

ABSTRACTS

Colloquia Workshops Contributed Papers (Oral and Poster)

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The Abstracts that follow are arranged in *numerical sequence* by the abstract number. For Poster Sessions, session numbers (in parentheses) follow the abstract numbers. Example: 545 (PS 6) represents abstract 545 in Poster Session 6; 797 (PS15) represents abstract 797 in Poster Session 15.

Abstracts for Oral Sessions, Colloquia, and Workshops are grouped by sessions, which are arranged more or less in numerical order by session number. To determine when a paper is to be presented, check the session number in the Program Schedule or the Conference at a Glance charts. The author presenting the paper is indicated by an asterisk.

27 COLLOQUIUM I (Abstr. 001–005)

001 HANDLING OF FLORIDA-GROWN AND IMPORTED TROPICAL FRUITS AND VEGETABLES.

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The tropical fruit and vegetable industry in South Florida is thriving, with imports of mangos, papayas, and tropical vegetables becoming a major area of expansion. An increasingly aware U.S. public has created a stronger demand for both Florida-grown and imported tropical commodities whose retail quality has increased due to improved handling and transportation practices. Systems for product temperature management, washing, grading, coating, and packaging are being modified to accommodate the conditions present in South Florida, Central and South America, and the Caribbean. The recent widespread

approval of hot-water quarantine treatment of mangos has facilitated international trading and allowed U.S. fruit companies to maintain nearly uninterrupted supplies.

002

POSTHARVEST TECHNOLOGY OF IMPORTED AND TRANSHIPPED TROPICAL FLORICULTURAL COMMODITIES

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Intercontinental trade in floriculture products exceeds US\$ 1,250 mln annually. One fourth are tropical commodities. Most of the US\$ 200 mln of tropical floriculture products imported into western Europe arrive by airplane and are transhipped before arriving at the country of destination. For cut flowers, it takes four to seven days from arrival at the port of entry to destination at the consumer. Mode of transport and market structure have as result that postharvest requirements for individual products are seldomly met. Potential vase life is reduced by five to ten percent for every day spent in the marketing chain. Because quality loss is often invisible, there is a necessity to have measures of internal quality. The only measure currently being used is a test on bacterial contamination. Internal quality tests based on carbohydrates, chlorophyll fluorescence or near-infrared spectra are being developed. Control on the application of pretreatments against bacteria, ethylene and drought needs to be intensified. Extension efforts continue to emphasize hygiene and temperature control.

003

PREHARVEST FACTORS INFLUENCING POSTHARVEST QUALITY OF TROPICAL AND SUBTROPICAL FRUIT

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Although postharvest handling schemes have improved during recent years, it is still possible to observe considerable variability in fruit quality between individual lots. Preharvest factors such as irrigation, nutrition and pest management practices, as well as rootstock and environmental variables, may greatly influence quality after harvest and may well account for some of the differences between individual lots. The influence of preharvest factors on postharvest quality of tropical and subtropical fruit will be discussed using pertinent examples from the literature. Emphasis will be given to those factors which can be manipulated to improve quality.

004

CHILLING INJURY OF TROPICAL HORTICULTURAL COMMODITIES

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Chilling injury inhibits the growth and development of tropical plants and shortens the postharvest life of tropical horticultural commodities. This presentation will emphasize the postharvest aspects of chilling injury. While most tropical commodities are sensitive to temperatures below 10 to 15°C, specific critical temperatures may vary with the species, stage of development, and type of tissue. Likewise, symptoms of chilling injury also vary with different commodities. Reduction of chilling injury can be achieved either by increasing the tolerance to chilling in sensitive tissues or by delaying the development of chilling injury symptoms. Some methods involve the manipulation and modification of the storage environment, whereas other techniques involve direct treatment to the commodities. Specific examples of the alleviation of chilling injury in various tropical commodities will be discussed.

005

Response of Tropical Horticultural Commodities To Insect Disinfestation Treatments.

