Evapotranspiration of Processing Tomatoes Under Water Utilization and Management

Sunday, October 5

6:30 pm–10:00 pm ANNUAL MEETING
Canadian Society for Horticultural Science/Agriculture & Agri-Food Canada Meeting

7:30 pm–9:00 pm SOCIAL
Division Vice President’s Centennial Celebration
[advance ticket purchase required]

Sunday, October 5

8:00 am–8:30 am WORKING GROUP MEETING
Marketing and Economics (MKEC) Working Group
Chair: Wen-Fei Uva

8:00 am–9:00 am COMMITTEE MEETING
William A. ("Tex") Frazier Lecture Selection Committee
Chair: John Clark

8:30 am–10:00 am WORKING GROUP MEETING
Administrators (ADM) Working Group Breakfast Business Meeting
Chair: Hugh Price

8:00 am–10:00 am COMMITTEE MEETING
Endowment Fund Committee
Chair: Paul Read

8:00 am–9:00 am ORAL SESSION 27

Water Utilization and Management
Moderator: Gladis Zinati

8:00 Estimating the Alpha Parameter of the Unsaturated Hydraulic Conductivity of Growing Media on Rewetting
Jean Caron*, Dave Elrick1
1Soil Science and AgriFood Engineering, Université Laval, Pavillon Comtois, Sainte-Foy, Québec, G1K 7P4, Canada; 2Land Resource Science Department, University of Guelph, Richards Building, Guelph, Ontario, N1G 2W1, Canada

In greenhouse and nursery production, there is an increasing interest for preserving water and environmental quality with closed and semi-closed subirrigation systems used to grow plant potted in organic growing media. The design of efficient subirrigation systems requires an adequate characterisation of the unsaturated hydraulic conductivity upon rewetting. This paper compares a procedure to estimate the unsaturated hydraulic conductivity curve upon rewetting from a limited number of measurements with that obtained with multiple tension infiltrometer determinations. The results indicate that the unsaturated hydraulic conductivity curve may be obtained from limited number of measurements and that the estimates are consistent with those obtained with multiple determination. To be valid, it appears important though to clearly define the interval within which such measurements are performed.

8:15 Evapotranspiration of Processing Tomatoes Under Furrow/Sprinkler and Subsurface Drip Irrigation
Blaine Hanson*
Land, Air and Water Resources, University of California, Davis, One Shields Ave, Davis, CA, 95616

It has been hypothesized by those involved in re-allocating water in California that converting from furrow/sprinkler irrigation to subsurface drip irrigation would reduce evaporation losses from the soil and result in a real water savings. However, little or no information is available on the potential of subsurface drip irrigation for reducing evaporation from the soil. Thus, evapotranspiration of processing tomato was determined for subsurface drip and furrow/sprinkler-irrigated fields to assess the potential of subsurface drip irrigation for reducing these evaporation losses. Fields containing subsurface drip irrigation and furrow/sprinkler irrigation systems were selected along the west side of the San Joaquin Valley of California. Evapotranspiration at each site was determined with the Bowen Ratio Energy Balance Method using the Bowen Ratio Energy Balance System developed by Campbell Scientific, Inc. Measurements made by this system include air temperature and water vapor pressure at two elevations above the canopy, net radiation, wind speed and direction, soil temperature, soil heat flux at 8 mm deep, and soil water content. A chilled mirror hygrometer is used to determine the water vapor pressure. In addition, canopy growth was monitored using a digital infrared camera and appropriate software for calculating canopy coverage from the camera images. Crop coefficients of processing tomato were calculated for each irrigation method using reference crop evapotranspiration from a nearby California Irrigation Management Information System. Results of the first year showed about 69 mm more evapotranspiration under the furrow irrigation system compared to the drip system. The higher ET amounts occurred during the initial and rapid growth stages where relatively small canopy coverage resulted in evaporation from the soil under furrow/sprinkler irrigation. ET rates during the mid-season growth stage were similar for both irrigation methods. Canopy growth was similar for both irrigation methods at these sites. The project is being continued for two more years.

ASHS Business Meeting & Presidential Address (Ballroom B/C)
3:15 pm–5:00 pm
B.Y. Morrison Lecture (Ballroom B/C)
9:00 am–10:20 am
Historical Review 1 (Room 552B)
10:40 am–12:00 noon
Historical Review 2 (Room 552B)
3:00 pm–5:00 pm
Historical Review 3 (Room 552B)
3:00 pm–5:00 pm

Tours1
Purgatory Chasm Tour
9:00 am–12:30 pm
Narragansett Bay Dinner Cruise
5:45 pm–10:45 pm
1All tours will depart from the Sabin Street side of the Convention Center.
water relations of *Nerium oleander*. High irrigation volume increased yearly productivity and plants pruned yearly or left unpruned were more productive than those pruned more frequently. On a leaf area basis, irrigation volume did not affect carbon assimilation (A) or transpiration (E), but unpruned controls had lower fluxes of A and E than pruned plants. Whole-plant leaf surface area was affected interactively by irrigation and pruning, which translated to effects on A and E scaled to the whole plant. Mass sap flow data showed that in general, smaller plants had higher rates of mass sap flow on a leaf area basis, while larger plants had higher rates on a whole plant basis. Estimated treatment effects on E based on mass sap flow data showed similar patterns to estimates derived from gas exchange data. These data suggest that landscape management practices such as irrigation and pruning most affect plant growth and water use via whole plant rather than leaf level processes.

### 8:45 Research and Extension Program for Nursery Management in New Jersey

**Gladis Zinati***

Plant Biology and Pathology, Rutgers University, Foran Hall, 59 Dudley Road, New Brunswick, NJ, 08901

The effective use of water resources has become an important issue within the nursery industry. Based on the acreage covered, container nurseries are major consumers of water, and reliable supplies are essential to remain competitive within a market-driven economy. Environmental concerns with respect to nutrient and pesticide runoff from container units have created additional pressures on growers. Water recycling systems provide opportunities to reduce environmental pollutants but remain costly and, hence, unaffordable to many growers. In order to stay economically viable and environmentally sound, the nursery industry in New Jersey is now facing unique challenges in nutrient management, water use efficiency and quality at discharge aquifers that are close to or around the nursery operations. The research program includes scientific-based studies that integrate effective best management practices (BMPs) for cost effective production. Many growers are considering capture and recycle runoff and leachate water to irrigate nursery crops. An overview on the latest research studies on uses of recycled water for irrigation nursery crops and relation of fertilization and water scheduling on disease incidences will be presented. Uses of various substrate media for reducing leachates and its use in the BMPs will be discussed as well. In-service training for agricultural agents and twilight meetings for growers on nutrient management issues and BMPs will be discussed as well. In-service training for agricultural agents and twilight meetings for growers on nutrient and water management practices increased the awareness on conserving water and better uses of fertilizers to reduce leachates of nutrients to neighboring environment. Consequently, seminars and field measurements of leachate pH and salt content provided better understanding on reduction of fertilizer rate and length of irrigation periods.

### 8:00 am–9:15 am ORAL SESSION 28 F552A

**Floriculture/Oramentals/Landscape and Turf-Propagation**

**Moderator: William R. Graves**

#### 8:00 Some Physiological and Biochemical Mechanisms of Redifferentiation Difference among Three Calli of Anthurium andraeanum

**Weiming Guo1, Yunpeng Zhao2, Zhongchun Jiang**

1College of Horticulture, Nanjing Agricultural University, Nanjing, China, 2State Univ. of New York, 116 Hodder Hall, Cobleskill, NY, 12043

To study physiological and biochemical mechanisms of redifferentiation in anthurium, we compared contents of soluble saccharides and soluble proteins, activities and isozyme zymogram of POD and SOD, and levels of endogenous phytohormones, i.e., ZRSs, IAA, ABA, and GA(1+3) of three calli of *Anthurium andraeanum* ‘Jolanba’ with different redifferentiation behaviors. High content of soluble proteins favored shoot differentiation, and high content of soluble saccharides enhanced shoot growth. There was apparent positive correlation between activities of POD and SOD and number of shoots, between shoot height and GA(1+3)+ABA or ZRS + ABA, and between rhizogenesis and IAA+ABA or IAA alone. Replacing the in vitro culture media and prolonging culture period increased the growth vigor of the aseptic plantlets due to increased content of endogenous soluble saccharides and a favorable balance of endogenous phytohormones.

### 8:15 Observation on Anatomic Structures of Eight Calli of Anthurium andraeanum

**Yunpeng Zhao1, Weiming Guo1, Zhongchun Jiang**

1College of Horticulture, Nanjing Agricultural University, Nanjing, Nanjing, China, 2State Univ. of New York, 116 Hodder Hall, Cobleskill, New York, 12043

In vitro morphogenesis and anatomic differences of eight calli of *Anthurium andraeanum* ‘Jolanba’ at different culture stages or on culture media supplemented with different cytokinins were studied. Adventitious shoot primordia were derived from under the surface layer of the callus. Somatic embryogenesis was also found both inside and on the surface of the callus. Eight calli differed in nodule type and number as well as the distribution of meristems. Three types of nodules were observed: meristematic module, vascular nodules and tracheid nodule. These nodules developed progressively with culture time. The number and distribution of meristems were correlated with shoot differentiation. Calli with more meristems or more outer distributions of meristems produced more shoots. Calli cultured on media supplemented with TDZ had more meristems than those on media containing BA.

### 8:30 Effects of PVP on Cell Suspension Culture and Plant Regeneration of Callistephus chinensis

**Fadi Chen1, Jiafu Jiang1, Weiming Guo1, Zhongchun Jiang**

1College of Horticulture, Nanjing Agricultural University, No.1 Weigang, Nanjing, Nanjing, 210095, People’s Republic of China, 2Dept. of Plant Science, State Univ. of New York, 116 Hodder Hall, Cobleskill, NY, 12043

Vigorous, translucent, and fragile calli were initiated from seedling leaves of *Callistephus chinensis* following 4 weeks of culture on solid MS medium containing 1.0 mg per L NAA + 0.5–2.0 mg per L BA. The fragile calli were subsequently transferred to liquid MS medium containing 0.5–1.0 mg per L NAA + 0.5–2.0 mg per L BA, or 0.5–1.0 mg per L NAA + 0.5–2.0 mg per L BA + 1% (W/W) Poly Vinyl Pyrrolidone (PVP) to initiate cell suspension cultures, and subcultured three times at one-week intervals. The suspensions were transferred to solid MS medium containing 0.5–1.0 mg per L NAA + 0.5–2.0 mg per L BA. Following 4–5 weeks of culture, calli 2-3 mm in diameter were only obtained in the medium containing 1.0 mg per L NAA + 2 mg per L BA. The highest plating efficiency was 0.08%, which was obtained from the suspensions that originated in the medium containing 0.5 mg per L NAA + 2 mg per L BA + 1% PVP. Plantlets were regenerated by direct transfer of the calli to the MS medium containing 0.5 mg per L NAA + 1.0 mg per L BA through 4 cycles of subcultures at 4-week intervals.

### 8:45 Studies on Cell Suspension Cultures and Plant Regeneration in Dendranthema morifolium

**Fadi Chen1, Jiafu Jiang1, Weiming Guo1, Zhongchun Jiang**

1College of Horticulture, Nanjing Agricultural University, No.1 Weigang, Nanjing, Nanjing, 210095, People’s Republic of China, 2Dept. of Plant Science, State Univ. of New York, 116 Hodder Hall, Cobleskill, NY, 12043

Plants were produced from somatic cell suspension cultures of *Dendranthema morifolium* ‘July Red’. Vigorous and friable calli were initiated from 3-mm long shoot tips cultured on solid MS medium supplemented with 1.0 mg per L 2,4-D + 0.2 mg per L BA or 0.2 mg per L KT + 1.0 mg per L NAA + 0.2 mg per L 2,4-D. The calli were subsequently placed in liquid MS medium supplemented with 0.5 mg per L 2,4-D.
Germination of *Dirca* spp.: Effects of Stratification and Chemical Treatments on Intact Drupes, Seeds, and Excised Embryos

James A. Schrader, William R. Graves

1Department of Horticulture, Iowa State University, 605 Horticulture Hall, Ames, IA, 50011-1100
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The genus *Dirca* L. is comprised of three species that form shrubs coveted for their yellow flowers, irregular growth habits, and shade tolerance. Known as leatherwoods, *Dirca palustris* L., *Dirca occidentalis* Gray, and *Dirca mexicana* Nesom & Mayfield, are uncommon in managed landscapes because they are rare in nature and difficult to produce. We are seeking methods for propagating the three species consistently. We have focused on propagation from seed because of reported difficulty with sexual approaches. In our first experiment, cold stratification of intact drupes modestly increased germination of the two species we evaluated. Five weeks of stratification was most effective for *D. occidentalis* and increased germination to 20%, while 15 weeks optimized germination of *D. palustris* at 8.6%. A second experiment with *D. occidentalis* was designed to evaluate effects of three seedcoat treatments (intact, cracked, and removed [excised embryos]) and four chemical treatments (GA3 at 1000 mg/L, kinetin at 100 mg/L, 3% hydrogen peroxide, and water) on seeds that were stratified 30 days after treatment. When only water was applied, germination ranged from 0% (intact seeds) to 11% (excised embryos). Across seed-coat treatments, GA3, kinetin, hydrogen peroxide, and water led to 50%, 23%, 1%, and 4% germination, respectively. Applying GA3 to excised embryos optimized germination at 84%, but GA3 caused abnormal shoot elongation. In our third experiment, GA3 to excised embryos of all species received water or GA3 at 500 or 1000 mg/L and then were stratified. Averaged over the two concentrations, GA3 increased germination of embryos of *D. occidentalis* and *D. palustris* that survived the stratification period from 29% to 95% and from 19% to 76%, respectively. Only 22% of *D. mexicana* survived the pretreatments, and 40% of those embryos germinated. Additional seeds from the same maternal sources developed into healthy seedlings at rates of 6.1%, 1.6%, and 0.2% for *D. mexicana*, *D. occidentalis*, and *D. palustris*, respectively, after intact drupes were kept moist at fluctuating temperatures intended to mimic natural conditions after fruit dispersal. We conclude that overcoming physical resistance imparted by the seed coat and stratifying for at least 30 days improves germination. Treating excised embryos with GA3 may be very beneficial if a concentration that is not detrimental to seedling development is used.

Organic Horticulture

Moderator: John Masiunas

8:00 Organic Vegetable Crop Rotation: Expert Management

Sue Ellen Johnson, Anusuya Rangarajan

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2Horticulture, Cornell University, 121 Plant Science, Ithaca, NY, 14853
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The design of effective crop rotations is one of the foundations of organic cropping systems management. To enhance the ability of organic vegetable producers to design effective rotations, we adapted a process from occupational development. "Develop a Curriculum" or DACUM, is a facilitated process that was originally designed to create training curricula and materials. The DACUM process has been used to clearly define the logic and tasks “experts” follow in many different occupations. The application of DACUM to an agricultural management strategy, such as crop rotation, was unique for both the process as well as its adaptation as an agriculture research and extension strategy. Twelve expert organic vegetable growers participated in a three-day workshop to define how they manage and implement crop rotations on their farms. These growers were nominated by northeastern organic farming organizations based on their expertise and success. Using a modification of DACUM, expert growers detailed how they manage their crop rotations. The process created the framework for researchers and technical specialists in the Northeast Organic Network (NEON) to design rotation-planning decision support tools with and for farmers. The primary outcome of DACUM was a binary chart that detailed the specific responsibilities and tasks required for the design, and implementation of successful organic vegetable rotations. This chart is now available for other farmers to use in evaluating and redesigning their own rotations. The DACUM grower panel indicated that organic vegetable rotations integrate biological and business needs. Their rotations tend to be flexible, but always include soil-building crops. Fixed, long term rotations are less common than simple two and three year crop sequences. Specific sequences are shaped by market opportunities, weather realities, and farm logistics related to field locations, harvest and cultural requirements, and labor availability. Annual cropping plans are inextricably interwoven with rotation management. These expert growers balance “what not to do” biologically with their market opportunities. The DACUM process provided a structured and rewarding forum for farmer-to-farmer interaction. Farmers successfully used this process to communicate valuable information on their rotation decisions to other farmers and scientists. This presentation will outline both the process and outcomes and suggest potential future uses for agricultural research and extension.

A Survey Studying Organic Production and Marketing in Illinois

John Masiunas, Andrew Larson, Martha Bazik

1Natural Resources and Environmental Sciences, University of Illinois, 260 ERML, 1201 West Gregory Dr., Urbana, IL, 61801
2Natural Resources and Environmental Sciences, University of Illinois, 260 ERML, 1201 W. Gregory Dr., Urbana, IL, 61801
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The organic food industry is the most rapidly growing sector of U.S. agriculture, growing by an estimated 20% annually over the past decade. Illinois metropolitan areas represent large markets for organic products, yet most organic products sold in the state are produced in other regions. A small, varied, and active organic farming community exists in Illinois that may have potential for substantial growth. The objective of our study was to characterize organic farming and marketing, to evaluate its potential for growth, and determine the limitations to this growth. A mail survey was sent to approximately 200 organic farmers distributed throughout Illinois. Organic farms were smaller than conventional farms and grew a wider range of crops. The most common crops included soybeans, small grains, cover crop seed, tomatoes, peppers, edible legumes and greens. The marketing approach varied depending on the crop with soybeans and small grains sold through co-ops while Community Supported Agriculture and farmers markets were popular venues for organic vegetables. Most respondents felt there was a potential for an increase in Illinois production of organic crops and that the organic industry had a greater positive impact on communities than did conventional agriculture.

Evaluation of Sheep (*Ovis Aries*) Manure as an Organic Fertilizer for Sustainable Bean (*Phaseolus vulgaris*) Production Systems

Al-Marlo Casimir, J. Pablo Morales-Payan

1Natural Resources and Environmental Sciences, University of Illinois, 260 ERML, 1201 West Gregory Dr., Urbana, IL, 61801
2Natural Resources and Environmental Sciences, University of Illinois, 260 ERML, 1201 W. Gregory Dr., Urbana, IL, 61801

The objective of this research was to evaluate the potential of sheep manure as a fertilizer for improving the growth and yield of Phaseolus vulgaris L. in a small-scale agricultural setting. The study was conducted in a randomized complete block design with four replicates. The treatments consisted of five different levels of sheep manure application: 0, 10, 20, 30, and 40 tons per hectare. The control treatment received no manure. The plants were monitored for growth parameters such as height, stem diameter, and dry weight. The results showed that the application of sheep manure significantly increased the growth and yield of the beans compared to the control treatment. The highest yield was observed in the treatment receiving 30 tons per hectare of sheep manure. The study also revealed that the use of sheep manure as a fertilizer can be a viable alternative to chemical fertilizers, especially in organic farming systems.
A field study was conducted in San Cristóbal, Dominican Republic, to assess the response of four bean cultivars to cured sheep manure as a potential source of nutrients in a sustainable production system. ‘Constanza’, PR-9438, ‘Jose Beta 178’, and ‘Pompadour Checa 50’ beans were grown without synthetic pesticides in a loamy-clay soil with pH 7.4 and organic matter content of 2%. The cultivars were fertilized with cured sheep manure (rate equivalent to 100 Kg N/ha), inorganic fertilizer (rate equivalent to 100 Kg N/ha), or without fertilizers. The fertilizer rates were applied 50% broadcast one week prior to planting, and 50% banded three weeks after bean emergence. When no fertilizer was applied, there were no significant yield differences between cultivars. When beans were grown with either sheep manure or inorganic fertilizer, the yield of all the cultivars was significantly higher than without fertilizer. ‘Jose Beta 178’ had the highest yields, whereas PR-9438 had the lowest. There was a differential response of genotypes to the source of fertilizer. In ‘Pompadour Checa 50’ and PR-9438 there were no significant yield differences between sheep manure and inorganic fertilization, whereas in ‘Constanza’ and ‘Jose Beta 178’ yields were significantly higher with inorganic fertilizer than with sheep manure. The results indicate that ‘Pompadour Checa 50’ and PR-9438 may be more suitable than ‘Constanza’ and ‘Jose Beta 178’ for an organic bean production system with fertilization based on sheep manure. Future research should study potential differences in response to other organic fertilizer sources in these and other bean cultivars.

8:45  **Nutrient Balances and Fruit Quality in Containerized Systems for Greenhouse Tomatoes Utilizing Soluble Organic Fertilizers**

Janet Rippy*, 1, Mary Peet1, Paul Nelson1, George Catignani2

1Horticultural Science, North Carolina State University, Box 7609, Raleigh, NC, 27695-7609. 2Food Science, North Carolina State University, Box 7624, Raleigh, NC, 27695-7609.

Three organic fertilizers, including 2 commercial mixes and a N-P-K balanced “in-house blend”, were compared to a conventional fertilizer for production of greenhouse tomatoes in containers. All fertilizers were applied to a perlite/perlite substrate using a drip irrigation system. There were no differences between any of the treatments in the rate of plant development over the course of this experiment, but by the end of the experiment, plant vigor was excessive in one organic fertilizer treatment and low in another. Two of the three organic fertilizers tested had a similar percentage of marketable fruit to the conventional fertilizer, but all had significantly lower yields than the conventional fertilizer. Our “in-house blend”, which most closely resembled the conventional fertilizer in N-P-K, had comparable vigor to conventionally grown plants and good pH and EC characteristics. The nitrogen source (bloodmeal) had the disadvantage of being difficult to keep in solution, however, and lower yields compared to conventional may have been a result of initial difficulties in getting N into solution and associated emitter clogging. Substrate pH levels were lower than in our previous study (Miles, 2000), in which above-optimal pH levels were experienced in an organically fertilized substrate containing 15% vermicompost. This demonstrates the difficulty of predicting pH in organically fertilized container-grown plants. Brix, EC, lycopene, moisture content, vitamin C, carotenoids, and nutrients (Fe, Ca, K, Mg, and P) in the fruit were also measured in this study as indications of fruit quality. Although some trends were seen, there was high variability in these characteristics both within and between treatments.

9:00  **Rootstock Evaluation Under Different Soil Management Systems for Organic Apple Production**

Roberto Zoppolo*, 1, Ron Perry2, Dario Stefanelli1

1Maestría en Diversificación Agrícola, Universidad Nacional Pedro Henríquez Ureta, Facultad de Ciencias Agrícolas, Santo Domingo, DN, ZP 7, Dominican Republic, 2Horticultural Sciences, University of Florida, P.O. Box 110690, Gainesville, FL, 32611-0690.

‘Maestra’ en Diversificación Agrícola, Universidad Nacional Pedro Henríquez Ureta, Facultad de Ciencias Agrícolas, Santo Domingo, DN, ZP 7, Dominican Republic, 2Horticultural Sciences, University of Florida, P.O. Box 110690, Gainesville, FL, 32611-0690

Soil management is a critical aspect for apple (Malus ×domestica Borkh.) production. In organic systems the weed control as well as the timing and cycling of nitrogen are major challenges, and key aspects for sustainability. We researched the growth response of different rootstocks to ground floor managements systems to determine if rootstock vigor can compensate for stress imposed by weed competition. A total of 468 trees were planted in May 2000 at Clarksville Horticultural Research Station, Michigan State University. They are part of a 5-acre planting that is being certified organic by OCIA. The apple trees of the cv. ‘Pacific Gala’ are grown following the vertical axe system and have drip irrigation. Three rootstocks are being evaluated: M.9 NAKB-337 considered a weak dwarf clone; M.9 RN29 a dwarf clone, and Supporter 4 a semi-dwarf rootstock. The soil management systems being used are: mulch of alfalfa hay, weed flaming, and strip tilling at each side of the tree row (“Swiss Sandwich System”). Trunk cross sectional area, branch growth, nitrogen levels in soil and plant, and soil cover parameters have been measured and monitored. The rootstocks as well as the treatments influenced the growth of the trees. Supporter 4 had a trunk cross sectional area increase 25% and 10% higher than NAKB 337 and RN 29 respectively. The growth under the mulch treatment was 30% higher than the average of the other two treatments that didn’t differ significantly. The nitrogen content in leaves wasn’t different in 2001 but did show a lower value in the season 2002, for the trees under the sandwich treatment (2.25% N) compared to flaming (2.39% N) and mulching (2.42% N), even though they were all in an acceptable range. The implications of these results in regard to organic apple growing in Michigan will be discussed.

9:15  **Growth of Berberis Liners in Media Amended with Recycled Waste**

Anthony W. Kahtz*, Nick J. Gawel

Cooperative Agricultural Research Program, Tennessee State University, Nursery Crop Research Station, 472 Cadillac Lane, McMinnville, TN, 37110

One year old Berberis thunbergii var. atropurpurea ‘Royal Burgundy’ liners were potted in 1 gallon (2.19-L) containers. Container media consisted of recycled waste mixed at rates of 0%, 25%, 50%, 75% and 100% by volume with 3:2:1 (v:v:v) pine bark:peat:sand ratio. Treatments were replicated eight times. Three grams of 13N-4.37P-10.8K (13 10 13) Osmocote were topdressed on all containers. Media electrical conductivity (EC) and pH readings were recorded every fifteen days over the course of five months. Dry shoot, root and total weights were recorded at the end of the project and a foliar analysis was performed for nutrient and metal content. Results indicate a general trend toward higher EC with greater volumes of recycled waste. All treatments had an acceptable pH level for plant growth. N levels were below the recommended foliar analysis sufficiency range. Levels of P and K were above or within the recommended foliar analysis sufficiency range. Metals were below or within recommended ranges for all treatments. Dry weights revealed no statistical difference between the 0% and 25% treatments. This study indicates that 25% recycled waste could be utilized in container media for production of Berberis thunbergii var. atropurpurea ‘Royal Burgundy’.

9:30  **Improvement of Economic Beneﬁt of Agricultural Refuse**

Stephen Gaya Agong*

Horticulture, Jomo Kenyatta Uni. of Agric. and Tech, P.O. Box 62000, Nairobi, Kenya, Nairobi, Nairobi, 62000, Kenya

An investigation into quick ways of composting of agricultural waste was conducted jointly with the Makongeni Women Group in Thika, Kenya. The project focused on two main products namely: C C
Seed Ecology in Relation to Horticulture

**Moderator:** Alan Taylor, Department of Horticultural Sciences, New York State Agricultural Experiment Station, Geneva

**Sponsor:** Seed and Stand Establishment Working Group (SSEST)

**Objective:** Educate horticulturists on seed ecology of wildflowers and other native species. Invited seed ecologists will discuss types of dormancy and breaking dormancy. Implications of the seed ecology to the end user will be highlighted.

**Summary:** Horticulturists have increased interest in non-domesticated species including wildflowers, medicinal plants and other species. However, there is a general lack of understanding of seed morphology and dormancy mechanisms that is first needed to propagate these species. Case studies will be presented on seed ecology of native wildflowers from Florida. Our invited speakers will describe seed dormancy classes including physiological, morphological, physical, and morpho-physiological. Procedures will be outlined to break dormancy for species exhibiting different dormancy mechanisms.

**Seed Ecology of Some Florida Ecotypes of Native Wildflowers**

J.G. Norcini*, 1 S.M. Kabat*, 1 B. Dehgan*, 1 J.H. Aldrich*

1University of Florida/IFAS, 2North Florida Research & Education Center, 155 Research Road, Quincy, FL 32351; 2Department of Environmental Horticulture, PO Box 110675, Gainesville, FL 32611-0675

There is a growing demand for regionally adapted native wildflowers for garden and roadside plantings. Propagation of these species by seed is often difficult or inefficient because dormancy mechanisms are often poorly understood, especially for endemic species. Studies were conducted on seed dormancy mechanisms of Florida ecotypes of Coreopsis leavenworthii, Gaillardia pulchella, and Rudbeckia hirta harvested in June 2001/2002, August 2002, and August 2002, respectively. Within 2 weeks after harvest, seed were buried in meshed bags and subjected to outdoor conditions. Seeds were harvested once per month and germinated under eight alternating temperature regimes (a light) that were based on Florida climate data. Nongerminated seed were tested for viability by a tetrazolium test. Germination of all three species fluctuated over time. Light affected germination of Coreopsis but had little effect on germination of Gaillardia or Rudbeckia through March 2003. Dormancy mechanisms for these species will be discussed. Related seed research involving other native wildflowers will be also be presented.

**Germinating Seeds of Wildflowers**

C.C. Baskin*, 1 J.M. Baskin*

1Department of Biology, University of Kentucky, Lexington, KY 40506-0225; 2Department of Agronomy, University of Kentucky, Lexington, KY 40546-0091

The five classes of seed dormancy are physiological (PD), morphological (MD), morpho-physiological (MIPD), physical (PY), and combinational (PY + PD). Based on a sample of 5,250 species from the major vegetation zones of the world, 69.6% of the species have dormant seeds. Among the species with dormant seeds, PD is the most common class, followed (in order of relative abundance) by PY, MIPD, MD, and (PY + PD). A major, first step in trying to break seed dormancy is determining what class of dormancy occurs in seeds of the species under investigation. Thus, we have developed an easy-to-use dichotomous key for the classes of seed dormancy. During the workshop, each class of dormancy, as well as dormancy breaking and germination requirements, will be discussed. Important clues about the environmental conditions required for dormancy break and germination can be obtained from a combined knowledge of the (1) annual temperature and precipitation regimes in the region where the species grows, and (2) reproductive life cycle of the species, e.g., time of seed maturation, dispersal, and germination in nature. Seeds with MD require moisture and species-specific temperature and light/dark conditions for embryo growth and germination. However, seeds with PD or with MIPD require exposure to simulated summer (warm stratification) and/or winter (cold stratification) conditions before they can germinate. Often it is very difficult to decide what dormancy-breaking treatments to use for seeds with PD and MIPD. Thus, we have developed the “move along experiment” to determine if dormancy breaking in water-permeable seeds requires a warm and/or cold stratification pretreatment. The technique requires only a relatively few seeds and involves two germination phenology studies conducted concurrently. Seeds (or fruits) with impermeable coats have an anatomical structure in the impermeable layer(s) that functions as a “water gap.” The water gap opens in response to an appropriate environmental signal, thereby creating an entry point for water. In seeds with combinational dormancy, (1) the dispersal unit must first become permeable to water and then PD must be broken before seeds can germinate, or (2) PD is broken before the seed or fruit coat becomes permeable to water.

**Environmental Physiology of Growth and Development**

Moderator: Luca Corelli-Grappadelli

**8:00 Cell Turgor Pressure and Water Relations of Developing Grape Berries**

Ken Shackel*, 1 Mark Matthews*, 2 Tyler Thomas*

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Several fleshy fruit exhibit a multiphasic growth habit in which two periods of rapid expansion (Stage I and III) are separated by a period of slow or no growth (Stage II). In grape, fruit ripening (e.g., softening and sugar accumulation) commences approximately coincident with the rapid transition from Stage II to Stage III. It is generally believed that the rate of expansive growth in plant cells and tissues increases with increasing cell turgor, but there is also evidence in a number of fruits that softening is associated with a decrease in cell turgor. Hence the simultaneous softening and increase in growth that occurs between stages II and III in grapes indicates that one or both of these beliefs may be incorrect. The relationship of cell turgor to the growth habit and berry softening was investigated by direct measurements of cell turgor with the pressure microprobe, and measurements of berry softening by force/deformation techniques. The turgor of mesocarp cells exhibited a complex pattern during development in which turgor decreased to about 0.1 MPa during the rapid growth of Stage I, then increased to about 0.4 MPa as growth slowed, and finally decreased again prior to the onset of the second period of rapid growth. Hence, there was a generally negative relation of cell turgor to berry growth. There was also an inverse, but nonlinear relationship of turgor to deformability. Most of the decrease in turgor, from 0.4 to less than 0.1 MPa, occurred prior to the significant increase in deformability (softening) that occurred at the end of stage II.
Antisense Inhibition of Sorbitol Synthesis Leads to Carbon Assimilation and Carbohydrate Metabolism of Grape (Vitis labrusca L. cv. Concord) Leaves in Response to Nitrogen Supply

Li-Song Chen, Lailiang Cheng*
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One-year-old grapevines (Vitis labrusca L. cv. Concord) were supplied twice weekly for 5 weeks with 0, 5, 10, 15, or 20 mM nitrogen (N) in a modified Hoagland’s solution to generate a wide range of leaf N status. Both light-saturated CO₂ assimilation at ambient CO₂ and at saturating CO₂ increased curvilinearly as leaf N increased. Although stomatal conductance showed a similar response to leaf N as CO₂ assimilation, calculated intercellular CO₂ concentrations decreased. On a leaf area basis, activities of key enzymes in the Calvin cycle, ribulose-1,5-bisphosphate carboxylase/oxygenase (Rubisco), NADP-glyceraldehyde-3-phosphate dehydrogenase (GAPDH), phosphoribulokinase (PRK), and key enzymes in sucrose and starch synthesis, fructose-1,6-bisphosphatase (FBPase), sucrose phosphate synthase (SPS), and ADP-glucose pyrophosphorylase (AGPase), increased linearly with increasing leaf N content. When expressed on a leaf N basis, activities of the Calvin cycle enzymes increased curvilinearly with increasing leaf N, whereas activities of FBPase, SPS, and AGPase did not show significant changes. As leaf N increased, concentrations of glucose-6-phosphate (G6P), fructose-6-phosphate (F6P), and 3-phosphoglycerate (PGA) increased curvilinearly. The ratio of G6P/F6P remained unchanged over the leaf N range except for a significant drop at the lowest leaf N. Concentrations of glucose, fructose, and sucrose at dusk increased linearly with increasing leaf N, and there was no difference between predawn and dusk measurements. As leaf N increased, starch concentration increased linearly at dusk, but decreased linearly at predawn. The calculated carbon export from starch degradation during the night increased with increasing leaf N. Our results showed that 1) grapes leaves accumulate less soluble carbohydrates under N-limitation; 2) the elevated starch level in N-limited leaves at predawn was the result of the reduced carbon export from starch degradation during the night; and 3) the reduced capacity of CO₂ assimilation in N-limited leaves was caused by the coordinated decreases in the activities of key enzymes involved in CO₂ assimilation as a result of direct N limitation, not by the indirect feedback repression of CO₂ assimilation, via sugar accumulation.

Regulation of Sorbitol Dehydrogenase Activity in Young Leaf Tissues by Sorbitol and Sucrose

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Sorbitol is a primary photosynthetic end product and the principal translocatable carbohydrate in the woody plants of Pomoideae and Prunoideae, which include some important tree fruits such as apple, pear, peach and cherry etc. Sorbitol dehydrogenase (SDH) is the main enzyme for the catabolism of sorbitol in the sink tissues. By changing the supply of the sugars to shoot tips with young leaves, we investigated the regulation of SDH activity. Transgenic apple plants with antisense inhibition of aldose-6-phosphate reductase had less sorbitol synthesis in the source leaves. SDH activity in the shoot tips with young leaves was down-regulated in these transgenic plants and it was highly correlated with the sorbitol concentration in the source leaves. Feeding with sorbitol via transpiration flow led to the enhance of SDH activity in the shoot tips with young leaves, whereas feeding with sucrose resulted in the inhibition of the enzyme activity. These results indicated that the availability of sorbitol and sucrose may regulate SDH activity in vivo. The mechanism for the regulation of SDH activity by sorbitol and sucrose was also investigated.

Crop Load Alters Whole-canopy Photosynthesis in Peach

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This study was conducted in Summer 2001, on two 8-yr-old trees of the cv. Red Gold, grafted on A6 clonal seedling, trained as Y-trellis, at a density of 1274 trees/ha. The trees are in one half Stark orchard at the University’s Sant’Anna Experiment Farm, and were subjected to standard cultural practices (pruning, soil and water management). The trees were hand-thinned 49 days after full bloom (DAFB), by removing either one in 4 fruit (high-crop tree), 75% of natural set retained, or retaining one in 8 fruit (low-crop tree, 12.5% of natural set). The daily light interception profiles of the canopies were determined on June 26, by a custom-built light scanner, which allows to obtain a very detailed map of the light intensities available on the ground under the tree. Eight determinations were made during the day. These data allowed calculation of the amount of light “missing” from under the ground due to the trees (our method does not account for light reflected by the canopy). On July 14 and 15, the gas exchanges of the East and West branches of the two trees were monitored separately, using 4 custom built “balloons” which recorded every 15 minutes the carbon and water exchanges of each of the four branches. However, because of a technical problem arisen in the West chamber of the low-crop tree, only data relative to the Eastern branches are reported. Immediately after the chambers were removed, the leaf area of both trees was determined, to express photosynthesis and transpiration on a leaf area basis. The low-crop tree had higher total light interception during the day, and also greater leaf area. Whole tree average instantaneous photosynthesis was higher on the low-cropping tree, following the greater light interception caused by...
by a more developed canopy. However, specific light interception and photosynthesis (per unit leaf area) were both greater in the high-cropping tree. The presence of the fruit caused a shift in partitioning of resources which reduced leaf area, but improved leaf photosynthetic efficiency, in accordance to previous findings in apple.

9:15  Growth and Photosynthesis of Lettuce Grown Under Red and Blue Light-Emitting Diodes (LEDs) with Supplemental Green Light
Hyeon-Hye Kim1, Gregory Goins2, Raymond Wheeler1, John Sager6
1National Research Council Resident Research Associate, NASA Biological Sciences Office, 2Advanced Life Support and Space Biology, DynaGas Corporation, 6Biological Sciences Office, NASA

Plants will be an important aspect of future long-term space missions. Lighting systems for plant growth chambers will need to be lightweight, reliable, and durable, and light-emitting diodes (LEDs) have these characteristics. Previous studies demonstrated the combination of red and blue LEDs as an effective light source for several crops. The addition of green supplemental lighting could offer more benefits, since green light can better penetrate the plant canopy and potentially increase plant growth by increasing photosynthesis from the lower canopy leaves. There is also a psychological benefit for the crew, since most plant leaves would appear green with the supplemental light similar to a natural setting under white light. In the preliminary study, lettuce plants grown under red and blue LEDs were compared to plants given an additional 5% (6 µmol·m–2·s–1) of green light. Light study, lettuce plants grown under red and blue LEDs were compared to plants given an additional 5% (6 µmol-m2-s-1) of green light. Light and CO2 photosynthesis response curves were measured along with several additional physiological parameters. There was no significant difference between the treatments. The use of green light at the 5% level would be beneficial, since the supplemental green light did not impact plant growth, it provided useful photosynthetically active radiation to the lower canopy once the light was absorbed, and the plants appeared green and healthy. The current research will continue the evaluation of supplemental green light, but at higher levels to determine the physiological effects on lettuce.

9:45  Exploring the Limits of Lettuce Productivity in a High Light, High Temperature, and High CO2 Environment
Jonathan Frantz*, Justin Robinson, Bruce Bugbee
Plants, Soils, and Biometeorology, Utah State University, Old Main, Logan, UT, 84321-4820

Rapid growth rates of lettuce can result in a calcium deficiency disorder called tipburn, which greatly reduces its marketability and quality. Because of the tradeoff between productivity and quality, the limits of lettuce growth have not been explored. We examined techniques to achieve high productivity while maintaining high quality. We were able to eliminate tipburn by blowing air through a tube onto the meristem. With this technique, there was no tipburn even at a PPFD of 57 mol per m2 per day (1000 mol per m2 per s; 16 hour photoperiod). When CO2 was elevated to 1200 ppm, the temperature optimum increased by 5 to 10 °C and leaf expansion, radiation capture, and yield almost doubled. Quantum yield (mol C fixed per mol of photons absorbed) was highest in the warmest temperature (33 °C) in elevated CO2. The use of supplemental electric lights usually results in an abrupt light/dark transition. Gradually increasing light and temperature in the morning and afternoon substantially reduced tipburn severity, presumably because plant water relations gradually changed at the light/dark transition. This ramping may help reduce tipburn in controlled environment production. These results provide insight into the factors limiting lettuce production, and suggest management techniques to increase productivity without sacrificing quality.

10:00  Fresh and Dry Weight Partitioning in Radicchio Lettuce cv. Firestorm Grown Under Infra-red Filtering and Light Diffusing Films
J. Mark Fletcher1, Richard Henbest2, James Carew1, Paul Hadley1
1Horticulture and Landscape, University of Reading, Whiteknights, University of Reading, Reading, Berkshire, RG6 6AS, United Kingdom, 2AGRI, BPI, Yarm Road, PO Box 343, Stockton-on-Tees, Cleveland, TS18 3GE, United Kingdom

It is widely acknowledged that every 1% reduction in light transmission will have a similar effect on crop yield. Manufacturers of polythene for greenhouse cladding have reached the limit in terms of current technology, for increasing PAR (photosynthetically active radiation) transmission of films. The highest light transmissions are now in the region of between 92% and 700mm (PAR). Therefore, a new approach is needed to increase yields further. Normally on a clear day the incident light is mainly in the form of direct beam radiation. However, on a cloudy day, light is scattered by the clouds and therefore reaches the earth mainly as diffuse light. This light can penetrate further into the crop as it enters at various angles and so can increase the efficiency of crop photosynthesis by a theoretical 15% compared to direct radiation. Using this theory there is scope for polythene manufacturers to improve yields by producing a film that will scatter the light as it passes through it converting direct beam radiation to diffuse radiation. The object of this work was to investigate the effects of two highly diffusing films with different PAR transmissions on crop growth in radicioto cv. Firestorm compared with two control films with their transmissions balanced to match the PAR transmissions of the diffusing films using shade netting. Significant differences were noted between treatments with Luminance THB producing the heaviest total and head weight and the white tint film the lightest (23% and 34%, respectively). These differences were similarly reflected in dry matter accumulation. These results are discussed in relation to the changes in the plant environment on fresh and dry matter accumulation.

Physiological and Genetic Factors Contributing to Flower and Fruit Abscession of the ‘Hass’ Avocado
Lauren Garner*, Carol Lovatt
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The ‘Hass’ avocado (Persea americana Mill.) is characterized by extremely low fruit set (<1%). To develop strategies for increasing yield under California growing conditions, flower and fruit abscession were quantified and factors contributing to abscession were identified. Nets were placed under ten trees in a commercial ‘Hass’ orchard in Carpinteria, CA and major periods of abscession were determined by collecting and quantifying flowers and fruit that abscessed from individual trees during 2 crop years. Consistent, distinct periods of abscession were observed each year. Factors influencing these periods of drop were investigated by several techniques. Abscised flowers were evaluated microscopically to quantify pollen grains, pollen tube growth and ovule viability to estimate the proportion of flowers that were unpollinated and unfertilized. Embryo and seed deterioration of abscessed and retained fruitlets were compared using Evan’s blue dye. Radio-immuno assay was used to measure differences in the hormone profile and titers between abscessed fruit and those retained by the tree. Microsatellite markers were used to identify the pollen parent of harvested fruit. Outcrossing rates and their relationship to yield were then calculated. From these results, key physiological and genetic factors significantly affecting fruit retention during developmental periods critical to fruit set were identified. The results provide fundamental information vital for the development of corrective measures to increase avocado yield.

Cabbage Yield and Glucobrassicin Concentrations as Affected by Nitrogen and Sulfur Fertility
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Glucosinolates are a class of nitrogen (N) and sulfur (S) containing compounds shown to have cancer-preventing properties and widely found in cruciferous plants. In oilseed rape (Brassica napus L.), high glucosinolates can reduce meal quality, and studies have shown that high N and low S fertility can minimize glucosinolate content of the seed. Based on these findings, the present study was conducted to determine whether N and S fertility affects glucobrassicin, the dominant glucosinolate in cabbage (Brassica oleracea L. Capital group). Field studies on sandy soils low in available N and S were conducted over a two-year period with both green (‘Grand Slam’) and red cabbage (‘Vorox’) cultivars. Treatments the first year evaluated only N rate effects (0, 80, 160, 240 kg ha⁻¹ N) with an adequate S supply (70 kg ha⁻¹ S), while in the second year the interactive effects of N and S were determined. In the first year, cabbage yield increased linearly with N rate, while glucobrassicin concentrations decreased linearly with N rate. The response was consistent over both cultivars, although glucobrassicin concentrations in ‘Vorox’ were approximately three times higher than those in ‘Grand Slam’. In the second year, cabbage yield tended to increase linearly with S application at the high N rate, but the effect at the low N rate was inconsistent. Glucobrassicin concentrations are currently being analyzed. Supported by the SOTA TEC fund.

