathology, Davis, CA, 95616

Strawberry anthracnose caused by *Colletotrichum acutatum* may kill strawberry plants or reduce plant vigor and marketable yield, resulting in multimillion dollar losses to strawberry industry. The fungus is often carried with transplants from nurseries to production fields undetected. The studies in one summer and two winter seasons near Oxnard, Calif., evaluated 30-second pre-plant dipping in ten fungicide solutions or water washing of transplants inoculated with *C. acutatum* as a means of reducing infection and improving fruit yield. In summer-planted 'Baeza,' the pathogen caused severe die-back and reduced marketable fruit yield 89% in inoculated, untreated controls compared to non-inoculated plants while plants dipped in Switch (cyprodynil + fludioxynil) at 0.38 g/L had 33% yield reduction. Other fungicides provided even less protection, resulting in 53% to 89% yield losses. During cooler winter seasons the pathogen remained latent and lesions appeared on 'Camarosa' when the day-night air temperatures reached 16 °C or more, 7–14 days after rain. None of the treatments reduced fruit lesion development, however, among plants dipped in strobilurin fungicides only 3% had *C. acutatum* symptoms (including early die-back) as opposed to 26% in inoculated, untreated controls. Plants dipped in Switch, Quadris (azoxystrobin), or Pristine (pyraclostrobin + boscalid) yielded similar to non-inoculated, untreated controls in 2003 and 10% to 12% more in 2005. These studies showed that strobilurin fungicides did not prevent fruit infection (indicating need for foliar in-season control) but improved marketable yield compared to the inoculated, untreated plants. Temperatures over 16 °C and precipitation may significantly increase disease development.

Drip Irrigation Configuration Influences Growth in Young Highbush Blueberries

David R. Bryla*

USDA ARS, Horticultural Crops Research Unit, Corvallis, OR, 97330

A study was done to determine the effects of irrigation with different drip configurations on growth of newly planted highbush blueberries (*Vaccinium corymbosum* L. 'Duke'). Plants were grown on raised beds mulched with sawdust. Different configurations included two laterals of drip tubing placed on the soil surface on each side of the plants, two laterals buried 0.1 m deep on each side of the plants, and one lateral suspended 1.2 m above the plants. Each treatment was irrigated three times per week (when needed) with enough water to replace 100% of the estimated crop evapotranspiration requirements. During the first 2 years after planting, plants irrigated by buried drip were larger and produced significantly more whips than those irrigated by drip placed at the soil surface. The size and whip number of those irrigated by suspended drip were intermediate. Subsurface drip eliminated water runoff and bed erosion observed with both surface drip configurations. It also maintained lower soil water content near the plant crown. Since plants tested positive for phytophthora and pythium root rot, lower soil water content may have reduced problems with the disease. As plants mature, the next objective will be to determine the effects of each drip configuration on fruit production.

Suppression of Flowering in 'Bluecrop' Highbush Blueberry

Brent Black*¹, Mark Ehlenfeldt², Robert Martin²

¹Utah State University, Plants, Soils and Biometeorology, Logan, UT, 84322-4820;

²Blueberry and Cranberry Research Center, USDA-ARS, Chatsworth, NJ, 08019

Precocious varieties of highbush blueberry may over-crop during the first few seasons in the fruiting field, adversely affecting plant establishment. Reducing or preventing bloom in the nursery and during establishment would be beneficial in preventing early cropping and reducing the risk of infection by pollen-borne viruses. We investigated the efficacy of foliar applications of ProVide® (Valent BioSciences), a commercial GA₄₊₇ formulation, for suppressing flower bud initiation in blueberry. One-year-old rooted cuttings of 'Bluecrop' were obtained from a commercial nursery and established in 11-L pots at the Blueberry and Cranberry Research Center, Chatsworth, N.J. Dilute foliar applications of ProVide® were made at concentrations ranging from 50 to 400 mg·L⁻¹ a.i., ranging from 7 July to 1 Sept. 2004, with 10 replicate plants per treatment. Floral and vegetative buds were counted the following spring. A separate experiment was initiated in 2005, with concentrations of 200 and 400 mg·L⁻¹ a.i. applied in August and September. For the 2004 study, the greatest flower bud suppression resulted from repeat applications at 400 mg·L⁻¹ a.i. Weekly applications from 7 July to 1 Sept. resulted in a 70% reduction in flower bud number, whereas three weekly applications from 18 Aug. to 1 Sept. reduced flower bud number by >88%. Neither treatment significantly reduced total bud numbers (vegetative + floral) compared to untreated and water-sprayed controls, indicating that the treatments did not reduce plant growth. Results for the 2005 treatments will also be presented.

Evaluating Hornfaced Bees (*Osmia cornifrons*) as Pollinators of Highbush Blueberry

Todd P. West*¹, Thomas W. McCutcheon²

¹West Virginia University, Division of Plant and Soil Sciences, Morgantown, WV, 26506-6108; ²West Virginia University, WVU Extension Service, WesMon Plaza, Morgantown, WV, 26501

The objective of this study was to investigate the use of hornfaced bees (*Osmia cornifrons* Radoszkowski) as a successful sustainable alternative for pollination of commercial highbush blueberry (*Vaccinium corymbosum* L.). The hornfaced bee is native to Japan and introduced to the United States in 1977 by the USDA. Hornfaced bees have been shown to be 300× more efficient in pollinating apples than honey bees. Hornfaced bees are active for 4–6 weeks (April to June), and then the adults die. The rest of the year (10 months), dormant hornfaced bees exist inside nest cells located in cardboard straws stored away from berry production areas. Currently, there are no reports on hornfaced bee use available for blueberry farmers. Five pollinator treatments were compared in 2005 including: hornfaced bees; honey bees; bumble bees; natural pollinators; and no pollinators. Enclosed pollination cages were constructed around mature field-grown highbush blueberry plants to prevent mixing of pollinator treatments. Each cage contained a single pollinator treatment except for the natural pollinator treatment. The five pollinator treatments were replicated three times inside separate netted cages on the farm. Three branches per plant were randomly selected that had a minimum of five fruiting buds and blossom number recorded. After pollination occurred the cages were removed to allow the berries to ripen. Ripe fruit were picked weekly over the season (July to August), with the fruit from each sample being counted and weighed. Blossom number was compared to fruit number and weight to determine efficiency of pollination as a result of the pollinator treatments. The results showed that hornfaced bees pollinated blueberries as well as or better than the other pollinators.