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There is a need to develop effective, non-damaging, non-polluting, non-carcinogenic procedures for insect disinfestation and disease control in fresh horticultural products. The loss of ethylene dibromide as a fumigant and the uncertainties of other fumigants, has meant that alternatives are needed. The most likely possibilities include irradiation, heat, cold and controlled atmospheres. Irradiation doses required for sterilization of insects cause only minor physiological changes, while controlled atmospheres appear to require longer periods of exposure than the postharvest life of most tropical fruit. The sensitivity of tropical commodities to temperatures less than 10°C makes cold treatments inappropriate for most tropical commodities. Heat treatments seem to be most promising. For papaya, the requirement is that the fruit core temperature reach 47.2°C, this can occasionally disrupt fruit ripening. The sensitivity to heat is modified by seasonal, variety and rate of heating factors. The sensitivity can be related to the heat shock response and the presence of heat shock proteins.

28 ORAL SESSION 1 (Abstr. 006-012)

Woody Ornamentals: Culture and Management I

006

EFFECT OF ROOT PRUNING SOUTHERN MAGNOLIA PRIOR TO TRANSPLANTING ON RATE OF ESTABLISHMENT IN THE LANDSCAPE

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Roots of four-year-old, field-grown southern magnolia (*Magnolia grandiflora* L.) were pruned in 1987 once during dormancy, following the first shoot growth flush or after the second growth flush, prior to transplanting in January 1988. By the end of the 1987 growing season, root pruning at all stages of growth reduced leaf number, tree height, trunk caliper, and total-tree leaf area and weight compared with unpruned controls. Total root weight was less for trees pruned during dormancy or following the first growth flush. Root pruning increased the proportion of fine roots (0 to 5mm-diameter class) to coarse roots (>5 to 10-mm diameter class). Shoot:root ratios were not affected by root pruning. During the first year after transplanting, root pruned trees grew at a slightly faster rate than unpruned trees but growth rates were similar for root pruned and unpruned trees the second and third year after transplanting. Trees required, at most, 1 year per inch of trunk caliper to become established in the landscape.

007

POST-TRANSPLANT WATER RELATIONS AND GROWTH

RESPONSES OF 'RED SUNSET' RED MAPLE TREES TO ROOT PRUNING AND Cu(OH)₂-TREATED CONTAINER PRODUCTION
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Rooted cuttings of *Acer rubrum* 'Red Sunset' grown in containers treated on interior surfaces with 100 g Cu(OH)₂/liter white interior latex paint, or left untreated, were root pruned or not root pruned and planted in a field plot. A pseudo-bareroot treatment, trees from untreated containers shaken free of media, was included. Height (115 vs. 108 cm) and caliper (12.0 vs. 10.7 mm) at transplant was slightly greater for copper treated trees than for untreated trees. Leaf water potentials (LWP) at transplant were similar for all treatments. Mid-day LWP of trees transplanted from untreated containers tended to be lower than that of trees grown in copper treated containers at days 3, 14, 28, and 53 after transplant. Pseudo-bareroot trees had the most negative mid-day and pre-dawn LWP through day 92. Soil water potentials were from -0.01 to -0.03MPa.

008

GROWTH OF KENTUCKY COFFEE TREE SEEDLINGS IN PROTECTIVE SHELTERS DURING FIELD ESTABLISHMENT
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Growth and water relations of seedlings grown in protective tree shelters were investigated during establishment in a field nursery. Shelters, 1.2 m high, were placed over 0.5 m Kentucky coffee tree seedlings following spring transplanting in a field experiment. Predawn leaf water potential (Ψ) and stomatal conductance (g_s) were monitored periodically through the season and growth was measured in late summer. In a second experiment diurnal microclimate, and seedling water relations and use, in the shelters were studied under controlled conditions. In the shelters, leaf and air temperature, humidity, and g_s exceeded non-sheltered levels while solar radiation was 70% lower. Despite greater g_s , normalized water use was 40% lower in the sheltered trees. While midday g_s was similarly high in the field-grown trees, no differences in predawn Ψ were detected through the season. Sheltered trees in the field had four times more shoot growth but 40% less caliper growth. Sheltered trees had leaf thickness lower than control trees, and together with the growth and radiation pattern, indicated that they were shade acclimated. Shelters can improve height growth and reduce water loss during establishment, but may not allow sufficient trunk development or taper for upright support