Tissue Ca in Field-grown Kale
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Ensuring adequate calcium (Ca) consumption has become an important nutritional concern. Sufficient consumption of Ca can help achieve and maintain maximum levels of bone mineral density. Kale is a leafy green vegetable with high levels of Ca and low oxalate content, which can prevent absorption of Ca. The objectives of this study were to measure the effects of different Ca sources and Ca application levels on leaf tissue Ca in ‘Winterbor’ kale. Plants were field grown in consecutive seasons using CaNO₃, CaSO₄, and CaCl₂ as Ca sources. Sources were applied at 75 kg/ha, 150 kg/ha, and 300 kg/ha Ca. Ten plants per treatment were harvested after eight weeks and the 3rd fully opened leaf was collected for analysis. Elements were measured using ICP analysis. Ca level caused a significant increase in leaf tissue Ca for the highest levels compared to the lowest level. Leaf tissue Ca responded significantly to year of evaluation (P < 0.001). During 2001, kale leaf tissue averaged 6916 ppm Ca. In 2002, kale leaf tissue Ca increased to 14,787 ppm when averaged across all treatments. This was likely due to an increase in average daily temperature for 2002. Since Ca follows the transpiration stream, this would increase the flow of Ca to the plant separate from the application rate. Combined results indicate a significant effect of Ca treatment level on Ca accumulation in kale leaf tissue. This increase in leaf tissue Ca would be expected to increase the nutritional contribution of plant-derived Ca in the diet.
8:45 The Canopy Reflectance as a Tool for “Dynamically Optimizing” the Nitrogen Supply in Tomato Crop: A Methodological Approach
Giorgio Gianquinto1, Paolo Sambo*1, Daniele Borsato1, Kathleen Delate2
1 Agronomy and Crop Production, University of Padova, Viale Università, 16, Legnaro, 35020, Italy, 2Agronomy and Horticulture, Iowa State University, 106 Horticulture Hall, Ames, IA 50011

The management of N fertilization through a method called “dynamic optimisation” of nitrogen supply requires the assessment of crop nitrogen status throughout the growing season. A tool for plant analysis, that aroused interest recently, is the Multispectral Radiometer (Cropscan Inc. Rochester, Minnesota), which permits prediction of plant nitrogen status from measurements of crop canopy reflectance. For practical use of this instrument, it is necessary to develop threshold values, below which decrease in yield would be expected. A procedure for the calculation of canopy reflectance threshold value was set using data obtained in a trial on processed tomato conducted in 2002 at the Experimental Farm of the University of Padova at Legnaro, Italy. The trial was included in a long-term experiment aimed to compare the effects of different type of fertilization on crop yield and soil fertility. The experiment was carried out on 60 plots of 30 m² area each. According to a randomised block design with 4 replicates, 5 increasing rates of N (0, 60, 120, 180, 240 kg·ha⁻¹) were factorially combined with 3 fertilization management (mineral only, mineral + incorporation of crop residues with or without poultry manure). Linear-plateau equations were developed for calculating the relationships between canopy reflectance values and relative tomato yield. Different reflectance indices were evaluated (NAVI, TSAVI, NIR/Green, NIR/Red) and used for the calculation of RTV (Reflectance Threshold Value) which represent the limit below which a reduction in yield occurs.

This paper describes the procedure step-by-step and gives RTVs for tomato cv. Perfection.

9:00 Evaluation of Nitrogen Uptake and Efficiency of Use In 5-Year-old Field Grown Sweet Cherry (Prunus Avium L.) Trees Cv. “Sam” Grafted on Standard (Mazzard) and Dwarfing Rootstocks (Gisela 5)
Costanza Zavalloni*, James A. Flore
Horticulture, Michigan State University, PSSB Michigan State University, East Lansing, Michigan, 48824

Sweet cherry dwarfing rootstocks are becoming more popular because of their precocity and higher productivity, relative to standard rootstocks. This research was initiated to determine if dwarfing rootstocks have an influence on nitrogen use efficiency (NUE) when compared to standard rootstocks. The objectives were to evaluate: 1) the NUE (expressed as microgram of N per mg of dry weight) in leaves at different tree phenological stages; 2) the N fertilizer uptake efficiency at different times during the growing season and 3) the efficiency of remobilization of N from leaves at leaf senescence. The experiment was conducted in 2002, using 5-year-old sweet cherry trees of cv. ‘Sam’ grafted on a standard rootstock, ‘Mazzard’ and on a dwarfing rootstock, ‘Gisela 5’. The orchard was located in Copemish, North Michigan, on a sandy-loam soil. During the growing season, 21 g of 15N as KNO₃ were applied three times: at full bloom (10th of May), 41 days after full bloom (DABF), and in fall, at 124 DABF. Shortly after bloom a severe frost eliminated all the existing years’ leaves. Leaves were sampled at 1, 5 and 10 days following the 15N applications, and subsequently every week until leaf senescence occurred. N content and % of 15N were measured in the leaves sampled during the season. Before leaf senescence, trees were enclosed in bird netting bags to collect the leaves to evaluate the amount of total N and N derived from fertilizer lost with leaf fall. NUE did not differ between the two rootstocks during the growing season. NUE was lower at bloom and progressively increased during the season. N from fertilizer started to accumulate in the leaves after only 5 to 10 days from application and was taken up in greater amount when applied at bloom and 41 DABF compared to 124 DABF. Four weeks after the bloom N application, the percent of N from fertilizer was 50% lower in leaves of the standard compared to the dwarfing rootstock. A similar trend was observed five weeks after the 41 DABF application of N. Total N, as well as the amount of nitrogen derived from fertilizer lost with leaf fall, was similar for standard and dwarfing rootstocks. The dwarfing rootstock was as efficient as standard rootstock in terms of nitrogen use but appears to rely more on the N from fertilizer.

9:15 Nitrogen and Phosphorus Fertilization of High Density Apple
Gerry Neilsen*, Denise Neilsen, Linda Herbert, Peter Toivonen
Agriculture and Agri-Food Canada, Pacific Agri-Food Research Centre, Hwy 97, Summerland, British Columbia, VOH 1ZO, Canada

Five new apple cultivars (‘Gala’, ‘Fuji’, ‘Cameo’, ‘Ambrosia’ and ‘Silken’) on M.9 rootstock were planted in 1998 in a high density planting, spaced at 1m within rows, separated by 3 m. Commencing in 1999, and for the past 4 growing seasons, the block has been maintained in a randomized, replicated split plot experimental design involving 8 fertilization main plot treatments each containing 3-tree subplots of each cultivar. Fertilizers were applied with daily irrigation quantities scheduled throughout the orchard block via atometer in order to minimize tree water stress. Fertilization treatments included low (28 mg N/L) and high (160 mg N/L) N-treatments, each applied at 3 different times after bloom including early (first 4 weeks post-bloom), mid-season (4–8 weeks post-bloom), and late applications (8–12 weeks postbloom). Two additional treatments were high early N plus 1) a pulse of P (20 g per tree as ammonium polyphosphate (10–34–0)) in the week following bloom and 2) high early B (0.5 g per tree as solubor) in the first 4 weeks postbloom. In the first 4 growing seasons, best tree performance has been measured for the high, early P-treatment which had significantly increased leaf and fruit P concentrations, highest cumulative yield over all cultivars and reduced incidence of water core in 2001–02. In contrast, much smaller yield increases were associated with increases in fertigation N solution concentration from low to high values. It was possible to increase leaf N concentration at any time during the growing season but effects were reduced for late season N-applications. SPAD-chlorophyll readings, which would be an easier measurement of tree N-status, were related to leaf N concentration for all tested cultivars. However, the relationship tended to deteriorate late in the growing season. There were important differences in leaf and fruit nutrient concentration and initial yield performance among cultivars.

9:30 Kentucky Bluegrass Cultivars with Higher Root Sugar Content Have Greater Root Nitrate Assimilation Potential
Zhongchun Jiang*1, Richard J. Hull1, W. Michael Sullivan1
1 Plant Science, State Univ. of New York, Hodder Hall 116, Cobleskill, NY, 12043, 2 Plant Sciences, Univ. of Rhode Island, 6 Greenhouse Rd, Kingston, RI, 02881, 3 Plant Sciences, Univ. of Rhode Island, Woodward Hall 210C, Kingston, RI, 02881

Selecting crop varieties that can utilize nitrate efficiently and understanding the mechanisms behind their efficient use of nitrate can help breed new crops that will have lower fertilizer N requirements. The objective of this project was to compare five cultivars of Kentucky bluegrass (Poa pratensis L.), Classic, Eclipse, Huntsville, Livingston, and Merit, for their metabolic characteristics in nitrate assimilation that contribute to efficient N use. Nitrate assimilation potential (NAP) and nitrite reduction rate of leaf blades and roots were analyzed using in vivo methods and sugar contents of roots were analyzed using a sulfuric acid/colorimetric method. Relative growth rate of the whole grass was similar in the five cultivars, regardless of the nitrate concentrations supplied, although the 1.0 mM nitrate
9:45 Statistical Grouping of Bedding Plants Based on Lime and Micronutrient Response
Paul R. Fisher**1, Ron M. Wik1, Brandon R. Smith2, William R. Argo3
1Plant Biology, Univ. of New Hampshire, 38 College Road, G28 Spaulding Hall, Durham, NH, 03824, 2Horticulture, Cornell Univ., Plant Science Building, Ithaca, NY, 14853, 3Blackmore Co., 10800 Blackmore Ave., Belleview, MI, 48111
The objective was to group 37 bedding plant cultivars into three nutritional groups representing Fe-inefficient, intermediate, and Fe-efficient plants. Plants were grown in a 70% peat/30% perlite (by volume) medium with three pre-plant lime rates to achieve pH levels averaging 4.98, 5.90, or 6.98. Multivariate analysis methods were used to group cultivars based on chlorophyll content and shoot dry mass at high vs. low pH, presence of leaf necrosis at low pH, and responses of chlorophyll, shoot dry mass, and toxicity symptom to an Fe drench at high pH. The Fe-efficient group was characterized by micronutrient toxicity symptoms at the lowest media-pH, toxicity symptoms followed a drench of Fe-EDDHA [ferric ethylenediaminedi(o-hydroxyphenylacetic acid) 45 mg L−1 Fe], at the highest media-pH, and no decrease in shoot dry mass or chlorophyll content as media-pH increased. Plants from the Fe-efficient group also had higher tissue Fe regardless of media-pH. Pelargonium cultivars dropped pH up to 1.5 units lower than other cultivars, and were grouped with Fe-efficient plants. The Fe-inefficient group was characterized by chlorosis and stunting at high pH, increased chlorophyll in response to an Fe drench at high pH, and no toxicity at low pH or following the Fe drench. Intermediate cultivars sit not tend to exhibit micronutrient toxicity symptoms or severe chlorosis when grown at any media-pH. This simple experimental approach has application for managing nutritional differences between cultivars, and for evaluating generic lines where reduced sensitivity to Fe-nutritional differences might be an important factor in disease development. However, other factors may be related to purple blotch incidence and severity in onions, including cultivar susceptibility, bed height and orientation, and plant spacing. Experiments were carried out in 2001 and 2002 in order to investigate the effects of chemical resistance activators and raised beds on purple blotch disease incidence and onion yield. The experiments were conducted at the Michigan State University Muck Soil Research Station, Laingsburg, Michigan. Onion cultivars Spartan Supreme, Altisimo and T-439 were sprayed with the following chemicals: 1) Acibenzolar-S-methyl (ASM) 20 ppm, 2) β-amino butyric acid (ABAB) 10 mg, 3) Methyl Jasmionate (MeJA) 10 mg, 4) Fungicides chlorothalonil 54% (1.68 kg a.i./ha) alternated with copper hydroxide 4.5 L.F. (0.84 kg/ha) and mancozeb 200 DF (1.09 kg/ha). In year 2002 we added a treatment combining MeJA 10 mg with fungicide chlorothalonil 54% (1.26 kg/ha) alternated with maneb (1.34 kg a.i./ha) or iprodione 4F (0.28 kg a.i./ha). Treatments were applied at 3, 5 and 7-leaf stages. One week after the last application, onion plants were sprayed with a solution of 8,500 spores/mL of A. porri added to surfactant Herbinmax 1%. At 23 days after inoculation in 2001, control plants had almost twice the number of lesions/plant as those treated with MeJA or fungicides commonly used in onions. Meanwhile, plants sprayed with ASM had 24 lesions/plant as those treated with MeJA or fungicides commonly used in onions. Purple blotch incidence was reduced with MeJA, total and marketable yield was the same among the treatments in 2001. Yields were reduced by MeJA and MeJA+fungicide treatments in 2002, thus requiring further experiments regarding dosage. Flat and raised beds were compared in 2001 and 2002. Spartan Supreme, Hoopla, and T-439 were seeded in 2001, and S. Supreme, Hoopla and Norstar in 2002. Flat beds had lower plant stand than raised beds, 34% and 22% reduction in plant stands in 2001 and 2002, respectively. Disease severity rating was 4 for flat beds (scale: 1 = <5% of leaf area affected by the disease, 5 = >70% of leaf area affected by the disease) compared to 3 for raised beds at 100 DAP in 2001. Total and marketable yield was greater in raised beds in 2001, and total yield was greater in raised beds in 2002, indicating that the use of chemical induced resistance activators and raised beds may reduce purple blotch incidence in the field, and maintain a higher plant stand. This new approach to disease control may offer a possibility of reducing fungicide application in onions.

10:00 Ericoid Mycorrhizal Colonization in Wisconsin Cranberry Beds
Kevin Kosola1, Beth Workmaster
Horticulture, University of Wisconsin, Madison, 1575 Linden Dr, Madison, WI, 53706
Do ericoid mycorrhizae play a role in nitrogen nutrition of cultivated cranberry? We collected soil and root samples from 100 cranberry beds throughout Wisconsin in June 2002. 19 different cranberry varieties were sampled. Among the 100 beds, substrates ranged from peat to deep sand, bed age ranged from 1 to 73 years, and soil pH ranged from 3.8 to 6.5. Preliminary data on colonization rates indicate that 80% of root length is colonized within 3 years in “Stevens” beds growing on deep sand. Multivariate analysis will indicate which factors had the greatest effect on root colonization (variety, bed age, soil pH, and bed substrate).

8:00 Induced Disease Resistance and Raised Beds Reduce Purple Blotch Disease of Onion
Jorge Arboleya*1, Bernard Zandstra1, Andrea da Rocha2, Irvin Widders1, Ray Hammerschmidt1
1Dept. of Horticulture, Michigan State University, 288 Plant and Soil Sciences Bldg., East Lansing, MI, 48824, 2Dept. of Plant Pathology, Michigan State University, 62 Plant Biology Bldg., East Lansing, MI, 48824
Purple blotch, caused by Alternaria porri, causes significant economic losses in Michigan onion production. Adverse weather is an important factor in disease development. However, other factors may be related to purple blotch incidence and severity in onions, including cultivar susceptibility, bed height and orientation, and plant spacing. Experiments were carried out in 2001 and 2002 in order to investigate the effects of chemical resistance activators and raised beds on purple blotch disease incidence and onion yield. The experiments were conducted at the Michigan State University Muck Soil Research Station, Laingsburg, Michigan. Onion cultivars Spartan Supreme, Altisimo and T-439 were sprayed with the following chemicals: 1) Acibenzolar-S-methyl (ASM) 20 ppm, 2) β-amino butyric acid (ABAB) 10 mg, 3) Methyl Jasmionate (MeJA) 10 mg, 4) Fungicides chlorothalonil 54% (1.68 kg a.i./ha) alternated with copper hydroxide 4.5 L.F. (0.84 kg/ha) and mancozeb 200 DF (1.09 kg/ha). In year 2002 we added a treatment combining MeJA 10 mg with fungicide chlorothalonil 54% (1.26 kg/ha) alternated with maneb (1.34 kg a.i./ha) or iprodione 4F (0.28 kg a.i./ha). Treatments were applied at 3, 5 and 7-leaf stages. One week after the last application, onion plants were sprayed with a solution of 8,500 spores/mL of A. porri added to surfactant Herbinmax 1%. At 23 days after inoculation in 2001, control plants had almost twice the number of lesions/plant as those treated with MeJA or fungicides commonly used in onions. Meanwhile, plants sprayed with ASM had 24 lesions/plant as those treated with MeJA or fungicides commonly used in onions. Purple blotch incidence was reduced with MeJA, total and marketable yield was the same among the treatments in 2001. Yields were reduced by MeJA and MeJA+fungicide treatments in 2002, thus requiring further experiments regarding dosage. Flat and raised beds were compared in 2001 and 2002. Spartan Supreme, Hoopla, and T-439 were seeded in 2001, and S. Supreme, Hoopla and Norstar in 2002. Flat beds had lower plant stand than raised beds, 34% and 22% reduction in plant stands in 2001 and 2002, respectively. Disease severity rating was 4 for flat beds (scale: 1 = <5% of leaf area affected by the disease, 5 = >70% of leaf area affected by the disease) compared to 3 for raised beds at 100 DAP in 2001. Total and marketable yield was greater in raised beds in 2001, and total yield was greater in raised beds in 2002, indicating that the use of chemical induced resistance activators and raised beds may reduce purple blotch incidence in the field, and maintain a higher plant stand. This new approach to disease control may offer a possibility of reducing fungicide application in onions.

8:15 Assessing the Effect of Spotted Tentiform Leafminer Injury to Apples
Kuo-Tan Li*1, Alan N. Lakso1, Jan P. Nyrop2
1Department of Horticultural Sciences, New York State Agricultural Experiment Station, Cornell University, 630 West North Street, Ithaca, NY 14853, 2Department of Plant Pathology, Michigan State University, 62 Plant Biology Bldg., East Lansing, MI, 48824
The objective of this experiment was to determine if inoculating apple trees with area affected by the disease) compared to 3 for raised beds at 100 DAP in 2001. Total and marketable yield was greater in raised beds in 2001, and total yield was greater in raised beds in 2002, indicating that the use of chemical induced resistance activators and raised beds may reduce purple blotch incidence in the field, and maintain a higher plant stand. This new approach to disease control may offer a possibility of reducing fungicide application in onions.
Geneva, NY, 14456, 1Department of Entomology, New York State Agricultural Experiment Station, Cornell University, 630 West North Street, Geneva, NY, 14456

Current integrated pest management guidelines (IPM) suggest two mines per leaf as a treatment threshold for spotted tentiform leafminer (STLM, Phyllonorycter blancardella F.). However, studies of STLM damage in apple trees are few and inconclusive. To evaluate the effects of STLM on leaf and canopy photosynthesis as well as fruit growth, experiments were carried out on McIntosh and Red Delicious apple trees with natural and simulated STLM injury. The results showed that a single STLM mine typically occupies about 0.5 cm², or 2% to 2.5% of the area of an average leaf, yet the visual injury appears much more severe. We found no statistically significant effect on photosynthesis of up to 10 mines per leaf. The green tissue remaining within the mined area might continue to photosynthesize, thereby reducing the effect of the mined area. In addition, mining by STLM might reduce the overall efficiency of leaf tissue and photosynthesis within the mined area. Natural STLM injury distribution within the canopy was simulated on trees in the field by punching holes in leaves with hose punchers. Although treatment with nine mines per leaf could remove more than 20% leaf area from a single leaf, it reduced total canopy leaf area by only about 8%, and the canopy photosynthetic efficiency was not significantly affected. STLM injury did not influence fruit size or quality, a result expected based on carbon balance modeling. However, natural STLM injury (averaging five mines per leaf) induced early, preharvest fruit drop in McIntosh trees. The result indicates that the current IPM threshold for STLM overestimates the impact of STLM in apple trees other than McIntosh. In comparison, thresholds for European red mite have been found to be much closer to the biological threshold for carbon-based reductions in fruit growth.

8:30
Sweet Corn Tolerance to Nicosulfuron and Mesotrione C. Edward Beste*
Dept. Natural Resource Sciences and Landscape Architecture, Univ. Maryland, 27664 Nanticoke Rd., Salisbury, MD, 21801

Post-emergence herbicides nicosulfuron and mesotrione provide alternatives to triazine herbicides for sweet corn with potentially less soil residual for successive vegetable crops. Weed competition was eliminated by pre-emergence, S-metolachlor applied to all treatments. Mesotrione·0.21 kg/ha (2X rate) postemergence on sweet corn ‘Dynamo’, Su and ‘Bonus’, Se caused 60% and 40% chlorosis, respectively, with the spray additive combination of urea and ammonium nitrate (UAN) (1.5% v/v) plus crop oil concentrate (1% v/v) with 142 L/ha spray volume; however, without spray additives, mesotrione caused 10% chlorosis to both varieties. ‘Dynamo’ and ‘Bonus’ yields were unaffected by mesotrione with or without spray additives. Nicosulfuron·0.070 kg/ha (2X rate) postemergence with non-ionic surfactant (0.5% v/v) to 20 cm height sweet corn ‘Bonus’, ‘Dynamo’, ‘GSS 9299’, Sh2 and ‘HMX 8392’, Sh2 reduced growth 0, 6, 15 and 60%, respectively; however, yield reduction occurred only with ‘HMX 8392’. Mesotrione·0.10 kg/ha or nicosulfuron·0.035 kg/ha (X rates or use-rates) postemergence with spray additives did not reduce growth or yields. Nicosulfuron·0.140 kg/ha (4X rate) reduced growth in all varieties, but reduced yields only in ‘Dynamo’ and ‘HMX 8392’. Pre-emergence mesotrione was non-injurious to ‘Dynamo’ or ‘Bonus’ sweet corn. Post-emergence herbicides appear to have greater potential for sweet corn crop injury than pre-emergence and variety tolerance to postemergence mesotrione and nicosulfuron should be determined.

8:45
Pre-emergence Control of Four Weeds Using Granular Formulations of Flumioxazin and Oxadiazon
Robert Stamps*, Annette Chandler
Environmental Horticulture, University of Florida/IFAS/MREC, 2725 Binion Road, Apopka, FL, 32703-8504

Weed control during containerized production of ornamental plants can be very costly unless preemergence herbicides are used. Granular formulations of preemergence herbicides are often preferred because they can be placed directly into containers, thereby reducing herbicide application to areas devoid of plants. In addition, granular formulations generally cause less phytotoxicity than other herbicide formulations. Weed control using one granular formulation of flumioxazin (0.38 kg·ha⁻¹·a.i.) and three of oxadiazon (4.5 kg·ha⁻¹·a.i.) were compared to a granular check (CK) treatment (oxyfluorfen + pendimethalin at 2.2 + 1.1 kg·ha⁻¹·a.i., respectively) and an untreated control (UTC). Ten-cm pots containing a soilless growing medium, placed pot-to-pot, were individually seeded with twenty Chamaesyce hirta, C. maculata or Oxalis stricta or 15 Eclipta alba seeds prior to herbicide treatments. Herbicides were hand broadcast over the one m² plots and irrigated in with 13 mm of water. There were four pots of each weed species per plot and plots were replicated three times in this randomized complete block experiment. Pots were held in full sun and irrigated with 8 mm of water per day. At 16 WAT, all herbicide treatments provided excellent (>98%) control of Oxalis stricta and C. hirta. However, control of C. maculata was less for the experimental formulations of oxadiazon than for the current commercial formulation or the other herbicides. The CK treatment, flumioxazin, and the current commercial oxadiazon formulation all provided good control of eclipta; however, the experimental formulations of oxadiazon failed to control eclipta.

Weed Control during Juneberry (Amelanchier spp.) Establishment
Harlene Hatterman-Valenti*, Paul Mayland
1Plant Sciences, North Dakota State University, 166 Lofstsgard Hall, Fargo, North Dakota, 58105, 1Plant Sciences, North Dakota State University, 166 Lofstsgard Hall, Fargo, ND, 58105

Field trials were initiated near Absaraka and Prosper, ND on a Spottswood sandy loam and Bearden-perella silt loam clay loam, respectively to evaluate cultural and chemical weed control methods during the establishment of Juneberries. Juneberry seedlings (Amelanchier alnifolia L. var. ‘Martin’) were transplanted June 4 at each location. Chemical treatments consisted of pendimethalin 1.85, linuron 1.12, and trifluralin 1.68 kg·ha⁻¹·a.i., respectively. All herbicides were applied prior to transplanting with trifluralin also receiving mechanical incorporation immediately after the spray application. Cultural treatments consisted of black landscape fabric (polypolyethylene with a polyester blend), black and white plastic (6 mil), ground flax straw (10–15 cm depth), wood chips (10–15 cm depth), mechanical cultivation (rototiller), and a rye cover crop that was planted approximately 15 days prior to transplanting. All cultural treatments except the rye were applied the day after transplanting. Visual evaluations of crop injury indicated that all treatments were safe to Juneberry. Tilled hand weeding of plots approximately 6 weeks after transplanting indicated that all treatments required less time to weed compared to the untreated control. At Prosper landscape fabric, black plastic, flax, wood chips, and linuron took the least amount of time to weed while at Absaraka, all treatments except rye and trifluralin had similar low times for weed removal. Common purslane was the most prevalent weed at Absaraka followed by redroot pigweed, common lambsquarters, green foxtail, and yellow foxtail. Weed populations were more evenly distributed at Prosper with yellow foxtail the most prevalent, followed by barnyardgrass, common lambsquarters, green foxtail, redroot pigweed, and common purslane. Black landscape fabric, wood chips, and linuron were the most consistent treatments to reduce the various weed numbers and dry weights at Prosper. Granular matrix sensors and thermisters installed in each treatment at a 15 cm depth, 15 cm from the plant stem following weed removal indicated that plots that had poor weed control such as rye and trifluralin became drier than treatments with wood chips, flax, landscape fabric, and black plastic. An exception occurred with white plastic. This treatment was also consistently drier due to weed growth under the plastic. Flax and wood chips moderated soil temperatures more than other treatments with

Evaluation of Allelopathic Potential of Wood Chips Used for Weed Suppression in Sustainable Fruit Crops Production Systems

James Ferguson1, Bala Rathaiahapathi2, Richard Reichenbach3

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Shredded and chipped wood mulches are often used for weed suppression in citrus, blueberry, and other perennial fruit crops, especially in sustainable and organic production systems. Wood chip mulches containing weed-suppressing allelochemicals may be more effective for weed control than mulches without such properties. Our objective was to test for the presence of water-soluble allelochemicals in wood chips derived from tree species commonly found in wood resource recovery operations in the southeastern U.S. Wood chips (2.5 cm long, and 5–6 g fresh weight per sample) were incubated in 50 mL of water for 24 h at 37 °C. The eluate was filtered using four layers of cheese cloth and a 0.2 µ filter. Presence of allelochemicals in these eluates were evaluated in a lettuce bioassay using seeds of cultivar Green Ice. Eluates of wood chips from red maple (Acer rubrum), swamp chestnut oak (Quercus michauxii), red cedar (Juniperus cymbica) and sweet bay (Magnolia grandiflora) highly inhibited germinating lettuce seeds, as assessed by germination percentage, hypocotyl and root length. The effects of eluates from these four species were more than or equal to, that found for eluates from wood chips of black walnut (Juglans nigra), a species previously identified to have weed-suppressing allelochemicals.

Competitiveness of Livid Amaranth (Amaranthus lividus) with Basil (Ocimum basilicum) as Affected by Phomopsis amaranthicola Applied with Different Surfactants

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A study was conducted to assess the influence of several surfactants on the efficacy of the potential mycoherbicide P. amaranthicola to reduce the competitive ability of the weed livid amaranth with sweet basil. Replacement series (4:0, 3:1, 2:2, 1:3, 0:4 crop:weed) of sweet basil transplants and livid amaranth were sprayed with P. amaranthicola (1x10^6 conidia/mL) 10 and 20 days after weed emergence. The surfactants tested were Ivod (nonylphenol ethoxylate, 0.03%), LI 700 (soy phospholipids + propionic acid, 0.25%), Liberate (lecithin+esters of fatty acids, 0.25%), and PCC 588 (experimental agricultural oil, 2%). The competitiveness of the weed with the crop was determined calculating relative yields from monoculture and mixed populations. When the potential mycoherbicide was not applied, livid amaranth was as competitive as basil. Thirteen days after the second mycoherbicide application, disease incidence in livid amaranth was 100% regardless of the surfactant utilized. However, disease severity differed depending on the surfactant utilized. When P. amaranthicola was applied with LI 700, the competitive ability of livid amaranth with sweet basil was not significantly reduced, whereas the competitive ability of livid amaranth with sweet basil was significantly lower when P. amaranthicola was applied with Liberate, Ivod, and PCC 588. The severity of P. amaranthicola on livid amaranth was higher and the competitive ability of the weed with the crop was lower when the potential bioherbicide was applied with Ivod.

Flame Control for Weed Management in Cabbage and Tomatoes

Annette Wszelaki5, Doug Doohan

Horticulture and Crop Science, The Ohio State University, 1680 Madison Ave., Wooster, Ohio, 44691

In Spring 2002, a field trial was established to control weeds safely, effectively, and economically in vegetable crops without the use of herbicides by employing a flame weeder. Ten-week-old transplants of ‘Peto 696’ tomato and ‘Bravo’ cabbage were treated with a 8-burner row crop flammer both on raised beds and on flat ground and at two times, in the morning and in the afternoon. Varying tractor speeds were used: 0 mph (control), 2.5 mph, 5 mph and 7.5 mph. Relative water content of the 4th leaf from the apex was measured pre- and post-flaming. Plant injury due to flaming (% vs. control) was evaluated 5 and 20 d after flaming. Weed control was evaluated 5, 20, 30, 40 and 50 d after flaming. At harvest, head and core traits were evaluated in the cabbage and diseases and disorders evaluated in the tomatoes that were flamed in the morning. Marketable and total yield were calculated for both crops. In tomato, regardless of flaming time (morning, afternoon), bed type (raised, flat) and speed, relative water content was significantly greater pre-flaming vs. post-flaming. Cabbage results were similar. Regarding tomato fruit quality, on flat ground, the 2.5 mph treatment had significantly less blossom end rot than the other treatments. Total and marketable yield were significantly greater in the 2.5 mph treatment than the 5 mph treatment, which was still greater than the control. On raised beds, the 2.5 and 5 mph treatments had significantly more marketable fruit, higher yields, and less blossom end rot than the 0 or 7.5 mph treatments. With cabbage, heavier heads were produced with the 2.5 mph treatment compared to all other treatments on raised beds; on flat ground the 2.5 mph treatment produced heavier heads than the 0 and 7.5 mph treatments. Marketable yield was greatest in the 2.5 mph treatment, regardless of bed type. Generally, the morning flaming treatments caused more injury to both cabbage and tomatoes plants than the afternoon flaming and the cabbage were more severely affected than the tomato plants, after 5 d. However, by 20 d, there was no evidence of injury in any treatment. Plants on raised beds also tended to be more severely injured than those on flat ground. Afternoon flaming in either crop caused very little injury, but controlled weeds much less effectively than the morning flaming. After 5 d, weed control was most effective in the 2.5 and 5 mph treatments. In all cases, any flaming speed provided greater weed control than the 0 mph control. In cabbage from 20–50 d, the 2.5 mph treatment provided significantly better control than all other treatments. Results were similar for tomato, though the 2.5 mph, raised bed combination was more effective in controlling weeds than the flat ground, as the 2.5 mph-raised bed treatment had 70% weed control at 50 d, while the 2.5 mph-flat ground treatment was no different than the control. Continued research will be carried out to provide the best treatment combinations for each crop.
chronic diseases, and examine the risk of microbial and chemical contamination of fruits and vegetables in human health. Topics will also include how genetic engineering techniques enhance the quality of fruits and vegetables, the content of antioxidants, and other health-protective phytochemicals. The safety assessment of bioengineered foods and consumer attitude along with the media trends will also be covered in this colloquium.

Presentation Order:

8:00–8:10 Shiow Y. Wang* - Introduction
8:10–8:55 H. Denman Scott
8:55–9:40 Jeffrey Blumberg
9:40–10:25 Beverly Clevidence
10:25–11:10 Bruce M. Chassy
11:10–11:55 David B. Schmidt

Chemical and Microbial Hazards Associated with Fruits and Vegetables: Assessing Risk and Communicating These Risks to the Public
H. Denman Scott

An important responsibility of public health agencies is to evaluate outbreaks of infectious disease related to food consumption and to assess potential risks of exposure to chemicals, particularly pesticides that might contaminate fruits and vegetables. This talk will first discuss outbreaks of gastroenteritis related to raspberries contaminated with Cyclospora, the risks of getting sick after eating tainted raspberries, the epidemiologic investigations that sought to ascertain the source of contamination, and the unanswered questions that remained in the wake of a very exhaustive study. The talk will then turn to an unexpected occurrence of ground water contamination with the pesticide Temik (aldicarb) that took place in the potato growing areas of Rhode Island. This agent, used to control a particular potato beetle, was not supposed to taint either potatoes or ground water. The concentrations found in the ground water were minute but, still, the anxiety among the exposed public was enormous. Careful review of the scientific literature and consultations with experts from the Centers for Disease Control showed no scientific basis for a serious threat to the health of the exposed individuals. Risk communication always poses a special challenge for public health officials. Dealing with a disagreeable but not life threatening gastroenteritis is usually more straightforward than dealing with trace chemical exposures that have no immediate impact on health, but that might pose some long term threat such as cancer. The talk will conclude with a discussion of the factors that influence the public’s perception of risk, some of the limitations of science, and methods of discussing these issues with the public.

Dietary Antioxidants of Fruits and Vegetables in Prevention of Chronic Diseases
Jeffrey Blumberg*

Associate Director and Chief, Antioxidant Research Lab, Jean Mayer USDA Human Nutrition Research Center on Aging, Tufts Univ., Boston, MA.

Epidemiologic studies have shown that consumption of diets rich in plant foods, especially fruits and vegetables, are associated with a reduced risk of cancer and cardiovascular disease as well as several other diseases common among older adults. While some of this benefit has been attributed to their content of vitamins C and E and carotenoids, emerging evidence suggests other antioxidants present in plants, particularly polyphenolic compounds like the flavonoids, may also contribute importantly. Major food sources of flavonoids are dependent upon dietary patterns; however, in “Western diets” they include apples, citrus fruits, onions, red wine, and tea. Information about the bioavailability of flavonoids in humans is scarce but most of the studies indicate these compounds are absorbed within a few hours and then rapidly cleared from plasma. Differences in bioavailability have been observed between pure flavonoids and those consumed in foods. Flavonoids have been shown to exert a range of biological activities, including anti-atherosclerotic, anti-inflammatory, anti-tumor, anti-thrombogenic, and anti-viral effects. Flavonoids have the capacity to scavenge reactive oxygen and nitrogen species and complex transition metals like iron. The oxidative modification and inflammation hypothesis of atherogenesis has been consistently supported by experimental data and observational studies. A variety of in vitro studies have shown that flavonoids can inhibit LDL oxidation and work in synergy with α-tocopherol and carotenoids. Flavonoids have also been shown to bind to LDL and subsequently inhibit their uptake by macrophages. Flavonoids can also suppress platelet activation and aggregation via inhibiting the activity of cyclooxygenase and lipoxygenase pathways. The capacity of flavonoids to inhibit some cell signaling pathways may also have a direct impact on the risk for cardiovascular disease as well as cancer. Although supportive epidemiologic evidence is limited regarding flavonoids and cancer, in animal models some of these compounds potently inhibit cell proliferation, block tumor growth, and influence both invasive and metastatic potential. Further, flavonoids have been shown in some systems to inhibit angiogenesis and induce apoptosis.

The Phytonutrients and their Food Sources
Beverly A. Clevidence*, Alanna J. Moshfegh*, Joseph D. Goldman†

†Research Leader, Diet and Human Performance Laboratory; ‡Food Surveys Research Group, Beltsville Human Nutrition Research Center, Beltsville Agricultural Research Center, Agricultural Research Service, U.S. Department of Agriculture, Beltsville, MD

Diet rich in phytonutrients hold promise for preventing disease and thereby extending productive, active life spans. This possibility has produced interest not only in identifying the phytonutrient contents of various foods, but also in identifying which phytonutrient-dense foods Americans eat, and how much and how often they eat them. This paper outlines various phytonutrient classes and identifies foods that provide rich sources of isoflavonoids (e.g., genistein, daidzein, glycitein), glucosinolates (e.g., glucoraphanin, glucobrassicin), flavonoids (e.g., anthocyanidins, isoflavones, catechins, flavonols, flavones, flavanones), and amino acid-based compounds (e.g., allyl sulfur compounds, glucosinolates, capsaicinoids). Additionally, dietary intake data from 9,872 adults 20 years and older from USDA’s 1994-96 Continuing Survey of Food Intakes by Individuals (CSFII) were used to determine average intake, both frequency and amount consumed, for selected fruits and vegetables that carry these phytonutrients. The CSFII provides nationally representative 24-h dietary recall data on the types and amounts of foods consumed by Americans. Of the vegetables rich in carotenoids, tomatoes are the most frequently consumed followed by carrots and corn. Of the vegetables known to contain glucosinolates, cabbage is the most frequently consumed food followed by tea, which is also a major source of catechins, and apple juice. Of the fruits and vegetables containing anthocyanins, strawberries are the most frequently consumed followed by blueberries, raspberries, and cherries.

Bioengineered Fruits and Vegetables, Designer Foods, and Natural Foods: Good for Us, But How do We Know They’re Safe to Eat?
Bruce M. Chassy*

Associate Director, Biotechnology Center, Univ. of Illinois, Urbana, IL

In recent years consumers around the world have displayed increasing interest in a wide variety of dietary supplements, natural foods, functional foods and designer foods that they believe will promote good health and prevent diseases such as cancer. Although there have been many recent research reports confirming that such foods may promote good health, consumer acceptance of these products often runs well
ahead of scientific consensus regarding efficacy. Many consumers view such products as "natural" and therefore inherently safe. In contrast, these same consumers often view synthetic chemicals as unnatural and inherently unsafe. Similar concerns about safety have been raised about the newly introduced varieties of common crops that are now being developed through the use of biotechnology. Biotech crops are, however, subjected to rigorous pre-market safety reviews by the EPA, USDA and FDA. Paradoxically, dietary supplements and designer foods may be marketed without prior safety review. The food safety assessment applied to biotech crops requires evaluation of: 1) the newly added DNA, 2) the safety of the newly introduced gene product, and 3) the overall safety of the balance of the food. The principal issues are: 1) potential toxicity of the newly introduced protein(s), 2) potential changes in allergenicity, 3) changes in nutrient composition, 4) and the presence of any unintended effects giving rise to allergenicity or toxicity. In the near future biotechnology will be applied to the development of crops with elevated levels of key nutrients and/or potentially health-beneficial phytochemicals. “Golden Rice”, a rice variety with greatly enhanced content of beta-carotene is an example. Oilseeds containing enhanced levels of omega-3 fatty acids or Vitamin E have also been developed. Literally hundreds of such products are under development. The acceptance of these products will depend on consumer perceptions and attitudes about biotechnology. While consumers accept familiar risks that can be quantified, they do not readily accept uncertainty about safety. The major risks related to food are food borne illness and the consequences of poor dietary choices rather than biotechnology. In general, good availability of reliable information reduces uncertainty. Biotechnologists and food safety experts are therefore faced with a science communication challenge.

**Current Status, Trends and Prospects of Functional Foods**

David B. Schmidt*

Senior Vice President, Food Safety & Global Relations International Food Information Council, Washington, DC

Scientific knowledge of the health benefits of foods and food components is developing rapidly. Consumers obtain nutrition information from a variety of resources, including the media, food labels, and health professionals, which can contribute to confusion and frustration. In addition, information from the human genome is providing us with tremendous potential to improve the quality of human nutrition in the future. The term “nutrigenomics” has now been coined to describe a new concept in “personalized nutrition” where an individual’s DNA profile will be used to better determine which foods or nutrients they should consume more or less of due to their increased risk for a particular disease or health condition. Using International Food Information Council’s six years of consumer attitudinal research on functional foods and more recently, “personalized nutrition,” this session will provide attendees the tools to evaluate emerging science and put its impact on health into context, while learning to effectively address the challenges and opportunities in communicating the health benefits of foods and food components to consumers.

**9:00 am–9:30 am  WORKING GROUP MEETING**

Production and Harvest Mechanization (MECH) Working Group
Chair: Fumiomi Takeda

**9:00 am–10:20 am  HISTORICAL REVIEW I**

9:00  **Deciduous Tree Fruit**

Frank G. Dennis, Jr.*, Jerome Hull, Jr.
Dept. of Horticulture, Michigan State University, East Lansing, MI 48824-1325

9:20  **Induction and Release of Bud Dormancy in Woody Perennials: A Science Comes of Age**

Rajeev Arora*, Lisa J. Rowland, Karen Tanino

*Dept. of Horticulture, Iowa State University, Ames, IA 50011, †U.S. Dept. of Agriculture—Agricultural Research Service, Fruit Laboratory, Beltsville, MD 20705, ‡Dept. of Plant Sciences, University of Saskatchewan, Saskatoon, SK, Canada, S7N 5A8

9:40  **Perspectives on Germplasm**

Edward J. Ryder*
US Dept. of Agriculture-Agricultural Research Service, 1636 E. Alisal St., Salinas, CA 93905

10:00  **Creating A More Beautiful World: A Century of Progress in the Breeding of Floral and Nursery Plants**

Richard Craig*
The Pennsylvania State University, University Park, PA 16802

**9:00 am–11:00 am  COMMITTEE MEETING**

Membership Committee
Chair: Patricia Knight

**10:00 am–11:00 am  COMMITTEE MEETING**

Technical Program Committee
Co-Chairs: Carl Sams, Dennis Ray

**10:00 am–11:00 am  ORAL SESSION 33**

**Seed and Stand Establishment**
Moderator: To Be Announced

**10:00**  **Gas Diffusion Through Seed Coating Films and Germination of Coated Seed Under Water Stress**

A.G. Taylor*, S-H Kim†, R.B. Hagenmaier‡

*HortSciences, Cornell Univ., 630 W. North St., Geneva, NY 14456, †Citrus & Subtropical, USDA-ARS, 600 Ave. S, NW, Winter Haven, FL, 33881

Film coating is a seed treatment technique used commercially on high-value vegetable and ornamental seeds. Film coating has both a cosmetic and functional role, and the primary functional role is to facilitate seed treatment application. However, the uniform films over the seed surface may alter gas diffusion and thus affect germination. Selected commercial film coating formulations were examined along with a reference film coating mixture of known composition. Permeabilities of O₂ and CO₂, measured for dried coatings of 25µm thickness, were about the same at 50 and 75% relative humidity. Snap bean (Phaseolus vulgaris) seeds were coated with film coating polymers, including a non-coated check. Coated seeds were sown in a sandy loam soil, and the moisture content was increased in one percent increments to the point of saturation. The soil oxygen diffusion rate was measured and decreased sharply as the soil approached saturation. The major factor decreasing germination was oxygen stress, while film coating had a secondary influence.

**10:15**  **Effect of Seed Maturation Temperature on Ethylene Production, Sensitivity to Ethylene and Lettuce Seed Germination**

Ivanka Kozareva*, Daniel Cantliffe*, Russell Nagata
Horticultural Sciences Department, University of Florida, 717 Hull Road, Fifie Hall, Gainesville, FL 32611

The purpose of this work was to establish whether the ability of certain maturation temperatures to increase lettuce thermotolerance was related to increased ethylene production or sensitivity to ethylene. Plants from the thermotolerant cultivar ‘Everglades’ (EVE) and the thermosensitive cultivar ‘Dark Green Boston’ (DGB) were grown at two different temperature regimes: 30/20 °C or 20/10 °C day/night temperatures (D/N). In light and 20 °C germination of all seed lots was 100%. However, at 35 °C, both EVE and DGB seeds matured...
Lettuce \textit{(Lactuca sativa L.)} Seed Quality Evaluation Using the Saturated Salt Accelerated Aging Test and the Seed Vigor Imaging System

Patricia Peñaloza-Aspe, Gerardo Ramirez-Rosales, Mark Bennett, Miller McDonald

1Facultad de Agronomía, Universidad Católica del Valparaíso, Estación Experimental La Palma S/N, Quillota, Chile, 2Horticulture and Crop Science, The Ohio State Univ., 2021 Coffey Road, Columbus, Ohio, 43210

Seed quality assessment is crucial for outstanding performance of lettuce \textit{(Lactuca sativa L.)} plants. The standard germination test has been used extensively to evaluate seed quality in lettuce. However, this test is conducted under ideal conditions, which are rarely found in the field. Consequently, it is necessary to evaluate other tests that better indicate how seeds might perform under wider range of environmental conditions. Experiments were conducted in the Seed Biology Laboratory at The Ohio State University (OSU, Columbus, OH). Six varieties of lettuce differing in seed coat color were evaluated in this study. Each variety included four different seed lots making a total of 24 treatments. Standard germination, saturated salt accelerated aging (SSAA, 48 and 72 h), greenhouse emergence and automated seed vigor tests were used to assess seed quality. Results indicated that lettuce varieties with white coated seeds had lower germination percentage, greater seed deterioration as indicated by the SSAA test, and lower seed vigor as determined by the OSU Seed Vigor Imaging System (SVIS) compared to black coated seeds. Similarly, white coated seeds consistently showed a higher fungus incidence during SSAA compared to black coated seeds. Seed lots having an initial germination percentage greater than 98% were slightly affected by SSAA (48 h) with 11.5% reduction. However, seed lots having germination percentages lower than 80% resulted in a 40% reduction in germination after 48 h SSAA. A similar trend was observed when seeds were subjected to SSAA for 72 h. These findings demonstrate that, in general, white-coated lettuce seeds display poorer quality than dark coated lettuce seeds. Both the SSAA and SVIS vigor assessment systems were superior to the standard germination test in evaluating lettuce seed quality of both seed coat colors.

10:45 Pollinator Effects on Seed Production in Greenhouse-Grown Herbaceous Ornamental Plants

Susan Stieve, David Tay

Ornamental Plant Germplasm Center, The Ohio State University, 670 Vernon Tharp St., Columbus, OH, 43210-1086

Seeds of herbaceous ornamental accessions conserved by the United States Department of Agriculture’s National Plant Germplasm System are traditionally produced in summer field cages with honey bees \textit{(Apis mellifera)} when pollinators are required. Efficient methods to produce high-quality seed in sufficient quantity in greenhouses may allow for year-round seed production. The effects of pollinating insects on number and weight of seed produced were studied in greenhouses at the Ornamental Plant Germplasm Center in 2002 in a randomized complete block experiment with two replications. Honey bees or bumblebees \textit{(Bombus impatiens)} were used as pollinators; one colony was placed in each greenhouse compartment. Controls included greenhouse compartments with no pollinator and field cages with honey bees. Cultivars evaluated included \textit{Cosmos sulphureus} ‘Bright Lights’, \textit{Melampodium paludosum} ‘Showsta’, \textit{Rudbeckia hirta} ‘Indian Summer’, \textit{Zinnia elegans} ‘Rose Starlet’, \textit{Antirrhinum majus} ‘Rust Resistant Yellow’, \textit{Dianthus chinensis} ‘China Doll’, and \textit{Phlox drummondii} ‘Palona Violet with Eye’. Seeds were harvested, cleaned, counted, weighed; 1000-seed weights were calculated. \textit{Cosmos}, \textit{Melampodium} and \textit{Rudbeckia} yielded more seed per plant on average in field cages than in greenhouse compartments, and \textit{Antirrhinum}, \textit{Dianthus} and \textit{Phlox} produced more seed on average with greenhouse pollination. \textit{Zinnia} produced similar seed quantities in all treatments. In the greenhouse, \textit{Antirrhinum}, \textit{Cosmos}, \textit{Dianthus}, \textit{Melampodium}, \textit{Rudbeckia} and \textit{Phlox} yielded more seed on average with bumblebee pollination than with honey bees or no pollinators. Each genus had similar 1000-seed weights on average in all treatments. Results suggest that bumblebee pollination in greenhouses may be an alternative method for seed production from herbaceous ornamentals.

Sunday, Oct. 5 · Morning–Oral 33–Oral 34

10:00 am–11:45 am · ORAL SESSION 34

556A Commercial Horticulture

Moderator: To Be Announced

10:00 Evaluation of Commercial Phytophthora Resistant Peppers

William H. Tietjen, Peter J. Nitzsche, Wesley Kline

1Rutgers Cooperative Extension, Rutgers University, 165 County Rd 519 S, Belvidere, New Jersey, 07823-1949, 2Rutgers Cooperative Extension, Rutgers University, PO Box 900 - Court House, Morristown, New Jersey, 07963-0900, 3Rutgers Cooperative Extension, Rutgers University, 291 Morton Ave., Millville, New Jersey, 08332-9776

Phytophthora blight of peppers caused by the soil-borne fungus, \textit{Phytophthora capsici}, is the most destructive and widespread disease of peppers in New Jersey. Two new hybrids, Paladin and Aristotle, have been developed with resistance to \textit{Phytophthora} blight. These disease resistant hybrids are the only option for some growers in northern New Jersey with limited land available for production. Trials were conducted (1999-2002) to compare the performance of Paladin and Aristotle to standard commercial cultivars. Paladin and Aristotle produced fruit of excellent quality and high yields in the trials.

10:15 Fumigant and Herbicide Combinations for Pest Management in Plasticiculture Production of Fresh Market Tomato and Cucumber

Doug Sanders, Lisa Ferguson, David Monks, Frank Louws

1Hort. Science, NC State Univ., Box 7609, NCSU, Raleigh, NC, 27695, 2Plant Pathology, NC State Univ., Box 7609, NCSU, Raleigh, NC, 27695

Methyl bromide (MB) is commonly used to manage weeds, pathogens, nematodes and soilborne insects which limit crop productivity. MB phase-out, coupled with the essential need for weed control, presented an opportunity to evaluate new chemical methods of weed control. Combinations of pre-plant alternative fumigants, metam-sodium (MS) and Telone-CT5 (TC), and herbicides should give the desired control of pests in cucumber and tomato. We aimed to identify a fumigant or fumigant/herbicide combination effective at controlling weeds, but not injurious to the crop. A split-plot design used three soil treatments, TC (35 gal/A), MS (75 gal/A) and non-fumigated (NF), as main plots and 12 weed management treatments as subplots. Weed management treatments for each crop will be discussed in detail... Cucumber yields differed among fumigants in both years. In 2000, both TC and MS improved control of purslane and carpetweed compared to NF control plots. In 2000 and 2001, hand weeded...
control plots produced the highest total and marketable cucumber yield, but several weed control strategies performed equally well. Plots treated with multiple applications of Premer and/or Alanan did not improve cucumber yields or quality above single applications of either product alone. In both years TC produced greater tomato yields than MS and NF plots. Tomato plant mortality by Sclerotium rolfsii infection was reduced in both years in TC plots compared to NF, with MS intermediate. Final root rot and root knot nematode galling severity was significantly reduced in TC treated plots compared to MS and NF plots, but did not differ in 2001. Weed counts, were equivalent to hand weeding in: Halo PRE and POST, D1 and D2, PF, Metribuzin 1 and 2, and the Grower’s Mix.

10:30 **Niche Market Dry Bean Variety Trial**
Carol Miles*, Madhu Sonde*

*Horticulture and Landscape Architecture, Washington State University, Vancouver Research & Extension Unit, 1919 NE 78th Street, Vancouver, WA, 98665; Extension, Washington State University, Vancouver Research & Extension Unit, 1919 NE 78th Street, Vancouver, WA, 98665

Niche market dry beans are well suited to small-scale and direct market production: they are easily stored and are a good addition at market at the beginning and end of the growing season. We conducted an organic variety trial of dry bean niche market varieties that included 53 varieties in 2001 and 64 varieties in 2002. Earliness was the key to variety suitability in the Pacific Northwest, and most varieties matured by 139 DAP. In this trial, the highest yielding types were Pinks, Cranberry, Dark Red Kidney and White Kidney. Highest yielding varieties were G-18689, NW-63, Etna, Montcalm and Magpie. Mean weight of 100 beans was 47.25 g, and differed significantly among varieties. Varieties with greatest 100-bean weight were Candy, Mansel Magic, Etna, Trout/Jacob’s Cattle, Old Fashioned Soldier, Cardinal and CELRK. Seed borne Virus and Halo Blight (Psedomonas syringae) may be a problem for some seed sources. We have developed a web page that describes dry bean varieties to facilitate variety selection by farmers for niche markets, http://SustainableSeedSystems.wsu.edu/NicheMarket/BeanVarieties.pdf. The type, color, pattern and size of dry beans play a large role in variety selection for niche markets.

10:45 **Norman J. Smith Pioneer in Plasticulture**
Wesley Kline*, Christopher Bylone

Department of Agricultural and Resource Management Agents, Rutgers Cooperative Extension, 291 Morton Ave., Millville, NJ, 08332

Norman Smith was born on a dairy farm in New York, received a Bachelors degree from Cornell University in 1949, and a Masters degree from Michigan State University in 1959. He pioneered work with plastic film mulch and drip irrigation in the United States and extended those benefits to agriculturists in South Africa, Canada, Japan, and Northern Europe. Many farms have adopted the highly productive and efficient plant production techniques of intensive food production systems promoted by Smith. The production of quality vegetable transplant seedlings grown in flats, within plastic film covered greenhouses became standard grower practice during his career. He collaborated with Richard Chapin of Chapin Watermatics to develop new technology now used worldwide. In 1993, the American Society for Plasticulture commemorated their historic work at the site of the first row crop drip irrigation plastic film mulch trial established in 1963 at Old Westbury Gardens in Westbury (Long Island), New York. Smith supported the National Agricultural Plastics Association (NAPA) from the 1960’s and was elected president in 1975. He helped organize the 7th International Agricultural Plastics Congress and was elected president of the organization. Smith received a patent related to drip irrigation. For the last 16 years of his career, he was a professor at Cook College, Rutgers University Cooperative Extension Service, as County Agent of Cumberland County. Smith was named Distinguished Professor II of Agricultural Science at Rutgers University, the only county agent to have this prestigious rank the highest academic level at the University.

11:00 **Peat-based Growing Medium Amended with Bacillus Subtilis to Improve Plant Protection and Growth Stimulation**
Edward J. Bloodnick*, Annie Bourassa*

*Premier Horticulture, 127 South, Fifth Street, Quakertown, PA, 18076; 1Premier Horticulture, 5, Avenue Premier, Riviere-du-Loup, Quebec, GSR 6C, Canada

The interest for biological control agents is increasing these days. According to this fact, it would be worthwhile for the greenhouse growers to use a biological control agent that can protect plants and stimulate their growth. In this perspective, a research project has been initiate to evaluate the survival and the efficacy of the bacteria Bacillus subtilis to control damping-off diseases and improve plants growth. The bacteria was previously diluted in water and incorporated into a germination mix (Pro-Mix PGX®) and a transplant mix (Pro-Mix BX®). Chemical and physical analysis has been done at the growing medium production and after 3, 6 and 12 months. Greenhouse tests were conducted with vinca and tomato for the growth stimulation and on geranium and basil for the protection against Pythium ultimum and Fusarium oxysporum basilicum, respectively. The presence of the bacteria in the growing medium did show an improvement of the plants growth compared to their control. Moreover, we observed a biofungicidal activity against Pythium ultimum and Fusarium oxysporum basilicum since the pourcentage of healthy plant is mostly higher with a mix amended with Bacillus subtilis. The results shows that Bacillus subtilis present a strong efficacy for biostimulation and biofungicidal effects when incorporated in growing medium Pro-Mix PGX® and Pro-Mix BX®.

11:15 **Root-knot Nematode Control on Cucumbers Using Drip Irrigation and Fumigants**
Peter Probasco*, Stephen Johnston*

*1Agricultural Agents, Rutgers University, 51 Cheney Road, Woodstown, New Jersey, 08098; 2Plant Biology, Rutgers Research and Extension Center, 121 Northville Road, Bridgetown, New Jersey, 08302

Root-knot nematode, Meloidogyne hapla, is a problem on late season cucumbers in southern New Jersey when grown on loamy sand or on sandy loam soils. This study compared the use of a soil fumigant, metam-sodium, to a nematicide, oxamyl, on cucumbers. The metam-sodium was injected through 3 drip irrigation lines 2 weeks before seeding at a rate of 50 gal/acre. The oxamyl was applied through the drip irrigation at 1 gal/acre (preplant) + 2 quarts/acre (post-plant) + 2 quarts/acre (post-plant). A combination treatment of 50 gal/acre metam-sodium (preplant) + 2 quarts/acre (post-plant) + 2 quarts/acre (post-plant) of oxamyl was also included. The cucumbers were rated for vine growth and harvested 7 times during the season for yield. Roots were dug up at the end of the trial and evaluated for galling under the galling index system (GIS). Root-knot nematode levels were high in this study and the nematode-treatment showed significant greater yield, vine growth, and reduced gall formation than the untreated check. Oxamyl treatments were not significantly different than the untreated check in total yield and vine growth. The addition of oxamyl post plant applications to the preplant metam-sodium application was not significantly better than the metam-sodium alone treatment in all parameters measured.

11:30 **The Effects of pH and Water Alkalinity on Growth and Nutrient Uptake of Pelargonium × Horticum**
Carinne A. Peters*, Marla S. McIntosh

Dept of Natural Resource Science and Landscape Architecture, University of Maryland, 6115 Plant Sciences Bldg, College Park, MD, 20742

Since 1995, the appeal of new varieties of geraniums for home and landscape use has triggered a 40 million dollar increase in revenue for the horticultural industry. (USDA, 2001). Regarding greenhouse plant production systems promoted by Smith.

10:15 Root Colonization and Growth Response of Mycorrhizal Plant Hosts Inoculated with Commercial VAM Products
Eric Wiseman*, Dr. Christina Wells
Horticulture, Clemson Univ., 179 Poole Ag. Center, Clemson, SC, 29634

Manufacturers of commercial vesicular-arbuscular mycorrhizal (VAM) inoculum claim that their products provide numerous benefits to landscape trees: increased water and nutrient uptake, better tolerance of environmental stresses, and protection from soil-borne pathogens. However, commercial VAM product trials on landscape trees have demonstrated few measurable benefits. Absence of plant benefits may be due to the application of non-viable inoculum: exposure to adverse conditions during manufacture and shipping may inactivate the product before it is applied to the host plant. We tested 7 commercial VAM inoculum products marketed for landscape trees to assess their viability at the time of purchase. The effects of 8 inoculum treatments (7 commercial products + control) on shoot dry weight and percent mycorrhizal colonization were assessed on three harvest dates (2, 4, and 8 weeks post-germination) using corn (Zea mays L. ‘Viking 6062’) as the mycorrhizal host. Corn seeds were sown in individual pots containing a steam-pasteurized sand/soil media (2:1 v/v). Inoculum products were incorporated into the media at 1:10 v/v prior to seedling establishment. At each harvest interval, shoots were oven-dried and weighed, and root sub-samples were stained with trypan blue and assessed for fungal colonization. At 2 weeks post-germination, 3 VAM products produced significantly greater mycorrhizal colonization than the control (P = 0.0001; n=8), and 1 product produced significantly greater shoot dry weight (P = 0.0049; n=8). At 4 weeks, all products produced significantly greater shoot dry weights than the control treatment (P = 0.0001; n=8). At 8 weeks, 6 products produced significantly greater shoot dry weights than the control treatment (P = 0.0001; n=8), and the shoot dry weights of inoculated plants were 1.8 times greater those of control plants. All of the commercial VAM inoculum products that we tested were viable and capable of infecting a mycorrhizal host. Whether these products are also capable of infecting landscape trees is unknown. We are currently testing the ability of 4 commercial VAM products to improve growth and mycorrhizal colonization of 2 endomycorrhizal woody species, Acer buergeranum and Magnolia virginiana, in the greenhouse.

10:30 Moisture and Hypoxia Influence Localized Occurrence and Anatomy of Nodules on the Wetland Shrub Alnus maritima
Heidi A. Kratsch*, William R. Graves
Department of Horticulture, Iowa State University, 106 Horticulture Hall, Ames, IA, 50011-1100

Although many Alnus spp. grow in wet soils, none is as closely associated with the low-oxygen, waterlogged soils of wetlands as Alnus maritima (Marsh.) Muell. ex Nutt. (seaside alder). An actinorhizal species with promise for use in horticultural landscapes, land reclamation, and sustainable systems, A. maritima symbiotically associates with Frankia bacteria, thereby forming root nodules in which gaseous nitrogen is fixed. Our objective was to determine how soil-moisture conditions influence the occurrence and location of nodules on roots in containers. Roots of A. maritima were subjected to four soil-moisture regimes (daily irrigation/ drained, partially flooded, totally flooded, totally flooded with argon-treated water) for eight weeks. In addition to the localized occurrence of nodules on root systems, shoot dry mass and nitrogen accumulation were measured, and root-zone oxygen contents associated with our treatments were determined. Most nodules occurred within the upper 4 cm of the soil/water/air interface. Although partially flooded plants accrued a high shoot dry mass, daily irrigated/dranked plants had higher nitrogen concentrations in their leaves (2.53 vs. 2.21 µg·g–1 after partial flooding). Nodulation occurred under all four treatments, but nodule development and Frankia infection were limited in totally flooded or argon-treated conditions. Access to root-zone oxygen appears critical to the Frankia-A. maritima symbiosis; total flooding reduced root-zone...
Soil Arsenic (As) Content After Using Chromated Copper (CCA) Treated Timbers

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1Horticultural Sciences, Texas A&M University, M.S. 2133, College Station, Texas, 77843-2133, 2Research and Extension Center at Dallas, Texas A&M University, 17360 Coit Road, Dallas, Texas, 75252

Four container-grown species, Gardenia augusta (L.) E. Merrill ‘Candle Light’ (gardenia), Pistacia chinensis A.A. von Bunge (Chinese pistachio), Platanus occidentalis L. (sycamore), and Taxodium distichum (L.) L.C. Richard (baldcypress), with a range of tolerances for alkaline soils were treated with micronutrients one week prior to transplant to the field (micronutrient priming) in an effort to improve internal nutrient reserves until adequate root regeneration to support the plants’ nutritional needs occurred. Drench applications of STEM (soluble trace element mix) dissolved in water were applied at 0, 1, 2, and 3 times the recommended label rate. Sprint 138 (a chelated Fe fertilizer) and zinc sulfate were applied at a concentration of Fe (0, 45, 90, and 135 mg·L−1) and Zn (27, 54, and 81 mg·L−1) as was applied in the corresponding STEM applications. Soil on the site was a clay loam with a mean pH of 8.3 and high calcium (867 mg·liter−1) and sodium (320 mg·L−1) contents. After two years, survival of Chinese pistachio (98.3%) and baldcypress (97.2%) was high, while that of sycamore (65.4%) and gardenia (80.0%) was moderate. Over the first two post-transplant growing seasons, Sprint 138 and zinc sulfate applications increased height growth of baldcypress relative to the zero concentration applications, while STEM increased height growth at the recommended concentration, but reduced height growth at the elevated concentrations. Mean trunk diameter of sycamore across fertilizer concentrations was greatest with Sprint 138 (23.1 mm), intermediate with STEM (22.2 mm), and least with zinc sulfate (21.1 mm). Mean trunk diameter of baldcypress was greater with Spring 138 (25.5 mm) and zinc sulfate (26.2 mm) than with STEM (23.8 mm) across concentrations. Chlorophyll content was greatest in sycamore with Sprint 138 (1.75 µg·mL−1) and zinc sulfate (1.65 µg·mL−1), while STEM (4.58 µg·mL−1) and Spring 138 (4.30 µg·mL−1) produced the greatest chlorophyll concentration in baldcypress. Leaf tissue concentrations of most nutrients (P, K, Ca, Mg, S, B, Fe, Mn, Cu, Zn, Al, and Na) were not consistently related to treatments. The averages were 0.789, 0.690, and 0.850, respectively for plots 1, 2, 3, and 4. The second year average readings to the timbers were 11.40, 7.43, 24.60, and 14.70, respectively, for the four plots. After 3 years, average readings were 17.80, 20.90, 22.70, and 23.7 for the four plots. Beginning the second year, the 3-, 6-, and 9-inch samples were taken in addition to those adjacent to timbers. Readings (combined mean for four plots) at the beginning of the second year were 1.097 and 0.755, respectively. At the beginning of the third year, the readings were 1.678, 0.727, and 0.795 for the 3-, 6-, and 9-inch plots. No differences were noted in arsenic content for the center of the plots.

Plant-level Response to Diurnal Temperature Cycling and Sub-diurnal Temperature Variation

Jean-Jacques Dubois*1, Frank Blazich1, C. David Raper2
1Horticultural Science, North Carolina State University, Kilgore Hall, Box 7609, Raleigh, NC, 27695-7609, 2Soil Science, North Carolina State University, Williams Hall, Box 7619, Raleigh, NC, 27695-7619

Continental-scale patterns of daily temperature are characterized not only by gradients in daily average temperature, but also by gradients in the difference between day and night temperature. During the growing season, the gradient in daily average temperature in the continental United States is primarily latitudinal, whereas the primary gradient in diurnal temperature differential is longitudinal. Likewise, temperature records of the last 5 decades indicate that day and night temperatures have not changed at the same rate. Night temperature has increased faster than day, resulting in change in both daily average temperature (increasing), and day/night difference (decreasing). Despite suggestive research by F.W. Went in the 1950s, and later reports by others, and despite ample information regarding the effects of DIF on morphology and development, little empirical evidence has been reported that would ascertain the importance, if any, of diurnal temperature cycling in the integration of heat input at the plant level. In addition, there are presently no empirical data relating total plant productivity and temperature variation at the sub-diurnal scale. The influence, if any, of day/night temperature difference on the geographical range of cultivation of plants, and on their adaptability to climate change, is unknown. Therefore, we assessed the effect of diurnal temperature cycling in two experiments involving eight taxa of herbaceous perennials with widely divergent climate adaptation, and the effect of temperature variation within the light and dark periods in two more experiments, involving two taxa. The eight taxa represented four genera: Campanula, Delphinium, Rudbeckia, and Stokesia. Delphinium and Rudbeckia were used in the second set of experiments. In the first two experiments, containerized plants were grown in growth chambers under 18 12h day/12h night regimes consisting of half a factorial combination of six day and six night temperatures (−10, 15, 20, 25, 30, or 35 °C). Leaf area and dry weights of shoots and roots were recorded for 15 plants from each treatment group after 13, 34, or 55 days. In all taxa, plant growth responded independently to day and night temperature, or alternatively, to average daily temperature and day/night difference. These effects were present whether a taxon grew optimally under constant, or cycling temperature. It is thus necessary to separate daily heat input into at least two periods, as daily average is insufficient to account for the effect of temperature on plant productivity. In the next two experiments, plants were grown in growth chambers under 14 temperature regimes averaging day/night temperatures of either 15/15 or 25/25 °C. These regimes were achieved through various sequences of 4 hour periods at 5, 10, 15, 25, 30, or 35 °C. In the first experiment, sub-diurnal variations were imposed during the light period, and during the dark period in the second experiment. While there were some significant differences between regimes, they were more than one order of magnitude smaller than the differences produced by day/night cycling. This suggests that under natural conditions, or in outdoor cultivation, the impact of sub-diurnal temperature variation on plant growth is considerably smaller than that of diurnal temperature cycling. These findings also suggest that in protected cultivation and under experimental conditions, regulating temperature fluctuations within the light and dark period may not be critical, provided that the average over each period is adequately controlled.

Partial Silicate Absorption in Oenothera macrocarpa Nutt. ssp incana (Gray) Wagner

Greg Litus*, James Klett
Horticulture and Landscape Architecture, Colorado State University, 111 Shepardson, Fort Collins, CO, 80523

An experiment was conducted to evaluate the phenotypic plasticity of Oenothera macrocarpa Nutt. ssp. incana (Gray) Wagner in response to heat, water and light stress. Ninety plants were arranged
in a complete random block design and exposed to three treatments: 1) a xeric control maintained at ambient soil moisture conditions, 2) a low light xeric treatment maintained at ambient moisture conditions and shaded with RE20NEARL shade film manufactured by 3M, and 3) a mesic treatment maintained at soil field capacity. July, 2002 was the hottest and driest on record for Colorado and pre-dawn leaf water potentials as low as −0.7 MPa were measured in the dry treatments. Average maximum temperature for the month was 32.2 °C with the maximum temperature measured at 38.3 °C. Only minor variations in plant form were observed. However, a phenomenon that we call partial style abscission occurred in late June and continued until early October. Unlike complete style abscissions that occur after pollination, the partial style abscissions occurred immediately upon flower bloom, prior to pollination and at the midpoint of the style. The occurrence of partial style abscission increased until it peaked on August 3rd with more than 40% of the flower blooms affected and then decreased as summer temperatures moderated in August/September. The abscissions occurred across all three treatments and paralleled total flower production that fluctuated with heat and water stress. This partial style abscission is an immediate response to heat stress and a consequence of resource commitment associated with flower bud initiation and corolla development.

11:00 Clonally Propagated Mahaleb (Prunus mahaleb) Rootstocks for Sweet (Prunus avium) and Sour Cherry (Prunus cerasus) Production
Steve Southwick*, Joe Grant*, Kitten Glozer*
1Pomology, UC Davis, One Shields Ave., Davis, CA, 95616, 2UC Cooperative Extension, UC Davis, 420 S. Wilson Way, Stockton, CA, 95209
We have developed 3 new selections of Prunus mahaleb (MH) rootstocks that can be used for both sweet and sour cherry production. These rootstocks were part of a large collection of MH materials that were evaluated for resistance to Phytophthora spp. The selections were challenged against Phytophthora megasperma f. sp. P. cambivora through stem inoculation and by growing young potted plants of selected rootstocks under flooded inoculated conditions and evaluated for disease. Resistant rootstocks were propagated by softwood and semi-hardwood cuttings and selected for ease of propagation. Those selections exhibiting resistance and ease of propagation were budded to ‘Bing’ sweet cherry and planted in a commercial cherry growing area around Stockton, CA in 1996. Additional evaluation sites were established in 1998 and 1999. Three selections have been identified for patenting and release. One selection reduces tree size by 15% to 20% and has 6-fold higher yield efficiency than those ‘Bings’ on standard mahaleb. Results of field trials and availability of rootstocks will be presented.

11:15 Comparison of Tight Vase and Perpendicular-V Training Systems for Peach in the South Carolina Piedmont
Gregory Reighard*, David R. Ouellette, Kathy H. Brock
Dept. of Horticulture, Clemson Univ., Box 340375, Clemson, SC, 29634-0375
‘O’Henry’, ‘White Lady’ and ‘Topaz’ peach varieties on Lovell rootstock were each planted in 1996 at 2 in-row spacings and trained as a tight vase shape or a perpendicular-V. The experiment was a randomized block design that had 3 varieties each receiving 2 treatments replicated 4 times. The treatments consisted of trees trained to a perpendicular-V (PV) and planted 2.2 m apart in 4-tree plots and trees trained as an open center or tight vase (TV) with 5 to 7 instead of 3 to 4 scaffolds planted 4.4 m apart in 4-tree plots. Approximate available linear row distance for each of the 2 (TV) and 4 (PV) interior data trees in the training systems totaled ~8.8 m. Parallel to row or in-row canopy widths as well as canopy volumes were measured or calculated on data trees. Tree growth parameters, estimated canopy volume, PAR readings, time to summer and winter prune, and fruit yield and individual fruit weight per tree and linear plot length were measured. There were no significant variety differences in tree growth parameters except for time to summer prune. PV trees were significantly taller but also smaller in trunk diameter and canopy width. PV trees took significantly longer to summer prune on both a tree and an 8.8m plot basis. PV trees also took significantly longer to dormant prune on a plot basis. There were no significant differences between treatments in fresh weight of dormant prunings on an 8.8 m plot basis, but PV tree canopies filled 1.0 m linear row space than TV trees. Light or PAR penetration at 1.0 m above the ground was significantly higher in the TV system. Individual fruit weight across 6 bearing years was significantly larger in PV trees. Fruit yield was significantly higher in TV trees on both a tree and 8.8 m plot basis. There were no fruit quality differences between training systems. After the 7th year, PV tree canopies at the 2.2 m in-row spacing still had not filled the entire in-row space; whereas TV trees had filled the 4.4 m in-row spacing.
Moderator: W.R. Okie

11:00 Release of Potato Minituber Bud Dormancy

Oktay Kulen*1, Cecil Stushnoff2

11:30 Neighborhood Management: Preliminary Observations

Desmond R. Layne*1, Eric J. Hitzler2
1Horticulture, Clemson University, 177 Poole Ag. Bldg., 50 Cherry Rd., Clemson, SC, 29634-0375, 2Horticulture, Clemson University, 604 S. Friendship Road, Seneca, SC, 29672

The purpose of this trial is to compare conventional South Carolina (SC) peach tree culture with higher levels of management for short and long-term impacts on tree growth, yield, cost of production and profitability. In 1999, the research orchard was established consisting of three tree training systems and planting densities: i) Open Center (18 x 18 spacing; 134 trees/acre); ii) Quad V (18 x 9 spacing; 269 trees/acre); and iii) Perpendicular V (18 x 6 spacing; 403 trees/acre); two rootstocks: i) ‘Lovell’; and ii) ‘Guardian’; and three irrigation/fertilization treatments: i) Rainfall only plus granular fertilization at standard commercial recommended rate (standard); ii) Supplemental irrigation plus granular fertilization at standard rate; and iii) Supplemental irrigation plus liquid fertilization (fertilization) at a reduced rate compared to the standard. The scion cultivar is ‘Redglobe’. During the first four years of the trial, supplemental irrigation has had a profound effect on tree growth. This is particularly the case since our rainfall from 1999–2002 is well below normal due to the four-year drought in SC. Supplemental irrigation substantially increased trunk cross sectional area (TCA) relative to the nonirrigated treatment. Tree growth in 2002 was influenced significantly by each of the main factors. Of the three training systems, the open center trees had the greatest TCA after 4 seasons of the experiment followed by the quad V and then the perpendicular V trees. The relationship between TCA and tree density was such that as trees became more tightly spaced in the tree row, more tree-to-tree competition existed and the resulting tree growth was less. Each year of the study including 2002, we have noted that trees on Guardian rootstock were more vigorous (having greater TCA) than trees on ‘Lovell’. In 2002, by reducing N application, we were able to reduce tree vigor and growth. Pruning time in 2002 was significantly influenced by each of the main factors. For the training systems, it took longest to prune the quad V trees with the perpendicular V trees being intermediate and the open center trees being pruned in the least amount of time. This was primarily due to the fact that V-trained trees were not adequately summer pruned in 2001. Although trees on ‘Guardian’ rootstock were pruned a little more quickly than those on ‘Lovell’, the time differences were small. Supplementally irrigated trees took longer to prune than trees not receiving supplemental irrigation. This was primarily due to the differences in tree growth that resulted when supplemental water was supplied. Three radiational frost events in 2001 dramatically reduced marketable tree yield for the shorter open-center trees in comparison with the taller quad V and perpendicular V trees. As a result, yield of quad V and perpendicular V trees was 4–5 fold greater than open center trees. Yield for supplementally irrigated trees was double that of nonirrigated trees. In 2002, yield was greatest for open center trees. For trees receiving supplemental irrigation, yield was approximately 30% to 40% higher and percent loss was substantially reduced in comparison with nonirrigated trees due to improved fruit size.

Oscillatory Bud Dormancy During Shoot Growth and Rest Period in Peach

Paolo Sabbatini1, Franco Zucconi1, James Antony Flore2, Davide Neri1
1Dept. of Energetics, Univ. of Ancona, Via Brecce Bianche, Ancona, Italy, 60100, Italy, 2Dept. of Horticulture, Michigan State Univ., S. W. Corner of Wilson Road & Bogue Street, East Lansing, MI, 48825-1325

Existing difficulties in the control of bud dormancy partially derive from a reduced knowledge of the physiological factors involved in its onset. The problem is rendered more complex by the fact that dormancy varies both between shoots, depending on vascular transport and growth habits, and along the shoot, depending on the bud position and time of formation. Moreover shoot growth dynamics varies with species and climates, under the influence of dormancy and positional hierarchies also. In consistency with such correlative events, the objective of this work was to change the trend of shoot growth dynamic, and observe its effect on the evolution of bud dormancy. Therefore, the growth habit of peach shoots was changed and the influence on bud dormancy observed. Measurements of dormancy in the following winter showed strong effects, interacting with the accumulation of chilling units. The analyses was carried out using binodal cuttings, since the inhibition of cell elongation of primary meristem, under favorable conditions, is considered an index that represents well dormancy and its intensity. The study of such dormancy shows an own dynamics, decreasing with time and along the shoot axis with a minimum in the apex. It also shows the existence of oscillations in time along the axes, an event that interacts also with cold in changing spring growth.

Sub-freezing Temperatures Affect Chilling Accumulation in Peach

W.R. Okie*1, Bryan Blackburn2, Kathryn Taylor2
1SE Fruit & Nut Res Lab, USDA-ARS, 21 Dunbar Rd, Byron, GA, 31008, 2Dept Horticulture, University of Georgia, 21 Dunbar Rd, Byron, GA, 31008

Current chilling models assume sub-freezing temperatures are ineffective for chilling accumulation. We tested this using terminal twigs 16-20 cm long, cut from bearing trees and stored in plastic bags in temperature-controlled chambers. After treatment they were placed in Flora-Life in individual polyethylene vials in a room held at 15, 20 or 25 °C. Cuttings were rated daily for flower buds that had reached ‘green calyx’ which were then rubbed off. Lateral and terminal budbreak was noted when 1 mm of leaf growth was visible, but buds were not removed.

In Test 1 ‘Juneprince’ (600 h chill rating), and ‘Redglobe’ (850) twigs were cut after 130 field units of chill and stored at 4 °C. A set of 8 twigs of each was moved to 15 °C or to 0 °C (for 2 weeks, then to 15 °C). Two weeks at 0 °C resulted in budbreak similar to that held at 4 °C for those 2 weeks, suggesting 0 °C was “effective” in chilling. In Test 2 ‘Redglobe’, ‘Cresthaven’ (950), and ‘Contender’ (1050) cuttings (field chill=615 units; 8 per treatment) were placed at –4, –1, 0, or 5 °C. At 4-d increments for 20 d (~100 hours of additional chilling each date), a set of cuttings was moved to the 15 °C room. Exposure to –4 °C also enhanced budbreak, although less so than to 0 or 5 °C. In Tests 3/4, ‘Redglobe’ (field chill = 230 or 410 units) was stored at –16, –5, –1, or 6 °C; and –16, –9, –5, –4, –1, or 6 °C for 24/32 or 21/50/80 d. Budbreak speed and frequency was inversely proportional to chilling temperature and duration. Budbreak was minimal after 24 d and 21 d treatments, but there was substantial budbreak after the 50 d treatment, even for –5 °C. These results indicate that placing cuttings at 0 °C can have a beneficial effect in satisfying the chilling requirement in peach.

11:45 Bud Dormancy of Vitis sp. ‘Lacrosse’ and ‘Chambourcin’; Effects of Abscisic Acid, Gibberellins and Rootstock
Sanjun Gu*, Paul Read
Department of Agronomy and Horticulture, University of Nebraska Lincoln, 377 Plant Science, Lincoln, NE, 68583

Plant growth regulators play an important role in bud dormancy. Previous research also showed that rootstocks might influence scions on the time of bud break. In our study of bud dormancy, one-year old dormant canes with lateral buds of Vitis sp. ‘Lacrosse’ (own-rooted) and ‘Chambourcin’ (own-rooted and grafted to ‘3309 Couderc’) were sampled monthly from January 2001 to March 2001 and from October 2001 to March 2002, in Nebraska, USA. Single-bud (the 5th to the 10th bud from the proximal end) cuttings were forced at 25/20 °C (day/night) and 16 h (light/dark) to determine the degree of dormancy and the effects of exogenous abscisic acid (ABA) and gibberellic acid (GA₃) on bud break. Endogenous ABA and GA₃ were quantified with monthly sampled buds by Gas Chromatography–Mass Spectrum (GC-MS). Results showed that level of dormancy decreased form October to March and the deepest dormancy took place in October. Dormancy of ‘Chambourcin’ was usually significantly deeper than of ‘Lacrosse’. Grafting ‘Chambourcin’ and the own-rooted ‘Chambourcin’ had a similar trend of dormancy, although grafted vines had deeper (but not significant) degree of dormancy than the own-rooted. The addition of ABA and GA₃ caused different influences on bud break. When buds were at deep dormancy, GA₃ tended to prolong the days needed for bud break and high level of ABA (at 50 to 100 ppm) seemed to shorten it. At less degree of dormancy, however, high level of ABA inhibited bud break while GA₃ still tended to inhibit bud break. Differences were found between ‘Lacrosse’ and ‘Chambourcin’, and the own-rooted ‘Chambourcin’ and grafted ‘Chambourcin’, regarding the responses of bud break to GA₃ or ABA. Quantification of endogenous ABA and GA₃ showed a trend of decreasing level of ABA and a trend of increasing level of active GAs as buds becoming less dormant. The effects of plant hormones and rootstocks on bud dormancy of grapevines are discussed.

11:15 Strengths and Weaknesses of the Greenhouse Industry in New Jersey
Robin Brumfield*
DES, Rutgers Univer., 55 Dudley Road, New Brunswick, NJ, 08901-8520

The green industry consists of the floriculture (greenhouse) sector and the environmental horticulture (nursery) sector. The floriculture sector includes cut flowers, cut cultivated greens, potted flowering plants, potted foliage plants, and bedding and garden plants. The environmental horticulture sector includes crops usually grown outdoors and used primarily for landscaping purposes, such as trees, shrubs, ground covers, turfgrass or sod, bulbs, and planting stock (Johnson, 1997). The green industry is the fastest growing sector of U.S. agriculture, representing 11 percent of gross cash farm crop receipts in 1997 (USDA, 1999). The greenhouse and nursery industry is the number one agricultural commodity in NJ with a value of cash receipts of $297,392,000, totaling 36.6% of the state’s total farm receipts and 2.3% of the total U.S. value for this commodity (2000 data, Economic Research Service, USDA, Washington, D.C.). Currently, there are approximately 300 greenhouse and 600 nursery operations in New Jersey. New Jersey benefits from a high income and a highly educated population. However, producers in New Jersey face high land and labor costs, and some of the toughest regulations, and one of the most challenging business climates in the country. The growth of the mass market has reduced costs and resulted in consolidation, but the shift from a production-driven to market-driven economy has also resulted in numerous niche markets which can be exploited by local producers. This project was conducted to explore the drivers of the greenhouse industry in New Jersey: its strengths, weaknesses, opportunities, and threats. A mail questionnaire was developed to survey the greenhouse sector of the green industry in New Jersey. This survey was developed with input from the industry and from and earlier Pennsylvania Greenhouse Survey (Brumfield, et al., 1993). One thousand seventy-three questionnaires were mailed in January 2001. An initial questionnaire was sent to all greenhouse growers on mailing lists of county agents kept for the green industry. This was followed by a reminder letter three weeks later, and finally, by a third letter and second questionnaire two months after the initial letter. Three hundred eighty seven questionnaires were returned between February and June 2001 yielding a 36% response rate. Of those, one hundred and sixty indicated that they were not a commercial greenhouse. One hundred eighty nine questionnaires were completely filled out, and indicated that they are a commercial greenhouse business.

11:30 Use of a Sensory Evaluation to Assess Consumer Perception and Acceptance of Edamame (Glycine max) Cultivars
Kathleen Kelley*, Elsa Sanchez
Horticulture, Penn State, 102 Tyson Bldg., University Park, PA, 16802

One hundred and thirteen consumers participated in a sensory evalu-
Exporting Fruit for the World Market—What Are the Research Challenges?

Jim McFerson*
Horticulture, Washington Tree Fruit Research Commission, 1719 Springwater Ave, Wenatchee, WA, 98801

Export markets for fruits produced in North America have provided lucrative returns and outlets for products in a saturated domestic market. Many years of supply exceeded demand, which allowed producers to set high prices. However, increasing global competition, decreasing consumer acceptance of fresh produce, and rising costs have interacted to decrease profits and profitability. To remain competitive, fruit producers need to develop new markets or diversify existing ones, via traditional or novel products or production systems.

Participants were recruited from the university community to rate three edamame cultivars, Early Hakucho, Green Legend and Kenko, based on firmness and overall appeal and rank the beans in order of preference. Participants were also asked about their experience with edamame prior to the sensory evaluation. Directional ratings for both Early Hakucho and Green Legend indicated that 44.3% of consumers thought they were “too firm” while 60.2% thought Kenko was “just about right” for the tenderness attribute. The mean scores for overall liking and moistness for Green Legend was significantly lower (x = 0.05) than for Kenko. Consumers then ranked the varieties of edamame in order of preference with Kenko significantly most preferred and Green Legend the least preferred. Seventeen percent of participants were familiar with or had heard of edamame prior to the sensory evaluation, while 12% had eaten edamame before. After tasting the edamame samples, 89% of the participants indicated they would be likely to purchase edamame from a store and serve it in a meal. Verbal comments from participants after the evaluation indicated that they were interested in knowing which retail outlets sold edamame in the State College, Pa. area. Results will be used as the basis for developing a marketing strategy that small-acreage farmers can use to target potential edamame consumers in their region or suitable marketing area.

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organic grain crop acreage is found in the north central region states (Greene, 2001). One of the obstacles to further expansion of organically produced agricultural commodities is the lack of organic seed sources and associated seed production and seedling establishment technologies for many crop species. The overall objective of this research project was to assess the use of several strategies, including soil amendment treatments for organic production of food grade soybean seed near Wooster, Ohio. Specific objectives were to: (1) assess the effects of soil amendments (manure, fertilizer, untreated check or compost) on soybean seed yield and quality and (2) determine seed quality levels of seed lots (at harvest and after 6 and 12 month storage) from different seed production systems. Integrated and organic cropping systems were used for comparison at a second location near Bowling Green, Ohio. There were no significant differences in seed yield among the manure/compost treatments, chemical fertilizer or no-amendment controls. Various seed vigor measurements (cold tests, saturated salt accelerated aging) were made for seed produced from plots receiving compost and or manure as well as chemical fertilizer and no amendment controls. Year one seed quality results (standard germination, cold test, saturated salt accelerated aging) for tests conducted within one month after seed harvest were similar among soil amendment treatments. Accelerated aging results at 5 days after sowing were significantly better for seed from plots receiving dairy/poultry compost, or no amendment. Cultural practices will also be applied to organic seed production for vegetable soybeans (edamame).

Germination Rate and Seedling Growth Rate Measures Different Aspects of Seed Vigor in Impatiens N.308E, Agriculture Sciences North, Lexington, KY , 40546

(399) Germination Rate and Seedling Growth Rate Measures Different Aspects of Seed Vigor in Impatiens

M. Dutt1, R. Geneve2

1Horticulture, University of Kentucky, N 308H Agriculture Sciences North, Lexington, KY, 40546, 2Horticulture, University of Kentucky, N308E, Agriculture Sciences North, Lexington, KY, 40546

Germination and seedling growth rates are two measures of seed vigor used to evaluate seed quality in small seeded horticultural crops. Germination rate as indicated by T50 or actual time to radicle emergence is frequently used as a method for determining vigor, because time intervals between evaluations can be as long as 24 hours. Likewise, seedling growth rate can be an imprecise measurement without an accurate determination of the actual time of radicle protrusion. Sequential digital images were captured every hour for germinating impatients seeds using a flat bed scanner and computer. This allowed the actual time to radicle protrusion and subsequent seedling length to be accurately measured. Untreated and primed seed lots were aged to provide a range of potential germination and seedling growth rates. Primed seeds had the lowest germination rate (T50) and highest seedling growth rate compared to untreated seeds. Germination rate increased and seedling growth rate following radicle protrusion decreased as untreated and primed seeds aged. For example germination rate increased from 52 hours to 60 hours as primed seeds aged for 6 months. Seedling growth rates remained linear for the first four days following radicle protrusion in non aged and aged seed lots for both untreated and primed seeds. However, germination rate and subsequent growth rate were unrelated on an individual seed or on a population basis regardless of the priming or aging treatment.(r2 was between 0.63 and 0.99). Although germination rate and seedling growth rate was consistent indicators of high vigor seed lots, each appears to measure a distinct, unrelated aspect of seed vigor.

(400) Enhancing Germination in Echinacea Purpurea For Commercial Production

Paul D. McIntyre1, Richard L. Harkess, Christopher Ruhs

Plant and Soil Sciences, Mississippi State University, 117 Dorman, Box 9555, Mississippi State, Mississippi, 39762

Germination and prompt emergence of Echinacea purpurea is frequently below economic thresholds in commercial production systems. The effects of removing the achene husk and response to ethylene gas as a germination enhancement treatment were evaluated in this study. Seed of three cultivars of E. purpurea were subjected to husk removal using a bench-top seed scarifier with a 2.70 mm mesh abrasive screen. Debris were removed via a South Dakota blower and all seed was stored at 0 °C until trials were conducted. Seed lots of whole achenes or de-husked seed were exposed to pure ethylene gas in a sealed chamber at 137.9 kPa for 0, 24, 48, or 24 h before placement in 20/30 °C standard germination temperatures. Percent germination was determined at 12 d for each seed lot and respective treatment. Removal of the achene husk did not significantly change percent germination under standard temperatures. Time to the onset of germination was not impacted by husk removal for any cultivar. Seed germination increased by 49%, 46%, and 54% when exposed to 24 h, 48 h, or 72 h of ethylene gas respectively compared to the untreated control. Whole achenes exposed to 72 h ethylene exhibited a 97% germination average under standard germination protocol across the three cultivars compared to 43% when untreated. Seedling length and cotyledon surface area were significantly greater with increased duration of ethylene gas exposure. Germination and emergence in E. purpurea was increased by an ethylene gas seed treatment and may impact establishment practice in production systems.