009

A CLOSED, INSULATED PALLET PRODUCTION SYSTEM

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A closed, insulated, pallet production system (CIPPS) has been designed to meet current challenges: 1) Elimination of production related pollution. 2) Reduction and conservation of resources. 3) Improvement of working conditions. 4) Alternatives to pesticides. 5) Prevention of temperature extremes and rapid temperature fluctuations in the plant environment. Biological feasibility of CIPPS was established in research on pathogen epidemiology, water and fertilizer efficiency, plant growth and development in CIPPS. Water and fertilizer ion movement-removal in the closed system was plant-driven in response to growth and transpiration; water and fertilizer use in CIPPS was 10% of that applied to open containers. Growth of 28 plant species ranging from herbaceous annuals to woody perennials was greater in CIPPS than in control, individual containers. *Phytophthora cinnamomi* did not spread from inoculated to noninoculated plants within CIPPS. Inoculation with nonpathogenic bacteria increased plant growth (gfw) in CIPPS but not in open plant containers.

010

THE USE OF TREESHelters IN NURSERY PRODUCTION

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Treeshelters are translucent, polypropylene tubes that have been used in England for 10 years to improve the transplantation success and early growth of trees in the landscape. The focus of the

presented research will be on the use of treeshelters in producing plants in the container nursery. The results from outdoor nursery and greenhouse, solution culture experiments will be presented. Treeshelters increase the temperature, relative humidity, and carbon dioxide concentration around those plants growing in them. Photosynthetically active radiation (PAR) inside shelters is reduced 40-60% depending on treeshelter color. Plants growing in treeshelters show increases in height and in the ratio between total fresh weight and total dry weight. However, plants growing in treeshelters also show decreases in leaf, stem, and root fresh and dry weights and leaf area. The potential benefits and current challenges surrounding the use of treeshelters will be discussed.

011

MINIMUM IRRIGATION OF LANDSCAPE GROUNDCOVERS.
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A previous field study had shown that *Baccharis pilularis*, 'Twin Peaks', *Drosanthemum hispidum*, *Vinca major*, *Gazania* hybrid, *Potentilla tabernaemontani* and *Hedera helix*, 'Needlepoint', express no loss in relative aesthetic appearance when irrigated for one season at 50% of reference evapotranspiration (ET₀), but three species did not perform acceptably at 25% of ET₀. In this study these six species were grown in the field for 16 months under treatments of 50%, 40%, 30% and 20% of real-time ET₀ to more closely determine their minimum irrigation needs.

Analysis of seasonal plant performance ratings indicates that for *Vinca*, *Gazania* and *Potentilla* there is no significant increase in relative performance when irrigated at more than 30% of ET₀. *Baccharis*, *Drosanthemum* and *Hedera* exhibited no significant improvement in performance when irrigated above 20% of ET₀. A general decline in aesthetic appearance and performance was observed during the study in *Gazania* and *Potentilla* at all treatments, suggesting that their long-term minimum irrigation need may be more than 50% of ET₀.

012

CARBOHYDRATE AND PROTEIN BALANCE DURING EPISODIC GROWTH IN *LIGUSTRUM JAPONICUM*
Jeff S. Kuehny* and Marv C. Halbrooks, Department of Horticulture, Clemson University, Clemson, SC 29634-0375.

Research defining actual changes in weight gain of roots and shoots during growth episodes of woody ornamentals is limited. The objective of this study was to develop a better understanding of the patterns of root and shoot growth, nitrogen uptake, and changes in carbohydrate and protein content of *Ligustrum japonicum*, an episodic species. Shoot elongation and lateral root formation were synchronous. The greatest increase in shoot percent of whole plant fresh weight occurred after shoot elongation however, and the greatest increase in root percent of whole plant fresh weight occurred during shoot elongation. Nitrate uptake was highest during shoot elongation and lateral root formation. Carbohydrate and protein content also varied with each episode of growth.