Donald T. Krizek1, H. David Clark2, Kathleen M. Davis2, Mary J. Camp3, Jerry C. Ritchie1

1USDA-ARS, Sustainable Agricultural Systems Lab., Bldg. 001, BARC-W, Beltsville, MD, 20705, 2USDA-NRCS, National Plant Materials Center, Bldg. 509, BARC-E, Beltsville, MD, 20705, 3USDA, Biometrical Consulting Service, Bldg. 005, BARC-W, Beltsville, MD, 20705, 2USDA-ARS, Hydrology and Remote Sensing Lab., Bldg.007, BARC-W, Beltsville, MD, 20705

A major obstacle to successful establishment of eastern gamagrass [Tripsacum dactyloides (L.) L.] is its erratic germination because of severe seed dormancy. Our previous studies indicated that 1998 and 1999 lots given a proprietary seed priming treatment (Germtec II™) showed a decline in germination in storage, particularly at 12°C; however, 1999 seed lots were also found to have significantly lower initial tetrazolium chloride tests run prior to shipment. For the 2000 seed lot at all dates, providing further evidence that this lot may have developed physiological and/or morphological barriers to germination during maturation. Further studies are needed to identify the precise nature of these barriers and to develop improved methods for breaking dormancy. The low germination rate for all seed lots may be partially explained by the high fraction of dormant seed, based on initial tetrazolium chloride tests run prior to shipment.

(402) Temperature Cycle Affects Seed Germination of Nicotiana Tabacum

Changhoo Chun, Emi Maeda

Department of Plant Production Science, Chiba University, 648 Matsudo, Matsudo, Chiba, 271-8510, Japan

We previously examined the effect of altering temperature (AT) between 20.0 °C and 30.0 °C on germination of Solanum torvum L. Percent germination was 45% with a temperature cycle of 1440 min (24 h), but it was 97% when the temperature cycle decreased to 1440 min. No germination was observed in any of the non-altering temperature (NT) treatments at fixed temperatures or in AT treatments in which the temperature cycles were smaller than 11.25 min or greater than 2880 min. In the present experiment, seeds of Nicotiana tabacum L. cv. MC1...
were subjected to nine different AT treatments in which the temperature cycles ranged from 22.5 to 5760 min. The ratio of the time at 20.0 °C to the time at 30.0 °C was 3:1 for all the AT treatments. Seeds were also subjected to three NT treatments (fixed temperatures of 20.0, 22.5 and 30.0 °C). Percent germination on days 1-4 varied with the temperature cycle and was greater in the AT treatments with temperature cycles of 90 to 360 min than in the other AT and NT treatments. A temperature cycle of 1440 min resulted in a smaller percent germination than the values obtained in the above-mentioned treatments. However, the difference among treatments gradually decreased and no significant difference was found on day 15. Results indicate that seeds of Nicotiana tabacum, unlike seeds of Solanum torvum, germinated in NT treatments and the percent germination was greater than 80% in all the AT treatments on day 15. On the other hand, a periodic change in temperature promotes seed germination of Nicotiana tabacum at the early germination stage, and the temperature cycle affected seed germination in a way similar to that observed in Solanum torvum.

(403) Promotion of Dormancy Breaking and Seed Set in Ginseng (Panax ginseng C.A. Meyer) with Combined Use of GA, and Ethephon
Sung Eun Kim, Jung Myung Lee*
Horticulture, Kyung Hee University, Seochun-ri 1, Kiehung-up, Yongin, Gyeyonggi-do, 449-701, Republic of Korea

Korean ginseng typically exhibits a long dormancy when harvested in the fall, thus causing considerable difficulties for rapid breeding. It has been reported that soaking the roots in GA3 solution prior to potting solution for 1 or 4 hours and then planted in flower boxes at 45-degree (120–240 mL/L) alone or in combination by soaking only the root in GA3 5 µg/L and ethephon 120 mL/L was most effective. More than 50% of the plants treated showed fruit set until 65 days after planting in a greenhouse condition whereas no fruit set was observed in plants treated with GA, or ethephon alone or in the non-treated control. Even though shoot emergence was markedly promoted by GA treatment, ethephon treatment showed no marked effect on any of the plant characteristics observed.

12:30 pm–1:30 pm POSTER SESSION 28
(Ballroom A
(Location numbers for the posters within the Poster Viewing Area are in parentheses)

Vegetable Breeding 2

(180) ‘KnuckleHull-VNR’, A Blackeye Cowpea Mosaic Virus and Root-knot Nematode Resistant, Crowder-type Southernpea
Richard Ferry*, Judy Thies1, A.G. Gillaspie2
1U.S. Vegetable Laboratory, USDA-ARS, 2875 Savannah Highway, Charleston, SC, 29414, 2Plant Genetic Resources Conservation Unit, USDA-ARS, 1109 Experiment Street, Griffin, GA, 30223.

The USDA has released a new knuckle-purple-hull, crowder-type southernpea cultivar named KnuckleHull-VNR. The new cultivar was developed as a replacement for Knuckle Purple Hull, a cultivar widely grown by fresh-market growers and home gardeners throughout the southeastern United States for many years despite susceptibility to Blackeye cowpea mosaic virus and root-knot nematodes. The major attributes of KnuckleHull-VNR are its excellent resistances to Blackeye cowpea mosaic virus and root-knot nematodes. KnuckleHull-VNR produces dry pods at Charleston, S.C., in 68 to 74 days. A typical pod is slightly curved, 20 cm long, and contains 14 peas. Fresh peas have a semi-crowder to crowder shape and a light green color. Dry KnuckleHull-VNR peas have a brown-colored, smooth seed coat, and are smaller in size than Knuckle Purple Hull peas (weight per 100 dry peas: KnuckleHull-VNR, 15.2 g; and Knuckle Purple Hull, 19.7 g). The results of replicated trials indicate that the yield potential of KnuckleHull-VNR is similar to that of Knuckle Purple Hull. KnuckleHull-VNR is recommended for use by fresh market growers and home gardeners who are concerned about yield losses to their Knuckle Purple Hull plantings caused by Blackeye cowpea mosaic virus and root-knot nematodes.

(181) Massive Preferential Segregation and Nonrandom Assortment of Linkage-Groups Produce Quasi-Linkage in an F2 Mapping Population of Watermelon
Amnon Levi*, 1Claude Thomas1, Melanie Newman2, Xingping Zhang3, Yong Xu4, Todd Wehner2
1U.S. Vegetable Laboratory, USDA, ARS, 2875 Savannah Highway, Charleston, SC, 29414, 2Plant Genetic Resources Conservation Unit, USDA, ARS, 1109 Experiment Street, Griffin, GA, 30223, 3Syngenta Seeds, Vegetable Breeding, 21435 Road 98, Woodland, CA, 95695, 4Vegetable Genetics and Breeding, National Engineering Research Center for Vegetables, P.O. Box 2443, Beijing, 100089, People’s Republic of China, 1Dept. of Horticulture, North Carolina State University, P.O. Box 7609, Raleigh, NC, 27695

Three populations were used to develop a comparative linkage map for watermelon (Citrullus lanatus). They include a BC population [(Citrullus lanatus var. citroides PI 296341 × C. lanatus var. lanatus cv. New Hampshire Midget; NHM) ×NHM], a testcross population (TC) [(C. lanatus var. citroides germplasm line Griffin 14113 ×NHM) × C. colocynthis PI 386015], and an F2 population (PI 296341 ×NHM). Common markers allowed the merging of linkage groups from the three maps, and confirmed consistent distances among markers within linkage groups. However, in contrast with the BC, and the TC populations, the F2 population displayed nonrandom assortment against several PI 296341 linkage groups. Major linkage groups that are distinct in the BC, and TC populations could be readily merged using common markers. However, in the F2 population nonhomologous linkage groups merged into one giant linkage group producing Quasi-Linkage. This linkage anomaly may be a result of strong affinity between nonhomologous chromosomes, causing them to pass to the same pole during cell division. This anomaly will likely be prevalent in other F2 populations derived from crosses between watermelon cultivars and C. lanatus var. citroides.

(182) Identification of Resistance to Anthracnose in Capsicum spp.
Hyo Guen Park*, Jae Bok Yoon
School of Plant Science, Seoul National University, 103, Suwon, 441-744, Republic of Korea

Pepper anthracnose caused by Colletotrichum gloeosporioides and C. acutatum is the most destructive disease resulting in serious yield loss in many other Asian countries as well as in Korea. Resistance breeding seems to be the most practical, economical and environmentally friendly way to control the disease, but there are no resistant variety developed worldwide. A total of 326 pepper accessions within five domesticated Capsicum spp. were screened to identify genetic resources for anthracnose resistance. Hundreds accessions of C. annuum, a major cultivated species worldwide, and the others except a few C. baccatum ones were evaluated to be susceptible to Korean isolate of C. gloeosporioides. Only twelve accessions belonging to C. baccatum were strong resistant. Among them, PBC80 and PBC81 reported to be resistant by AVRDC were used to examine their usefulness for resistance breeding. They were highly resistant to other pathogen isolates of C. acutatum as well as C. gloeosporioides. In addition, their strong resistance was well maintained even though under natural field conditions in Indonesia as well as in Korea. Consequently, reliable and usable genetic resources for anthracnose resistance were successfully identified in C. baccatum germplasm and these materials would be used
to develop resistant variety in chili pepper (C. annuum) if we can use interspecific hybridization method.

(183) History of Asparagus Cultivar Development in New Jersey
Stephen Garrison¹, Chee-Kok Chin², Wesley Kline*³, Peter Nitzsche⁴
¹Rutgers Agricultural Research and Extension Center, Rutgers Cooperative Extension, 121 Northville Rd., Bridgeport, NJ, 08032, ²Plant Biology and Pathology, Rutgers Univ., Foran Hall 263, Dudley Rd., New Brunswick, NJ, 08901, ³Agricultural and Resource Management Agents, Rutgers Cooperative Extension, 291 Morton Ave., Millville, NJ, 08332, ⁴Agricultural and Resource Management Agents, Rutgers Cooperative Extension, P.O. Box 900, Court House, Morristown, NJ, 07963

New Jersey produced 11,900 acres of asparagus in 1929, but by 1996, acreage had declined to 900. This decline started in the 1970’s because of successive wet years when Fusarium sp. became prevalent. Lyman G. Shermertorn started the Rutgers breeding program in the 1940’s. He released the first cultivar ‘Raritan’ in the early 1950’s. ‘Raritan’ was not a commercial success because it lacked rust resistance. In the late 1950’s, Howard Ellison began selecting plants for vigor, rust resistance and spear quality from commercial fields. He developed several hybrids released ‘Rutgers Beacon’ in the 1970’s, a breakthrough in asparagus tissue culture protocol by Chee-Kok Chin in the late 1970’s for the efficient tissue culture of selected parent plants. This spurred the introduction of clonal hybrid cultivars having a single female and a single male parent. Ellison released the first dioecious clonal hybrid ‘Jersey Centennial’ in 1982. Research followed to select homoygous plants for maleness and to cross with selected female plants. The first male hybrids released were ‘Jersey Giant’ and ‘Greenwich’ in 1985. ‘Jersey Giant’ is still the most popular New Jersey variety today. ‘Jersey Gem’, ‘Jersey Knight’, ‘Jersey King’, ‘Jersey General’ and ‘Jersey Prince’ released these foundations in 1989. ‘Jersey Titan’ was released in 1991 followed by ‘Jersey Jewel’ in 1993. Stephen Garrison took over the program upon Ellison’s retirement in 1990. The latest release under his leadership was ‘Jersey Supreme’ in 2001.

(184) Breeding Crisphead Lettuce for Rib Blight Resistance
Sylvie Jenni*, George Emery
Agriculture and Agri-Food Canada, Horticultural R&D Centre, 430, Boul Gouin, St-Jean-sur-Richelieu, Quebec, J3B 3J5, Canada

Midsummer crisphead lettuce grows under temperatures often greater than the optimal 7 to 24 °C range, and heads frequently develop physiological disorders. Rib blight is a physiological disorder, which results in important losses in lettuce quality. A breeding program was established in 1998 at Agriculture and Agri-Food Canada to create a crisphead lettuce variety resistant to rib blight and other heat-related physiological disorders, such as bolting, ribbiness and tipburn. Breeding for resistance to physiological disorders is often difficult since their symptoms are triggered by specific environmental conditions that may or may not be present in the field. First crosses were made in 1998 after screening for sources of resistance to rib blight. Since then, more than 1000 crosses were performed. Progeny lines were seeded in the greenhouse and transplanted in commercial and experimental fields for evaluation. At optimal maturity, lettuce heads showing no rib blight symptoms and good agronomic characteristics were selected and prepared for in vitro culture. Both axillary and apical meristems were cultured. After rooting and acclimation, the in vitro plants were grown in the greenhouse during fall and winter and harvested for seeds. Two generations a year were obtained. Elisa tests were performed to test for Lettuce Mosaic Virus. Several advanced lines are currently under evaluation.

(185) Cultivars for Watermelon Rind Pickles
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Among home gardeners and other growers, there is interest in finding cultivars suitable for making watermelon (Citrullus lanatus) rind pickles. Cultivars for pickling should have a thick, white rind (mesocarp). In addition, the cultivar should have characteristics that make it good for eating fresh, since pickled rind is usually a secondary use of the watermelon. The objective of this study was to evaluate adapted and obsolete cultivars for use as pickling types. Cultivars were divided into classes based on adaptation, fruit size, fruit shape, and fruit color. None of the cultivars in the small fruit class had a thick rind. Thick rind, red flesh, adapted cultivars included ‘Crimson Sweet’, ‘Jubilee’, and ‘Mardi Gras’. Thick rind, red flesh, obsolete cultivars included ‘Tom Watson’, ‘Georgia Rattlesnake’, and ‘Black Diamond’. Thick rind, orange or yellow flesh cultivars included ‘Tendersweet Orange Flesh’, ‘Orangeo’, and ‘AU-Golden Producer’.

(186) Environmental and Genetic Effects on Garlic Growth, Flowering, and Bulb Characters
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Garlic yields vary widely across climates and clones, but the relative influences of these two important variables have not been well-described. Furthermore, the primary character distinguishing garlic clones is their tendency to form a flower stalk, but the influence of environment on stalk formation has not been evaluated. We grew 15 garlic clones produced in Oregon and varying in flower stalk formation and other plant and bulb attributes over three years in Wisconsin, Washington, and southern and central California. Trials were fall-planted in all locations and leaf, stalk, and bulb attributes were measured. Warmer climates increased leaf number, length and width, and bulb diameter and weight, but reduced the incidence of stalk formation and height. When bulbs grown in Wisconsin were then used to replant the crop, incidence of stalking increased in subsequent years.

(187) Genetic Combining Ability of Glucoraphanin Level and Other Horticultural Traits of Broccoli
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Broccoli (Brassica oleracea L., Italica Group) is recognized as a source of glucosinolates and respective isothiocyanate metabolites that may have chemoprotective effects in humans. Glucoraphanin (4-methylsulfonylbutyl glucosinolate; GR) is a predominant glucosinolate of broccoli, and its cognate isothiocyanate is sulforaphane. Sulforaphane has proven to be a potent inducer of phase II detoxification enzymes, and numerous lines of evidence indicate this induction may provide protection against both carcinogens and toxic electrophiles. Little is known about the genetic combining ability and types of genetic variation (i.e., additive vs. dominance) for glucosinolate levels in broccoli. To better elucidate genetic factors known to influence glucoraphanin content, a diallel mating design was employed to estimate general and specific combining abilities for this trait. This design included nine doubled haploid (inbred) parents and all possible crosses (36) among them, excluding reciprocals. The complete diallel was grown in two field experiments employing randomized complete block designs conducted in Fall 2001 and Spring 2002. Horticultural traits (i.e., head weight) of all entries were assessed in the trials and harvested heads were lyophilized and assayed for GR concentration using a hydrophilic interaction liquid
chromatography method on an HPLC. In fall 2001 GR concentration of broccoli heads ranged from 0.83 to 6.00 µmole/gdw, and in spring 2002 ranged from 0.26 to 7.82 µmole/gdw. In both years, significant general combining ability was observed for GR concentration, as well as for days from transplant to harvest, head weight, and stem diameter. Conversely, no significant specific combining ability was observed for any trait in either year. Results indicate that a given inbred will combine with others to make hybrids with relatively predictable levels of head glucosinolates and also other important horticultural traits. This should allow identification of inbreds that give relatively high GR levels when hybridized with others.

(188) Evaluation of Lettuce Varieties, F1 Hybrids, and Interspecific Hybrids for Resistance to Lettuce Big-vein Disease
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Lettuce big-vein (BV) disease is caused by a virus transmitted by the obligately parasitic soil-inhabiting fungus Olpidium brassicae. One of the most practical methods of control is to use resistant cultivars. Therefore, we searched resistant lettuce to BV. “Thompson,” released as a resistant cultivar, was most resistant among crispahead varieties in our test, but its resistance was insufficient. On the other hand, no disease was observed in many varieties of other types (butterhead, cos, stem, and leaf). Next we examined the resistance of F1 lettuce. When F1 parents have different level of resistance, the F1 hybrids generally showed the middle level between their parents. This result suggests that resistant genes to BV show incomplete dominance. It has been reported that resistance of Lactuca virosa (wild lettuce) is very high. Then we evaluated the resistance of the progenies from L. virosa - L. sativa (crispahead) crosses.

(189) Genetic Barriers in Interspecific Hybridization of Capsicum Annuum and C. Baccatum
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Since anthracnose resistance was only identified in Capsicum baccatum germplasm, interspecific hybridization had to be conducted to transfer the resistance gene(s) from C. baccatum into C. annuum. Fruit set and seed formation after pollination and fertilization were very normal. However, development of internal embryo and endosperm of the seeds were delayed and severely aborted in many cross combinations. Fortunately, the difference in embryo development was observed among C. annuum parental lines. According to the result, we could divide female parents (C. annuum) into partially compatible and completely incompatible. Interspecific hybrids were obtained via embryo rescue and tri-species (bridge) crosses for partially compatible and completely incompatible cross combinations, respectively. All interspecific- and 3-way hybrids, however, were showed highly male sterility caused by abnormal behavior of meiotic chromosomes during microsporogenesis. The abnormality included uni- and multivalent formation at diakinesis and metaphase I, lagging chromosomes at anaphase I, and formation of micronuclei at telophase I and II. Hybrid sterility was overcome and hundreds of interspecific BC F1 progenies were obtained through intensive backcrossing used C. annuum as a male parent. The male sterility was considerably recovered in BC F1 progenies. Therefore, resistant individual plants showed as strong as original resistant parent, PBC81, could be selected in the population. In conclusion, embryo abortion and hybrid sterility were determined to be first and second genetic barrier in interspecific hybridization of C. annuum and C. baccatum. Using embryo rescue and interspecific backcrossing could overcome the genetic barriers. The interspecific BC F1 population might be used to analyze inheritance of anthracnose resistance and to commercialize resistant variety in chili pepper.

(390) Weed Control on Direct Seeded and Transplanted Watermelon
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Herbicide treatments included two rates of Sandea (0.024 and 0.032 lbs ai/acre) or two rates of Strategy (0.79 and 1.05 lbs ai/acre) in combination with applications made prior to or after direct seeding or transplanting, or as shielded applications following planting or transplanting. All treatments were applied as a broadcast spray over the top of the plot, except for shielded applications. Plots received 0.5 inch of irrigation immediately following applications. Plots were 3-m wide by 8-m long, arranged in a randomized block design with four replications. Recorded data included crop phytotoxicity and efficiency of Amaranthus palmeri. S. Wats. and Mollugo verticillata L. Harvest data included individual fruit weights for each plot. Weed pressure in the study was extremely high, particularly for Amaranthus palmeri. Herbicide treatments that provided consistent control included Sandea at both rates with the higher rate providing higher levels of control and Strategy applied after seeding. Yields were highest when adequate weed control was provided. Based upon the results of this study, the authors conclude that Sandea and Strategy applied after direct seeding at the lower rates used in the study provided adequate weed control and resulted in the highest yields for direct seeded watermelons. The authors further conclude that for transplanted watermelons, Sandea applied before or after transplanting without the use of shielding to protect the crop provided the highest levels of weed control and transplanted crop yields in the study.

(391) Teratological Effects of the Herbicide Pendimethalin Applied to Cabbage Seedlings
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Potted seedlings of cabbage were either mist-sprayed with carrier only (controls—Ctr) or with carrier plus 1.1 kg per ha (1.0 lb per acre) active ingredient pendimethalin (Pdm) at each of three seedling stages: 2 leaf, 5 leaf, and 6 leaf. Seedlings were grown in a greenhouse at 21 °C day/night with a 14-h photoperiod under 1000 W metal halide lamps (300 µmol·m–2·s–1). Five seedlings each of Ctr and Pdm were harvested for histological study when sprays dried and at 1, 2, and 3 weeks thereafter. All Ctr plants were normal in development and grew more and larger leaves than did Pdm plants. Extreme anatomical malformations occurred with Pdm applied at the 2–3 leaf stage. Plants had severe stunting, reduced leaf production and leaf area, increased lamina and petiole thickness, leaf crinkling, loss of leaf and stem stiffness, and leaf reflection. Shoot meristems lacked normal cytokinesis during cell division; thus, giant vacuolated, polymucleate cells resulted. The shoot apex had only one tunica layer and a few-celled cortex of giant vacuolated cells, while the shoot apex of Ctr plants had a 2-layered tunica and a corpus having small, relatively non-vacuolate cells. At initiation, leaf primordia in Pdm plants had few, but giant cells, with precocious cell enlargement. Leaf
midrib and lamina was thickened, but differentiation of mesophyll and vascular tissues was poor. Xylem in both leaf and stem was especially affected: metaxylem initials became extremely large and multi-nucleate, and they failed to produce a thickened lignified secondary wall. Wall lignification also was weak in the sclerenchyma of secondary xylem. The xylem’s biomechanical support was thus compromised. Phloem cells appeared unaffected, at least at the magnifications we used in microscopy. Teratological effects persisted at least six weeks post spray in the 2–3 leaf seedlings, but any effects dissipated in the 6–7 leaf seedlings over the same period.

(392) Herbicides for Use in Plasticulture Systems with Pumpkin Transplants
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Some pumpkin growers are using transplants for high value cultivars to ensure uniform stands. Transplants could be used with plasticulture systems to to shorten crop cycles, produce high quality fruit, and provide in-row weed control. This may allow for double cropping pumpkins. The objectives of this two year study were to evaluate current and potential new pumpkin herbicides for their weed control and crop safety. Clomazone, ethalfluralin + clomazone (Strategy), halosulfuron, isoxaflutole, and s-dimethenamid were applied between the polyethylene covered beds with a backpack sprayer. The data collected at 2 and 4 weeks included plant stand, herbicide injury, plant stunting, and percent control of common purslane, redroot pigweed, velvetleaf, and grasses. At maturity, the number of fruit, fruit weight, and fruit quality were determined. Weed control and crop safety were similar in both years. Clomazone controlled purslane and velvetleaf but not pigweed. Halosulfuron provided poorer purslane and better pigweed control than clomazone or clomazone + ethalfluralin. Isoxaflutole provided good weed control through 4 weeks after application. None of the herbicides reduced pumpkin stand, caused stunting, or crop injury. The number of fruit was not effected by herbicide treatment but total fruit weight and fruit size varied between treatments. Clomazone and the isoxaflutole at 0.052 kg/ha had the greatest fruit weight. The ethalfluralin + clomazone and halosulfuron treatment provided excellent weed control until canopy closure and resulted in good yields but the combination is currently costly. The experimental herbicides isoxaflutole and s-dimethenamid also were promising.

(393) Field Bindweed (Convolvulus Arvensis L.) Control On Drip-irrigated Asparagus
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Field studies were conducted during the 2000 season with the purpose to get production’s technology for field bindweed control on a drip irrigated asparagus plantation. In the Caborca area agricultural drip irrigation system is increasingly being used due to water constraints. Therefore, is very important to obtain more information to make more efficient this irrigation infrastructure. The importance of knowing the optimum period to make each application was clear; it was different treating every 30 to 60 days. Treating every 30 days exhibited a better field bindweed control due to a general reduction of all treatments around 15% in control and return growth period in relation with 60 days period. Also, it was detected the importance of the combination of soil and foliar applications. In fact, the treatment of 150 cc/há Dichamba + 2,4-D (through drip system) and 200 cc/há (foliar); this treatment got a reduction of 30 and 80% on the field bindweed shoot length and coverage in relation to the control plot, while Glyphosate 3% got 35 and 60% higher shoot number per plant than the others treatments. The non conventional treatment (acetol acid 10%) through the drip system and the Larrea tridentata juice extracts (15%) through the drip system and 20% foliar had intermediate effects with respective reductions of 30 and 40%; although it is necessary evaluate more growing seasons to get more specific information about this non conventional product. The asparagus plant was not affected with the application of this products. However, caution should be considered when the Dichamba + 2,4-D combination is used through the drip irrigation system because such combination is very aggressive.

(394) The Morphology of Weedy Nightshades
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Nightshades are problem weeds of a range of horticultural crops. They completely with crops for resources, interfere with harvest, and can reduce crop quality. Nightshades can severe as alternate hosts of diseases attacking related solanaceous horticultural crops. Nightshades are difficult to control in solanaceous crops because of similar appearance, growth habits, and susceptibility to herbicides. Eastern black nightshade (Solanum ptycanthum), American black nightshade (S. americanum), black nightshade (S. nigrum), hairy nightshade (S. sarrachoides), horsemettle (Solanum carolinense), and jimsonweed (Datura stramonium) are all problems weeds while other genus in this family, such as groundcherrys including clammy groundcherry (Physalis angulata) and smooth groundcherry (P. subglabrata) are not problem weeds. The objective of our study was to characterize the morphological variation of nightshade species. Accessions of horsemettle, eastern black nightshade, jimsonweed, and clammy groundcherry were collected from throughout the eastern U.S. and grown in a greenhouse in Urbana. Plant habit and stem, leaf, inflorescence, flower, and fruit characteristics were all described. Leaf shape, margin, and pubescence along with flower color and size varied between species but generally was consistent between accessions within a species. American black nightshade and black nightshade both had entire leaf margins. Horseettle leaves were oke-leaf shaped or had a few large pointed teeth. Eastern black nightshade leaves were serrated. The berries of most eastern black nightshade were purple with a few accessions having green berries at maturity. The most obvious variation in jimsonweed was in stem color with some accessions having green stems other having purple stems. The variations in morphology were not related to the location the accession was collected or to its potential weediess.

(395) Interference of Yellow Nutsedge (Cyperus Esculentus L.) with Sweet Basil (Ocimum Basilicum) is Affected by Nitrogen Fertilization Rates
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A study was performed to determine the effect of nitrogen (N) rates (50, 75, 100, 125, and 150 Kg/ha) on the interference of yellow nutsedge with transplanted sweet basil growing in a Florida sandy soil. N was applied to the soil two days before transplanting sweet basil. The crop was grown weed-free or competing with 30 yellow nutsedges per m². Yellow nutsedge emerged 4 days after transplanting the crop, and was allowed to interfere with basil during the complete crop season (60 days). The best yield in weed-free basil was obtained with the N rates of 75-125 Kg/ha. Sweet basil yield decreased at N rates >125 Kg/ha. Increasing N rates resulted in increased biomass accumulation in yellow nutsedge, and yellow nutsedge-infested sweet basil produced lower yields than weed-free sweet basil grown at the same N fertilization rates. Yield losses in yellow nutsedge-infested...
Vegetable Crop Physiology

(17) Effect Of Rootstocks on the Vegetative Development and Grafting Success of Watermelon (Citrullus Lanatus Schard.) Variety Tri-X 313
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Vegetables are important source of employment and income in Mexico. Watermelon is one of the most important vegetables, and in the State of Colima about 1260 hectares are annually cultivated. Several problems are faced during the development of the plants, such as the environmental temperatures with ranges between 9 and 37 °C during the night and noon, respectively, these fluctuations provoke physiological disorders such as broken branches and poden inviability or germination having as results the lack of fruit exportation quality. Grafting horticultural plants on adequate rootstocks enhance the survival, increase the branch diameter, increase the yield and fruit quality. This study was conducted to evaluate improved and local rootstocks on the vegetative growth of the Watermelon variety Tri-X 313. A local pumpkin (Cucurbita maxima), the calabazilla or Buffalo gourd (Cucurbita foetidissima), estropajo or pepinillo (Luffia operculata), and improved pumpkin variety ‘Shintosa Kamel’ (Cucurbita maxima × Cucurbita moschata) were used. This study was conducted under dry tropical conditions in Tecomán, Colima, Mexico, located in the Southwestern coast of Mexico. The cleft grafting method was used when the seedlings had the first couple of true leaves, once the cicatrization was succeeded, the grafted plants were transplanted to field conditions using black plastic mulching and dropping irrigation. Statistical significant differences were obtained between rootstocks (P < 0.01). The highest succeeded grafts were obtained with regional or local pumpkin, and 82% of percent of grafting success was registered. A 100% of adapted plants to field conditions was obtained with the Shintosa Kamel variety. The Shintosa Kamel and Calabazilla had the highest number of branches with four branches per plant. The regional pumpkin had the shortest period to blooming with 63 days. Regional pumpkin exhibited the best compatibility with the Watermelon Tri-X 313. The vegetative development and growth as well as the shortest period to blooming depended on the rootstocks used. The environmental temperature affected the adaptation of grafted plants to field conditions.

(18) Oxalic Acid Concentrations in Spinach Leaves Depend on the Variety and Nitrogen Source in Hydroponics
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High oxalic acid (OA) concentrations in leaves of plant species, have been of concern because of the harmful health effects associated with the intake of high OA, which may combine with essential minerals such as calcium and iron, to form insoluble salts known as oxalates and hinder their bio-availability. Spinach (Spinacia oleracea) is a cool season annual herb that is a popular vegetable eaten raw, boiled or baked into various dishes. Since spinach is consumed as a source of essential minerals especially calcium and iron, it is important to find cultivation practices that will minimize the oxalic acid concentration in spinach leaves. Growing tips, fully expanded mature leaves at the 3rd and 4th nodes from the top, and older leaves at 5th and 6th nodes were harvested from two spinach varieties (Tyee and Springer) grown in hydroponic systems containing Nitrogen (200 µg·mL−1) as nitrate (NO3−) to ammonium (NH4+) ratios (1.0, 0.75:0.25, 0.5:0.5, and 0.25:0.75), and analyzed for OA concentrations. Results indicate that the Tyee had 20% to 30% lower oxalic acid concentrations compared to Springer. The growing tips had up to 45% more oxalic acid than the mature and older leaves. Spinach leaves of both varieties had 35 to 58% lower oxalic acid concentrations when grown in solutions containing ammonium compared to the leaves grown with no ammonium. In both the spinach varieties, the dry weight (DW), and fresh weight (FW) were not influenced by the NO3−: NH4+ ratios in hydroponics.

(19) Pectin Ultra-Degradation and the Deciduous Character of Tabasco Pepper Fruit During Ripening
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Pectin characteristics were analyzed during fruit ripening of two tabasco pepper (Capsicum frutescens L.) genotypes to determine their association with the ease of fruit detachment at the junction with the calyx. These tabasco lines differ in the deciduous character of the fruit when ripe: ‘McIlhenny Select’ or easy pick (EZ) requires a lower force to detach from the calyx while ‘Hard Pick’ (HP) requires higher force. Tissue disintegration is another characteristic that differentiates fruit of the EZ line from those of the HP line. Pectin solubility in water from the detachment area of fresh ripe EZ fruit was 14% times higher compared to the HP line. Chelator soluble uronide from inactivated EZ cell wall from the detachment zone, however, was only 1.8 times higher. Fruit detachment force and pectin dissolution from the detachment area of the EZ genotype were inversely correlated (r = −0.97) and followed sigmoidal curves during fruit ripening. Total pectin content in dry tissue was not different and was maintained throughout ripening, however, the degree of pectin esterification in extracted cell wall decreased only in EZ ripe fruit. Size-exclusion chromatography of EDTA-soluble polyuronides indicated that pectin was degraded in both tabasco lines as fruit ripened, but the degree of depolymerization was much more extensive in the EZ line. These results indicate that the deciduous character of the fruit is associated with pectin ultra-degradation. Since polygalacturonic acid activity extracted from fruit detachment zone was the same in both lines, pectin de-esterification may have a role in the enhanced pectin depolymerization.

(20) Regulation of Pumpkin (Cucurbita pepo L.) Flower Sex Expression by Ethylene at Normal and Elevated Temperatures
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When pumpkin plants are grown in elevated temperatures (32/27 °C day/night for about a week during the flower development stage), fewer female flower buds are formed than at normal temperatures (20–25 °C day/night, and only a small percentage of these reach anthesis. This high temperature stress can cause major reductions in pumpkin fruit yield in areas where such temperatures prevail. Exposure to ethylene can increase the number of female flowers formed on pumpkin plants. To determine if application of the ethylene-releasing compound ethephon can overcome the suppression of female flowers at high temperatures, ‘Baby Bear’ pumpkin plants were treated at the 2-leaf stage with 100 or 300 µL·L−1 ethephon as a foliar spray, and then grown in two greenhouse compartments set at 32/27 or 20/15 °C day/night temperature. At the cool temperature, 17% of the first 15 produced female flowers buds on control plants, and virtually
all of these developed into open flowers. Ethephon application at 300 µL·L⁻¹ stimulated 37% of the first 15 nodes to produce female primordia, but only 29% reached anthesis. At the high temperatures, only 3% of nodes formed female flower buds, and 2% flowered. Application of ethephon did not significantly increase female expression at high temperature, and none of the buds reached anthesis. Treatment with an inhibitor of ethylene formation (aminoethoxyvinyl glycine at 100 or 300 µL·L⁻¹) or ethylene action (silver thiosulfate at 1 mM or 5 mM Ag⁺) reduced female flower bud formation at the low temperature, and entirely suppressed female flower buds at high temperature. Additional experiments will be reported, in which ethephon and silver thiosulfate treatments are applied to both a heat-susceptible (‘Baby Bear’) and a heat-resistant (‘Schooltime’) cultivar grown in the two temperature regimes. The results should indicate if chemical regulation of ethylene can be used as a screening tool to identify heat-tolerant pumpkin cultivars.

(21) Response of Muskamelon Seedlings to Chilling Stress and Exogenous Trehalose
John Jifon*

Cold tolerance is an important trait in low temperature-sensitive crops such as muskmelons that are often planted early in spring. Reductions in water uptake due to changes in root membrane ultrastructure and function have been implicated in the chilling response. The effects of chilling stress and exogenous treatment with trehalose (an osmoprotectant) on seedling physiology and development of muskmelon (Cucumis melo L. cv. ‘Primo’) were studied. Five-week-old seedlings, treated with water or trehalose, were exposed to a 10/4 °C (day/night) temperature regime for 48 h under a 10 h light/14 h dark photoperiod and then returned to the normal growth temperatures (26/15 °C). Leaf carbon exchange rate (CER) was reduced by 10-15% following chilling stress, but recovered rapidly when the growth temperature was increased to 26 °C. The reduction in CER at low temperature was less in trehalose-treated plants (12%) than in control plants (16%). The maximum quantum efficiency of photosystem II (PSII), measured as dark-adapted chlorophyll fluorescence, \( Fv/Fm \) (where \( Fv \) is variable fluorescence and \( Fm \) is maximum chlorophyll fluorescence), was also reduced by about 10% following chilling stress. The reductions in PSII efficiency were 5% and 14% in trehalose-treated and control plants respectively. Low temperature-induced electrolyte leakage from root segments was about 8% in trehalose-treated plants and 12% in control plants. Chilling stress slowed plant development and delayed female flower opening by 3 to 5 days on average. The results demonstrate the potential use of trehalose to improve cold tolerance during early spring establishment of chilling-sensitive crops.

(22) Root Zone Calcium has a Dramatic Influence on Growth of Potato Apical Meristem and Maintenance of Apical Dominance
Senay Ozgen*, Jiwan P. Palta*

It is well known that Ca plays an important role on plant growth and development including cell division and cell elongation. The purpose of the present study was to determine the impact of root zone Ca on the growth and health of potato apical meristem and maintenance of apical dominance. For this purpose, node 48 h under a 10 h light/14 h dark photoperiod and then returned to the normal growth temperatures (26/15 °C). Leaf carbon exchange rate (CER) was reduced by 10-15% following chilling stress, but recovered rapidly when the growth temperature was increased to 26 °C. The reduction in CER at low temperature was less in trehalose-treated plants (12%) than in control plants (16%).

Calcium concentration in the tuber can be increased by placing calcium in the tuber area during the time of tuber bulking. In the present study, uptake and mobilization of calcium was investigated using \(^{45}\)Ca. Experiments with Russet Burbank and Dark Red Norland were conducted utilizing a divided pot. \(^{45}\)Ca was fed to either the main root system or the stolon and tuber portion of the plant. Radioactivity was detected in the above ground shoot regardless of which portion of the plant was labeled. Radioactivity was detected in tubers only when \(^{45}\)Ca was applied to the stolon and tuber producing portion of the plant. Redistribution of calcium from the aerial shoots to the tubers did not occur. Direct uptake of calcium through tuber periderm did not occur. These results support previous studies and demonstrate that: (i) Calcium can be supplied to the leaves by both the stolon and tuber area as well as by the main roots. (ii) Tubers obtain calcium only from the soil surrounding the tuber and stolon area. Furthermore, calcium in leaves and stems does not mobilize to the tuber. (iii) Calcium does not move from the soil directly into the tuber. Thus calcium moves into the tuber along with water via tuber and stolon roots. These results have very important implications in the placement and timing of calcium for enhanced tuber uptake.

(24) Effect of Varieties and Seeding rates on Internal Green Shoulders (GS) in Carrots (Daucus carota var. sativus)
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Green shoulder (GS) is a physiological disorder in carrots indicated by chlorophyll accumulation at the crown. GS not only affects root appearance but also makes it unfit for consumption due to its bitter taste; nearly, one million pounds of the processed carrots contain GS. Photo electronic sorters in the freezing tunnels cannot completely eliminate GS products. The objectives of this study are to evaluate genotypic and phenotypic variation and to monitor the effect of plant population densities on the occurrence of internal GS and establish a relationship between canopy volume and GS. Thirty four varieties were field evaluated at Great Village, Nova Scotia using a randomized complete block design (RCBD). Each variety was replicated four times in single 10m rows. Slicer (Caro Choice) and dicer (Red Core Chantenay) varieties were grown with five different seeding rates as treatments at Great Village, Nova Scotia using a RCBD. Each treatment was replicated four times in a plot size of 7 rows (4.2 m x 10 m). Leaf area index (LAI) was determined using the LAI-2000 Plant canopy analyzer. The percentage length of the internal greening was measured using a Computer Image Analysis system (CIA). LAI (P < 0.0001) differed significantly but the percentage length of the internal...
greening ($P = 0.0550$) of the varieties did not differ significantly. A weak correlation was seen between the two ($r^2 = 0.46$). Although LAI differed significantly in slicer and dicer varieties, there was no significant difference in the percentage of the internal greening in the dicer ($P = 0.659$) and the slicer ($P = 0.375$) varieties. A weak correlation was seen between the LAI and the slicer and dicer varieties indicating that the canopy volume does not completely control GS. It is possible that the GS may perhaps be induced even prior to canopy development. Since, exposing hypocotyls to light increased greening during early seedling emergence, GS may be a phenomenon that the young seedlings encounter in the field which may have attenuated until after maturity. It is also possible that other factors such as herbicides may contribute to GS. Early greening of the seedlings needs to be controlled to prevent GS in matured plants.

(25) Ripening Stimulation and Ethylene Evolution in Red Pepper (*Capsicum annuum* L.) as Influenced by Lysophosphatidic Acid (LPA) and Lysophosphatidylethanolamine (LPE)

Chung-Kil Kang*1, Yeo-Rok Oh2, Guk-Hoon Chung2, Jiwan Paul Pahl3

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This experiment evaluated the ripening stimulation and ethylene evolution in red pepper (*Capsicum annuum* L., cultivar Podocheong) as influenced by lysophosphatidic acid (LPA) and lysophosphatidylethanolamine (LPE). The experiment in 2002 season was conducted on an upland grower field located in Chunji of Chunbuk province. The chemicalics tested were applied on Sep. 27 and Oct. 3. The red fruits were harvested 7 days after treatment. The experiment used randomized complete-block design with 5 replicates. Fruits were collected from 15 plants in each replicate. Both LPE and LPA stimulated the fruit coloring of red pepper. LPA at 50 mg·L−1 was the most effective treatment, which showed a marketable yield increase of 75.3% as compared to control. No significant difference was found in fruit quality as compared with untreated control. No phytotoxicity was observed when LPA was applied on red peppers. A mixture of LPE and LPA was less effective as compared to LPA alone. LPA treatment also stimulated ethylene evolution in this test by 67% over control. These results suggest that LPA can strongly stimulate the ripening of red pepper, which was closely related with ethylene evolution.

12:30 pm–1:30 pm POSTER SESSION 31 Ballroom A

(Location numbers for the posters within the Poster Viewing Area are in parenthesis)

**Controlled Environments—Crop Physiology**

(34) Comparison of Onion Growth and Pungency Under High-pressure Sodium and Cool-White Fluorescent Lamps

Sharon Edney*1, Neil Yorio2, Gary Stutte1, Oscar Monje1, Lanfang Levine1, Jan Bauer1, Raymond Wheeler2

1 Advanced Life Support, Dynamac Corporation, Mail Code DYN-3, Kennedy Space Center, Florida, 32899, 2 Biomedical Operations and Research Office, NASA, Hangar L, Kennedy Space Center, FL, 32899

A study comparing the growth of eight cultivars of radish was performed in separate tests in controlled environment chambers under either high-pressure sodium (HPS) or cool-white fluorescent (CWF) lamps. Air temperature, relative humidity, CO2, PPF, and photoperiod were maintained for all tests at 23 °C, 65%, 1200 µmol·mol−1, and 16-h light/8-h dark, respectively. Time-course growth measurements were made and final harvest was taken at 42 days after planting (DAP). Results showed that maximum biomass accumulation was not reached at the 42 DAP final harvest for any cultivar. This suggests that a longer cropping cycle may be necessary to achieve both maximum productivity and cropping efficiency under both lamp types. Only one cultivar, Deep Purple, showed a significant difference ($P < 0.035$) of edible dry mass and total dry mass between lamp types. Cv. Deep Purple had greater top mass and total dry mass under HPS than CWF. No effect on carbon partitioning (harvest index) was observed between lamp types for any variety. Pyruvic acid levels were used as a measure of pungency, and no significant differences in concentration were observed between lamp types for any cultivar. When data from both lamp types were combined and analyzed by ANOVA, cv. Guardsman had a greater plant height, edible dry mass, and total dry mass than all other cultivars. However, cv. Kinka appeared to be the best variety for use in potential space flight experiments because of its high germination rate, erect uniform growth and short plant height.

(35) Comparison of Radish Growth Under High-pressure Sodium and Cool-White Fluorescent Lamps

Neil Yorio*1, Sharon Edney1, Oscar Monje1, Gary Stutte1, Raymond Wheeler2

1 Controlled Biological Systems, Dynamac Corporation, Mail Code DYN-3, Kennedy Space Center, Florida, 32899, 2 Spaceport Engineering & Technology Directorate, NASA Biological Sciences Office, Mail Code YA-E4-C, Kennedy Space Center, Florida, 32899

A study comparing the growth of eight cultivars of radish was performed in separate tests in controlled environment chambers under either high-pressure sodium (HPS) or cool-white fluorescent (CWF) lamps. Air temperature, relative humidity, CO2, PPF, and photoperiod were maintained for all tests at 23 °C, 65%, 1200 µmol·mol−1, 300 µmol·m−2·s−1, and 16-h light/8-h dark, respectively. Time-course growth measurements were made throughout the tests and a final harvest was taken at 21 days after planting. Results showed no effect on growth, edible yield, partitioning (harvest index), and net photosynthetic rates among cultivars grown under CWF compared to HPS. However, a ~5% reduction in total dry mass was observed for CWF compared to HPS lamps, suggesting that photomorphological development (i.e. greater leaf expansion) for plants grown under HPS lamps may account for the differences in growth observed due to increased light absorption. Combining the lamp-treatment data for each cultivar indicated greatest edible fresh and dry mass gain for cv. ‘Cherry Bomb II’ compared to the other cultivars. High edible yield and uniformity suggested cv. ‘Cherry Bomb II’ was the best variety for inclusion into crop trials for potential space flight applications.

(36) Percent Photoperiod and Lighting Cycle Affect Flower-stalk Elongation of *Spinacia Oleracea*

Changhoo Chun, Sayaka Nagakura*

Department of Bioproduction Science, Chiba University, 648 Matsudo, Matsudo, Chiba, 271-8510, Japan

Flower-stalk elongation of *Spinacia oleracea* L. cv. Dimple was investigated under fifteen photoperiodic conditions, obtained by combining one of five lighting cycles (photoperiod + dark period: 24, 360, 720, 1440 and 2160 min) and one of three percent photoperiods (100% photoperiod/lighting cycle: 33%, 50% and 67%). Cool-white fluorescent lamps were used as an artificial light source and the integrated photosynthetic photon flux during a 30-d experiment was 250 mol·m−2 for all the treatments. Air temperature, relative humidity and CO2 concentration were set at 23 °C, 65% and 1000 µmol·mol−1, respectively. Flower-stalk length (distance between base of cotyledon and flower-bud apex) 30 days after sowing (DAS) decreased with increasing lighting cycle for all the percent photoperiods, and increased with increasing percent photoperiod for all the lighting cycles. In all the treatments of 24 and 360-min lighting cycles, anthesis was observed at
30 DAS. Anthesis was also observed in all the 67% percent photoperiod treatments except in the treatment that had a lighting cycle of 2160 min. Results indicate that flower-stalk elongation and anthesis of spinach were affected by both lighting cycle and percent photoperiod. These results could be utilized in plant production systems using artificial lighting to control bolting and/or flowering of plants.

(37) Enhancement of Growth and Development of tomato Seedlings by Lengthening Light Period Each Day
Hiromi Toida*, Yoshitaka Omura, Katsumi Ohyama, Toyoki Kozai
Faculty of Horticulture, Chiba University, 648 Matsudo, Matsudo, Chiba, 271-8510, Japan

Light and dark periods can be easily controlled under artificial light. To better understand the effects of alternation of light and dark periods on the growth and development of plants, we classified non-periodic alternation of light and dark periods into 6 types (Toida et al., 2003), and studied the growth and development of plants in each type. One of 6 types of non-periodic alternation was called NF.

In this study, tomato (cv. Momotaro) seedlings grown under two variations of NF (NF-1 and NF-2) were compared with seedlings grown under a treatment of periodic alternation (P: constant 12 h light and dark period). In all treatments, photosynthetic photon flux (PPF) was maintained at 280 µmol·m⁻²·s⁻¹; the sum of each light period and the following dark period was 24 h; and each of the integrated light and dark periods was 132 h for 11 days. In NF-1, the initial light and dark periods were 7 and 17 h, respectively, and the light period was lengthened 1 h per day, while in NF-2, they were 17 and 7 h, respectively, and the light period was shortened 1 h per day. At the end of the experiment, dry mass per seedling was greater and flower-bud initiation of the first flower truss was earlier in NF-1 than in NF-2 and P, even though the integrated PPF during the experiment was the same in all treatments. Growth and development of tomato seedlings can be enhanced under the same electric energy consumption for lighting by gradually lengthening the light period in a treatment of non-periodic alternation of light and dark periods.

(38) Quality Improvement of Tomato Transplants under Continuous Light by Controlling Air Temperature
Katsumi Ohyama*, Yoshitaka Omura, Toyoki Kozai
Faculty of Horticulture, Chiba University, 648 Matsudo, Matsudo, Chiba, 271-8510, Japan

In transplant or seedling production under artificial light, providing continuous light (24 h/d photoperiod) at a relatively low photosynthetic photon flux (PPF) is one possible way to reduce both initial and operational costs for lighting and cooling. On the other hand, providing continuous light often causes leaf chlorosis and/or necrosis of tomato seedlings. In the present experiment of tomato ‘Momotaro’ transplant production under continuous light, the effects of constant air temperatures (16, 22 and 28 °C) and alternation of high (28 °C) and low (16 °C) air temperatures (periods of high/low air temperatures: 24 h/16 h) (NF) on growth and development of the seedlings were investigated. The objective of experiment was to find a better air temperature regime under continuous light for avoiding leaf chlorosis and necrosis, and at the same time for enhancing floral development of the seedlings. The seedlings with fully expanded cotyledons were grown for 15 days in all treatments at 150 µmol·m⁻²·s⁻¹ PPF. 70% relative humidity, and 350 µmol·mol⁻¹ CO₂ concentration. When air temperatures were alternated, neither leaf chlorosis nor necrosis was observed, while leaf chlorosis was observed under the constant air temperatures regardless of average air temperature. Faster floral development was observed in the seedlings grown at lower average air temperatures. In short, quality of tomato transplants grown under continuous light can be improved by controlling an average air temperature with modification of periods of high and low air temperatures.

(39) Length of Individual Internodes of Tomato Seedlings can be Controlled by Changing DIF with Time
Yasuyo Koyano*, Changhoo Chun, Toyoki Kozai
Department of Bioproduction Science, Chiba University, 648 Matsudo, Matsudo, Chiba, 271-8510, Japan

Elongation of individual internodes of Lycopersicon esculentum was investigated under eight treatments, obtained by combining one of two DIFs (photoperiod temperature – dark period temperature: +10 and –10 °C) and one of three periods of growth (6–13, 14–21, and 22–28 days after sowing). The lengths of hypocotyl and all the internodes of tomato seedlings were measured at the start of each photoperiod and their daily elongation rates were calculated. The temperatures used to create the DIFs were 20 and 30 °C. In the growth chambers illuminated with fluorescent lamps, the photosynthetic photon flux was set at 250 µmol·m⁻²·s⁻¹ with a photoperiod of 12 h/d, and the saturation deficit was set at 1.0 kPa. The change in the elongation rates of hypocotyl and individual internodes with time closely matched a Gaussian curve. The peak height and the number of days to reach the peak varied from one internode to another. The stem length of the seedlings and the proportions of hypocotyl and individual internodes varied among the treatments. Results indicate that the length of hypocotyl and individual internodes of plants can be controlled by changing DIF with time. This method could be applicable in production of scions and rootstocks with controlled length of hypocotyl and individual internodes for efficient grafting operations of tomato and other horticultural crops.

(40) A Preliminary Study on the Effects of EC and Grafting on Growth of Greenhouse, Gas Exchange and Fruit Quality of Hydroponic Tomato (Lycopersicon esculentum)
Mark Kroggel*, Chiieri Kubota
Plant Sciences, University of Arizona, 303 Forbes Building, Tucson, AZ, 85721-0036

Grafted and non-grafted seedlings of tomato (Lycopersicon esculentum; ‘Rapsodie’ scion) were grown in greenhouse using three different electrical conductivity (EC) levels (approximately 2, 4 and 9 dS·m⁻¹) of a complete hydroponic nutrient solution to determine the effect of EC and grafting on plant growth, gas exchange, and fruit quality. Plants were topped above the second fruit truss 3 weeks after the start of EC treatment (WAT). Non-grafted and grafted plants had lower stomatal conductance and transpiration rates at higher EC during the first 3 WAT. The highest EC reduced transpiration rate and stomatal conductance at all light levels during the first 3 WAT. Final total fresh weight (TFW) measured on 11 WAT decreased significantly with increasing EC for both grafted and non-grafted plants and TFW was less for non-grafted plants for all EC levels. Final total dry weight was greater by 22% in grafted seedlings than non-grafted seedlings. Blossom end rot was induced at both 4 and 9 dS·m⁻¹ for non-grafted plants, but only at 9 dS·m⁻¹ for grafted plants. Fruit soluble solid concentration (%Brix) was greater at 9 dS·m⁻¹ than at 2 or 4 dS·m⁻¹ for both grafted and non-grafted plants. Results obtained in the present study indicated that grafting altered physiological responses of tomato plants to high EC.

(41) Effects of High EC, Planting Location Inside the Greenhouse, and Cultivar on Leaf Gas Exchange and Fruit Quality of Hydroponic Tomato (Lycopersicon esculentum)
Chieri Kubota*, Pat Rorabaugh, Min Wu

SUNDA pm
Department of Plant Sciences, The University of Arizona, 303 Forbes Building, Tucson, AZ, 85721-0036

Manipulation of the EC of a hydroponic solution during fruit development has been known to improve fruit quality of tomatoes. However, optimum EC level for maximizing fruit quality while minimizing potential yield reduction will be dependent on other environmental conditions (such as air temperature and light intensity) and cultivar. Five tomato cultivars (Blitz, Mariachi, Quest, Rapsodie, and Trust) were grown hydroponically on rockwool (seeded July 26, 2001; transplanted August 23, 2001, with a final harvest June 11, 2002) in a University of Arizona CEAC greenhouse (465 m², north-south orientation). Thirty seven weeks after transplanting the EC level of the nutrient solution was increased gradually from 2.6 dS·m⁻¹ (conventional level) to approximately 5 dS·m⁻¹ by increasing the entire nutrient concentration in order to examine plant responses to high EC. Total soluble solid concentration (TSS, % Brix at 20°C) of fruits gradually increased with time from 2 to 6 weeks after increasing EC. The highest TSS was 7%, observed for Mariachi planted on the south side of the greenhouse. Regardless of cultivar, fruits harvested from the south side of the greenhouse had greater TSS than those from the north side. This was due to higher air temperature and greater daily PPF (photosynthetic photon flux) received on the south side than on the north side of the greenhouse. Cultivar showed a relatively weak effect on TSS due to the large variation of TSS within the same cultivar. Single leaf gas exchange rates measured at a constant PPF (1000 µmol·m⁻²·s⁻¹) indicated that both planting location and cultivar affected leaf transpiration rate but not net photosynthetic rate. TSS increased with increasing mole ratio of net photosynthetic rate and transpiration rate (PT ratio), but neither photosynthetic rate nor transpiration rate had significant effects on TSS, regardless of planting location or cultivar. This indicated that greenhouse environment, cultivar, and cultivation techniques reducing transpiration rate while maintaining net photosynthetic rate would potentially increase the TSS and improve the fruit quality. It also suggests that quantitative understanding of the in situ plant gas exchange rate will be helpful in selecting environmental conditions, cultivation practices, and cultivars for high quality hydroponic tomato production.

(42) Effects of Irrigation Frequency and Duration on Water Content and Salinity of Substrate, and Growth and Root Activity of Potted Plants (Kalanche blossfeldiana ‘New Alter’) in Nutrient-Flowing Wick Culture System
Jung-Eek Son*, Myung Min Oh
Plant Science, Seoul National University, 103 Seodun, Kwonsun, Suwon, 441-744, Republic of Korea

Irrigation frequency and duration are important factors to control the water content of substrate in a nutrient-flowing wick culture system (NFW), which uses the capillarity of wick and control the irrigation frequency and duration. Adequate irrigation can maintain better root zone environment and can lead to better growth of potted plants. In this study, the water contents of substrate were measured and compared among different substrate compositions (peatmoss:perlite = 1:1, and 1:3, v/v), subirrigation conditions (2 and 5 times a day in NFW, continuous in NCW, once a day in ebb & flow), and pot sizes (6, 10, and 15cm). The salinity accumulation at each location was analyzed, and the growth and root activity of Kalanche blossfeldiana ‘New Alter’ observed. The water contents were fluctuated from relatively higher level of 40 to 60% in ebb & flow, while from 25 to 30% in NFW. In ebb & flow, it is difficult to accurately control the water level that a little higher level may make a much higher increase in the water content. In NCW, it gradually increased from 30 to 40%. Although the water content of substrate showed similar tendencies as above in both substrate compositions of 7:3 and 1:1, it was 5% higher in 7:3 than in 1:1 due to higher water holding capacity. The EC of substrate was highest in NCW due to continuous water supply through wick and surface evaporation, but it does not influence the growth of plants. The root activity was higher in NFW than in ebb & flow, because of more air exchange in the substrate inducing higher activity of roots. The growth of Kalanche in fresh and dry weights, plant height, number of flower and bud were better in 4-time irrigation in NFW and NCW, compared with 2-time irrigation a day which was low in NFW. Therefore, it is concluded that the irrigation frequency and duration greatly affect the growth of potted plants, and more than 4 times a day in NFW was required for adequate root zone environment and a good growth of potted plants.

(43) Hypobaric Conditions Effect Gas Exchange, Ethylene Evolution and Growth of Lettuce and Wheat
Chuanjiu He¹, Fred T. Davies, Jr. ², Ronald Lacey³, Malcolm C. Drew¹, Denise Brown⁴
¹Horticultural Sciences, Texas A&M University, MS 2133, College Station, TX, 77843-2133, ²Biological and Agricultural Engineering, Texas A&M University, MS 2133, College Station, TX, 77843-2133

Elevated levels of ethylene occur in enclosed crop production systems and in space-flight environments -- leading to adverse plant growth and sterility. There are engineering advantages in growing plants at hypobaric (reduced atmospheric pressure) conditions in biomass production for extraterrestrial base or spaceflight environments. Objectives of this research were to characterize the influence of hypobaria on growth and ethylene evolution of lettuce (Lactuca sativa L. cv. Buttercrunch) and wheat (Triticum aestivum L. cv. USU-Aprogeo). Lettuce and wheat were grown under variable total gas pressures (30, 50, 70, and 101 kPa (ambient)) and had no significant differences in net photosynthesis and stomatal conductance in a series of experiments lasting 10 days. There was a reduction in net photosynthesis and an increase in stomatal conductance, regardless of total gas pressure. In another study, lettuce and wheat were direct seeded, germinated and grown in the same chambers for 28 days at 50 or 101 kPa. The hypobaric (low pressure) effect did not alter germination rate or seedling growth. The plant hormone, ethylene, accumulated in chambers with lettuce or wheat during 10-day studies. Ethylene production for both lettuce and wheat was reduced more than 65 % under 30 kPa compared with ambient pressure (101 kPa). Low O₂ (6.2% v/v) inhibited ethylene production with lettuce under both low (30 kPa) and ambient pressure, whereas ethylene production of wheat was inhibited by low pressure but not low O₂. There was a negative linear correlation between increasing ethylene concentrations vs. decreasing net photosynthesis and chlorophyll content of lettuce and wheat. Lettuce had higher production of ethylene and showed greater sensitivity to ethylene than wheat. The hypobaric (low pressure) effect on reduced ethylene production was greater than that of just hypoxia (low oxygen).
there were about 80 open pit greensand mines in New Jersey. There are only a few of these mines still operating today. Greensand contains a clay mineral called glauconite. The mineral is unusual because unlike most clays, which are very fine, glauconite often exists as sand-sized pellets. Glauconite does not behave like most sands. It is sand size, but behaves like a ball of clay. Greensand has sometimes been used in agriculture as a natural source of potassium. Although greensand does contain a relatively high content of potassium (56%), very little of this potassium is plant available. Greensand contains stable balls of clay and silt size particles that contain many micropores. In this way, it differs from other sands which are composed of minerals such as quartz and feldspars. The micropores increase the available water holding capacity within the sand fraction unlike most other sands. Greensand has a high cation exchange capacity which enhances the ability of sandy soils containing greensand to store nutrients such as calcium, magnesium, potassium and micronutrients. These desirable physical and chemical properties should spur renewed interest in the use of greensand for horticulture.

(385) A History of Commercial Vegetable Production in Central and Southern Florida
Mary Lamberts*, Elizabeth Lambb, Richard Tyson1, Eugene McAvoy3, Phyllis Gilreath, Kenneth Shuler5


Commercial agricultural production began in central Florida in the mid 1800s and in southern Florida toward the end of the same century. The back-to-back freezes of 1894 and 1895 devastated all commercial agriculture with the exception of Dade and Broward Counties in the extreme southeastern corner and groves along the Caloosahatchee River near Ft. Myers. Early transportation was by rail, which extended as far south as Palmetto in Manatee County. The rail line was built prior to the great freezes, and by ship for the other two counties. The first off-season crops included celery (central) and tomatoes (south), with other crops as well. Areas such as Homestead in extreme southern Florida became famous for winter tomatoes as early as the late 1890s, with production peaking in the 1920s at 35 train carloads per day. Vegetable production in southwest Florida is documented from 1909, with the vast muck region around Lake Okeechobee being developed in 1915. The formation of Campbells Soup Company in NJ, further increased the demand for tomato production, which peaked in 1937 at 13,000 acres. Possibly the most famous tomato cultivar, ‘Rutgers’, was developed by Lyman G. Shermerhorn of the New Jersey Agricultural Experiment Station. The ‘Rutgers’ tomato was so successful, that in the early 1950s this cultivar was used by over 70% of tomato canners in the USA. The NJ canning industry collapsed during the early 1960’s, and since that time fresh market tomato production has predominated. In 2002, fresh market tomatoes were planted on 3,400 acres, for a total value of $27,342,000.00.

(387) History of the Rutgers Tomato and New Jersey Tomato Industry
Peter Nitzsche*, William Hibbik, Wesley Kline1

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The production of tomatoes, Lycopersicon esculentum, has endured a long and interesting history in New Jersey. Tomatoes were first grown in NJ, sometime in the early 1800’s, and the first canning of tomatoes occurred in Jamesburg, NJ. Production of tomatoes increased tremendously during the Civil War, turning NJ into a major growing area in the USA. The formation of Campbells Soup Company in NJ, further increased the demand for tomato production, which peaked in 1937 at 13,000 acres. Possibly the most famous tomato cultivar, ‘Rutgers’, was developed by Lyman G. Shermerhorn of the New Jersey Agricultural Experiment Station. The ‘Rutgers’ tomato was so successful, that in the early 1950s this cultivar was used by over 70% of tomato canners in the USA. The NJ canning industry collapsed during the early 1960’s, and since that time fresh market tomato production has predominated. In 2002, fresh market tomatoes were planted on 3,400 acres, for a total value of $27,342,000.00.

(388) The Horticultural History of the Cooperative Extension Service in Florida
Elizabeth Lamb*, Mary Lamberts*, Jack Hebb1, Ed Skvarch1, Phyllis Gilreath, Gene McAvoy, Richard Tyson1, Ken Shuler2


Extension work started in Florida in 1899 as 14 Farmer’s Institutes, conducted by the Agricultural Experiment Station and the College of Agriculture, and Cooperative Demonstration Work, conducted by the Bureau of Plant Industry. In 1907 and 1911 respectively, boys clubs and...
girls canning clubs were added. On May 25, 1915, following the approval of the Smith-Lever Act by the State Legislature, the Agricultural Extension Division was started, in connection with the University of Florida, with a grand budget of $70,699.78. Thirty-nine counties had demonstration agents and 22 counties had home demonstration agents in that year and the first bulletin was issued in April, 1915. Work on citrus has been an important part of Extension’s work in Florida since its inception, including the Citrus Advisory Committee (1947–54) and Florida Citrus Institutes (1930’s–1970’s), and continues today through the State Major Program on Citrus Management with action teams on disease and insect control, best management practices and genetic resources. Even though vegetable crops have been important in Florida for decades, winter tomatoes being a major crop as early as 1899, formal Extension programs in vegetable crops did not begin until 1948. This program expanded rapidly in the 1950’s and the Production Guides were initiated during this period. County agents were instrumental in the success of the tomato, strawberry, and potato industries in the state. Current emphases are in production, marketing, postharvest handling and Integrated Pest Management. Programs in Ornamental Horticulture started in 1953 to cover commercial and home owner questions on ornamental plants. The broad range of crops, production systems, and markets for ornamental products requires an expanding emphasis on environmental horticulture in the Florida Cooperative Extension system. As changes in the demographics of the state and market competition horticultural products continue, Extension will continue to adapt to support the commercial industry and homeowner interest in Horticulture.

(389) History of Horticultural Research at the U.S. Department of Agriculture in the Washington, D.C. Area

Rob Griesbach*

Floral & Nursery Plants Research, US National Arboretum, USDA, ARS, BARC-W, BLDG. 010-A, Beltsville, Maryland, 20705-2350

Horticultural research at the U.S. Department of Agriculture in the Washington, D.C. area has had a tremendous impact on Industry. Research has resulted in economically valuable cultivars, as well as pivotal parents for many Industry and University breeding programs. Research has also resulted in many revolutionary discoveries in physiology, development, biochemistry, pathology and genetics.

12:30 pm–1:30 pm POSTER SESSION 33 Ballroom A

(Viticulture and Small Fruit)

(272) Cultural Methods for Production of Hydroponic Strawberries

Jim E. Wyatt, Emily W. Gatch, Mitchell V. Hatchett

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Strawberry cultivars ‘Camarosa’, ‘Chandler’, ‘Sseqoia’, and ‘Gaviota’ were grown in a greenhouse using an ebb-and-flow hydroponic system from Nov 2001 through Apr 2002 at the West Tennessee Experiment Station, Jackson, TN. Other cultural methods tested were 4 vs. 8 applications per day of nutrient solution and a comparison of 7.6 cm plastic pots containing commercial potting mix vs. rockwool plugs for plant support in the hydroponic system. Each plot consisted of seven plants and the study was replicated four times. The system was constructed with 10.2 cm diameter PVC pipes with plants spaced 15.2 cm apart in the pipes. Fertilization was with 45 g N–8N–12P–32K per 100 L, 45 g Ca(NO3)2, per 100 liter, and 30 g MgSO4 per 100 liter. Conductivity was maintained at approximately 1.60 mhos and pH was held at 6.5 to 6.8. Minimum temperature of the greenhouse during the growth period was about 15 °C. ‘Camarosa’ and ‘Chandler’ yielded significantly more than ‘Gaviota’. ‘Chandler’ had the largest mean fruit size in the study while ‘Seqoia’ had the smallest fruit. Application of the nutrient solution eight times per day promoted significantly more plant growth, higher fruit yield and larger mean berry size than application four times per day. Plants supported in pots were larger and produced significantly higher yields than those in rockwool. During a period of cloudy weather in late February to early March, some fruit which developed were distorted and misshapen. The loss due to deformed fruit was less than two percent with ‘Gaviota’ having the highest amount of distorted fruit and ‘Chandler’ having the least amount.

(273) A Mini-rhizotron Method to Determine Root Growth Pattern in Strawberry Daughter Plants Treated with Prohexadione-Ca

Julia Reckie, Peter Hicklenton, Paul Struik

Atlantic Food and Horticulture Research Centre, Agriculture and Agri-Food Canada, 32 Main Street, Kentville, Nova Scotia, B4N 1J5, Canada; 2Wageningen University, Department of Plant Sciences, P.O. Box 947, 6700 AH Wageningen, The Netherlands

Prohexadione-Ca (Pro-Ca; BASF trade names Apogee and Regalis), a gibberellin biosynthesis inhibitor is effective in reducing petiole length in strawberry transplants, and it may also affect root development in treated daughter plants. A growth cabinet study was carried out using mini-rhizotrons to determine root growth pattern in strawberry daughter plants treated with Pro-Ca. Each rhizotron consisted of an open-topped plywood box 46 cm high x 30 cm wide x 5 cm deep perforated on the bottom, and with a front panel constructed of 0.25 cm plexiglas. The rhizotrons were filled with a uniformly dark, peat-based growing medium and wrapped in a removable cardboard-aluminum foil shield to eliminate light from the root zone. Each unit was set on a stand at a standard 15 degree angle from the vertical. The strawberry cultivars Sweet Charlie and Camarosa were used. Mature mother plants each with one runner and a single daughter (two leaves with a few root initials) were sprayed to run-off with 62.5 µL L–1 Pro-Ca, and the daughters were planted in their own rhizotron immediately after treatment. Control plants were planted the same way after spraying with water. Root growth was recorded at 5-day intervals by taking a digital image of roots as they appeared on the plexiglas side of each rhizotron. Each digital image was analyzed using appropriate computer software and root length and root area were determined for each plant over a duration of 25 days. Untreated plants consistently had more root length and root area than treated plants for the duration of the experiment. However, transplants treated with Pro-Ca had more roots and these roots were shorter and thicker than roots from untreated transplants. As a result, root growth pattern differed between treated and untreated daughter transplants; treated plants showed a greater concentration of root mass within the first 15 cm below the soil surface.

(274) Progress in Breeding Strawberries with Synthetic Octoploids

J. Alan Sullivan, Rebecca Harbut, H.J. Swartz, Bob Bors

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The synthetic octoploid system was developed as a means to bring diploid, tetraploid and hexaploid species to the octoploid level. This would facilitate introgression into the cultivated strawberry to broaden the genetic base and for further breeding. Approximately 200 synthetic octoploids composed of several Fragaria species have been produced and crossing with the cultivated strawberry begun in 1999. Since then,
was to characterize the CO₂ assimilation rates (A) of the wild species cultivars fruit size improved significantly. Some primary fruit were 5 cm in length and weighed over 30 g. Fruit firmness was also improved. Vegetative vigour was reduced compared to the first cross with a cultivar. Some families exhibited strong resistance to leaf diseases.

Vegetative vigour was reduced compared to the first cross to strawberry cultivars (eg. Honeoye) had high levels of vigour and dense canopies. Some families had exhibited strong resistance to leaf diseases.

Production of hybrids and derived germplasm. Two lineages, including wild species, SO, F1 and derived germplasm. Two lineages, including wild species, SO, F1 hybrids and first backcross hybrids (BC1), were grown in greenhouse conditions at the University of Guelph. Photosynthetic rates were measured with a portable photosynthesis meter during periods of vegetative growth at greenhouse conditions. Different levels of N, K, and P were applied to these plants. The results obtained are the first description of the domestication of B. lutea in Argentina. The mean number of plants/grower of 175. An additional 25 plantings will be established on farms in 2003. A website (http://www.beachplum.cornell.edu/) was activated in February of 2002 and includes handouts, photos, contacts, annual reports, a grower’s guide, goals, news articles, a consumer focus group report and links to websites of similar interest. Conditions: the greenhouse in combination with 6 g of fertilizer applied per plant generated the highest values with 38 fruits produced per plant. Furthermore, the fruit weight was also affected by these factors. Again, the highest values were obtained in plants growing in the greenhouse with 6 g of fertilizer applied per plant. Plants growing in such conditions yield significantly higher the fruits produced in the field compared to those produced in the greenhouse. The higher fruit yield obtained in plants growing in the greenhouse with 6 g of fertilizer per plant could be explained by the great number of fruiting shoots found in these plants compared to plants grown in the field and with lower fertilizer doses. The results obtained are the first description of the domestication of B. lutea in Argentina.

(275) Carbon Exchange Rates of Fragaria species and Derived Germplasm
R.M. Harbut*1, J.A. Sullivan1, J.T.A. Proctor1, H.J. Swartz2
1Department of Plant Agriculture, University of Guelph, Bovey Building, Guelph, Ontario, N1G 2W1, Canada, 2Department of Natural Resource Sciences & Landscape Architecture, University of Maryland, 2102 Plant Science Building, College Park, Maryland, 20742-4452
Four wild Fragaria species, F. moschata, F. vesca, F. triloba, and F. orientalis, have been incorporated into strawberry cultivars through the development of synthetic octoploids (SO). These wild species have not previously been incorporated into the cultivated strawberry (F. x ananassa). In early generation testing SO x cultivar crosses have shown unique characteristics (e.g., large leaves, dense canopies, upright cymes) and extreme levels of vigour. The objective of this research was to characterize the CO₂ assimilation rates (A) of the wild species and derived germplasm. Two lineages, including wild species, SO, F1 hybrids and first backcross hybrids (BC1), were grown in greenhouse conditions at the University of Guelph. Photosynthetic rates were measured with a portable photosynthesis meter during periods of vegetative growth at greenhouse conditions. Different levels of N, K, and P were applied to these plants. The results obtained are the first description of the domestication of B. lutea in Argentina.
During Fall 2001, dormant plants of two raspberry cultivars (‘Heritage’ and ‘Tulameen’) were purchased from a Pacific NW nursery and chilled in a walk in cooler from 7 Nov. through 28 Dec., 2001. Raspberries were planted on 28 Dec. inside a polyethylene tunnel in a two-bed system containing a soilless medium (1:1:1 peat : perlite : vermiculite). Plants were spaced at 50 cm or 25 cm in-row, with 1.8 m between rows. Polyethylene lines and microtubes were installed down the row middles to supply irrigation and a wire-trellis system was used for plant support. Vegetative budbreak began in Feb., 2002, and the number of buds breaking was recorded. Floral budbreak began just prior to vegetative budbreak, and was recorded every other day. Flower and fruit number per node were recorded. Floral budbreak began earlier in ‘Heritage’ (43 days after planting) than in ‘Tulameen’ (51 days after planting), but the bloom period was longer for ‘Heritage’ than for ‘Tulameen’ (57 vs. 49 days, respectively). The fruit development period was not different between cultivars, averaging 35 days. The bloom period was longer at the 50 cm in-row spacing compared with the 25 cm spacing, but the fruit development period was similar. There was no interaction between cultivar and in-row spacing on flowering or fruit development period. Ripe fruit were harvested from 9 Mar. through 18 May. There were no differences in flower or fruit numbers between cultivars, with an average of 100 fruit per plant. However, fruit size was significantly larger in ‘Tulameen’ (3.1 g) compared with ‘Heritage’ (1.7 g). Thus, yield was higher for ‘Tulameen’ than for ‘Heritage’. Fruit number averaged 118 fruit per plant at the 50 cm spacing and 80 fruit per plant at the 25 cm spacing. There was no effect of in-row spacing on fruit size, but the increased fruit number at the wider spacing resulted in higher yield compared with the closer spacing. Although our yields compared favorably with raspberry yields in other annual tunnel culture systems, they appeared to be lower than expected yields in traditional, commercial systems. The yield decrease was apparently due to reduced fruit number and size which were 25 to 50% lower than averages reported for the same cultivars grown under traditional systems.

(279) Susceptibility of Blackberry Genotypes to Three Tip Blight Pathogens

Philip Stewart**, John Clark¹, Patrick Fenn²

¹Horticulture, University of Arkansas, PTSC 316, Fayetteville, AR, 72701, ²Plant Pathology, University of Arkansas, PTSC 217, Fayetteville, AR, 72701

Seedling populations, breeding selections, and cultivars of blackberry were screened for resistance to three pathogens: Erwinia amylovora, Pseudomonas syringae, and Botryosphaeria dothidea. Squares of B. dothidea mycelia were inserted into wounds in both detached cane segments in the laboratory and plants in the greenhouse. Bacterial inoculations were made by injecting bacterial suspensions into growing shoot tips of greenhouse-grown plants. The lengths of the resulting lesions were measured, and each plant rated on a scale of 0-4 according to the severity of the reactions. Initial results revealed significant differences in susceptibility among genotypes. To investigate in more detail differences in resistance and possible sources of resistance genes, seedling populations were obtained from crosses made in April and May 2002 among six blackberry cultivars and seedlings grown from seed and screened in the greenhouse in early 2003. Other populations were obtained from breeding program crosses made in 2001, including primocane-fruiting types. Nine cultivars and eight breeding selections were also evaluated. Differences in resistance and susceptibility and their relationship to genotype will have useful implications for future breeding and cultivar development.

(280) Effect of Drainage Control on the Movement of Chlorothalonil and Chlorpyrifos Residues Out of Cranberry (Vaccinium macrocarpon) Beds

Eric Hanson*, Steven Marquie, Andrew Fogiel

Horticulture, Michigan State University, Plant and Soil Science Bldg, East Lansing, MI, 48824

Drains exiting cranberry beds are usually closed for 3-5 d after pesticide applications to reduce the potential for pesticide movement out of plantings. Six 0.12 ha experimental cranberry beds in southwest Mich. were used to measure the impact of this water holding practice on pesticide movement. The planting was constructed in 1996 by excavating beds in a silty clay loam soil on an upland site, installing a subsurface plastic tile drain system, and filling the beds with 0.3 m of a fine sand growing media. Drain from each bed was equipped with tipping bucket flow meters, which activated sampling pumps at predefined flow increments. Beds were treated 2-4 times in 2000, 2001, and 2002 with chlorothalonil (fungicide) and chlorpyrifos (insecticide). Drains exiting half of beds were closed for 3-5 d following each application, while others were left open. The total seasonal quantity of water and pesticide residues exiting beds was not affected by water holding. Amounts of pesticides exiting beds were low, representing less than 1% of the quantity applied.

(281) Comparative Foliar and Fruit Responses to Infection by Anthracnose (Colletotrichum acutatum Simmonds) in Highbush Blueberry (Vaccinium corymbosum L.)

Mark Ehlenfeldt**, Allan Stretch¹

¹Fruit Laboratory, USDA-ARS, 125A Lake Oswego Road, Chatsworth, NJ, 08019, ²Fruit Laboratory, USDA-ARS (retired), 125A Lake Oswego Road, Chatsworth, NJ, 08019

Foliar response to infection by Colletotrichum acutatum was assayed on 82 highbush blueberry clones using a detached leaf-disk assay. After one week of incubation, disks were digitally imaged, and images analyzed for percent leaf decay. Infection percentages across cultivars averaged 32%, and ranged from 9% to 79%. Fruit infection was assayed by inoculating potted plants at the green-fruit stage, incubating for 24 hours at 100% R.H., then growing plants in a greenhouse until fruit ripened. Harvested fruit was incubated for one week at room temperature and 100% R.H., then evaluated for the percent of total berries decayed. After adjusting values to standards, fruit infection averaged 54%, and ranged from 12% to 93%. No correlation was observed between foliar response and fruit response to anthracnose infection; however, several clones were observed to have good resistance to both foliar and fruit infection. Cultivars with particularly good resistance to both phases included ‘Elliott’, ‘Brigitta Blue’, and ‘Star’. Colletotrichum acutatum inoculum overwinters primarily in foliar tissue. Breeding new cultivars with foliar resistance may assist in the control of this disease under field conditions.

(282) Responses of Highbush Blueberry (Vaccinium corymbosum) to Inoculation with Ericoid Mycorrhizal Fungi Depends on Fertilizer Type, Fungal Isolate, and Plant Genotype

Carolyn Scagel*

Horticultural Crops Research Laboratory, USDA-ARS, 3420 NW Orchard Street, Corvallis, OR, 97330

Rooted tissue culture plantlets of seven highbush blueberry cultivars were inoculated with one of three different isolates of ericoid mycorrhizal fungi and grown for two years with either inorganic (IN) or organic (OR) fertilizer. Root colonization of non-inoculated plants was low (<10%) regardless of fertilizer source. Colonization of inoculated plants ranged from 15% to 30% and was generally higher when plants were grown with OR fertilizer than with IN fertilizer. Stem, root, and leaf biomass of three cultivars was higher when grown with IN compared to OR fertilizer. Plants grown with OR fertilizer generally partitioned more biomass to the roots than above ground. Inoculation with any of the different fungi increased biomass of three cultivars, while the biomass responses of the remaining of the cultivars varied with fungal isolate. Our isolate of Pezicellula ericaceae had the most influence on root biomass, while Oidiodendron griseum had the most influence on above ground biomass. Inoculated plants generally partitioned more biomass to the roots than above ground. When plants were grown with IN fertilizers, inoculation with all three fungal isolates had no influence on above ground biomass and slightly
increased root biomass, while when grown with OR fertilizers inoculated plants had significantly higher stem, leaf, and root biomass compared to non-inoculated plants. Root colonization was significantly correlated with root biomass for three cultivars but showed no correlation to above ground biomass. Mineral composition of stems, leaves and roots were significantly altered by inoculation and changes in composition resulting from inoculation varied with fertilizer type, particularly for phosphorus, calcium, sulfur and nitrogen. Cultivars that were genetically close showed a high degree of variability in response to mycorrhizal fungi, while responses to fertilizer type were similar in closely related cultivars.

(283) Immediate and Residual Effects of Kaolin Clay Particle Film on Southern Highbush Blueberry (Vaccinium Corymbosum x) Plant Photosynthesis and Transpiration Rates
Donna A. Marshall*,1 James D. Spiers2 James M. Spiers3 Frank Matta4
1USDAARS, Small Fruit Research Station, 306 South High Street, Poplarville, MS, 39470, 2Department of Plant and Soil Sciences, Mississippi State University, 306 South High Street, Poplarville, MS, 39470, 3USDA ARS, Small Fruit Research Station, 306 South High Street, Poplarville, MS, 39470, 4Department of Plant and Soil Sciences, Mississippi State University, 1194 Bobwhite Dr, Starkville, MS, 39759.

Two studies were initiated to study the response of blueberry plants to kaolin clay particle film. In one study MS 111, a southern highbush selection (Vaccinium corymbosum x) received a single application of kaolin. The photosynthesis and transpirations rates were measured at 1, 3, and 192 hrs (8 days) after application to determine the immediate and delayed plant response. After 1 hr the photosynthesis rates were higher on sprayed plants than on unsprayed plants. After 3 hrs and up to 192 hrs, the photosynthesis and transpiration rates were lower on sprayed plants than on unsprayed. There was no difference in the leaf temperatures after 1 hr or 3hrs, but up to 192 hrs the leaf temperature was reduced 1.6 °C by the kaolin application. A separate study was initiated to determine the effects of plants being continually covered with the kaolin. Kaolin was applied to ‘Magnolia’ southern highbush blueberry plants as needed after rainfall to maintain a constant coverage of the plants. From Julian date (JD) 179 through 228 the photosynthetic and transpiration rates of sprayed plants were either equal to or higher than unsprayed plants. After JD 228 the photosynthesis rates of sprayed plants were consistently lower than unsprayed plants, and transpiration rates were lower on two of the three dates measured.

(284) A Method to Determine Chilling Requirements of Blueberry Plants Using Cuttings
James M. Spiers*, Donna A. Marshall
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A study was initiated to determine the accuracy and efficiency of using cuttings from plants to determine the sufficient accumulation of chilling for bloom. A previous study showed that floral bud development in cut stems approximate that of intact plants for a period of 4 weeks if using cuttings from plants to determine the sufficient chilling had been obtained. In this study two rabbiteye (Vaccinium ashei Reade) ‘Tifblue’ and ‘Climax’ and two southern highbush (V. corymbosum x) ‘Jubilee’ and ‘Magnolia’ cultivars were naturally chilled. At 100 chilling hour intervals (<7 °C), plants and cuttings were placed in a greenhouse and allowed to bloom. Floral development was rated weekly. ‘Climax’ plants and cuttings reached stage 3 within 4 weeks after 500 hrs of chilling. ‘Tifblue’, ‘Pearl River’, and ‘Jubilee’ plants and cuttings needed 400 hrs of chilling for both to reach stage 3 within 4 weeks. ‘Magnolia’ plants and cuttings advanced to a stage 3 within 4 weeks after 500 hours of chilling. The study indicates that cuttings from blueberry plants can be used to determine approximate chilling requirements if plants reach a floral bud development scale rating of ≥3 within a 4 week forcing period.

(285) Observations on Bud Meristems and Starch Granules of Dormant Vitis sp., ‘Lacrosse’ and Own-rooted/grafted ‘Chambourcin’ Vines
Sanjun Gu*, Paul Read
Department of Agronomy and Horticulture, University of Nebraska Lincoln, 377 Plant Science, Lincoln, NE, 68583

Dormancy is defined as a temporary suspension of visible growth of any plant structure containing a meristem. In our study of bud dormancy, one-year old dormant canes of Vitis sp. ‘Lacrosse’ (own-rooted) and ‘Chambourcin’ (own-rooted and grafted to ‘3309 Couderc’) were sampled monthly from January 2001 to March 2001 and from October 2001 to March 2002 in Nebraska. The lateral buds excised at the 5th and 6th nodes from the proximal end and the internode between the 5th and 6th nodes were dissected or sectioned for investigations of bud meristems or starch granules under scanning electron microscopy (SEM). Results showed that dormant buds were slowly growing as illustrated by the expanding size, increased number of primordia and number of bud structures of primary, secondary and tertiary buds during the dormant seasons. All lateral buds observed had the primary bud and secondary bud. The tertiary bud, however, did not present all the times. There were about 40% to 50% or 60 to 80% of buds sampled from October to December or January to March had the tertiary bud. Some significant differences between the cultivars and the months tested were found in terms of primordium number, bud width, and number of bud structures. Rootstock affected the development of lateral buds. The dormant buds of grafted ‘Chambourcin’ were more advanced than those of the own-rooted. Observations of cross, tangential and longitudinal sections of dormant shoots showed that starch granules were mainly located in ray parenchyma cells. No significant differences in distribution and content of starch granules were observed in the cultivars and sampling dates investigated, indicating that the growth of lateral buds in the dormant season may consume little reserves that are not readily seen under a SEM.

(286) Occurrence of Grape Chlorosis in Relationship to Soil and Climatic Conditions
Joan Davenport*, Robert Stevens, Kelly Whiteley
Crop and Soil Sciences, Washington State University, 24106 North Bunn Road, Prosser, WA, 99350

Every year Concord grape in Washington’s Yakima Valley shows a leaf yellowing symptom known as grape chlorosis. The severity of this disorder varies from year to year and from vineyard to vineyard. However, leaves of grape plants that develop this symptom eventually die and fall off resulting in a reduction of productivity and, in time, can result in vine death. Historically grape chlorosis was thought to be due to a deficiency in the plant nutrient iron. However, research looking at iron supplements has had little to no positive effect on the disorder. The fact that the disorder appears around bloom and varies from year to year indicates that there may be a relationship with annual weather (climatic) patterns. There is also a possibility of a nutritional relationship. To study grape chlorosis, we selected six vineyards to work in, two that have a history of having chlorosis every year, two that occasionally show chlorosis symptoms, and two that have never shown chlorosis symptoms. During the 2001, 2002 and 2003 growing seasons we monitored presence of chlorosis via GPS mapping, monitored soil water and temperature, collected and analyzed soil and tissue (leaf blade and petiole) samples for cation nutrient elements, and collected data on gross meteorological conditions. The findings from 2001 and 2002 indicated that the single factor most closely related to the occurrence of chlorosis was high soil moisture during the bloom period. This suggests that if there is a mineral nutrition component to this disorder it is related to root limitations during this key phenological stage.

(287) Evaluation of Grape Rootstocks in North Florida
Zhongbo Ren1, Jiang Liu1, Peter Cousins2
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2Department of Agronomy and Horticulture, Virginia Polytechnic Institute and State University, Blacksburg, VA, 24061

Vitis x labruscana is a major rootstock for many grapevine cultivars. However, some rootstocks are more susceptible to grapevine root disorders such as grapevine root decay. The objective of this study was to evaluate the performance of the rootstocks in three north Florida vineyards for grapevine root disorders, yield, and quality. The study was conducted for 2 years from 2001-2002. The rootstocks included own-rooted Concord, 7选6, 7选7, 7选8, 7选9, and 7选10 rootstock. The results indicated that the rootstocks with 7选6 and 7选7 rootstock were more susceptible to grapevine root disorders. The yield and quality of the wine grapes were not significantly different among the rootstocks. The results of this study suggest that the rootstock selection should be based on economic factors rather than the root disorder resistance.

SUNDAY pm
To understand the adaptation of grape rootstocks commonly used in major grape production areas worldwide to Florida, where Pierce’s Disease (PD) and anthracnose are prevailing, ten grape rootstocks were evaluated at the experimental vineyard, Florida A&M University, Tallahassee, Florida, for their disease incidence and growing performance. PD and anthracnose symptoms were scored in September and October, 2002, based on the severities of leaf symptoms. None of the grape rootstocks was completely resistant to PD and anthracnose, and the severity of diseases varied. ‘Ramsey’ and ‘St. George’ showed less PD symptoms, while ‘Freedom’ and ‘3309C’ had the highest PD scores. For anthracnose disease, ‘5C’, ‘St. George’ and ‘Freedom’ showed lower disease incidents, while ‘Ramsey’, ‘110R’ and ‘039-16’ had more severe anthracnose symptoms. Vine vigor was evaluated in the fall of 2002 and varied among the rootstocks as evidenced by trunk diameter, annual shoot length, annual shoot node number, internode length and shoot diameter. Shoot death rate ranged 7% to 56%, with ‘Freedom’ the highest and ‘039-16’ the lowest.

(289) Rootstocks and Mounding Affect Growth and Cold Hardiness of Young ‘Gewürztraminer’ (Vitis riparia) Vines
Sanjun Gu*, Paul Read
Department of Agronomy and Horticulture, University of Nebraska Lincoln, 377 Plant Science, Lincoln, NE, 68583

Rootstocks have been proved to have resistance or tolerance to some biotic and abiotic stresses and affect vine growth, yield, fruit and wine quality of scions. Vitis species, especially vinifera, cannot survive extreme winter temperatures. In regions with minimum temperatures lower than the critical limit, protections of vines have to be employed. Here we report the effects of rootstock and mounding on vine growth and coldhardiness of Vitis vinifera ‘Gewürztraminer’ at Nemaha County and Otoe County, Nebraska. The rootstocks used were ‘Riparia Gloire’ (Vitis riparia), ‘St. George’ (V. rupestris), ‘3309 Coudes’ (V. riparia × V. rupestris), ‘110 Richter’ (V. riparia × V. rupestris), ‘1103 Paulsen’ (V. berlandieri × V. riparia), and ‘MG 420A’ (V. berlandieri × V. riparia). Mounding was done by piling up soils about 40 cm x 60 cm around vine bases. Three years’ results showed that young ‘Gewürztraminer’ responded differently to the mild or harsh winter(s). Rootstock did not significantly affect vegetative growth of young ‘Gewürztraminer’ vines regardless of winter types. It, however, modified coldhardiness of scions. Vines on rootstocks ‘3309C’ and ‘420A’ were the cold hardest in the harsh winter of 2000-01. Bud break of unmounded vines was also affected by rootstocks. All rootstocks except ‘3309C’ had delayed bud break of scions, comparing to the own-rooted controls. Mounding was able to protect ‘Gewürztraminer’ vines from winter cold. It also increased vine growth, as the pruning weight of mounded vines was significantly increased. Significant differences of pruning weight and cold hardiness were found between the two sites. Vines at the Peru site were larger than at the Otoe site, which might have contributed to the more cold hardy vines at the Otoe site than at the Nemaha site. It is concluded that mounding and using of cold hardy rootstocks should be helpful to grow European grape cultivars in regions with similar climate to Nebraska.