29 ORAL SESSION 2 (Abstr. 013-019)

Vegetable Crops: Fertilizer Management

013

COVER CROP AND NITROGEN FERTILIZER RATE INFLUENCES ON YIELDS OF SEQUENTIALLY PLANTED VEGETABLES

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Fall-planted cover crops of hairy vetch (*Vicia villosa* Roth), Austrian winter pea (*Pisum sativum* subsp. *arvense* L. Poir.), and crimson clover (*Trifolium incarnatum* L.) were each followed by spring-planted 'Sundance' summer squash [*Cucurbita pepo* var. *meloepo* (L.) Alef.] and 'Dasher'

cucumber (*Cucumis sativus* L.). Squash and cucumber crops were followed by fall 'Florida Broadleaf' mustard green [*Brassica juncea* (L.) Czerniak] and 'Vates' collard (*Brassica oleracea* L. *Acephala* group), respectively. The same vegetable sequences were also planted without benefit of cover crop. Three nitrogen (N) rates were applied to each vegetable crop. Squash following winter pea and crimson clover produced greater yields than did squash planted without preceding cover crop. Cucumber following crimson clover produced the greatest yields. No cover crop effect was noted with mustard or collard. Elimination of N fertilizer resulted in reduced yields for all crops, but yields of crops with one-half the recommended N applied were generally comparable to those receiving the full recommended rate.

014

NITROGEN USE IN AN ASPARAGUS/LIVING MULCH CROPPING SYSTEM

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Seedlings of Syn 4-56 hybrid asparagus were planted in May, 1990 on loamy sand in the irrigated Central Sands region of Wisconsin. Treatments were unsuppressed living mulches of perennial ryegrass, Dutch white clover, a mixture of ryegrass and clover and cultivated bare ground. Ammonium nitrate was banded at rates of 90, 45, and 0 kg/ha across all treatments. Measurements of weed populations, asparagus growth, and soil and tissue nitrogen levels were made in 1990 and 1991. Soil nitrate and ammonium levels were measured in 30 cm increments to a depth of 90cm. In 1990, asparagus fern growth was greater in the bare ground controls than in any of the mulch treatment plots. In 1991, asparagus growth in the clover-based mulches was greater than that in the ryegrass mulch, although also still less than that of the bare ground control. Total accumulated nitrogen in clover-based mulch plots at the end of each season was more than twice the level of that of either the grass mulch or the cultivated plots. Percent nitrogen in asparagus tissue varied with mulch treatment: in 1991, the %N was higher in the asparagus tissue grown with clover than either that grown with the grass or on bare ground. Weed control in all mulch plots was good; in clover plots it was nearly 100%.

015

FIELD TESTS EVALUATING PRE- AND POST-PLANT NITROGEN FERTILIZER PROGRAMS FOR MUNG BEAN PRODUCTION

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Field tests were conducted in commercial mung bean (*Vigna radiata*) fields in 1986, 1987, and 1989. The objective of these tests were to: determine optimum nitrogen fertilizer rates; evaluate preplant, postemergence or split applications of nitrogen; and develop data to utilize petiole sampling as an analytic technique to quantify plant nitrogen status.

Seed yields were significantly increased two of the three years by the addition of nitrogen fertilizers. Over three years, the addition of 40-120 pounds of nitrogen per acre resulted in an average seed yield increase of 14-37 percent, compared to an untreated control. Maximum yields were obtained with eighty pounds of nitrogen per acre. Within specific rates, there was a trend for preplant or split applications to result in the greatest yield increases.

Petiole nitrate levels did not appear to be a reliable indicator of plant nitrogen status, with wide differences between rates in different years. An average for the three-year test, six weeks after crop emergence, was 1270 ppm for the control and 2340 ppm for treatments receiving 80 pounds of nitrogen per acre.

016

DRIP/TRICKLE FERTILIZING EGGPLANTS

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The effectiveness of varying rates and timing of applied primary plant nutrients as a completely soluble N-P-K fertilizer through a drip/trickle low volume irrigation system was studied during 1991 on eggplant (*Solanum melongena* cv. Harris Special Hibush). Before the drip irrigation tubing and black plastic mulch were laid on a coastal plain sandy loam soil, plots were treated with 0, 22, 45, and 67 kg ha⁻¹ of nitrogen (N), phosphate (P₂O₅) and potash (K₂O). The higher rates of preplant fertilization did have a significant beneficial effect on total seasonal yields of quality eggplants. The preplant treatments also had an influence on mid and late season production. As the frequency of drip/trickle applied primary plant nutrients increased up to 6 seasonal applications, the total quality fruit production substantially increased. Frequency of applications also had an influence on

seasonal yields. Applying increased rates of the primary plant nutrients at a low seasonal frequency of 3 applications had little influence on increasing total quality yields of eggplants. Individual quality fruit was significantly heavier from plants which received 5 to 6 applications of the soluble N-P-K fertilizer than from plants which received no fertilizer through the drip/trickle irrigation system for the season.