1:30 pm–3:00 pm BUSINESS MEETING
Ballroom B/C

Plenary Session—100th Annual ASHS Business Meeting
Presiding: R. Daniel Lineberger
Dept. of Horticultural Sciences, Texas A&M Univ., College Station, TX, Chair of the ASHS Board of Directors

Agenda (included in the registrations materials with related reports)
will include
Board of Directors Report
Observation of a moment of silence for deceased Members
Open discussion on matters of importance to Members
Association of Collegiate Branches (ACB) report
Presentations in recognition of services to ASHS
Introduction of the 2003–2004 ASHS President & Board of Directors

Presidential Address:

ASHS 2003: Planning for Our Bicentennial
L. George Wilson
North Carolina State University

In 2003 the American Society for Horticultural Science (ASHS) celebrates its first 100 years of leadership in horticultural science. The next century will be even more challenging, scientifically, technically, and with regard to information exchanges and communications. We are here to celebrate horticulture and horticultural science. We have horticultural products all around us: flowers and potted plants in our homes, shrubs and trees in our yards and surrounding our work places, vegetables and fruits in our gardens. Our refrigerator and pantry is stocked with fresh and processed fruits and vegetables. What has become commonplace for us as consumers is based on the contributions of our profession of horticultural science. I have concluded that everybody is a horticulturist. Let’s make it easy for them to identify with the sources of the art and science of all things horticultural. This more often than not involves linkages to ASHS.

Our predecessors have built a strong base over the past century. The task ahead of us is clearly to acknowledge appropriately our achievements, anticipate and respond to the many changes related to horticulture in this new century, and move on to even bigger and better things. The stage has been set, and we have our work cut out for us. Science will always be basic to everything horticultural. Horticultural industries everywhere are continuing
George Wilson is the fourth of five sons and the seventh of 10 children whose parents were fruit, vegetable and dairy farmers along the shores of Lake Ontario in Niagara County, New York. His produce marketing experiences eventually led to choice of horticultural science as a career—starting with his BS in Pomology from Cornell University in 1961, followed by an MS in Horticulture at Washington State University in 1963. Wilson is also a Research Associate in Plant Physiology with the Division of Tropical Research of United Fruit Company in La Lima, Honduras. He took a leave to earn his PhD in Postharvest Horticulture from Michigan State University (1969), then returned to the Division of Tropical Research as a Research Plant Physiologist. He worked on several tropical crops, but focused mostly on postharvest handling of bananas and physiology of African oil palm. After nine years in the tropics, Wilson joined the Horticultural Science faculty at North Carolina State University in 1975 as Associate Professor and sweetpotato, potato and postharvest Extension Specialist. He was promoted to Professor in 1979 and, over the past three decades, was twice assigned to NC State USAID projects in Peru—as Extension Leader in 1982 and as Chief of the Provider in 1991. In 1993 Wilson worked in Bulgaria on a USDA Extension project. In 1997 he was appointed Coordinator of International Programs for the College of Agricultural and Life Science. Since 2002, Wilson has served as Vice Provost for International Affairs.

Dr. Wilson has been a member of ASHS since 1961 and was elected president-elect in 2001. He was the first ASHS/AAAS Congressional Science Fellow in 1990 and was elected Fellow of the Society in 1992. In 1978-80 he chaired the International Affairs Committee, which led to the formation of the ASHS International Division. Wilson served as vice president of the Extension Division in 1983-84, and vice president of the International Affairs Division in 1987-88. He has served in numerous other capacities, including: Postharvest, Horticultural Consultants, International Concerns in Horticultural Education working groups, and National Issues, and Tropical Horticulture committees. At last year’s International Horticultural Congress, Wilson co-organized the Horticulture and Emerging Economies symposium. He is also a member of the Southern Region ASHS, the International Society for Horticultural Science and the Interamerican Society for Tropical Horticulture.

George and Claudia, his wife of 41 years, have three children and three grandchildren.

3:00 pm–3:15 pm WORKING GROUP MEETING

Organic Horticulture (ORGH) Working Group
Chair: Sieglinde Snapp

3:00 pm–3:45 pm ORAL SESSION 39

Ornamentals/Landscape and Turf—Weed Control and Pest Management
Moderator: Cynthia McKenney

Selection and Evaluation of Perennial Groundcovers for Weed Suppression in Home Landscapes

Jennifer Allaire*, Andrew Senesc, Leslie Weston1

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Public fears and increasing environmental concern are leading to greater restrictions regarding chemical use, including herbicides, in the landscape. As a result we are evaluating the use of weed suppressive groundcovers in the home landscape as a means to reduce the overall need for labor and herbicide applications. Currently, comparative evaluation of weed suppression by various herbaceous ornamental groundcover species is not well represented in the literature. The objective of this study was to select and evaluate groundcovers for their ability to suppress weeds. Twenty-five groundcovers were selected for evaluation of weed suppressive ability based upon vigorous, low, dense growth. Groundcovers were grown at two sites, Ithaca and Riverhead, and data were collected on weed number and dry aboveground biomass divided into broadleaf weeds (BLW) and grasses, sedges and rushes (Grass), time for hand weeding, percent light transmission through the canopy after establishment and percent ground cover by the groundcover. Disease and insect infestation was also noted. For all parameters tested, Stachys byzantina (lamb’s ear) emerged as the most suppressive species, requiring the least time to weed, having the fewest weeds with the lowest weed biomass, and the greatest percent ground coverage by the last data collection in both sites. S. byzantina also had the least light transmittance. Other species that appeared to have some weed suppressive ability include Dianthus deltoides ‘Brilliant’ (maiden pinks), Dianthus myorhiza (pinks), Petrorrhagia saxifraga (tunic flower), Mentha xiperitum (peppermint), Heuchera Americana ‘Chocolate Veil’ (coral bells), and Cerastium tomentosum var. columnae ‘silbetteppich’ (snow-in-summer). Species showing the greatest promise will be evaluated in demonstration trials across NY State in 2003.

Fall-applied Paraquat Affects Spring Growth of Narcissus

Timothy Miller*

CROP and Soil Sciences, Washington State University, 16650 State Route 536, Mount Vernon, WA, 98273

Narcissus bulbs are generally produced in a multi-year cycle in northwestern Washington; that is, bulbs are planted in August or October of year 1, grown in place for all of year 2, then harvested in July of year 3. Paraquat is often used in the fall of year 2 to kill weeds and hasten the drying time of narcissus foliage prior to reshaping of hills. The potential for paraquat to injure narcissus was investigated in this study. Two rates of paraquat were applied at three timings to ‘Flower Carpet’ narcissus in the fall following their first year in the field. Paraquat applied at 0.53 and 0.87 kg ai/ha to half-green foliage in late July or early August caused 59% yellowing of new daffodil leaves in late February and 31% by late March. Paraquat applied after leaves were 90% yellowed did not cause injury. When applied early, paraquat at both rates reduced flower height, while flower number was reduced only by the higher rate. Compared to nontreated narcissus, average bulb weight at harvest was reduced 20 and 15% by the high and low rates of early-applied paraquat, respectively; later treatments did not reduce average bulb weight.

Alitca litigate (Flea Beetle) Feeding Damage of Oenothera spp. (Afternoon Primrose) and Calyphorus spp. (Sun Drops)

Cynthia McKenney*, James Reinhart, Raul Cabrera

1Department of Plant and Soil Science, Texas Tech University and Texas A&M Research and Extension Center, 17360 Coit Road, Dallas, Texas, 75252; 2Texas A&M University, Research and Extension Center- Dallas, 17360 Coit Road, Dallas, TX, 75252

Alitca litigate, a metallic blue-green flea beetle, exhibits a voracious appetite for many native species of the family Onagraceae. Oenothera


797
and the closely related genera of Calylophus are commonly called
Afternoon primrose. Several species of primrose serve as breeding
hosts for this flea beetle, which has the potential to severely damage
valuable ornamentals in the landscape. In this study, twelve genotypes
of Oenothera and Calylophus were used to bioassay for Aliis litigat
larvae and adult feeding in a no-choice laboratory experiment. O.
speciosa, O. jamesii and O. elata proved to be excellent hosts for both
the flea beetle adults and larva. O. macrocarpa macrocarpa was an
excellent host for larvae but produced moderate adult mortality. C.
hartwegii and O. macrocarpa incana had no eggs deposited while
O. elata, O. brachycarpa and O. macrocarpa macrocarpa were poor
oviposition hosts. Resistance to flea beetle damage was found in both
genera and provides promise for future improvement.

3:00 pm–4:45 pm  ORAL SESSION 40  555A
Postharvest Fruit 1
Moderator: Christopher S. Walsh

3:00  Factors Affecting the Rate of Water Loss in Apple Fruits,
and the Contribution of Turgor Pressure to Apple Fruit Texture
Theophanes Solomos*, 1 John Bouwkamp2
1Natural Resource Science and Landscape Architecture, University of
Maryland, Plant Sciences Bldg, College Park, MD, 20742. 2Natural
Resource Sciences and Landscape Architecture, University of Mary-
land, Plant Sciences Bldg, College Park, MD, 20742

The rate of water loss from ‘Gala’ apples is almost twice that
from ‘Granny Smiths.’ On measuring the number of open lenticels
in the two cultivars, we found that their ratio was similar to the rate
of water loss. The texture of ‘Gala’ apples is greatly affected by
water loss. However, fruit kept in plastic bags lose very little
water and are firmer than fruit kept in boxes at 70% to 80% RH. We
have developed a method for measuring the water potential of apple
fruits using gas chromatography. This method, in conjunction with
the osmotic potential, allows the indirect determination of turgor
pressure. The data show that the difference in texture between the
above storage treatments is reflected in the turgor pressure, i.e.,
the higher the turgor pressure, the firmer the texture.

3:15  Relationship of Antioxidant Protection Systems to Browning
or Flesh Browning-related Disorders of Different Cultivars of Apples
(Malus ×domestica) and in Response to Phosphorus and Calcium Nutrition
Peter M.A. Toivonen*, Cheryl Hampson, Denise Neilsen,
Gerry Neilsen, Sabina Stan
Pacific Agri-Food Research Centre, Agriculture and Agri-Food Canada,
4200 Highway 97, Summerland, British Columbia, V0H 1Z0, Canada

This work was conducted to evaluate whether there was a relationship
of enzymatic and/or non-enzymatic antioxidant protection systems
to quality in apples. In the first study, four cultivars known to be suscep-
tible (‘Red Delicious’ and ‘Spartan’) or resistant (‘SPA343’ and ‘Ambrosia’)
to cut-edge browning were examined in relation to lipid- and water-
soluble antioxidant contents and to peroxidase and superoxide dismutase
activities in the tissues. A good relationship between browning suscepti-
bility and antioxidant systems was found. The strongest relationship
to browning was found with water-soluble antioxidant content and
peroxidase activity in the tissue. In the second study, application of
phosphorus fertilizer reduced tissue leakage and cut-edge browning
of ‘Silken’ and ‘Fuji’ apples. These differences were associated with
differences in both water- and lipid-soluble antioxidant contents in the
tissues. In the third and final study, the effect of foliar calcium applica-
tion on internal browning and water- and lipid-soluble antioxidants was
assessed in ‘Braeburn’ apples. Calcium applications reduced incidence
of internal browning after 3 months of storage. This reduction in internal
browning was associated with increased water- and lipid-soluble anti-
oxidant contents in the flesh. These results demonstrate that differences
in browning and flesh browning-related disorders in apples are at least
partially explained by differences in antioxidant protection systems.

3:30  Volatile-producing Fungus Muscodor albus Controls
Brown Rot of Peaches and Blue Mold and Gray Mold of
Apples
Julien Mercier*, Jorge Jiménez
Research and Development, AgraQuest, Inc., 1530 Drew Avenue,
Davis, CA, 95616

Muscodor albus produces several antimicrobial volatile compounds
that inhibit and kill a wide range of fungi and bacteria. Because M. albus
volatiles are lethal to most fruit decay pathogens, this fungus could be
used as a biofungiment to control postharvest diseases. Short-term
fumigation of apples (cv. Gala) and peaches (cv. Ross and Zee Red) with
grain culture of M. albus was attempted at ambient room temperature for
periods ranging from 24 to 72 h treatments were performed by placing
30 g of M. albus grain culture with fruits (no physical treatment) in
closed 1 L plastic containers. Before treatment, fruits were wounded
and inoculated with Monilinia fructicola for peaches and with Botrytis
cinerea or Penicillium expansum for apples to obtain infection rates
close to 100%. Biofumigation for all periods tested immediately after
inoculation completely controlled brown rot of peaches, as well as blue
mold and gray mold of apples. Furthermore, biofumigation of apples 24 h
after inoculation was effective in controlling gray mold and blue mold.
Ther rye culture of M. albus was found to produce 9 major volatiles,
among which 6 were found to be inhibitory to fungi.

3:45  Fruit Maturation, Tree Ripening and Cracking Suscepti-
bility in ‘Gala’ Apple Fruits
Christopher S. Walsh*, Steven A. Altman, Kathleen W. Hunt
Natural Resource Sciences and Landscape Architecture, University of
Maryland, 2102 Plant Sciences Building, University of Maryland,
College Park, MD, 20742-4452

Ethylene evolution rate (EER) was measured in detached ‘Gala’ apples
during fruit maturation and tree-ripening in August and September. EER
was more closely correlated with the starch-iodine test than with any
other fruit maturity index measured over a two-year period. Similar data
were measured during maturation in three other cultivars; ‘Jonagold,’
‘Oregon Spur Delicious,’ and ‘Empire.’ Treatment of ‘Royal Gala’
apples with aminoethoxyvinylglycine reduced EER as expected, and
suppressed the loss of starch and increase in soluble solids during fruit
maturity. Treated fruits were also firmer at harvest and again after
storage, although treatment did not affect starch content after storage.
The EER measured in maturing ‘Gala’ apples was much lower than
EER measured in any of the other cultivars, and dramatically lower
than the EER measured in ‘Gala’ apples after cold storage. We suggest
that one factor contributing to the unique quality of this early-season
cultivar is a strong ‘parent-plant’ inhibition of ethylene biosynthesis.
At two-year study using six ‘Gala’ cultivars was also conducted to test
the role of maturity indices as predictors for cracking susceptibility.
Visual observations and test-cracking in buckets demonstrated that
 cracking is well-correlated with starch index and a slight loss in
fruit firmness. Cracking susceptibility increased dramatically once
starch degradation was measurable in the outer fruit flesh. This cor-
responded to a score of 6 (on a 1–8 scale) on the Cornell Starch Chart.
In years of low rainfall and high temperatures, cracking problems
increase in commercial orchards. We believe that a delayed harvest
of smaller, tree-ripe fruits contributes to fruit cracking problems in
commercial orchards.

4:00  Lumenex: A Protocol for Post Harvest Development of
Red Color in Apples
Peter Hirst*, Stacey Mickelbairt, Steven L. Doud
Horticulture and Landscape Architecture, Purdue University, 625
Agricultural Mall Drive, West Lafayette, IN, 47907-2010

HORTSCIENCE, VOL. 38(5), AUGUST 2003
A protocol for producing designer apple fruit following harvest was developed. Following harvest, fruit of ‘Idared’, ‘Melrose’ and ‘Cortland’ were selected that showed little red color development. A number of controlled environment experiments were conducted to measure the effect of light source, light intensity, temperature, length of time in cold storage and cultivar on red color development. Fruit was exposed to light from cool white (CW), daylight (DL) or cool white + ultra violet (CW + UV) light sources. The greatest red color developed under CW + UV light, but UV had a tendency to burn exposed fruit. CW alone resulted in acceptable fruit color after 72 hours exposure. Within the range tested, light intensity had no effect on color development. Color development was rapid (3 days for maximum color) with temperatures of 15 or 25 °C but color developed slowly at 10 °C. Storage duration did not affect the coloring ability of fruit, up to 46 days storage. There was a continuum of coloring responses among cultivars with ‘Cortland’ and ‘Idared’ among the highest coloring and ‘GoldRush’ and ‘Royal Gala’ the least responsive cultivars. These data have been synthesized into a protocol to successful produce designer apple fruit after harvest in a process termed “Lumenex”.

4:15 Studies of the “Tree Factor” and its Role in the Maturation and Ripening of ‘Gala’ and ‘Fuji’ Apples
Shu-fei Lin1, Christopher Walsh
NRSL, University of Maryland, 2102 Plant Sciences Bldg., College Park, MD, 20742

The term “tree factor” was used to describe an unknown compound or compounds which are hypothesized to be synthesized in apple leaves and transported via the phloem to apple fruits. ‘Red Delicious’, ‘Golden Delicious’ and ‘Jerseymac’ apples have showed the existence of an inhibitor (so-called “tree factor”) which blocks the onset of massive ethylene production in fruits attached to the trees (Sfakiotakis and Dilley 1973, Lau and Yang 1986, and Blandin 1993). “Tree factor” delays the onset of system 2 ethylene production but not other ripening processes such as firmness loss or starch degradation. Our two years of data showed that detachment at 10–14 day intervals during maturation and ripening in ‘Gala’, but suppressed ethylene production in ‘Fuji’ apples. At that time, the longer the ‘Gala’ apples remained attached to the tree, the swifter the onset of the rise in ethylene occurred. Detachments made during and after commercial harvest peak had no significant effect on ethylene concentration in either ‘Gala’ or ‘Fuji’ apples. Both girdled+detached and detached treatments stimulated starch degradation without a concomitant increase in ethylene concentration or firmness run through ripening stage in Fuji apple. Preliminary field results of Fuji apples (2001) showed that the ethylene production on site was highly affected by the change of ambient orchard temperature. Inconsistent data were due to large variability from fruit to fruit. Our results infer that “tree factor” may only exist in early varieties, and there may not be a “tree factor” in Fuji apples (late variety). Instead there is a necessary ripening message produced in leaves and transported by the phloem to the fruits. In order to elucidate the biochemistry and physiology of the “tree factor”, it is worth emphasizing the differential gene expressions on the transition from maturation to ripening. Ongoing research relating identifying developmentally regulated genes during maturation and ripening in ‘Gala’ and ‘Fuji’ apples with cDNA-AFLP will be presented.

4:30 Peach Variety and Advanced Selection Evaluations and Web Site
Desmond R. Layne1, W.R. Okie2, Eric J. Hitzler3
1Horticulture, Clemson University, 177 Poole Ag. Bldg., 50 Cherry Rd., Clemson, SC, 29634-0375, 3Southeastern Fruit and Tree Nut Research Laboratory, USDA-ARS, 21 Dunbar Road, Byron, GA, 31008, 2Horticulture, Clemson University, Musser Fruit Research Farm, 604 S. Friendship Road, Seneca, SC, 29678

During 2000–02, more than 200 commercial peach and nectarine varieties were evaluated at the Musser Fruit Research Farm, Clemson University. The variety orchard comprised both yellow and white-fleshed varieties. Harvest began the first week of May and ended the middle of September. Bloom dates, fruit set, and ripen date were determined for each variety. Fruit samples were collected at commercial ripe stage and evaluated for the following characteristics (size, firmness, fuzziness, red coloration, attractiveness, pit freeness from flesh and taste). Digital photographs of representative fruit samples were taken on a standard scaled background. Results from 2000, 2001, and 2002 evaluations have been posted on our website. In addition, variety descriptions for all named cultivars have been added. The website has been completed updated and is found at: (http://www.clemson.edu/hort/peach/index.html). Two grower trials in the major peach production regions of SC have also been established. Grower trials comprise 17 standard accepted varieties spanning the entire harvest season. 35 advanced selections from the USDA-Byron breeding program are being evaluated alongside the industry standards. 2002 data for the trial in Monetta is currently on-line. 2003 data for the Musser trial and the grower trials in Monetta and Cowpens, SC will be presented.

3:00 pm–5:00 pm CENTENNIAL SPOTLIGHT
557
Centennial Spotlight: Video Interviews With Noted Horticulturists

3:00 pm–5:00 pm HISTORICAL REVIEW 3
552B

3:00 Milestones in Fruit and Vegetable Production, Processing, and Quality
Justin R. Morris, Pamela L. Brady*
Institute of Food Science and Engineering, University of Arkansas, 2650 N. Young Ave., Fayetteville, AR 72704

2:30 Herbs in American Fields: A Horticultural Perspective of Herb and Medicinal Plant Production in the United States, 1903 to 2003
Lyle E. Craker*, Zoë Gardner, Selma C. Etter
Dept. of Plant and Soil Sciences and Physical Sciences and Engineering Library, University of Massachusetts, Amherst, MA 01003

3:40 Human Issues in Horticulture
Paula Diane Relf*, Virginia I. Lohr2
1Dept. of Horticulture, Oregon Polytechnic and State University, Blacksburg, VA 24061-0327, 2Dept. of Horticulture and Landscape Architecture, Washington State University, Pullman, WA 99164-6414

4:00 The Nursery Industry in the United States—Always New Frontiers
J.L. Green*, A.K. Green2
1Dept. of Horticulture, Oregon State University, Corvallis, OR 97331-7304, 2Consulting Historian and Research Librarian, 53rd Ave. N. Brooklyn Center, MN 55429

4:20 Progress in Mineral Nutrition and Nutrient Management for Vegetable Crops in the Last 25 Years
George J. Hochmuth*
Horticultural Sciences Dept., North Florida Research and Education Center, University of Florida, Quincy, FL 32351-5677

Adel A. Kader*
Dept. of Pomology, University of California, One Shields Avenue, Davis, CA 95616

3:00 pm–5:00 pm COMMITTEE MEETING
554A
Crucifer Crop Germplasm Committee
Chair: To Be Announced
Sunday, Oct. 5 · Afternoon–Meetings–Workshop 16

3:00 pm–5:00 pm COMMITTEE MEETING 550B
Finance Committee
Chair: Mary Lewnes Albrecht

3:00 pm–5:00 pm COMMITTEE MEETING 554B
Root & Bulb Vegetable Crop Advisory Committee
Chair: To Be Announced

3:00 pm–5:00 pm WORKSHOP 16 555B

Recent Advances in Machine Harvesting of Fruits and Vegetables
Moderator: Fumiomi Takeda

Sponsor: Production and Harvest Mechanization Working Group (MECH)

Summary: In the last decade, significant engineering strides have been made for machine harvesting of fruits and vegetables. For example, now sweet cherry can be machine-harvested for the fresh market with an improved mechanical harvester. This and other advances in shake-and-catch technology help the US horticultural industry remain competitive in the global marketplace and reduce dependence on a large workforce for labor-intensive harvesting of fruits and vegetables. More recent R&D efforts in robotics, computer vision, neural networks, and controls for agricultural production and harvesting present opportunities for both the engineers and horticulturists to design plant architectures to maintain productivity as well as to facilitate highly efficient, rapid computer-based harvesting of highly perishable fruits and vegetables. In this workshop, we will have four speakers from ASAE talk on the engineer’s perspective on harvest mechanization of several horticultural crops. Discussions will focus on the needs of both engineers and crop production specialists for implementation and acceptance of new harvest technologies.

Introduction
Fumiomi Takeda*
Chair-MECH WG, Appalachian Fruit Research Station, USDA-ARS, Kearneysville, WV 25430

Mechanical Harvest for Florida Process Citrus
Galen K. Brown*
Florida Department of Citrus, 700 Experiment Station Road, Lake Alfred, FL 33850.

Hand picking, by snapping each fruit from its stem, has been the traditional method of harvesting Florida oranges and grapefruit. In July 1994 a new harvesting research and development program was initiated by the Florida Department of Citrus. The growers are taxed about one cent per box of production to fund the program. An industry Advisory Council oversees the program, and recommends projects and funding. The objectives were to greatly increase labor productivity and reduce unit-harvesting cost. The program has provided improvements in hand harvest management developed several methods for mechanical harvesting, and discovered/evaluated several fruit abscission agents. About 20,000 of the 600,000 acres of process oranges were mechanically harvested during the 2002-03 season, and mechanically harvested acreage is expected to increase. Two methods can increase labor productivity by 5 to 15 times and reduce unit-harvesting cost by 50% or more. Such savings are essential to successfully compete in free-trade markets and for operation without undocumented labor. Many old-style plantings will be replaced over the next 10 years. The program accomplishments and future expectations will be discussed.

Harvest Mechanization Progress and Prospective for Fresh Market Quality Deciduous Tree Fruits
Donald L. Peterson*
Appalachian Fruit Research Station, USDA-ARS, Kearneysville, WV 25430

The availability of a skilled workforce to harvest tree fruits is a major concern of the U. S. fruit industry. Tightening of labor supplies has led to shortages in recent years. Competition from countries with significantly lower labor costs is threatening the viability of U.S. producers. Mechanization could be an effective tool to increase worker productivity and keep U.S. fruit industries competitive in the world market. No deciduous tree fruit crops are mechanically harvested for the fresh market. I will discuss the reasons for lack of mechanical harvesting, research attempts to mechanically harvest tree fruits, and then speculate on requirements for successful harvest mechanization.

Engineering Aspects of Production and Mechanization for Fresh and Processing Vegetables
James L. Glancey*
Department of Bioresources Engineering, University of Delaware, Newark, DE 19717

A dwindling labor supply, growing concerns for government regulatory requirements, the consolidation of several large food processors and equipment suppliers, and increasing global competition are forcing changes in the US vegetable industry. New and improved methods for production, especially harvesting, are being developed and adopted to survive in the 21st century. For example, there is increasing use of mechanical harvesting methods for vegetable crops like pepper and squash that were traditionally only hand picked. North Carolina’s pickling cucumber industry, a region where vegetable crops have always been hand picked, has begun to evaluate mechanical harvesting-based production alternatives. These new production techniques are not without consequences. Most Gerkin cucumber production has relocated to foreign countries where hand-pick methods are inexpensive. Small operators that can’t afford the large investment of mechanical harvesters have chosen to purchase rather than grow some vegetables. For canned and frozen vegetables, once-over mechanical harvested crops require more energy and water for cleaning and grading than hand harvested products. Differential GPS and Real-Time Kinematic positioning, which provides precise computer-based control of several machine operations, has been used for planting and cultivating in tomato and potato production. Precision computer guided steering not only reduces the variation in row spacing between adjacent planter spacing, but also provides exact position information on plant row location. High-speed cultivation can be performed in the dark without damage to the roots or drip irrigation tubing. Mechanical harvester-based production systems that reduce field losses and fruit damage, improve recovery, and decrease the foreign materials in the harvested product are evolving. Improved cultural production systems and crop varieties that are adapted for once-over machine harvest are needed. Specifically, an integrated approach in which crop characteristics along with planting, cultivation, and harvesting techniques are considered is needed to develop profitable alternatives to hand harvest production. Improvements in plant architectures and yields and other modifications to crops are required before some vegetables can be machine harvested. These characteristics include more uniform fruit sets, increased mechanical damage resistance, prevention of premature or difficult fruit detachment, and more robust post-harvest quality and stability.

Robotics and Machine Vision - Engineering and Horticultural Aspects of Robotic Fruit Harvesting Technology – Opportunities and Constraints
Tom Burks*
University of Florida, 225 Frazier Rogers Hall, Gainesville, FL 32611-0570
In growing global markets, citrus growers are facing increasing pressures to reduce production cost. Florida citrus growers annually harvest about 150,000 acres for fresh fruit markets. The Florida Department of Citrus is working with harvesting equipment inventors and manufacturers to develop highly productive mechanically based mass harvesting systems for the 600,000 process juice acres. In contrast, fresh market citrus cannot be harvested by mechanical mass harvesting systems because of concerns over peel quality, and shelf life. Further, mass harvesters are limited in their ability to harvest processed 'Valencia' oranges after May 15th, since next year's crop is already on the tree and could be lost or damaged by the mass harvesting approach. The primary metrics of a successful fresh citrus robotic harvesting system are 90 to 95% fruit removal; average cycle times of 2 seconds pick; and labor productivity increases of 6- to 8-times that of hand harvesting. Tree factors which may limit robotic harvesting efficiency and rate include: a) fruit position, especially if masked by heavy leaf density and closed limb structure, b) canopy depth, which determines the maximum distance (thus, time) a robotic arm must reach, and c) tree size. Grove factors may include: between row spacing, in-row spacing, and hedging practices. Tree form and fruit position may be improved by mechanical, chemical, and genetic means resulting in more favorable robotic harvesting conditions while maintaining economic viability.

3:00 pm–5:00 pm WORKSHOP 17  
Marketing and Economics of Labeling the Intangible Attributes for Horticultural Products: 
Food Certification and Traceability 

Moderator: Wen-Fei Uva 
Sponsor: Marketing and Economics Working Group (MKEC) 
Objective: Labeling programs to promote intangible product attributes, such as food safety, environmental impact, fair trade, and nutrition is a growing phenomenon in horticulture. The objectives of this workshop are to 1) elevate the level of awareness of ASHS professionals to the marketing and economic impact of labeling intangible product attributes on horticultural products; and 2) show the influence of different intangible quality/process labeling programs for both horticulture businesses and consumers. 
Summary: Consumer interest in foods with intangible attributes such as organic production, sustainability production, food safety, nutrition and locally grown has sparked a growing effort in marketing products with labels bearing these quality or process attributes. There is also an increased regulatory activities by national governments to assure quality of the labeling programs. The workshop will examine consumer interests in different labeling programs of intangible quality attributes (organic, food safety), how well these programs work, how government policy affects their operation and performance, and how these systems impact producer profitability.

Economics and Markets of Organics—Does Organic Matter? 
Cynthia Barstow* 
University of Massachusetts Extension 

From Lettuce to Caesar Salad—Traceability Issues, Why Trace & Does the Market Care? 
Julie Caswell* 
University of Massachusetts, Dept. of Resource Economics 

The Economics of Organics and Sustainable Systems: Does It Pay for the Producer? 
Robin Brunfield* 

Rutgers, The State University of New Jersey, Dept. of Agricultural, Food and Resource Economics 

3:00 pm–5:00 pm WORKSHOP 18  
Formulation and Environmental Effects on the Performance of Foliar Applied Plant Growth Regulators 
Moderator: Terence Robinson 
Sponsor: Growth Regulators in Fruit and Nut Production Working Group (PGR) 
Objective: This workshop will present a review of recent research on the effects of formulation and environment on the performance of foliar applied plant growth regulators. 
Summary: Foliar-applied plant growth regulator (PGR) performance is in part determined by effective delivery of the spray solution to the plant surface and the eventual uptake and translocation of the PGR to the active site within the plant. This workshop reviews recent research on formulation and environmental effects on PGR performance.

Maximizing the Performance of Plant Growth Regulators by Improving Spray Application 
Martin J. Bukovac* 
Dept. of Horticulture, Michigan State Univ., East Lansing, MI 48824 
Foliar spray application is the most common method for delivery of plant growth regulators (PGR) to control physiological processes in plants. PGRs are unique chemicals that have a narrow effective concentration response range and must be absorbed by the plant to achieve the desired biological effect. Thus, for optimum response, the appropriate dose must be delivered uniformly over the intended target. The application process can be viewed as consisting of a series of complex, inter-related events, namely, formulation of the active ingredient (AI), spray solution/suspension, atomization, droplet delivery, impaction (reflection or retention leading to spreading), AI deposit formation and penetration. A failure in any one of these components may limit the effectiveness of the spray application process. Although several of these events may be beyond the control of the applicator, it is important to understand and appreciate the role that each may play in maximizing PGR performance. Formulation of the AI may alter the physical and chemical nature of the spray solution, which may affect the solubility of the AI, droplet formation (size) during atomization, impaction, droplet drying, and the formation and nature of the droplet residue. It is well established that penetration takes place from both the droplet and the droplet residue and thus the nature and composition of the deposit may be critical. Spray additives of varying chemistry (e.g. surfactants, buffers, spray drift inhibitors, UV stabilizer, other pesticides, etc.) are frequently added as a tank-mix without definitive data on their effects on PGR performance. Surfactants, in particular, often exhibit multiple effects—e.g. decrease surface tension, increase wetting, retention, spreading, alter the donor characteristics of the deposit and affect penetration. The significance of the various spray application components to performance of foliar applied PGRs will be discussed with emphasis on the effects of spray additives, and their interaction among the AI, spray solution and the plant surface, and the inherent limitations of orchard spray application equipment to deliver the desired dose uniformly over fruit trees with varying canopy size, shape and density.

Adjuvant Effects on the Performance of Foliar Applied Plant Growth Regulators 
P.D. Petrake*, D.D. Woolard 
Valent BioSciences Corporation, 6131 Oakwood Road, Long Grove, IL 60047 
Adjuvants are often used in spray solutions to improve the consistency
of the performance of foliar applied plant growth regulators (PGRs). Compounds such as surfactants and buffers are used to improve PGR solubility and stability in solution, spray droplet wetting and retention and deposit formation on the plant surface, and PGR uptake into plants. Spray solutions potentially could be specifically formulated to improve droplet/deposit formation and cuticular penetration based on the size and polarity of the PGR molecule. In these formulations, factors such as droplet pH and surface tension, deposit hygroscopicity, and direct surfactant effects on the cuticle itself would be specifically altered to optimize uptake. The effects of formulation on aminothioxynlyglycine (AVG) uptake will be presented to illustrate the effects of formulation on PGR performance.

**Environmental Effects on the Performance of Foliar Applied Plant Growth Regulators**

E.W. Stover*1, D.W. Greene2  

1 Indian River Res. & Ed. Center, Univ. of Florida, Ft. Pierce, FL 34945,  
2 Dept. of Plant & Soil Sci., Univ. of Massachusetts, Amherst, MA 01003  

Environmental conditions immediately prior to and during application are likely to affect plant growth regulators (PGR) absorption, while environmental conditions over a more extended period of time may interact with PGR influences on metabolism. Effects of environmental conditions on uptake of PGRs have been investigated intensively in laboratory studies. Higher temperatures clearly increase uptake of PGRs, and many studies report a linear correlation between temperature and uptake with an inflection point and greater response slope above 25 °C. Higher humidity and drying time also are regularly reported to increase PGR uptake in laboratory studies. These results are consistent with many grower observations on effects of environmental factors on chemical thinning, and precautions are incorporated into many product labels and extension recommendations. Relative few field experiments have been reported assessing relationship between PGR response and environmental conditions. Shading during early fruit growth is reported to increase fruitlet abscission and further increases effectiveness of some thinning agents. Chemical thinning of apples with ethephon is reported to correlate strongly with temperature in the days after application. Weather prior to application is believed to influence fruitlet development and thus penetration. However, in many cases the effects of environmental conditions on field response to PGRs are less obvious. Seemingly, the longer drying times at lower temperatures largely compensate for greater uptake rate at higher temperatures. In apple thinning trials comparing applications at various dates, stage of fruitlet development often appears to be more important than environmental conditions. Data from published and some unpublished experiments will be presented to stimulate discussion and promote ideas for further elucidation of this important cause of PGR response variability.

**3:00 pm–5:00 pm WORKSHOP 19**  

**556B**  

**Relationship Among Competing Sinks in the Whole Plant**  

**Moderator:** Martin Gent  

**Sponsor:** Crop Physiology Working Group (CRPP)  

**Objective:** To discuss concepts and models that describe the competition for metabolites, such as sugars and nitrogen compounds, among various organs of the whole plant.  

**Summary:** Plant organs, such as fruit, leaf, stem and root, compete or coordinate their use of sugars or nitrogen compounds to support metabolism and growth. We will discuss concepts or models that describe this competition. Short presentations to highlight a concept are followed by discussion and comments from the audience.

**Branch Autonomy and Dependence of Fruit Growth on Local as Opposed to Distant Sources**  

Ted De Jong*  

**Pomology Dept. University of California, Davis**  

**Competition Between Leaf and Fruit in Citrus for Nitrogen and Carbohydrates**  

Jim Syvertsen*  

Citrus Research Center, University of Florida  

**Root Growth as a Function of Fruit Load in Tomato**  

Martin Gent*  

Forestry & Horticulture, Connecticut Agricultural Experiment Station
hybrids between plants. To circumvent the postzygotic genetic barrier, we used embryo TSWV isolates that overcome Sw-5, we have developed interspecific
128660, although repeated testing of cuttings of the putative resistant
and/or pollination and fertilization.
epigenetic effect on transgene expression during megagametogenesis
was maternally inherited suggests differential gametic selection or an
screening trials of on the near isogenic lines 89R (Sw-5/Sw-5), and 89S (Sw-5+/Sw-
crosses between transgenic 'Atlantic
levels of progeny bearing the transgene did not differ. However, in
the parent-of-origin of a transgene. Using ELISA to determine transgene
phenomenon affecting transgene expression that may be in
for the future of both asexually and sexually propagated potato.
program&abstract, p. 655-868   803 8/19/03, 1:52:13 PM
molecular markers linked to the ms-3 gene have not been reported. Also, RAPD and SCAR markers for the gene were not confirmed in different populations to indicate their merit in breeding. Our objective was to convert the RAPD marker OAM08.650 linked to the ms-3 gene into a robust and reliable SCAR marker for use as a selection tool. Also, we want to determine if the linkage of the RAPD and SCAR markers with the ms-3 gene in an F1 population from a cross of ms-3 with a different fertile cultivar could be confirmed. To develop the SCAR marker from the RAPD marker OAM08.650 we designed a specific forward (AC-
CAGGTGTCGGCAGAAGAAT) and reverse (ACCCAGGAT-
GAGGGATCTTCTAGA) 24-mer primer pair containing the original sequence (underlined) of AM08 primer. The SCAR marker amplified with the specific primer pair was present in ms-3 and the male-sterile DNAbulk, whereas it was absent in Dulce and the fertile DNAbulk. The
resistant
were present in each of 32 fertile maintainers carrying the ms-3 gene. These confirmations of the RAPD and SCAR markers linked to the ms-3 gene will facilitate rapid backcrossing of the male-sterile gene into cultivars/lines.

(198) Characterization of the Late Blight Resistance of Lycopersicon pimpinellifolium Accession L3708 and Comparison of Resistant Lines Bred from Different Program

Minniea Kim*, Martha Mutschler
1Plant Breeding, Cornell University, 301 Bradfield, Ithaca, NY, 14853, 3Dept. of Plant Pathology, Univ. of Nebraska, Lincoln, Nebraska, 68583
The disease late blight (caused by Phystothora infestans (Mont.) de Bar) is an increasingly significant problem to processing tomato production. The breeding program created a series of late blight resistant fixed lines derived from L. pimpinellifolium accession L3708. Detached leaflet assays were performed to examine the race specificity of the late blight resistance in these lines. Sporangia numbers/leaflet and diseased area were measured against five P. infestans isolates. The resistant fixed lines were, indeed, resistant against all five isolates. The heterozygous F1 hybrids were resistant to US-11, partially resistant to US-17, NC-1 and DR4B, and susceptible to US-7. Therefore, there are differential responses of homozygous vs. heterozygous tomato genotypes to varied pathogen isolates. Initial field observation of resistant tomato lines created by AVRD researchers also using L3708 suggested that their resistance differed from that of the Cornell lines. To address the possibility of partial transfer of the resistance, the lines bred at Cornell and the AVRD were tested together against 5 pathogen isolates, with data analyzed using half-normal probability analysis. The Cornell bred fixed lines were resistant against all five isolates, but AVRD lines were resistant to US-11, partially resistant to US-17, NC-1 and DR4B, and susceptible to US-7. Screening additional AVRD lines gave the same differential response and testing progeny of AVRD lines indicated that these lines are not segregating for late blight resistance. Therefore, the L3708-derived Late Blight resistance is controlled by more than one gene, at least one of which is missing from the AVRD lines.

(199) Survey of RAPD and SCAR Markers Linked to the Ur-6 Gene for Specific Rust Resistance in Diverse Bean Cultivars/Breeding Lines

S.O. Park*, K.M. Crosby1, D.P. Coyne2, M.A. Brick1, J.R. Steadman4
1Plant and Animal Sciences, Brigham Young University, 301 Bradfield, Ithaca, NY, 14853, 3Dept. of Horticulture, Univ. of Nebraska, Lincoln, Nebraska, 68583, 4Dept. of Soil & Crop Sciences, Colorado State Univ., Fort Collins, Colorado, 80523, 5Dept. of Plant Pathology, Univ. of Nebraska, Lincoln, Nebraska, 68583
Bean rust, caused by Uromyces appendiculatus, is an important
Bridgity based on visual selection and marker genotype. Comparisons of Wisconsin-Madison and USDA lines such as: W259B, W283B, 6366B, 2566B, crosses included: W451C, W452C, W437, Lutz Greenleaf, W371B, carrot breeding programs. We used AFLP markers to genotype parents to errors in the breeding process. We sought to determine how effective a way to classify hybrid progeny. However, if heterosis for size is impossible. Misidentification of hybrid progeny will be difficult or impossible. Misidentification in such cases can result in systematic errors in the breeding process. We sought to determine how effective visual selection of hybrid progeny is in the context of the red and yellow populations. These RAPD and SCAR markers linked to the high pigment concentration and TDS levels in the outer zone of the root may be due to smaller cell size associated with new growth near the exterior of the root.

200 Visual vs. Marker-based Identification of F1 Hybrid Progeny in Fertile x Fertile Crosses of Carrot and Table Beet
Margaret Schaberg*, Irwin Goldman
Horticulture, University of Wisconsin-Madison, 1575 Linden Dr., Madison, Wisconsin, 53706
Cytoplasmic male sterility (CMS) evolved as a method for outcrossing in plant species, and breeders use this system as well as self-incompatibility to ensure cross pollinations. Beet and carrot breeding utilize cytoplasmic-genic sterility systems, and plants carrying normal cytoplasm (N) are often desirable when introducing new germplasm into a breeding program. In addition to this beet is self-incompatible and requires self-pollination occurs, while carrot is self-compatible. Crosses within these crops therefore require a mechanism to discern hybrid progeny from self-pollinated progeny. Breeders typically use visual identification of heterosis for size as a way to classify hybrid progeny. However, if heterosis for size is lacking, proper identification of hybrid progeny will be difficult or impossible. Misidentification in such cases can result in systematic errors in the breeding process. We sought to determine how effective visual selection of hybrid progeny is in the context of the red and yellow populations. These RAPD and SCAR markers linked to the high pigment concentration and TDS levels in the outer zone of the root may be due to smaller cell size associated with new growth near the exterior of the root.

201 Pigment and Total Dissolved Solids Distribution in Table Beet Populations Selected for Increased Pigment Concentration
Veronica Gaertner*, Irwin Goldman
Horticulture, University of Wisconsin-Madison, 1575 Linden Drive, Madison, WI 53706
Half-sib recurrent selection programs were initiated at the University of Wisconsin-Madison in 1978 and 1995 to increase betalain (beta-cyanin and betaxanthin) concentration in red and yellow table beets, respectively. Chosen cycles of selection from both the red and yellow table beet breeding programs were evaluated for pigment and total dissolved solids (TDS) distribution in five tissue zones (outer, middle and center zones of the root; leaf and petiole). From C0-C3, betaxanthin concentration in petiole and leaf tissue of yellow populations increased by 148 (11.83 mg/100 g fresh wt.) and 60% (3.99 mg/100 g fresh wt.), respectively. From C2-C16, betacyanin concentration in petiole and leaf tissue of red populations increased by 107 (20.33 mg/100 g fresh wt.) and 97% (10.13 mg/100 g fresh wt.). Pigment concentration of the outer root zone increased more than middle and center zones: 46.6 mg betaxanthin/100 g fresh wt. and 201 mg betacyanin/100 g fresh wt. for yellow and red populations, respectively. Results indicate a correlated response to selection for pigment concentration in leaf and petiole tissue in both populations. Results also demonstrate that TDS and pigment concentration is highest in the outer zone of the root. Across all table beet populations, pigment concentration of the outer root zone was 55 and 62% higher than middle and center zones, respectively. TDS of the outer root zone were 10 and 12% higher than middle and center zones, respectively. These findings suggest that although selection has resulted in increased pigment concentration throughout all tissue sections, selection has had the greatest effect on the outer root section. The higher pigment concentration and TDS levels in the outer zone of the root may be due to smaller cell size associated with new growth near the exterior of the root.