017

SULFUR UPTAKE AND UTILIZATION IN SHORT-DAY ONION CULTIVARS

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Sulfur fertility influences flavor in onions. To determine how sulfur is utilized by onions over the course of growth and development, five short-day onion (*Allium cepa* L.) cultivars were grown at high (4.0 mequiv. liter⁻¹) and low (0.1 mequiv. liter⁻¹) sulfur fertility regimes under greenhouse conditions. Plants were measured for foliar sulfur content at 4 week intervals during the course of the growing season and for bulb sulfur and pyruvic acid development at plant maturity. Patterns of sulfur uptake and utilization were similar for all five cultivars but cultivars differed in their magnitude of sulfur accumulation. Foliar sulfur accumulation correlated poorly with bulb sulfur and pyruvic acid development at all sampling dates.

018

COMPARISON OF IN-FIELD TECHNIQUES FOR MONITORING PLANT AND SOIL NITROGEN STATUS

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California vegetable growers are adopting drip irrigation at an accelerating pace, which affords the opportunity for more exacting control of nitrogen nutrition. Consequently, the need for quick, accurate, grower-friendly techniques for monitoring nitrogen status in soil and plant material has increased. Three field monitoring techniques were examined in detail: the analysis of soil water samples drawn by soil solution access tubes (SSAT), leaf reflectance as measured by the Minolta SPAD 502 chlorophyll meter, and petiole sap analysis with a Horiba portable nitrate-selective electrode meter. Nitrate concentration in soil solution was highly stratified in drip-irrigated soils, both with regard to location in the field and position with respect to the drip line, making the use of SSAT technology impractical as a tool for routine N fertigation scheduling. Correlation of SSAT nitrate values to any measure of plant N status was poor. Similarly, leaf reflectance correlated poorly with any measure of tissue N in the crops examined. Nitrate content of petiole sap was highly correlated with conventional laboratory analysis of dry petiole tissue over a range of crops and nitrogen levels.

019

CROP ROTATION AND NITROGEN RATE INFLUENCE PROCESSING TOMATO QUALITY

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A study was conducted from 1989 to 1991 to examine the effects of continuous tomato cropping, short-term crop rotation and, nitrogen fertilization rates on processing tomato quality. Research was conducted at two sites in southwestern Ontario, Leamington and Dresden, in split-plot experimental design. The rotations included tomato (*Lycopersicon esculentum*) - winter wheat (*Triticum aestivum*) (underseeded with red clover (*Trifolium pratense*), tomato-winter wheat-soybean (*Glycine max*), tomato-alfalfa (*Medicago sativa*), and tomato-rye (*Secale cereale*). Nitrogen fertilization rates of 0, 45, 90 and 135 kg/ha were used. Processing tomato cv. Heniz 9230 and Nabisco Brands Ltd. 7107 were assessed for colour, % soluble solids and total solids, and blossom end rot [BER]. In most instances, continuous tomato [C-T] had significantly poorer colour, soluble solids, and total solids than fruit from the various crop rotations. High nitrogen rates for C-T at Leamington, resulted in improved soluble solids and total solids, but had no significant effect on colour. A lower incidence of BER consistently occurred with low rates of nitrogen. Our results indicate that short-term crop rotation and nitrogen management in processing tomatoes can enhance fruit quality when compared to C-T.

30 ORAL SESSION 3 (Abstr. 020-026)

Cell and Tissue Culture: Fruits and Nuts

020

IN VITRO SHOOT REGENERATION FROM INTERNODE SEGMENTS AND INTERNODE - DERIVED CALLUS OF BLUEBERRY (*VACCINIUM* SPP.)

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In an effort to increase somaclonal variation in blueberry, a protocol was developed to regenerate viable shoots from internode segments. The explant consisted of the last-formed, fully developed internode taken from 3 different genotypes of *Vaccinium* grown in vitro. Explants were cultured 6 weeks on Zimmerman's Z-2 medium supplemented with 2iP, zeatin, thidiazuron, kinetin, or BA at concentrations of 5, 25, 50, and 100 uM. Explant response to the treatments varied and included: no response, callus growth only, callus growth and subsequent shoot formation originating from the callus mass, and adventitious shoot formation directly from the internode segment without an intervening callus. Greatest shoot regeneration (20-25 shoots/explant) was obtained on medium supplemented with zeatin at 5, 25, and 50 uM, however treatment response was not consistent across all genotypes. Regenerated shoots could be readily sub-cultured, rooted in soil mix and will be evaluated for somaclonal variation.

021

MICROPROPAGATION OF CHOKECHERRY AND PINCHERRY (*Prunus virginiana* and *P. pensylvanica*)

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Chokecherries and pincheries are commonly used in landscaping. Some of the selections such as 'Garrington', 'Mary Liss' and 'Jumping Pound' have large fruits of good quality suitable for food processing. The species are also very well adapted to severe winter conditions of the Prairie Provinces. In our studies, in vitro propagation of the selections was undertaken. The best results with initiation of cultures were observed when dormant buds were used as explants on MS medium with 30 g/L sucrose, 0.1 mg/L NAA and 1.0 mg/L BAP (4 wks, 24/22°C day/night, 16 hrs photoperiod 3000 lux). Optimal proliferation in both species was on MS medium with 1-2 mg/L BAP, 80 mg/L AdS0₄ and 170 mg/L NaH₂P0₄. Rosettes produced were placed on medium without hormones prior to rooting. Rooting was performed ex vitro in root-trainers (soilless mix) on the greenhouse bench under mist. Basal dip in commercial rooting powder Stimroot 1 (0.1% IBA) was equally effective to spray application (2 mg/L IAA with 0.5 mg/L NAA). Average of 77% rooting with 'Garrington', 72% and 81% rooting with 'Jumping Pound' and 'Mary Liss' was observed respectively.

022

REGENERATION OF *PISTACIA*

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Cotyledons and embryonic axes of *Pistacia vera* L. 'Kerman' were cultured on modified DKW or MS media. Cotyledonary petioles regenerated shoots when cultured on DKW medium supplemented with (in g/liter) 2.5 Zn(NO₃)₂, 0.48 H₃BO₃, 100 KNO₃ and (in mg/liter) 1 BA, 0.01 IBA, 2 kinetin and 250 glutamine whether under light (80 μmol·m⁻²·s⁻¹) or dark conditions. Cotyledons regenerated floral parts from their abaxial surfaces when cultured on (1) DKW or MS, both supplemented with (in mg/liter) 600 glutamine, 300 glycine, 200 asparagine, 50 arginine, 20 ascorbic acid and 0.05-0.1 2,4-D plus 0.1 BA or 0.1 zeatin under light or dark conditions or (2) DKW medium supplemented with (in g/liter) 2.5 Zn(NO₃)₂, 0.48 H₃BO₃, 100 KNO₃ and (in mg/liter) 0.002 thidiazuron plus 0.2 2,4-D under light conditions.

EFFECTS OF PULSED EXCIMER LASER RADIATION ON SHOOT REGENERATION AND REDUCTION OF CONTAMINATION OF *PHOENIX DACTYLIFERA* L. (DATE PALM)

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The seeds of two cultivars of *Phoenix dactylifera* L. (Medjol and Deglet-Nour) were cultured on modified Murashige and Skoog (MS) medium containing 0.5 mg/l NAA and 2.0 mg/l BA. Later they were treated with 25 or 50 pulses of excimer laser radiation. The results indicate that these seeds exhibited significantly less contamination than control. The highest percentage germination for both cultivars was obtained with explants treated with 50 pulses excimer laser radiation. Compared to other treatments, the occurrence of somatic embryogenesis and shoot regeneration was greater with the Medjol cultivar.

WATER RELATIONS OF TISSUE-CULTURED APPLE SHOOTS UNDER WATER DEFICITS.

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The contribution of in vitro-formed roots to the water status of tissue culture plants was studied by observing the stomatal responses of rooted and unrooted apple shoots. Stomatal conductance was measured on whole plants with a modified steady state porometer in a temperature-controlled room. The porometer was maintained at a steady 90% RH and conductance was measured every 30 seconds. Plants were kept in the gas exchange system for about 28 h. Steady state values of stomatal conductance for rooted and unrooted shoots were 220 (S.E.= 19) and 163 (S.E.=23) mmol m⁻² s⁻¹, respectively. When the plants were exposed to a light stimulus (1200 µmol m⁻² s⁻¹), rooted shoots showed an increase of about 64% in stomatal conductance. In the absence of roots, no response to light was observed. These results suggest that the presence of the roots improved, at least partially, water uptake and plant water status.