202 A One-pass Semi-quantitative Method for Extraction and Analysis of Carotenoids and Tocopherols in Carrot (Daucus Carota) and Examination of the Reduced Pigment (Rp) Mutation
Tom Koch*, Irwin Goldman
Horticulture, University of Wisconsin-Madison, 1575 Linden Drive, Madison, WI 53706
Carotenoids and tocopherols serve as powerful antioxidants in the human diet. Carrot (Daucus carota) has been selected for high levels of carotenoids, contributing to its orange color. Seed oils have been shown to possess high levels of tocopherols, but little is known about their levels in the edible portions of most vegetable crops. To ascertain this a one-pass HPLC method for the extraction and quantification of both carotenoids and tocopherols was developed. This simultaneous measurement of both tocopherols and carotenoids will decrease time necessary for analysis, allowing more germplasm to be tested in the short time between field and breeding seasons. A survey of current commercial carrot cultivars has shown levels of tocopherol measured on a dry weight basis ranged from 0.07 to 0.15 ppm, levels of lycopeno ranging from 0.00 to 0.73 ppm, levels of α-carotene ranging from 204.89 to 690.30 ppm, and levels of β-carotene ranging from 383.65 to 1059.58 ppm. In xylem tissue, α-tocopherol was significantly (P < 0.001) positively correlated with α-carotene (r = 0.65) and with β-carotene (r = 0.52). This positive correlation indicates it may be possible to select for both increased α-tocopherol and carotenoids in carrot. This extraction and quantification protocol may allow for efficient selection of increased tocopherol levels in carrots. An inbred line carrying a mutation in the carotenoid synthesis pathway was examined through above protocol. The reduced pigment (rp) mutation was shown to result from a 96% reduction in levels of α- and β-carotene and a 25% to 43% reduction in α-tocopherol when compared to a near isogenic line. In the rprp-genotype, a substantial increase was observed in a compound believed to be phytoene, a precursor to the carotenoids, suggests the location of the rp lesion in the carotenoid synthesis pathway.

203 Molecular Data Suggest Multiple Members Comprising the Alliinase Gene Family in Garlic
Pablo Cavagnarino**, Ricardo Masuelli†, Philipp Simon‡
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The enzyme alliinase [S-(alk(en)yl)-L-cysteine sulfoxide lyase] found in garlic is involved in the release of the garlic compound allyl methyl sulfide. It can be an important factor affecting garlic flavor and aroma. A gene family analysis was performed using a combination of molecular markers and sequencing. The RAPD marker OBC06.300, we designed a specific forward (GAAGGGAGAAGAAAAAAGAAAAAT) and reverse (GAAGGGAGAGACCTAGCTGAAAG) 24-mer primer pair containing the original sequence (underlined) of BC06 primer. The SCAR marker amplified with the specific primer pair was present in Olathe and the resistant DNA bulk, whereas it was absent in Andean origin, along with other independent rust resistance genes, could be utilized to pyramid multiple genes into a bean cultivar for more durable rust resistance.

Carotenoids and tocopherols serve as powerful antioxidants in the human diet. Carrot (Daucus carota) has been selected for high levels of carotenoids, contributing to its orange color. Seed oils have been shown to possess high levels of tocopherols, but little is known about their levels in the edible portions of most vegetable crops. To ascertain this a one-pass HPLC method for the extraction and quantification of both carotenoids and tocopherols was developed. This simultaneous measurement of both tocopherols and carotenoids will decrease time necessary for analysis, allowing more germplasm to be tested in the short time between field and breeding seasons. A survey of current commercial carrot cultivars has shown levels of tocopherol measured on a dry weight basis ranged from 0.07 to 0.15 ppm, levels of lycopeno ranging from 0.00 to 0.73 ppm, levels of α-carotene ranging from 204.89 to 690.30 ppm, and levels of β-carotene ranging from 383.65 to 1059.58 ppm. In xylem tissue, α-tocopherol was significantly (P < 0.001) positively correlated with α-carotene (r = 0.65) and with β-carotene (r = 0.52). This positive correlation indicates it may be possible to select for both increased α-tocopherol and carotenoids in carrot. This extraction and quantification protocol may allow for efficient selection of increased tocopherol levels in carrots. An inbred line carrying a mutation in the carotenoid synthesis pathway was examined through above protocol. The reduced pigment (rp) mutation was shown to result from a 96% reduction in levels of α- and β-carotene and a 25% to 43% reduction in α-tocopherol when compared to a near isogenic line. In the rprp-genotype, a substantial increase was observed in a compound believed to be phytoene, a precursor to the carotenoids, suggests the location of the rp lesion in the carotenoid synthesis pathway.
in *Allium* plants is involved in the production of organosulfur compounds responsible for odor, pungency, health benefits, and plant pathogen resistance. It catalyzes the degradative conversion of S-alk(en)yL-cysteine sulfoxides (ACSOs) to their corresponding thiosulfimates and has been suggested to be a family of isozymes differing in their substrate specificity and accounting, therefore, for the variable thiosulfimate composition observed among *Allium* species. We are currently studying the genomic structure and expression patterns of the alliinase gene-famil-ily in garlic. Two approaches were carried out to estimate the number of gene copies and identify different sequence variants. Southern Blot analysis suggests at least 4–8 copies depending on the garlic clone, whereas PCR amplification and sequencing of an intron-bearing fragment revealed 27 sequence variants. The possibility that alliinase genes are arranged in tandem in the genome may account for underestimates of the copy number suggested by Southern blot data. Alliinase sequences were most variable in the intron region, while the coding regions were more conserved. However a 17 bp deletion was observed in the coding region of several, probably not functional, variants. An intron-less copy was also identified. Our results suggest multiple and diverse copies comprising the alliinase gene family in garlic. Several genes could be functional and contribute to the high alliinase content in garlic bulbs. Transcribed copies are being analyzed. Multiple copies of this gene in the garlic genome may play an important role in the development, adaptiveness and evolution of this species.

(204) Inheritance and QTL Analysis of Resistance to Anthracnose and Powdery Mildew in Interspecific BC$_1$F$_2$ of (*Capsicum annuum*, *C. baccatum*)

Jae Bok Yoon*, Dong Cheol Yang, Jae Wahng Do, Jun Dae Lee, Hyo Guen Park
School of Plant Science, Seoul National University, 103, Suwon, 441-744, Republic of Korea

*C. baccatum* causes anthracnose and *Leveillula taurica* causes powdery mildew have been reported to be the most destructive fruit and foliar diseases in chili pepper, respectively. To analyze inheritance of anthracnose and powdery mildew resistance, interspecific BC$_1$F$_2$ progeny was made using PBC81 (*C. baccatum*) resistant to both anthracnose and powdery mildew and Matikas (*C. annuum*) susceptible to both ones. All interspecific hybrids showed resistant to both diseases, indicating that those resistances seemed to be inherited dominantly. However, both resistances were not co-segregated in BC$_1$F$_2$ progeny, suggesting that they appeared to be inherited independently. Segregation of BC$_1$F$_2$ progeny was not fitted genetic ratios of 1:1 or 3:1 (resistant: susceptible), suggesting that the resistance was not qualitative trait and more than two genes control the resistance in both diseases. In QTL analysis of anthracnose resistance by SF-ANOVA and multiple regression analysis between phenotypic data and 141 (53 RAPD and 88 AFLP) molecular markers, four QTLs accounted 30.3% of the phenotypic variation were identified to be associated with anthracnose resistance. In powdery mildew resistance, three QTLs accounted 61.2% of the phenotypic variation were detected. Among them, ED1M1002 locus accounted 54.5% of the phenotypic variation seems to be a major QTL closely associated with powdery mildew resistance. In addition, the major QTL was also identified and positioned in LG12 by MAPMAKER/QTL analysis with LOD threshold of 2.0. The LOD peak of the locus valued more than 12.0, indicating that the marker directly associated with powdery mildew resistance. These molecular markers would be used to develop MAS for breeding pepper resistant to anthracnose and powdery mildew.

(205) The Influence of Root and Shoot Genotype on Fusarium Root Rot Resistance in Common Bean

Karen Cichy*, Sieglinde Snapp
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Fusarium root rot caused by the fungal pathogen *Fusarium solani* f. sp. *phaseoli* is responsible for significant yield losses of common bean (*Phaseolus vulgaris*) in most major bean producing regions of the United States. Genetic resistance has been successfully bred into commercial bean cultivars of the majority of the major market classes. Shoot growth habit may be a factor in breeding for Fusarium root rot resistance in bean because all commercial cultivars with resistance to *F. solani* have indeterminate shoot growth. It has proven difficult to transfer resistance to beans with determinate shoot growth habit including snap and kidney bean. Based on the apparent importance of indeterminate shoot growth habit in breeding beans for resistance to Fusarium root rot, the objective of this research was to determine the role of the shoot genotype and the root genotype in resistance. In this study, reciprocal grafting of a resistant bean genotype and a susceptible bean genotype, followed by inoculation with *F. solani* f. sp. *phaseoli* spores was used to measure the contribution of the shoot and the root to resistance. ‘Montcalm’, the susceptible genotype is a commercially grown kidney bean cultivar with a determinate growth habit. ‘FR266’, the resistant genotype is a determinate type snap bean that was released as a breeding line, but has not been successfully used to transfer Fusarium root rot resistance into commercial snap bean cultivars. The results of this work indicated that when the susceptible cultivar ‘Montcalm’ served as the root genotype there was a significant increase in root rot severity as compared to other graft combinations (‘FR266’ self grafted or ‘FR266’ root grafted to ‘Montcalm’ shoot). These data suggest the bean shoot genotype does not have a significant role in conferring resistance to Fusarium root rot.

Pest Management

(296) Integrating Low-dose Soil Fumigation and Organic Amendments Suppresses Southern Blight and Results in a Shift in PLFA Biomarker Composition

Martin T. Lyons*, Carl E. Sams1, Aaron D. Peacock2, David C. White3
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Soilborne pathogens that deleteriously affect plasticulture vegetable production are commonly controlled with pre-plant soil fumigation. However, increasing concerns over negative environmental impacts and regulatory restrictions will require growers to alter conventional chemical disinfection practices. The removal of methyl bromide from the marketplace may prompt the adoption of an integrated approach to disease management. Effective management of the soil microbial ecology is important in developing more sustainable production under integrated systems. Research conducted from 2000 to 2003 at The University of Tennessee involving phospholipid fatty acid (PLFA) analysis has linked characteristic soil microbial community compositions with disease suppression. Integrated pre-plant soil treatments that involved fumigation with a methyl isothiocyanate-based product applied at 50% of recommended dosage significantly decreased incidence of Southern Blight (**Sclerotium rolfsii**) and increased yields in tomato plants compared to controls. This treatment produced an enhanced microbial biomass and a shift in community composition. PLFA quantification revealed a relative increase in monounsaturated signature lipid biomarkers, indicating an elevated population of gram-negative bacteria, and a decrease in polyunsaturates proportional to total biomass. The latter indicates a decrease in microeukaryotes in relation to overall biomass counts. Thus, PLFA biomarkers may be useful in quantifying soil microbial composition to aid management decisions in integrated production systems.
(297) Effect of Fungal Microorganisms to Colonize Tomato Roots, Improve Transplant Growth and Control Fusarium Crown and Root Rot in Hydroponically Grown Tomatoes

Nusret Orzbi1, Steven E. Newman2*
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Diseases caused by Fusarium spp. are important limiting factors in the production of tomato. One of the most damaging soilborne pathogens of tomato is Fusarium oxysporum f. sp. radicis-lycopersici, which causes Fusarium crown and root rot (FCRR). One strategy to control FCRR is the use of antagonistic, root colonizing fungus Trichoderma spp. Experiments were conducted to evaluate Trichoderma harzianum strains for promoting plant growth and suppressing Fusarium crown and root rot in fresh market tomatoes grown in a research greenhouse during 2001 and 2002. Tomato (Lycocecum esculentum Mill., cultivar Caruso) plants were inoculated with T. harzianum strains (PlantShield®, T22 and T95) prior to sowing and to roots at transplanting at two inoculum densities (rockwool and coconut coir) prior to sowing and to roots at transplanting at two inoculum densities. 106 or 107 conidia/mL. Compared to controls, significant reduction in disease incidence and severity was obtained with the use of biological control agents. Maximum disease control was obtained when T. harzianum strains applied at transplanting. The protective effect of T. harzianum strains resulted in a significant increase in the yield of tomatoes. In addition to their bicontrol activities, the strains improved transplant growth.

(298) Plant Parasitic Nematodes Associated with Vegetable Crops in Southern Illinois

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Plant-parasitic nematodes are important parasites of vegetable crops, but their importance is often over-looked or underestimated. The plant-parasitic nematodes associated with vegetable crops in southern Illinois were determined as well as if damage threshold population densities exist. Six genera of plant-parasitic nematodes were identified from vegetable production fields in southern Illinois during the 2001, 2002, and 2003 growing seasons including Helicotylenchus, Meloidogyne, Paratylenchus, Pratylenchus, Tylenchorhynchus, and Xiphinema, with all nematodes sporadically distributed. For most vegetable crop and nematode combinations, damage thresholds have not been determined; however, in a few samples, Meloidogyne spp. was above threshold levels. All other nematode population densities detected were insignificant over the three years ranging from 0 to 73 (Helicotylenchus spp.), 0 to 35 (Paratylenchus spp.), 0 to 62 (Pratylenchus spp.), 0 to 33 (Tylenchorhynchus spp.), and 0 to 64 (Xiphinema spp.) per 100 cc soil. It appears that Meloidogyne spp. have the greatest potential to damage vegetable crops in southern Illinois, although this species was detected above the damage threshold in less than 5% of fields sampled.

(299) Developing a Monitoring Program for Helicoverpa zea in California Sweet Corn

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Helicoverpa zea is a pest of sweet corn (corn earworm), tomatoes (tomato fruit worm), and cotton (cotton bollworm). Monitoring systems that have been developed for tomatoes and cotton are not sensitive enough to detect damaging levels in sweet corn. This research was initiated to develop a more sensitive monitoring program appropriate for sweet corn. Six trap designs, four pheromone lures, and several trap placements were evaluated for their ability to detect corn earworm (CEW) in 1999, 2000, and 2001. The bucket and heliothus style traps were far superior to other traps in their ability to catch CEW moths. The bucket trap is inexpensive, easy to service and much more suitable for routine field monitoring purposes than the heliothus trap. The Trece red rubber septa caught significantly more CEW than all other lures. Traps placed on the upwind sides of the field (north and west) caught significantly more moths than those placed on the downwind sides. And traps placed 10–20 feet outside the field averaged 25% more moths than those placed within the first few corn rows. In summary, bucket traps baited with Trece CEW septa, placed 10–20' outside the field on the upwind side are sensitive enough to allow growers to avoid spraying fields until moths are caught in the traps. This project was funded by the University of California, Center for Pest Management Research and Education (CPMRE).

(300) Strawberry Cultivars Grown under Protected Structure and Their Susceptibility to Natural Infestation of the Cotton Aphid, Aphis gossypii Glovers

Silvia Rondon, Ashwin Paranjpe*, Daniel Cantliffe
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The cotton aphid, Aphis gossypii Glovers (Homoptera: Aphiidae), is one of the most important greenhouse pests worldwide. This soft-bodied insect secretes honeydew, which results in a sooty mold that blocks the photosynthetic leaf area reducing the growth capability of the plant, and potentially causing yield reduction. In order to determine the susceptibility of the strawberry (Fragaria xananaus Duch.) to natural infestation of the cotton aphid in a passive ventilated greenhouse, seven strawberry cultivars were grown and evaluated. The cultivars Carmine, Festival, Camarosa, Treasure, Sweet Charlie, Earlbirte and FL 97-39 were planted at a density of 22 plants per m2. No insecticide was used. Ten strawberry leaflets were selected at random, and the total number of aphids per leaflet was counted weekly. Five releases of Aphidius colemani L. and of Lysiphltes testaceipes L. at an approximate rate of 200 wasps per 18 m row were made. ‘Sweet Charlie’ and ‘Carmine’ sustained the greatest average number of aphids per leaflet throughout the growing season; while ‘FL 97-39’ and ‘Camarosa’ had the lowest number of aphids per leaflet. The population dynamics of the aphid continued to rise in all cultivars from late November to mid-January; however, 95% aphid control was achieved by the end of February. The yield for ‘FL 97-39’ was the greatest, which correlated with the lowest number of aphids per leaflet throughout the season; however that cultivar had the greatest susceptibility to powdery mildew.

(301) Management Approach and Fungicide Combinations Affect Foliar Diseases and Yield of Pumpkin in the Southeastern United States

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Foliar fungal diseases often reduce yield of vine crops in the
southeastern USA. This study was conducted to investigate manage-
ment approaches and fungicide combinations for the control of
foliar diseases on pumpkin. Plantings were grown at two locations
in Mississippi and two in Tennessee during 2002. At each location,
the experimental design was a randomized complete block with four
replications. Treatments were arranged factorially with two levels of
management and seven levels of fungicide combinations. Manage-
ment was defined as either preventative or reactive. The preventative
approach began fungicide applications ~20 days after seeding. The
reactive approach began fungicide applications at a time when leaf
disease(s) first became evident on the foliage. Both preventative and
reactive approaches were continued on a 7 to 10 day schedule until
harvest. For fungicide combinations, Quadris (aoxystrobin) was ap-
plied in rotation with Equus 720 (chlorothalonil) for all treatments
except a water-only control. Spray treatments consisted of a control
(water) or one of six combinations of Quadris/Equus alone or with
various combinations of Armacarb 100 (potassium bicarbonate)
and/or foliar phosphate (0–28–26) and/or CoRoN (28–0–0), a foliar-
applied nitrogen product. Plants were visually rated at all locations
for powdery mildew and/or downy mildew several times during the
season. The preventative approach increased yield (kg/ha and no/ha)
by 17% compared to the reactive approach. Fungicide combination
also affected yield (kg/ha and no/ha). Regardless of the specific fun-
gicide combination, application of a fungicide increased yield by 40%
compared to the control. There were few differences among fungicide
approaches, indicating that the Quadris/Equus rotation, without any
other chemicals, could be recommended for general use. Ratings of
powdery mildew and downy mildew disease development confirmed
these results, with significantly less disease development under the
preventative approach compared to the reactive approach and, in
turn, significantly less disease development with fungicides than
without fungicides.

(302) Effect of Growing Media's Physical Properties on
the Root Rot Disease Caused by Pythium
Viviane Juneau*, Jean Caron, Philippe Jobin, Hani Antoun
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Soil-borne diseases require important attention in crop management
for greenhouse productions. This study was conducted to determine
the physical properties of growing mixes having an incidence on the
importance of the root rot disease caused by Pythium spp. Brown
peat and sawdust, plus 10% of compost, were used in different
proportions to create four substrates forming a gradation of aeration
and water retention properties, likely to affect microbial populations.
Rockwool was used as a control. The experiment took place in the
fall season on a tomato [Lycopersicon esculentum Mill., cv Trust]
crop grown in greenhouse. The conditions were propitious to
Pythium spp. establishment. At the end of the production all the treatments
were affected by Pythium spp. The highest infection (91% of roots
attacked) occurred in the rockwool which had the lowest air-filled
porosity (0.08 m3/m3). The results showed that the higher the peat
proportion in the substrate, the higher the infection.

5:00 pm–6:00 pm POSTER SESSION 36  Ballroom A
(Location numbers for the posters within the
Poster Viewing Area are in parenthesis)

Cover Crops

(308) Cover Crop Mixtures & Components vs. Synthetic
Nitrogen Effect on Above Ground Biomass and Yields of
Tomato
Wayne Whitehead*, Bharat Singh
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During the 2002 growing season, a study was conducted to de-
termine effects of cover crop, their mixture and fertilizer N rates on
above ground biomass, fruit number, and tomato yield. The follow-
ing winter-spring fertility treatments were applied using randomized
complete block design with three replications: 1) 0 N winter+fallow-0
N spring, 2) 0 N winter+hairy vetch-0 N spring, 3) 0 N winter+abruzzi
rye-0 N spring, 4) 0 N winter+hairy vetch-N spring, 5) 0 N winter+fallow-90 kg N/ha spring, and 6) 0 N winter+abruzzi
rye-90 kg N/ha spring, 7) 0 N winter+hairy vetch-90 kg N/ha spring, 8) 0 N winter+abruzzi rye+hairy vetch-90 kg N/ha spring, 9) 0 N
winter+fallow-180 kg N/ha spring, 10) 0 N winter+abruzzi rye-180 kg N/ha spring, 11) 0 N winter+hairy vetch-180 kg N/ha spring, 12)
0 N winter+abruzzi rye+hairy vetch-180 kg N/ha spring. In Spring,
‘BH444’ tomatoes were transplanted. Total yield and fruit number
were compiled over four weeks, while total vegetative dry matter was
measured at final harvest. Highest above ground biomass (229.8 g/plant)
was produced by treatments 5) 0 N winter+fallow-90 kg N/ha spring,
and 11) 0 N winter+hairy vetch-180 kg N/ha spring. Results indicate
the legume cover crop can be an effective N source in supporting plant biomass, fruit number and yield comparable to those receiving synthetic N. Results indicate that the legume cover crop can be an effective N source in supporting plant biomass, fruit number and yield tomato.

(309) Growth Analysis of Cowpea Cover Crop Varieties
Guangyao Wang, Jeff Ehlers, Eddie Ogbughiekwel, Shengping Yang, Milton McGiffen*
Department of Botany and Plant Sciences, Uuiv. of California, Riv-
eride, Riverside, CA, 92521
Cowpea (Vigna angustifolia(L.) Walp.) cover crops are planted to
provide nitrogen for cash crops, improve soil physical properties, and
suppress pest populations. It fits very well in the vegetable cropping
system of southern California. Twelve cowpea cover crop varieties
were planted in the summer of 2000 and eighteen planted in the summer of
2002 to compare biomass yield and growth rate of each cowpea variety.
Canopy height and canopy width of cowpea, light intensity above and
below the canopies, and leaf area index (LAI) were measured weekly.
Plants were also sampled weekly to measure leaf area and dry weight of
plants. Seed weight per 100 seeds, primary leaf area, leaf area per
mature leaf, and leaf thickness of mature leaves were also measured.
Growth parameters RGR (Relative Growth Rate), NAR (Net Assimila-
tion Rate), SLA (Specific Leaf Area), LAR (Leaf Area Ratio), and LWR
(Leaf Weight Ratio) were calculated from measured variables using
the functional growth analysis method. Regression of biomass yield
with all other measured and derived variables found that NAR, LAI,
primary leaf area, and percent ambient (percent light unabsorbed by plant
canopy) explained 83.84% variation of biomass yield. NAR, LAI, and
primary leaf area were positively correlated with biomass yield, while
percent ambient was negatively related to biomass yield. The multiple
correlation results also showed that biomass yield positively correlated
with NAR, LAI, canopy height, and RGR, and negatively correlated
with percent ambient, LAR, and SLA. Correlation coefficients of NAR
(0.74), percent ambient (-0.72), and LAI (0.65) were the cowpea growth
factors most related to biomass yield. It appears that selecting for traits
that enhance the ability of cowpea to capture and utilize light will re-
SUNDAY pm

(310) Economic Return for Production of Lettuce and
Cantaloupe is Affected by Cropping System and Value of
Hand Weeding
Edmund Ogbughiekewel*, Milton McGiffen**, Mathieu Ngouajoj***
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ces Building, East Lansing, MI, 48824-1325
Field experiments were established at the University of California
Desert Station in Coachella Valley from 1998 to 2000. The main plot

807
(31) Selecting a Winter Cover Residue for No-Till Pumpkins

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Reducing tillage in pumpkin production systems requires management techniques not considered in row/plant systems. Winter cover residue selection is important because different residues may provide specific benefits and concerns. Choosing a small grain cover crop (rye, barley, wheat, triticale, or ryegrass) for winter residue should provide adequate mulch during the summer growing season but could influence germination and early growth. No-till pumpkins were established for six location/years in the Piedmont and Mountains of Western North Carolina. In this study, three cultivars of pumpkins (Or or Mystic Plus and Magic Lantern) were planted into 13 to 17 different small grain cover residues to examine the effect of winter cover residue on pumpkin yield. All winter cover crops gave adequate residue cover, with biomass in the order rye<triticale>barley<ryegrass>rye. No-till pumpkin yields (both T/ha and number/ha) varied by location and year, with little difference due to variety or species of small grain. Rate (kg/ha) of residue biomass did not influence pumpkin yield due to adequate rainfall during this two year experiment at four locations. These experiments showed no winter cover residue negatively affecting no-till pumpkin yields.

(32) Integrating Summer Cover Crops into Cucumber-Tomato Rotation

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In Michigan, vegetable growers are increasingly interested in improving short crop rotations with use of cover crops. Timing of cover crop planting remains a key issue, especially if growers have to skip an entire season to grow cover crops, an alternative would be to plant the cover crops after harvest of a short season cash crop such as cucumbers. In Michigan, early plantings of cucumbers are harvested by the end of July. When the cover crops were planted on August 9, 2002, biomass production was 650 g m⁻² and 170 g m⁻² for sudangrass and cowpea, respectively. Our results suggest that sudangrass and cowpea could be used in short cucumber-tomato rotation systems to improve soil organic matter and fertility. The cover crops could be planted in fallow plots or after cucumbers harvest. They are also compatible with the current winter cover cropping practices.

(33) Expanding Conservation Tillage Production Practices in California’s Central Valley

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Several very diverse reduced, minimum, or conservation tillage (CT) production system alternatives are currently being developed and evaluated in row crop fields in California’s Central Valley. The Conservation Tillage Workgroup, which is made up of more than 250 University of California, USDA Natural Resources Conservation Service, farmer, private industry, public agency and environmental group members and affiliates, has documented a dramatic increase in interest and experimentation in various CT approaches that are currently being developed for the particular production issues of this region. Unlike in other areas where CT systems have been adopted primarily to reduce soil erosion, the primary motivations for CT systems in the Central Valley appear to be to reduce production costs, to decrease particulate matter emissions and to minimize surface water runoff from fields. Both minimum tillage approaches that effectively recondition planting beds and mix surface crop residues with the soil using reduced tractor pass implements, and more “classic” CT systems such as no-till or strip-till are currently being evaluated.

5:00 pm–6:00 pm POSTER SESSION 37 Ballroom A

(Fruit Crop Physiology)

(1) Effect of Solar Irradiation on Apples Temperature and Fruit Damage During Vegetation

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Temperatures of air and fruit exposed to sun and shaded ones have been measured. For photosynthesis temperature 25 °C is considered to be optimal,
be an optimum one. The most part of plant crops of temperature zone grows at maximum temperature 30–35 °C. It has been established that variation between temperatures of shaded and sun exposed sides increases in the result of temperature rise. 3.2 °C and 8 °C variations can be observed at air temperatures 22 °C and 34 °C correspondingly. In July when maximum air temperature is 40 °C or even higher assimilating tissue organs of an apple are warmed up to >55 °C that results in temperature denaturation of tissue followed by its clarification, browning and breakdown. Delayed growth of tissue cells of the side exposed to sun results in increase of firmness of cell membrane. In September firmness of fruit of an apple cv. Corey on a sun exposed and shaded sides was 10.5 ± 0.3 kg/cm² and 9.6 ± 0.25 kg/cm² correspondingly.

(2) Effects of CO₂ Enrichment and N Application After Harvest on Reserve Nutrient Status, and Growth and Fruiting of Apple Trees

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Dept. of Horticulture, Cornell University, 134A Plant Science, Ithaca, NY, 14853

Gala/M.26 trees were grown at ambient or elevated CO₂ (1000 ppm) for 5 weeks after harvest. At each CO₂ level, trees received 10 mM soil nitrogen and carbohydrate levels. Remaining trees were regrown with no nitrogen or 10 mM N the following year. Elevated CO₂ significantly increased the total amount of reserve carbohydrates. Soil N application in the fall significantly increased N content and total amount of N accumulated in the tree, but reduced the concentration and total amount of reserve carbohydrates. Fall CO₂ enrichment did not affect total leaf area, fruit number, or fruit yield the following year. Regardless of the current nitrogen supply, trees with high N reserves but low carbohydrate reserves had a larger total leaf area, higher fruit number, and total yield than those with low N reserves but high carbohydrate reserves. Spring N supply also significantly increased total leaf area, leaf N content, fruit number, and total yield. We conclude that the growth and fruiting of apple trees in spring are primarily determined by reserve nitrogen, not by reserve carbohydrates.

(3) Factors Affecting Carbon Exchange Characteristics of an Apple Tree

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The characteristics of net photosynthesis (Pn), stomatal conductance (gs), mesophyll resistance (Rm), intercellular CO₂ concentration (Ci), and leaf temperature (Tl), and the environmental parameters of ambient CO₂ concentration (Ca), vapor pressure deficit (VPD), photosynthetic active radiation flux (PAR), were measured under field conditions during a diurnal period at midsummer. At each measurement period, leaf temperature response was measured by altering measurement chamber temperature. Rm of leaves from the east side of the tree was low at 0830 hr then increased during the day. The Ci:Ca ratio responded similarly. These diurnal changes in Rm and Ci:Ca were negatively correlated to changes of Pn. Rm of leaves from the west side of the tree was high at 0830 hr then decreased as Pn increased. The response of Pn to PAR at 26 °C indicates that the Rm of leaves of both east and west side of trees was high at 100 µmol m⁻² s⁻¹ then decreased with the increase of Pn. Rm reached a minimum at 1200 µmol m⁻² s⁻¹ as Pn achieved its maximum. It appears the response of Pn to PAR were mainly caused by the increase in Rm. The response of Pn to Ti at PAR of 1050 µmol m⁻² s⁻¹ indicates that while Ti changed from 20 to 28 °C the gs of leaves increased slightly but decreased when the Ti changed from 32–40 °C. Pn changes during the experiment were related to Ti but inversely related to Rm and Ci:Ca. Observations suggest that the diurnal changes of Pn were mainly due to responses of Rm to CO₂. The response of Pn to Ti appears to be largely controlled by Rm and gs.

(4) Fruit Growth and Maturity as Affected by Hand Thinning in ‘Abbé Fetel’ Pear Trees

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The effects of crop load on fruit growth and maturity of 8-year-old ‘Abbé Fetel’ (Pyrus communis L.) pear trees trained to pyramidal leader were examined at the Comahue National University (lat. 38°56’S, long. 67°59’W, Argentina. At 17 days after full bloom (DAF), the trees were subjected to the following hand thinning treatments: 1) 2.05 fruit/cm² trunk cross-sectional area (TCA), no fruit removed from tree; 2) 1.65 fruit/cm² TCA; and 3) 0.99 fruit/cm² TCA. Fruit size was recorded every two weeks (n = 20 per date and treatment) and at 138 DAFB (initial commercial harvest), fruits were graded into size categories and the maturity indices were determined. Analysis of variance was used and means separation was tested by Tukey’s test. Tests 2 and 3 increased the percentage of fruits ≥70mm in diameter by 75% and 100%, compared with the control. However, decreasing fruit-fruit competition in the most intensively thinned trees was counter-productive in terms of yield, expressed by kg of fruits ≥70mm. 3.2% and 8.7% for treatments 1, 2 and 3, respectively. Mean fruit weight (FW) was increased only slightly and not significantly by treatment 3. Consequently, there were no significant differences among treatments in starch index (range 2.2–3.0), soluble solids concentration (range 12.2–15.2 °Brix), or fruit firmness (range 55.7–60.3 N). The following logistic model best fitted the fruit growth vs. time curve on the control trees: FW = 318.83/(1+e⁵.48-0.05DAFB), R² = 0.95. Final crop load was 130.2, 105.0 and 52.8 fruit/tree for treatments 1, 2 and 3, respectively. Further studies are needed to establish the appropriate degree of thinning in ‘Abbé Fetel’ pear trees, since larger economic returns are likely when relatively small crop load reductions result in larger increases in fruit size.

(5) Nitrogen, Phosphorus and Potassium Applications Affect Growth, Yield and Composition of Lowbush Blueberry (Vaccinium angustifolium Ait.)

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An experiment examining the main and interactive effects of soil-applied nitrogen (N), phosphorus (P) and potassium (K) in the vegetative and cropping phases of production was conducted in Nova Scotia in 2001 and 2002. The N, P and K sources consisted of ammonium sulfate (0 to 80 kg ha⁻¹ of N), triple superphosphate (0 to 220 kg ha⁻¹ of P₂O₅) and potash (0 to 80 kg ha⁻¹ of K₂O). A completely randomized rotatable design was used with 16 treatments, 4 replications, a plot size of 6 × 8 m and 2 m buffers between plots. Overall, leaf tissue N, P and K levels were increased with the applications of the N, P and K fertilizers. Significant main and interactive N, P and K effects on stem density, individual stem dry weight, fruit set, harvestable yield and total anthocyanin content were present with treatments applied in the vegetative phase of production. Despite an increase in stem dry weight with increasing applications of N in the cropping phase of production, no beneficial effects on harvestable yield were present. Results from this study (1) indicate the importance of monitoring plant density and leaf tissue analysis; (2) provide insight into the main and interactive effects of N, P and K on lowbush blueberry growth, yield and composition; and (3) add further support to the characterization of the lowbush blueberry as containing a large nutrient reservoir with stress tolerant capabilities.
Physiology of Ornamental and Floricultural Crops

(13) Effect of Arbuscular Mycorrhizal Fungi and Organic Fertilizer on Photosynthesis, Growth, Nutrient Uptake and Root Phosphatase Activity of Ipomoea carnea subsp. fistulosa

Lucila Amaya-Carpio, Fred T. Davies, Jr.1, Theodore Fox, Andrew Cartmill, Mike A. Arnold, Chuanjiu He
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A greenhouse study was conducted to determine the effect of arbuscular mycorrhizal fungi (AMF) inoculation and organic fertilizer on the physiology, growth, and phosphatase activity of Ipomoea carnea subsp. fistulosa. Uniform, rooted cuttings of I. carnea subsp. fistulosa were grown in 9.6 L containers with a substrate mixture of (1 sandy loam: 1 sand: v:v). The AMF treatment consisted of a commercial isolate of Glomus intraradices (MycorisePro) and a noncolonized (NonAMF) control. Organic fertilizer (Nitrell SN—3P—4K) was applied at 10%, 30% and 100% of the manufacturer’s recommended rate, which were respectively 1.2 kg m⁻³, 3.6 kg m⁻³ and 12 kg m⁻³. AMF enhanced the growth index, height, stem diameter, root, leaf, shoot and total plant dry mass of I. carnea subsp. fistulosa at the different organic fertilizer rates. In addition, AMF increased leaf number, leaf area, leaf area ratio and net photosynthesis. Leaf uptake of N, P, K, Fe, Cu and Zn were higher in AMF plants. Colonization levels of AMF inoculated plants ranged from 27% to 79%. The commercial AMF isolate used in this experiment was effective in enhancing growth and mineral ion uptake even at the 100% organic fertilizer rate. Enzymatic root activity of acid phosphatase (ACP) and alkaline phosphatase (ALP) increased in AMF plants. The correlation between ACP activity and total P uptake in AMF plants was higher than NonAMF plants. A higher correlation between ACP activity and total P uptake in AMF plants was double that at the other sites in October 2003. Extractable soil N in Wisconsin was twice that at the other sites. N uptake was negatively correlated at one location (Wisconsin), with N uptake being 79% higher at the Wisconsin site compared to the other sites. The commercial AMF isolate used in this experiment was effective in enhancing growth and mineral ion uptake even at the 100% organic fertilizer rate. Enzymatic root activity of acid phosphatase (ACP) and alkaline phosphatase (ALP) increased in AMF plants. The correlation between ACP activity and total P uptake in AMF plants was higher than NonAMF plants. A higher correlation between ACP activity and total P uptake in AMF plants was double that at the other sites in October 2003.

(14) Fertility Affects Susceptibility of Chrysanthemum to Cotton Aphids (Aphis gossypii): Influence on Plant Growth, Photosynthesis, Ethylene Evolution and Herbivore Abundance

Fred T. Davies, Jr.1, Chuanjiu He1, Amanda Chair2, Kevin M. Heinz2, Andrew Cartmill1
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This is one of the first reports on the response of chrysanthemum (Dendranthsma grandiflora Tzvelev var. “Charm”) to cotton aphids (Aphis gossypiiGlover) — detailing the influence of fertility on herbivore abundance, plant growth, photosynthesis and ethylene evolution. We tested five fertilization treatments that consisted of 0%, 5%, 10%, 20% and 100% (375 ppm N) of recommended nitrogen levels. Four rooted cuttings per pot were established for four weeks in a growth chamber. Five apterous aphids were subsequently transferred to each pot and monitored weekly for an additional four weeks. Aphids depressed plant vegetative and reproductive growth, and altered carbohydrate partitioning at high fertility. Aphid inoculated (AI) plants at high fertility had increased specific leaf area (SLA), i.e. thinner leaves and greater leaf area than aphid-free (NonAI) plants. Aphids caused greater ethylene production in reproductive buds and young leaves of high fertility plants, but had no effect on ethylene evolution in physiologically mature or older plants. Plant growth, leaf nitrogen (N), phosphorus (P), iron (Fe) and manganese (Mn) increased at higher fertility, as did chlorophyll and photosynthetic rates. Leaf N was highest in young and physiologically mature leaves compared to basal leaves. At increasing fertility, AI plants had lower leaf N than NonAI treatments. The % leaf carbon was unaffected by aphids or fertility. Aphids reduced photosynthesis in young leaves of high fertility plants, where as physiologically mature and older leaves were unaffected. Aphid abundance was greatest at high fertility. A higher proportion of aphids were observed in physiologically mature and older leaves at low fertility, whereas at high fertility young leaves had 33% more aphids than older, basal leaves.

(15) Cuticle Characteristics and Volatile Emissions of Petals in Antirrhinum majus

S. Mark Goodwin1, Natalia Kolosova1, Christine M. Kish1, Karl V. Wood1, Natalia Dudareva1, Matthew A. Jenks1
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Floral volatiles, which are small and generally water-insoluble, must move from their intracellular sites of synthesis through the outermost cuticle membrane before release from the flower surface. To determine whether petal cuticle might influence volatile emissions, we performed the first analysis of petal cuticle development and its association with the emission of flower volatiles using Antirrhinum majus L. (snapdragon) as a model system. Petal cuticular wax amount and composition, cuticle thickness and ultrastructure, and the amounts of internal and emitted methylbenzoate (the major Snapdragon floral scent compound) were examined during 12 days from flower opening to senescence. Normal (n-) alkanes were found to be the major wax class of Snapdragon petals (20.9% and 34.3%) throughout the 12 days examined. Besides n-alkanes, Snapdragon petals possess significant amounts of methyl branched alkanes (23.6% to 27.8%) and a unique class of hydroxy esters (12.0% to 14.0%). These hydroxy esters have not been previously reported in plants, and are represented by a series of six homologues varying in the carbon number of the acid moieties. Changes in amount of methylbenzoate inside the petals followed closely with levels of methylbenzoate emission suggesting that Snapdragon petal cuticle may provide little diffusive resistance to volatile emissions. Moreover, clear associations did not exist between methylbenzoate emission and the cuticle properties examined during development. Nevertheless, the unique wax composition of Snapdragon petal cuticles shows similarities with those of other highly permeable cuticles, suggesting an adaptation that could permit rapid volatile emission by scented flowers.

(16) Cottonwood Growth Rate and Fine Root Condensed Tannin Concentration

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Phenolic compounds can play critical roles in plant-insect interactions and litter decomposition. Despite the wealth of information on phenolic compounds (including condensed tannins) in leaves of many tree species, there is little known about factors influencing root phenolics. We examined the relationship between tree growth rate and fine root condensed tannin concentration in twelve genotypes of eastern cottonwood (Populus deltoides) planted in three sites across the U.S. upper Midwest. Genotype growth rate and root condensed tannin concentration were negatively correlated at one location (Wisconsin), and uncorrelated at the other two locations (Iowa and Michigan). This genotype by environment interaction may be due to higher soil nitrogen availability at the Wisconsin site; extractable soil N in Wisconsin was double that at the other sites in October 2003.
Stress Physiology

(344) An Aeroponics System for Control of Root-zone Oxygen During N₂ Fixation Assays
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The presence and concentration of oxygen in the root zone is critical for the optimal fixation of nitrogen by Frankia bacteria in root nodules of actinorhizal plants. Many researchers culture plants in liquid during acetylene-reduction assays for nitrogen fixation. However, ethylene gas, the product of nitrogenase-reduced acetylene in the acetylene-reduction assay, is soluble in water and may be underestimated when plants are cultured in liquid. Further, liquid cultures may impede oxygen diffusion, thereby confounding efforts to control gas composition around nitrogen-fixing nodules. We have devised an aeroponics system that, combined with an inexpensive gas-dispersal mechanism, facilitates precise control of root-zone oxygen during acetylene-reduction assays in closed systems. Roots of intact plants were held in closed 1-L Mason jars, with one plant per jar and the stem emerging from a sealed hole drilled in the lid. Ultra-fine misting nozzles were connected to a programmable timer to spray roots periodically with nutrient solution. Gases were mixed and delivered by using a system of capillary tubes to make the appropriate gas mixture and control its flow rate. Our system allows manipulation of the concentrations of the root-zone gases delivered to individual plants. This permits randomization of treatments and has allowed us to determine the optimal oxygen concentration for nitrogen fixation across a wide range of O₂. This system eliminates oxygen shock associated with the transfer of plants or nodules to assay conditions, and it is easily modified for use with nitrogenase assays in either open or closed systems.

(345) Both Xanthophyll Cycle-dependent Thermal Disipation and the Antioxidant System are Up-regulated in Grape (Vitis labrusca L. cv. Concord) Leaves in Response to N Limitation
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One-year-old grapevines (Vitis labrusca L. cv. Concord) were supplied with 0, 5, 10, 15, or 20 mM nitrogen (N) in a modified Hoagland’s solution twice weekly for 4 weeks. Effects of N supply on xanthophyll cycle and the antioxidant system in leaves were systematically investigated. As leaf N decreased in response to N limitation, leaf chlorophyll (Chl) decreased linearly whereas leaf absorbance declined curvilinearly. Compared with high N leaves, low N leaves had lower quantum efficiency of PSII as a result of both an increase in thermal energy dissipation, measured as non-photochemical quenching, NPQ, and an increase in closure of PSII reaction center at high photon flux density (PFD). Both the xanthophyll cycle pool size on a Chl basis and the conversion of violaxanthin (V) to antheraxanthin (A) and zeaxanthin (Z) were enhanced in low N leaves under high PFD. NPQ was closely related to A+Z expressed either on a Chl basis or as a percentage of the xanthophyll cycle pool. On a leaf Chl basis, superoxide dismutase (SOD) activity decreased linearly with increasing leaf N content; the activities of catalase (CAT) and glutathione-reductase (GR) increased linearly and ascorbate-peroxidase (APX), monodehydroascorbate reductase (MDAR) and dehydroascorbate reductase (DHAR) decreased rapidly first, then gradually reached a low level. In response to N limitation, the contents of ascorbate (AsA), dehydroascorbate (DAsA), reduced glutathione (GSH), and oxidized glutathione (GSSG), expressed on a Chl basis, increased, whereas the ratios of both AsA to DAsA and GSH to GSSG decreased. It is concluded that in addition to decreasing light absorption, both xanthophyll cycle-dependent thermal energy dissipation and the total antioxidant system are up-regulated to protect low N leaves from photo-oxidative damage under high light.

(346) CO₂ and Light Intensity Effects on Growth and Nutrition of Cacao
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In South America, cacao (Theobroma cacao) is grown under various levels of shade. In recent years concentration of atmospheric levels of CO₂ has risen to ~370 µmol·mol⁻¹, with levels expected to double by the end of 21st century. A temperature-controlled greenhouse experiment was undertaken to assess the influence of CO₂ and photosynthetic photon flux density (PPFD) on the shoot and root growth and nutrient concentrations of cacao in its early growth stages. Two greenhouses were used to maintain two levels of CO₂ (380 and 700 µmol·mol⁻¹). In each greenhouse, three levels of PPFD, (65, 190, 1050 µmol·m⁻²·s⁻¹) of average light intensity were achieved by constructing mini shade frames covered with various layers of plastic shade cloth. Plants were grown for 57 days. Increasing CO₂ increased shoot parameters (dry wt. of stem and leaves, height, leaf area) and root wt. At both CO₂ levels, increasing PPFD from 65 to 190 µmol·m⁻²·s⁻¹ increased growth parameters. PPFD of 1050 µmol·m⁻²·s⁻¹ was detrimental to growth at both levels of CO₂, however its effects were more severe at 380 µmol·mol⁻¹ of CO₂. At 380 µmol·mol⁻¹ of CO₂, increasing PPFD increased concentrations of Al, K, Mg, Fe and Mn, decreased concentrations of N, Ca, Na and S and had no effect on concentrations of P, B and Cu. At 700 µmol·mol⁻¹ of CO₂; increasing PPFD increased concentrations of Al, N, K, Ca, Mg, B, Cu and Mn, decreased concentrations of Na and S, and had no effect on P concentration. Data from this experiment indicates that light intensity of 190 µmol·m⁻²·s⁻¹ is desirable and increasing levels of CO₂ are beneficial to improve cacao growth.