DEVELOPMENT OF AUTOMATED VISION TECHNIQUES FOR IMMEDIATE ANALYSIS AND CONTROL OF BETALAIN-PRODUCING CELL CULTURES

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Natural plant pigments (produced as secondary metabolites in cell culture) can replace controversial synthetic chemical colorants to enhance the appearance of processed foods. Intensive bioreactor-based production systems designed for betalain pigment-producing cultures of *Beta vulgaris* are still not economically competitive, in part due to the slow, prohibitively expensive, and incomplete conventional methods (HPLC analysis, biomass estimates, cell counts) which must be used to assess culture status. As an alternative, software was written using Semper 6 (a high level programming language for image analysis) for collection of exacting morphometric (spatial) and photometric (spectral) process information from an intense violet cell line. Uniform, crisp images of 1 ml culture samples in multiwell plates were captured macroscopically, and the pattern of pigment production was traced at 3 day intervals over the course of a 15 day growth cycle with monochromatic color filters and image grey level data. Rod-shaped cells and aggregates were automatically sorted and measured using parameters of particle size, density, and circularity. The machine vision method offers greater opportunity to fine-tune cell selection for enhanced pigment content.

CALOGENESIS AND ORGANOGENESIS OF SOMATIC MATERIAL FROM APPLE SEEDLINGS (MALUS DOMESTICA BORKH) AS AFFECTED BY SOURCE MATERIAL AND DARK PERIOD.

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The aim of this work was to study different apple of somatic material as callus and adventitious shoots are concerned, for further utilization in the research of somaclonal variation. The somatic materials were: leaf discs, cotyledons and hypocotyls of Gala apple seedlings, cultivated in a MS medium added by B5 vitamins in addition to (in mg/l): BAP (1,0), NAA (0,5) mio-inositol (100,0) sucrose (30,0 g/l) and solidified in agar (6,0 g/l). The several times of explant exposition to the dark affected the final callus weight. Callus weight derived from leaf discs were higher than those for cotyledons and hypocotyls. Explants exposed directly under light or up to two weeks in the dark showed less percentage of regenerative callus as compared to those of three weeks in the dark. The leaf explants presented the highest percentage of regenerative callus. The least response was obtained for those derived from hypocotyls. The highest number of adventitious shoots was obtained keeping the explants three weeks in the dark as compared to directed light exposition.

31 ORAL SESSION 4 (Abstr. 027-033) Fruits and Nuts: Stress Physiology

THE EFFECT OF IRRIGATION STRATEGIES ON PEACH FRUIT GROWTH AND FINAL SIZE

R. Scott Johnson*, Claude Phene, and Charles Medawar, Department of Pomology, University of California, Davis, Kearney Agricultural Center, Parlier, CA 93648

Six irrigation strategies were imposed on a block of O'Henry peach trees irrigated by fanjets. Treatments received different percentages of ET during the various stages of fruit growth and postharvest. ET was estimated by a large weighing lysimeter containing 2 trees and located in the center of the block. Fruit diameters were measured weekly and final fruit weights were determined at harvest. Adjusted fruit weights were estimated by statistically adjusting each treatment to the same fruit load.

Adjusted fruit weight correlated well with soil water content during the month before harvest but not during early stages of fruit growth. Treatments which applied 50% ET during early stages of fruit growth showed reduced fruit size at that time. However, with applications of 150% ET during the final fruit growth stage, fruit size recovered. Adjusted fruit weight also correlated with measures of tree water status including midday leaf water potential and canopy temperature.

ASIAN PEAR (NASHI) TREE WATER RELATIONS IN LYSIMETERS.

A. Richard Renquist*, Horst W. Caspari, and David J. Chalmers, Department of Horticultural Science & Plant Health, Massey University, Palmerston North, New Zealand.