(347) Drought Assessment and Management in Wild Blueberry Production
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An experiment assessing the impact of water availability on photochemistry and leaf gas exchange of the wild blueberry (Vaccinium angustifolium Ait.) was conducted at the Nova Scotia Wild Blueberry Institute (NSWBI), during the 2002 growing season. A randomized complete block design consisting of four treatments with five blocks was used with a plot size of 6 x 8 m. Treatments used consisted of: (1) control (naturally fed rainfall), (2) irrigation (2.5 cm per week), (3) irrigation corresponding to the water usage of the blueberry, and (4) drought stress (water exclusion). Diurnal measurements of leaf fluorescence, leaf gas exchange, stem water potential, and soil moisture were collected on July 12, August 1, and August 29. The drought stress treatment lowered the soil moisture and decreased the stem water potential. However, this did not result in a significant treatment effect on leaf photochemistry and gas exchange. The quantum efficiency of PSII in a light adapted state increased on August 29 and this corresponded with significantly higher Pn rates. Therefore, results from this preliminary investigation indicate that the photochemistry of the wild blueberry is very resilient to drought.

(348) Drought Tolerance Determined for Bigtooth Maples Indigenous to the Southwest
Emad Bsoul*, Rolston St. Hilaire

It is concluded that in addition to decreasing light absorption, both xanthophyll cycle-dependent thermal energy dissipation and the total antioxidant system are up-regulated to protect low N leaves from photo-oxidative damage under high light.
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Several ecological traits of bigtooth maple (Acer grandidentatum Nutt.) suggest that the plant has the potential for widespread use in managed landscapes. But the tolerance of bigtooth maples to environmental stress remains largely unknown. We studied plant development of fifteen sources of bigtooth maples indigenous to Arizona, New Mexico, Texas, and Utah. Plants were grown in a greenhouse in New Mexico. Plants were maintained as well-irrigated controls or exposed to drought and irrigated based on evapotranspiration. After 132 days of drought treatment, lamina surface area of plants was different between irrigation treatments but not among plant sources. Half siblings from a tree native the Guadalupe Mountains in Texas (designated as GM3), had the greatest xylem diameter and plant height regardless of irrigation treatment. Plants from GM3 had the highest net assimilation rate (NAR) in both irrigated (0.38 mg·cm⁻² per day), and drought-stressed plants (0.13 mg·cm⁻² per day). Among all plants, half siblings from GM3 had the highest relative growth rate (RGR) (0.027 g·g⁻¹ per day) and shoot dry weight (24.74 g). Drought-stressed plants from a West-facing slope in the Logan canyon of Utah had the lowest RGR (0.0061 g·g⁻¹ per day). Drought-stressed plants from a North-facing slope in the Logan canyon of Utah had the lowest shoot dry weight (2.03 g). Based on these growth characteristics, we conclude that half siblings from the tree designated as GM3, might warrant use in landscapes that are exposed to drought.

(349) Effects of Heat and Drought on Photosynthesis, Water Relations, and Soluble Carbohydrates of Two Ecotypes of Redbud (Cercis canadensis) Jason Griffin*1, Thomas Ranney2, Mason Pharr3
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Net photosynthesis (PN) of two ecotypes of redbud (Cercis canadensis L.) was studied following growth under high temperatures and increasing drought. Although mexican redbud (C. canadensis var. mexicana (Rose) M. Hopkins) exhibited greater PN than eastern redbud (C. canadensis var. canadensis), PN decreased at a similar rate under water deficit stress for both ecotypes. Mexican redbud also had greater instantaneous water use efficiency (WUE) than eastern redbud. Differences in both PN and WUE may have been due to differences in leaf thickness, which was approximately 30% greater in the mexican redbud. The optimum temperature for potential photosynthetic capacity (37 °C) was unaffected by irrigation or ecotype. Tissue osmotic potential at full turgor was more negative in eastern redbud, but was unaffected by drought stress in either ecotype. Soluble carbohydrate content was higher in eastern redbud, and in both ecotypes, D-pinitol was the major soluble carbohydrate and was considerably more abundant in the water-stressed plants. Total polyol content (myo-inositol + ononitol + pinitol) was also greater in the water-stressed plants. Both ecotypes were very tolerant of high temperatures and drought.

(350) Environmental Regulation and Tissue Localization of 25 kD Dehydrin in Relation with Cold Hardiness in Rhododendron Calin O. Marian1, Atilla Eris2, Stephen L. Krebs3, Rajeev Avora4
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The influence of day-length and temperature on the accumulation of 25 kDa dehydrin and cold acclimation in Rhododendron cv. "Chionoides" was studied by growing four groups of plants under different photoperiod and temperature regimes. Combination of short days/low temperature induced the greatest cold hardiness and 25 kDa accumulation, while exposure to long days and relatively high temperatures failed to induce any significant cold tolerance in leaves. Shortening day-length is sufficient to trigger both the first stage of cold acclimation and 25 kDa dehydrin induction, however, low temperatures prevalent later in the Fall and winter caused more pronounced increase in both hardiness and dehydrin accumulation. Data indicated that the water content of plant leaves maintained under natural photoperiod was lower than that of plants grown under extended photoperiod, regardless of the temperature regime. It is hypothesized, therefore, that early 25 kDa dehydrin accumulation may be due to short-day-induced cellular dehydration. This dehydrin is also induced by water stress, while the exogenous abscisic acid (ABA) application failed to trigger its accumulation. Tissue localization studies show that the 25 kDa dehydrin accumulates more in the leaf lamina than in the midrib: its lower accumulation in the midrib is paralleled by a higher incidence of freeze injury in midrib vs. lamina tissues of Rhododendron leaves.

(351) Evaluation of Various Irrigation Regimes on the Growth and Maintenance of Coleus in the Landscape Sioane Scheiber*, Richard Bescos, Jianjun Chen, Qibing Wang

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Solenostemon scutellarioides were grown in drainage lysimeters to evaluate growth responses and aesthetic quality of annual bedding plants in relation to different irrigation regimes. Drainage lysimeters (250L) were backfilled with native field soil to simulate landscape conditions. Each lysimeter was managed with Best Management Practices with the exception of irrigation regime. Following establishment, lysimeters were irrigated at one of three rates: 1.3 cm daily, 1.3 cm every other day, and 1.9 cm every 3rd day. Leachate was collected daily and total volume was recorded. Irrigation volumes and climatic data were also recorded. Canopy growth indices, leaf gas exchange, and root:shoot ratios were evaluated relative to irrigation regimes. Measurements of leaf gas exchange were repeated over time with a significant interaction (α < 0.05) between irrigation regime and date found. Assimilation rates, stomatal conductance, and transpiration rates generally decreased as time increased from irrigation date. Daily irrigation resulted in the highest assimilation rates; however, no significant differences were found among treatments for final biomass. No significant differences were found in leachate volumes among treatments.

(352) Evapotranspiration and Crop Coefficients Determined for In-Ground Container Plants of Mexican Elder Cathleen Feser*, Rolston St. Hilaire
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Mexican elder (Sambucus mexicana Presl.) has an extensive presence in landscapes of the southwest United States, but water use of this tree is unknown. Five Mexican elder trees were potted into 76L pot-in-pot containers, irrigated every 48 h, and weighed every 24 h for 88 d to calculate evapotranspiration (ET). Crop coefficients (Kc) were calculated by dividing crop evapotranspiration (ETc) by reference evapotranspiration (ET0). Kc = ETc / ET0. Monthly (21 Feb., 2002 to 20 May, 2002), and seasonal water use and crop coefficients were determined. Seasons were defined as late winter (21 Feb. to 21 Mar.), early spring (22 Mar. to 21 Apr.), and late spring (22 Apr. to May 20). Monthly water use averaged 12% higher in March than in April, and 42% lower in March than May. Water use in May (3967 g) averaged 44% higher than the average for April (2225 g). Seasonal
Three cultivars of sweet potato (Ipomoea batatas L.) from the local farms of Jamaica were propagated in vitro. Axillary bud cultures of these cultivars Martha, Cocupip and Facey were used to study the effects of salt stress on their morphology and physiology. Dried sea salt was used for obtaining various salt concentrations ranging from the 0 [control] to 10 g L\(^{-1}\). After 8 weeks of growth, plantlet shoot height, number of nodes, levels of proline, soluble carbohydrate, protein, sodium and potassium were measured. Nitrate reductase activity in shoot and root were also measured. Generally, the lowest salt concentration (1.0 g L\(^{-1}\)) was slightly beneficial to the growth but higher concentrations resulted in stunted growth, brittle leaves and decreased nodes in all the cultivars. Proline content increased in the shoot but not in roots, though the level of increase varied in different cultivars. Both soluble carbohydrate and protein contents decreased in all the cultivars in both shoot and roots suggesting that proline was synthesized at the expense of soluble carbohydrate and protein. Sodium and potassium levels show different trends in roots and shoots. Nitrate reductase activity increased in the roots while it decreased in the shoots of all the cultivars. Lower carbohydrate and protein levels coupled with increased nitrate reductase activity suggest an increased metabolic pressure on the root system, resulting in poor growth of the plantlets due to salt stress.

(354) Interaction of CO\(_2\) and High Temperature on Growth, Photosynthesis, Tissue Nutrient Concentration, Yield and Fruitset in Tomato

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Treatments applied to the greenhouse tomato cultivar Clairea in 4 controlled environment chambers in the North Carolina State University Phytootron consisted of 26/22 or 30/26 °C day/night temperatures under 1000 L·L\(^{-1}\) or ambient CO\(_2\). Elevated CO\(_2\) increased carbon exchange rate (CER) by 30% and specific leaf mass (SLM) by 67% and reduced stomatal conductance by 20% compared to ambient CO\(_2\). Temperature regime had no effect on CER, SLR or conductance. Leaves of plants growing at elevated CO\(_2\) had significantly lower nitrogen concentration than those at ambient CO\(_2\) levels, but higher temperature regime significantly increased N concentration at both CO\(_2\) levels. CO\(_2\) enrichment significantly reduced the concentrations of N, P, and K, increased that of Ca, and had no effect on Mg. Higher temperature regime, on the other hand, enhanced the concentration of N and P but reduced the concentrations of Ca and Mg in all the plant parts. Concentrations of K were reduced only in leaves and stem, however. Plants raised under high CO\(_2\) concentration showed a significant increase (20%) in dry matter yield compared to ambient CO\(_2\), in both temperature treatments. Fruit yield was 30% higher with CO\(_2\) enrichment in the low temperature regime. Total dry matter per plant was significantly reduced at the higher temperature regime at both CO\(_2\) levels. No fruit set occurred at high temperature under either CO\(_2\) regime, although the number of flower clusters and total flower number increased under high temperature at both CO\(_2\) levels.

(355) Manzano Olive Fruit Set as Influenced by the Source of Pollen in a Desertic Condition

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‘Manzano’ olive trees grown under arid environments, conditions prevailing at the Caborca region, shows a low and erratic fruit set, being reflected in attaining low yields; these conditions affect the profitability of this crop in the region and another zones with similar conditions. One of the main reasons that influence the low fruit set is high temperature, affecting the pollination process. Thus, we carried out a field study with the objective to determine the magnitude of the influence of different sources of pollen on the ‘Manzano’ fruit set. The experiment was established in a 14-year-old olive ‘Manzano’ orchard, surface-irrigated; the study consisted in a hand application of different sources of pollen to shoots previously covered with a cloth bag. The shoots were previously selected and tagged around the trees, before blooming started. The sources of pollen used were Gordal Sevillana (Sevillano), Mission, Barouni and Manzano (self-pollination) used as the Control plot; the pollen was applied at full bloom. All the selected shoots showed a similar number of inflorescences and flowers. Barouni and Sevillano showed the highest fruit set values, with 2.23 and 1.87%, respectively; the lowest fruit set value was obtained when using Mission as a pollen donor with 0.55%. This value was almost 50% lower than the fruit set obtained with the Manzano self-pollinated. According with other studies the low fruit set value attained when using Mission as the source of pollen is due to incompatibility problems. Thus, based on this and another studies the use of Mission as a source of pollen is not recommended given the problems mentioned above; on the other hand, under our conditions, the use of Barouni or Sevillano pollen is recommended as good sources of pollen for improving fruit set in Manzano olive trees. It is important continue evaluating these and another sources of pollen as potentials for using them with artificial pollination or as established polinizers in ‘Manzano’ olive orchards.

(356) Olive Fruit Growth and Quality as Affected by Regulated Deficit Irrigation

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Water constraints are limiting the cultivated area with different crops at this region, and olive trees are not the exception. Olive is considered a water-stress tolerant fruit tree, and is a good crop option for Mediterranean climate region, however, for more extreme climate conditions prevailing at the Caborca region, shows a low and erratic fruit set. One of the main reasons that influence the low fruit set is high temperature, affecting the pollination process. Thus, we carried out a field study with the objective to determine the magnitude of the influence of different sources of pollen on the ‘Manzano’ fruit set. The experiment was established in a 14-year-old olive ‘Manzano’ orchard, surface-irrigated; the study consisted in a hand application of different sources of pollen to shoots previously covered with a cloth bag. The shoots were previously selected and tagged around the trees, before blooming started. The sources of pollen used were Gordal Sevillana (Sevillano), Mission, Barouni and Manzano (self-pollination) used as the Control plot; the pollen was applied at full bloom. All the selected shoots showed a similar number of inflorescences and flowers. Barouni and Sevillano showed the highest fruit set values, with 2.23 and 1.87%, respectively; the lowest fruit set value was obtained when using Mission as a pollen donor with 0.55%. This value was almost 50% lower than the fruit set obtained with the Manzano self-pollinated. According with other studies the low fruit set value attained when using Mission as the source of pollen is due to incompatibility problems. Thus, based on this and another studies the use of Mission as a source of pollen is not recommended given the problems mentioned above; on the other hand, under our conditions, the use of Barouni or Sevillano pollen is recommended as good sources of pollen for improving fruit set in Manzano olive trees. It is important continue evaluating these and another sources of pollen as potentials for using them with artificial pollination or as established pollinizers in ‘Manzano’ olive orchards.
differences between treatments. These results, apparently shows that the application of the regulated deficit irrigation at this fruit growth stage, has not an important influence on the final size and weight of the olive fruit, and it is a great opportunity to save water.

(357) Photosynthetic Activity of Vitis vinifera and Vitis Labrusca as Affected by High Temperature
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Evaluation of photosynthesis rate and growth of intact leaves of five wine grapes were conducted. One-year-old vines of four French (Vitis vinifera) wine grapes of Cabernet Sauvignon, Chardonnay, Pinot Noir, Semillon and one American (Vitis labrusca) Cynthiana were placed into controlled environment chambers set at 20/15, 30/25, and 40/35 °C day/night temperatures and 85% to 90% relative humid- ity for four weeks. Pots were watered daily to prevent water stress. Photosynthesis rate, chlorophyll content, and chlorophyll fluorescence were measured weekly. Shoot and root growth were measured after four weeks. Induced (F0), variable (Fv), maximum (Fm) fluorescence, and the photochemical efficiency (Fv/Fm) of all grape cultivars were similar at 20/15 and 30/25 °C. However at 40/35 °C, F0 increased whereas Fm, Fv, and Fv/Fm decreased with the most severe changes in Cynthiana and Cabernet Sauvignon and the least changes in Semillon and Pinot Noir. Photosynthesis rate, stomata conductivity, chlorophyll content, and shoot and root growth showed similar response pattern to temperatures as in chlorophyll fluorescence.

(358) Production of Transgenic Cucumber Plants Over-expressing the Arabidopsis thaliana Transcriptional Factor CBF Show Enhanced tolerance to Salinity
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Crop productivity throughout the world is limited by drought and salinity stress. We sought to engineer increased salt tolerance in cucumber (Cucumis sativus L.) by introducing the Arabidopsis thaliana transcriptional activator CRT/DRE binding factor 1 and 3 (CBF1 and CBF3) genes. The CBF transcription factors play an essential role in activating genes involved in plant adaptation to dehydration-related stress conditions such as freezing temperature, salinity, or drought. Gene incorporation and transfer to the next generation was verified using ELISA and PCR for 6 CBF1 families and 4 CBF3 families; gene expression was verified in T0 and T2 plants by Northern blot analysis. The transgenic CBF plants showed elevated proline (5-7 fold) and sugar content (2-3 fold) under non-salt stress and salt-stressed conditions relative to control plants (parental plants and non-transgenic segregants). Growth of the transgenic and non-transgenic plants under non-stressed conditions was equivalent as measured by fresh weight, dry weight and number of leaves. However, when subjected to salt stress, transgenic families showed significantly less inhibition of growth; 9% to 38% reduction at 100 mM NaCl (average 26% reduction) relative to 55% to 63% reduction for non-transgenic plants. The accumulation of soluble sugars and proline was directly correlated with the tolerance to salt stress in transgenic plants as measured by accumulation of dry weight. These results show that the CBF-expressing cucumber plants showed elevated resistance to salt conditions in controlled greenhouse trials. Field experiments will be performed this summer to test the ability of CBF-expressing cucumbers to withstand salt and drought stress under semi-arid conditions.

(359) Prohexadione-Ca Modifies Growth and Increases Photosynthesis in Strawberry Nursery Plants
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Prohexadione-Ca (Pro-Ca), a new reduced-risk gibberellin (GA) biosynthesis inhibitor, has been used for vegetative growth control in pome and stone fruits. Our previous work has identified its potential for height control in strawberry transplants, a use that could lead to improved plant establishment and earlier fruiting in annual hill plasticulture. A better understanding of the effect of Pro-Ca on the physiology and development of strawberry nursery plants is necessary to design appropriate treatments. Pro-Ca was applied to ‘Camarosa’ and ‘Sweet Charlie’ strawberry plants at a concentration of 62.5 µL·L⁻¹ to determine the effects on dry weight allocation and growth over 42 days. In a parallel experiment changes in net photosynthesis due to Pro-Ca application were measured in plants grown in either growth chambers or in the field. Pro-Ca reduced plant height, leaf area and specific leaf area (SLA). By the end of the experiment there were no differences in total dry weight of ‘Camarosa’ plants. Treated ‘Sweet Charlie’ plants, however, had greater mean dry weight than the controls. Treated plants of both cultivars consistently allocated more dry weight to roots, and proportionally less to shoots. Net photosynthesis was enhanced by Pro-Ca in growth chamber experiments and in the field, but the effects were more pronounced in the field. The increase in net photosynthesis may be related to changes in SLA and a greater concentration of chlorophyll per unit leaf area, or to un-investigated changes in respiration, diffusion resistance or carboxylation efficiency. The magnitude of the effect seems to be related to light intensity and persists for weeks after application of the growth regulator. Changes in morphological (root: shoot ratio) and physiological (net photosynthesis) traits in Pro-Ca treated plants may aid their establishment in annual hill systems and lead to increased earliness and/or yield.

(360) Response of Matthiola incana to Saline Wastewaters
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To explore the possibility that saline wastewater may be used to grow high value floriculture crops, the effects of salinity were tested on Matthiola incana (L.) R. Br. Two cultivars of stock (‘Cheerful White’, ‘Frolic Purple’) were planted in 30 greenhouse sand tanks in Riverside, California and irrigated initially with complete nutrient solution. Three weeks after planting, saline treatments were imposed with solutions differing in ion composition: 15 tanks were irrigated with waters typical of agricultural wastewaters present in the San Joaquin Valley (SJV) and 15 tanks were irrigated with waters compositions found in saline tailwaters in the Imperial/Couachella Valleys (ICV). Five treatments of each salinity type were used with electrical conductivities of 2.5, 5, 8, 11, 14 dS·m⁻¹. Stem length of both cultivars was reduced from 86 to 65 cm as salinity increased from 2.5 to 14 dS·m⁻¹; however reduction was not significant until salinity reached 8 dS·m⁻¹. Stem length was not significantly affected by ion composition of the irrigation waters. Stem weight of both cultivars irrigated with ICV waters was unaffected by salinity up to 8 dS·m⁻¹, whereas in response to SJV waters, decreases in stem weight were observed only at higher salt levels. Mineral composition of the vegetative tissues generally reflected ion concentration in the irrigation waters in that shoot-Mg and-Cl were higher and shoot-Na and sulphate decreased in plants irrigated with ICV waters than with SJV waters. This study illustrates that, with improved management practices, selected cut flower species may be economically produced under irrigation with low to moderately saline wastewaters.

(361) Seedling Traits of Bigtooth Maples Indigenous to the Southwestern United States
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We examined traits of seedlings of bigtooth maples (Acer grandidentatum Nutt.) that might represent adaptations to drought. Seeds were collected from 26 trees in Utah, New Mexico and Texas. Seeds were stratified for 16 weeks in moist sphagnum moss held at 4 °C. Seedlings were grown in a greenhouse at New Mexico State University for eight months. Lamina surface area of plants originating from a north-facing slope in Utah was among the smallest and averaged 7.6 cm². Abaxial leaf surfaces of plants from a tree in the Guadalupe Mountains in Texas were the most pubescent and averaged 547 trichomes per cm². Another tree originating from the Guadalupe Mountains had the highest number of stomates (561 stomates/mm²) on abaxial leaf surfaces. Leaves from trees indigenous to Utah and New Mexico had among the highest mean specific leaf weight (dry weight of a 1 cm² leaf disc divided by area). However, further studies are needed to determine whether the high specific leaf weight of plants in Utah and New Mexico is due to cell density or other factors such as chloroplast density. We conclude that pubescence and high stomatal frequency on the leaves of plants native to the Guadalupe Mountains could mitigate the effects of drought.

Temperature Fluctuation in Fraxinus pennsylvanica Var. Subintegerrima and its Surrounding Environment

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Temperature fluctuation (TF) in an 18-year-old Fraxinus pennsylvanica var. Subintegerrima and its surrounding environment was monitored every 15 minutes in 2002 and 2003 at the Morton Arboretum, Lisle, Illinois. HoboPro temperature (T) sensors were inserted in different locations: canopy, east, west, north and south side of the trunk, inside the trunk, inside the root, soil (6" under the mulch), soil (12"), sod (2"), 18" inch above the sod, mulch (3"), 6" above the mulch and 2" above the mulch (for snow or base of trunk T). There were significant differences between TF in 2002 and 2003 (severe record breaking cold T). The south side of the trunk had the highest TF followed primarily by the west side, and occasional peaks in the east. Root, soil and sod had uniform TF vs. mulch, canopy and base of the trunk. The inside of the trunk TF was lower compared to the canopy. The stem and bud water content, stem water potential and time of the bud break in relation to TF will be reported.

The Effects of Irrigation and Mulch on the Cold Hardiness of Leyland Cypress
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Cultural practices have been shown to influence the onset and maintenance of cold hardiness of various woody landscape plants in the fall and winter. Two watering regimes (no irrigation and irrigation one hour a day on Mondays, Wednesdays, and Fridays) and four mulching regimes (no mulch, pine bark mulch, perma-mulch circles, and plastic strips) were evaluated on Leyland cypress plants established in the landscape. Laboratory cold hardiness estimates were measured monthly, from October through April over three years. Our data indicate that there were no significant differences in the acclimation or maintenance of cold hardiness on any of the sample dates during the three years of the study. The plants attained a cold hardness of ~8 °C in October. They reached their maximum cold hardness in January (~21 °C) and by April lost most of their cold hardness (~9 °C). These results indicate that the irrigation and/or mulch regimes have little effect on the establishment and maintenance of cold hardiness in Leyland cypress in the landscape.

The Role of Desaturases in Wounding Stress in Peach
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Plants react to wounding stress activating the octadecanoic pathway in which linolenic acid (18:3) is converted to jasmonic acid, a putative hormone considered to be involved in the activation of defense genes. Omega-3 desaturases allow the insaturation of dienoic fatty acids to trienoic, in particular they enhance the concentration of linolenic acid. We investigated the role of plastidial omega-3 desaturases in the activation of defense mechanisms in peach (Prunus persica), with specific focus on the rapidity of plant answers. Northern blots hybridized with the isolated clone of peach plastidial desaturase show that the level of the transcript starts to decrease as early as 1 minute after the cut; 15 minutes later however, the expression of the enzyme starts to increase, until it doubles its intensity one hour later. Peach trees detect wounding, and are able to react to this stress by rapid changes in expression level of 3 desaturase, thus confirming the central role of this enzyme in the defense pathway activation.

The Transgenic Tomato (Lycopersicon Esculentum) that Overexpresses SOD or APX Exhibits Enhanced Tolerance to Flooding Stress
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The potential role of cytosolic ascorbate peroxidase (APX) and manganese superoxide dismutase (SOD) in the protection against flooding stress was examined using transgenic tomato plants. Transformants were selected by using Kanamycin resistance and confirmed by PCR, Southern and Northern analysis. After exposure of seedlings to flooding for 5 weeks, the transformants showed better growth performance than the untransformed controls. The height, shoot fresh weight, shoot dry weight, root fresh weight and root dry weight of transgenic plants under flooding stress were significantly greater than that of the wild type plants under flooding stress. The total leaf APX or SOD activity in the transgenic plant was several folds greater than that of the wild type control. In conclusion the transgenic tomato that over expresses SOD or APX levels performed better than the wild type plants under flooding stress.
(367) Drought Tolerance of Mexican Elder Grown in an Arid Environment
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We studied drought responses of Mexican elder (Sambucus mexicana Presl.). Ten Mexican elder trees were potted into 76L pot-in-pot system containers and assigned as control (irrigated every 24 h) or drought. Plants subjected to drought were irrigated in five cycles. When initial pot weight decreased by 30% due to evapotranspiration, the cycle was terminated. Drought cycle length ranged from 11 to 28 days. Differences in predawn water potentials between the two groups decreased from 38% in the second cycle to 6% in the fifth drought cycle. In all cycles, droughted plants had higher midday water potentials. Variable fluorescence was lower in the drought plants until the fifth drought cycle, when variable fluorescence in drought plants (0.76) approached that reported for healthy tissues (0.8). Variable fluorescence is an indicator of maximum quantum efficiency, and averaged 0.7 in plants irrigated every 24 h. Stomatal conductance, percentage transpiration in the fourth and fifth drought cycles was 2% and 21% higher, respectively, for the drought plants. Droughts also had higher transpiration rates than controls in the fifth drought cycle. Leaf area to dry root weight ratio was higher in controls and relative water content was similar between treatment groups. Neither net assimilation rate nor relative growth rate were different among treatment groups, suggesting that drought treatments did not impact carbon assimilation. For plants subjected to drought, the lowering of predawn water potential, and the increase in gas exchange and maximum quantum efficiency indicate that these plants may have developed the capacity maintain physiological functions after five cycles of drought.

(368) Seasonal Cold Hardiness and Seed Dormancy Evaluation of Ulmus parvifolia Jacq. in Northern Latitude
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“Lace-bark” elm (Ulmus parvifolia Jacq.) has extensive distribution in China. Mottled reddish “lace-bark” trunk is a distinctive feature of this tree. The high resistance of this elm to Dutch elm disease and other elm problems makes it an excellent tree for urban landscapes. These elms grow satisfactorily in northern Illinois, but are not sufficient to meet urban demands. These experiments were conducted to determine the effects of defoliation, dormancy, and weather on resistance of Ulmus parvifolia Jacq. groups from different provenances in China at The Morton Arboretum, Lisle, Illinois, for stem cold hardiness and dormancy in October 1999, January and March 2000. There were significant differences between these groups for acclimation and deacclimation associated with their provenance origin. Chilling requirements for seed germination were determined. Response of seeds to freezing temperature were determined. Response of seeds to freezing temperature associated with their provenance origin. Chilling requirements for seed differences between these groups for acclimation and deacclimation

(369) Heat Tolerance of Seven Summer-flowering Chrysanthemum Cultivars
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Heat tolerance of seven summer-flowering chrysanthemum cultivars was compared under natural conditions. Physiological indices, i.e., stomatal density and opening, conductivity, soluble protein content, and chlorophyll content under heat stress were measured and the relationship between these indices was analyzed. Heat resistance depended on the stomatal density and relative aperture size. Relative conductivity and its peaking time were also closely related to heat resistance. Soluble protein content and chlorophyll content of heat-tolerant cultivars under heat stress were higher than those of heat-intolerant cultivars. Cultivar difference in soluble protein content showed a similar pattern as cultivar difference in chlorophyll content. Cultivar Bai Aisheng was the most heat-tolerant, followed by ‘Qi Yuehong’, ‘Jin Lian’ and ‘Lu Hua 19’. Cultivars Ai Hong, Zhan Huang, and Yao Hong were intolerant.

(106) Impact of Deficit Irrigation and Environment on Lycopene and Quality of Watermelon
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Irrigation efficiency is becoming more important for production and quality of watermelon [Citrus lanatus (Thunb.) Matsum & Nakai] in southern regions of the U.S. This experiment was conducted to determine the effects of deficit irrigation and environment on lycopene content, quality, and yield of diploid and triploid watermelons. Irrigation rates were 1.0 evapotranspiration (ET), 0.75 ET and 0.5 ET. Diploid cvs. were ‘Summer Flavor 710’ and ‘Summer Flavor 800’, and triploid cvs. were ‘Summer Sweet 524’ and ‘Super Seedless 718’. The experiments were conducted in three Texas locations: Uvalde, Weslaco, and Lubbock. All experiments used similar cultural strategies (plant spacing, subsurface drip, black plastic mulch, and containerized transplants), except for transplanting and harvesting dates. Deficit irrigation reduced total marketable yield by about 30% in Uvalde and Lubbock, and it increased the yield of small fruits (<5 kg). Individual fruit size was more variable for diploid than triploid at 0.75 ET and 0.50 ET. Soluble solid content (SSC) was lower at 1.0 ET rate for triploids, but not diploids. Generally deficit irrigation did not decrease SSC, and significantly increased flesh firmness in triploids compared to diploids. Fruit lycopene content increased with maturity at all irrigation rates and cultivars. This work across three diverse Texas locations demonstrated that deficit irrigation directly reduced yield, but had less effect on lycopene development and fruit quality of triploid watermelon.

(107) Watermelon Fruit Potassium and Lycopene Content in Response to Increased Potassium Fertility
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Watermelon contains lycopene, a carotenoid pigment with strong antioxidant properties. Watermelon also provides about 330 mg potassium (K) per 280 g (2 cup) serving. Nutrition labels for produce can be used for individual vitamins and minerals if the amount per serving is equal to or greater than 10% of the recommended daily intake for that nutrient. Watermelon falls just short of the 350 mg potassium needed for this claim, at 336 mg per serving. Values for potassium content of watermelon have varied by 20% over the years they were tested for the USDA compositional database, indicating that cultivar and cultural practices may slightly affect mineral composition of the fruit. Additional studies on increased potassium fertility of horticultural crops have shown that color and pH could be affected. We conducted an experiment to determine if variable rates of applied K fertilizer would increase the potassium and lycopene content of watermelon fruit. ‘Sangria’ watermelons were planted in a sandy loam soil amended preplant with K at 68, 140, 280 (recommended rate), 560, and 840 kg/ha using KCl as the source. Treatments were incorporated into plots 3 m wide by 9.8 m long. One row, with plants 3 m apart,
was positioned in the center of each plot. Fruit yields peaked at 280 kg/ha K. Melon diameter and pH of flesh decreased inversely with fertilizer K level. Conversely, rind thickness increased with fertilizer K. The K content of the watermelon flesh increased slightly (14%) between 34 and 280 kg/ha treatments, but lycopene content did not increase. These results indicate that field application of potassium can affect the quality and phytonutrient content of watermelon.

(108) Watermelon Lycopene Degrades after Low Temperature Storage
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Lycopene, a carotenoid pigment that imparts the red color to red-fleshed watermelons, has antioxidant properties and a high dietary lycopene intake is associated with a reduced incidence of some cancers. Watermelons are chilling sensitive, developing rind pitting, brown staining, and loss of internal color when whole fruit are held for more than 7 days below 7 °C. Conversely, flesh color has been reported to become more red in melons held above 20 °C. This experiment was done to determine if lycopene content was correlated to a loss or gain in flesh color. Ten to 20 watermelons each of the cultivars ‘Black Diamond’ (light red, seeded heirloom), ‘Summer Flavor 800’ (bright red, seeded hybrid), and ‘Sugar Shack’ (bright red, seedless tripod) were obtained from local growers and stored for 0 and 12–14 days at 5, 13, and 21 °C. Melons were rated for symptoms of chilling injury and internal flesh color (L*, a*, b*, hue, chroma) was measured by Minolta CR200. Soluble solids content (SSC), pH, and lycopene content were determined on 40 g of pureed sample. The average lycopene contents were 34, 57, and 58 μg/g for ‘Black Diamond’, ‘Summer Flavor 800’, and ‘Sugar Shack’ melons, respectively. The lycopene content of all melons stored at 13 °C was similar to that of fresh melons. Lycopene content was 12% to 24% lower in melons held at 5 °C and 12% to 24% higher in those held at 21 °C, compared to fresh watermelons. Puree pH increased with increasing storage temperature while SSC showed no consistent change with storage. Color, as a* values, best paralleled lycopene content. Color was less red and lycopene content was lower in watermelons held at 5 °C, and higher in those held at 21 °C, and the degree of loss was similar for all types of melons. These results indicate that lycopene content in stored uncult watermelons can be significantly affected by storage temperature.

(109) Germplasm and Environmental Influence on Antioxidants in Raspberries
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There is much interest in the antioxidant properties of fruits and vegetables, especially those in small fruits, which appear to have numerous health benefits. Medical studies with raspberries indicate that some types (colors and species) and cultivars may be more effective than others for treatment of chronic conditions such as cancers and heart disease. In blueberries, genotype and environmental effects have been shown to play a large role in the antioxidant content, but these effects on raspberries are unknown. Raspberry selections consisting of four purple, five black, seven yellow, eight species, and 74 red types were harvested from Washington and New York over the 2002 harvest season. Eleven selections were harvested at both locations. Total phenolic and anthocyanin contents were measured by Folin-Ciocalteau and pH differential methods to determine the effects of germplasm on raspberry response to environment. Values for total phenolic content ranged from 88 to 250 mg gallic acid equivalents/100g fresh weight, and were usually highest in black and purple raspberries. Total anthocyanin content ranged from 0.8 to 450 mg cyanidin-3-glucoside/100 g, with the most anthocyanin found in black types and least found in yellow raspberries. Total soluble solids content ranged from 8 to 17%. Selections harvested in New York were generally higher in total phenolics and anthocyanins than their Washington counterparts.

(110) Effect of Carbon Dioxide Enrichment Conditions on the Level of Antioxidant Compounds and Antioxidant Activities in Field-grown Strawberries
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Growing strawberry plants under carbon dioxide enrichment conditions increased antioxidant capacity and flavonoid concentration in strawberry fruit (Fragaria ×ananassa Duch.). High anthocyanins and phenolics such as p-coumaroylglycerol, dihydrodavolanol, quercetin 3-glucoside, quercetin 3-glucuronide, kaempferol 3-glucoside, cyanidin 3-glucoside, pelargonidin 3-glucoside, and pelargonidin 3-glucoside-succinate were also found in fruit of carbon dioxide treated plants.

(111) Preservation of Fresh-cut Apple Slices Using GRAS Substances
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A calcium ascorbate wash treatment is commercially used for the prevention of browning on fresh-cut apple slices but has little to no antibacterial activity against spoilage or foodborne pathogens. The possible alternative use of isosorbic and propionic acid, calcium, and N-acetyl-L-cysteine solutions at pH 3.0 were studied for instrumental and sensory quality retention as a function of storage time as compared with similar products treated with calcium ascorbate. The antibacterial activity of the wash solutions was also compared. The commercial and experimental wash treatments similarly maintained instrumental surface color, firmness, and quality-associated volatile levels during 3 weeks storage at 5 °C in air. The concentration of compounds in the experimental solutions was adjusted to prevent browning without compromising consumer sensory scores for flavor, texture, and overall acceptability. Prior to their use on apple slices, the experimental wash solutions reduced survival of Escherichia coli O157:H7, Listeria monocytogenes, Shigella flexneri, Salmonella serovar Typhimurium, and Vibrio cholerae, whereas the commercial wash treatment had antibacterial activity only against V. cholerae. Antibacterial activity was inversely related to pH of wash solutions. During increasing exposure to apple slices, the experimental wash solutions rapidly lost their antibacterial activity. The results indicate that the experimental wash treatments are a promising alternative to calcium ascorbate for quality retention of fresh-cut apple slices during storage and have strong potential from a microbial safety viewpoint. Alternative application strategies that maintain the antibacterial properties of the wash solutions during usage with fresh-cut apple products are under investigation.

Marketing and Economics

(144) Economic Analysis of No-till and Black Plastic Mulch Fresh Market Cucumber Production Systems
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Four cucumber production systems, conventional black plastic mulch, black plastic mulch with rye/vetch habitat strips, rye/vetch mulch no-till direct seeded, and rye/vetch mulch no-till transplants, were assessed in 1998 and 1999. Five-year (1994–98) weekly average terminal market prices for 1/4 carton medium grade fresh market cucumbers in Atlanta Ga., Columbia S.C., Baltimore Md., Philadelphia Pa., and New York N.Y., were used to assess the fresh market cucumber values and periods during the growing season when the systems were profitable in these markets. The five-year weekly average prices for 1/4 carton fresh market cucumber was highest in Atlanta Ga. Gross revenue was calculated as the amount of produce harvested times the weekly average price. Net revenue per hectare was determined by subtracting production costs, brokerage fee, and transportation costs (based on distance from the market) from gross revenue. The no-till systems ($1802–5317 in 1998, $2316–6656 in 1999) had higher cumulative net revenue than plastic systems ($1238–1052 in 1998, $193470 in 1999). Net revenues were highest for plasticulture systems during July (8595–2198 in 1999), earlier in the season than no-till systems ($112–974). Net revenues in no-till transplanted system were highest in July ($880–2393 in 1998, $1123–2740 in 1999) and early (1–15) August ($1209–2764 in 1999), while net revenues in no-till direct seeded system was highest in late (16–31) August ($1478–2935 in 1998, $1522–3051 in 1999) and early (1–15) September ($67–964 in 1999). The no-till system using transplants had higher profit potential than other systems in July, while the no-till system where cucumbers were direct seeded had higher net revenues than other systems in late August both years and in early September 1999. The plasticulture systems were more profitable than other systems in July 1999.

(145) Consumer Preference Survey for Marketing Louisiana Satsumas

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Increased acreage and absences of hard winter freezes have allowed for a recent expansion in the south Louisiana satsuma industry. Effective marketing strategies are needed to help grower/packers move the increased production volume at profitable prices. A consumer survey was designed to identify the preferred fruit characteristics and packaging types for satsumas. A total of 216 respondents were obtained from 12 different demographically different areas of the state, urban Baton Rouge and rural Abbeville. Satsumas have good market recognition and acceptance among Louisiana consumers, but fruit quality is variable and there are few retail packaging options. The preferred individual consumer pack was a mesh sleeve, followed by lesser preferences for a rigid plastic clamshell or perforated plastic bag. The majority of respondents preferred large or medium-sized fruit (weight range from 125 to 175 gm vs. small <100 gm) or extra large (>225 gm) sizes. External peel color is an important fruit quality parameter, with the majority of respondents preferring a deep yellow or orange color. De-greening of early season satsumas would likely result in increased market acceptance and enhanced sales, as 77% of respondents indicated they preferred not to purchase green peel colored fruit. Two-thirds of survey respondents indicated they would purchase Louisiana satsumas year round, if available. Therefore, utilization of improved postharvest storage facilities to extend shelf life would allow growers to significantly expand their marketing period beyond the current 2 to 3 month harvest period.

(146) Consumer Research to Explore Market Opportunities for Beach Plum (Prunus maritima March.) Products

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Beach plums are currently marketed fresh, frozen, and as jams and jellies. The fruits are small (1–2 Ohwashi, Tsukuba, Ibaraki, 305-8686, Japan) and need to be de-greened. While approximately 11% of consumers have tried de-greening at home, few beach plum products are available in retail stores. Consumers prefer jam and jelly production from native, wild stands that have good market recognition and acceptance along the Washington-to-Boston corridor. Beach plum jam and jelly production from wild stands is a cultural tradition and a thriving cottage industry in Northeast coastal areas. To successfully develop beach plum as a viable crop for the Northeast, a better understanding of consumers’ knowledge and preferences for different beach plum products and the value the market places on the “beach plum image” is essential for the industry to assess market potential and develop effective marketing strategies for expanding beach plum markets. This paper presents the consumer focus group study conducted in Manhattan, New York City on March 13, 2002. The results were as follows: 61% brochure, 23% commercial, 22% display, and 14% television. Products purchased among gourmet consumers in coastal metropolitan areas; packaging with price is the primary marketing tool to communicate that beach plum products are gourmet, giftable and otherwise special; gourmet jams and jellies are purchased from various independent stores or farm markets and not from supermarkets; jams or jellies made with cultivated beach plums will not impede consumers’ interests in trying the product; consumers’ interests in beach plum presented market opportunities for new product development.

(147) Evaluating the Effectiveness of the ‘Where to Find ‘Jersey Fresh’ in Union County, NJ” Marketing Promotion

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Farm markets and garden centers in Union County, NJ have an interesting marketing challenge. The small county, 103 square miles, is home to nearly half a million consumers with diverse income levels. To meet this challenge, Rutgers Cooperative Extension and the Union County Board of Agriculture, in cooperation with the New Jersey Department of Agriculture, have sponsored a “Jersey Fresh” market campaign since 1995. The promotion consists of brochures, cable television commercials, displays, nutrition education programs, and a web site. Businesses who sell produce and ornamental plants grown in the state are eligible to participate in the promotion. In 2001–02, Rutgers Cooperative Extension conducted a marketing survey to evaluate the effectiveness of the promotion and to identify the needs and interests of consumers in the area. The promotional brochure, followed by a survey, was randomly mailed to 200 county residents. The survey was also administered to visitors to “Jersey Fresh” displays at community events and on the promotion’s web site, www.unioncountyfresh.com. One hundred and eighty consumers participated in the survey. Eighty percent (145) of the respondents indicated that they visited farm markets and garden centers advertised in the brochure. People visited an average of three businesses. Most consumers reported they spend $11–$20 on average visits to a farm market or garden center. Survey respondents were asked to identify all the ways they found out about the promotion. The results were as follows: 61% brochure, 23% commercial, 22% display, 7% web site, 8% nutrition education programs and other sources, and 5% newspaper articles. Thirty-nine (22%) of the participants indicated they would use public transportation to visit a farm market or garden center. The top seven items purchased by survey respondents were annuals, vegetables, fruits, perennials, vegetable transplants, trees and shrubs, and pumpkins. Most of the survey respondents spend $11–$20 on fresh vegetables and fruits per visit. The consumers spent $1–$10 on pumpkins and $11–$20 on vegetable transplants. Respondents indicated that they spend >$50 on ornamentals: annuals, perennials, trees, and shrubs.
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U.S. consumption of mature colored bell peppers has been increasing over the past decade. That increased consumption has been satisfied with increased imports and increased U.S. production. In Florida, peppers are mostly harvested at the immature green stage of development because open field environmental conditions negatively affect fruit quality and fruit yields of mature colored fruits. Greenhouse-grown peppers of red, orange, or yellow colors were imported during 1993–2002 from The Netherlands, Israel, and Spain at average year round fruit market prices of $4.80 per kg, with higher prices in the Nov.–May period. By contrast, local and imported field-grown green peppers averaged only $0.91 per kg. With high market prices and a suitable environment for growing colored peppers under inexpensive greenhouse structures (<$50 per m²), greenhouse-grown peppers are currently achievable fruit yields of 10 and 15 kg·m–2 were $30.17, $19.25, and $13.79, respectively. With an estimated transaction cost of 15% of the market prices, breakeven prices per 5-kg box ranged from $26.23 to $9.62 based on a range of possible marketable fruit yields of 6 to 20 kg·m–2, respectively. The average prices (in $ per kg) for transactions of colored peppers at the Miami market during the harvesting months were Nov: $5.50, Dec: $5.28, Jan: $5.63, Feb: $4.75, Mar: $5.30, Apr: $6.00, and May: $5.50. With an estimated transaction cost of 15% of the market prices, breakeven prices per 5-kg box for marketable fruit yields of 6, 10, and 15 kg·m–2 were $30.17, $19.25, and $13.79, respectively. With currently achievable fruit yields of 10 and 15 kg·m–2, production costs were $28.42 and $30.55 per m²; and with Nov–May average market prices, the returns to management were $9.75 and $26.72 per m². Local production of greenhouse-grown peppers could represent a viable vegetable production alternative for Florida growers. However, fruit yields should be greater than 7.13 kg·m–2 in order to generate positive returns to management.