Nashi pear (*Pyrus serotina* Rehder, cv. Hosui) trees were planted in 12 computerized 1m-wide drainage lysimeters in September 1987. During the 1990 season tree water use was monitored via lysimeter and neutron probe readings. Diurnal leaf water relations were studied using a pressure chamber for water potential (Ψ) and a porometer for leaf conductance (g_s). Xylem sap trunk flow velocities were measured with an experimental heat pulse device and converted to xylem flux. Close agreement existed between 24 hr xylem flux and lysimeter water use when comparing trees with different soil water content. Xylem flux also was very sensitive to changes in evaporative demand. During 9-13 day drying cycles pre-dawn Ψ became progressively lower, morning decline more rapid, and afternoon recovery slower. The diurnal g_s pattern also shifted during drying cycles, such that g_s of water stressed trees always decreased from time of first measurement of sunlit leaves rather than increasing during the morning as on non-stressed trees. Late afternoon was the best time to distinguish between fully irrigated and stressed trees using g_s measurements.

COMPARISON OF DROUGHT TOLERANCE AMONG PRUNUS SPECIES FROM DIVERGENT HABITATS.

Mark Rieger, Dept. of Horticulture, Univ. of Georgia, Athens, GA

Root and shoot characteristics related to drought tolerance were studied for *Prunus persica*, *P. andersonii*, *P. besseyi*, *P. maritima*, *P. subcordata*, and *P. tomentosa*. In general, shoot characteristics were more closely associated with drought adaptation than root characteristics across species. The most xeric species, *andersonii*, had the most xerophytic leaf morphology, highest rates of leaf gas exchange, high root length/leaf area and root weight/leaf area ratios, but had root length and hydraulic conductivity similar to that of more mesic species. Water use efficiency (WUE) increased as water potentials (Ψ) dropped to -3.0 to -4.0 Mpa during a 5-7 day drought for the xeric *andersonii* and *subcordata*. However, after an initial increase, WUE decreased with declining Ψ in the other 4 species, indicating that carboxylation was affected by stress in the -1.5 to -3.0 range of Ψ for *besseyi*, *maritima*, *persica* and *tomentosa*. CO₂ assimilation (A) decreased linearly with Ψ during drought in all species, but the Ψ at which A reached zero was not well correlated with drought adaptation. Root hydraulic conductivity was similar for all species, indicating a lack of importance of this parameter for drought tolerance. The data suggest that introduction of xerophytic shoot characteristics into commercial cultivars of *Prunus* would improve drought tolerance to a greater extent than using drought tolerant species as rootstocks.

PHYSIOLOGICAL RESPONSES OF YOUNG APPLE TREES ON 3 ROOTSTOCKS TO DROUGHT STRESS

Rodney T. Fernandez*, Ronald L. Perry and James A. Flore, Department of Horticulture, Michigan State University, East Lansing, MI 48824-1325.

'Imperial Gala' on M.9 EMLA, MM.111 and Mark rootstocks were planted in a rain exclusion shelter. Two drought stress periods lasting approximately 1 month each were imposed during 1991. Water was supplied at 2 liters per day per tree before and after each drought cycle while water was withheld from half of the trees during the drought stresses. Maximal and variable chlorophyll fluorescence and fluorescence quenching were significantly reduced by the drought stress with M.111 generally affected first and with the largest difference between drought and control followed by Mark and then M.9. Leaf and stomatal conductance, assimilation and transpiration usually occurred first and were lowest for M.9 followed by Mark and then M.111 during the first stress cycle while Mark responded more rapidly and to a greater extent than M.9 and M.111 during the second stress. Water potential was lower for the stressed trees during both stress periods but osmotic and turgor potentials were reduced only during the first stress period. Changes in water relations were noticed first and to a greater extent for Mark followed by M.9 with M.111 exhibiting the least sensitivity and differences.

032

DECLINE AND RECOVERY OF HEDGEROW WALNUTS FROM SUSTAINED DEFICIT IRRIGATION

David A. Goldhamer*, Robert Beede, Steve Sibbett, and Dave Ramos, Department of Land, Air and Water Resources, Department of Pomology, University of California, Davis, CA 95616

Mature hedgerow walnut trees (*Juglans regia* L. cv. Chico) were irrigated at rates of 33, 67, and 100% of potential orchard ETc (about 350, 700, and 1050 mm/season, respectively) for three years. All trees were then returned to 100% ETc for the subsequent three year period.

Deficit irrigation reduced vegetative growth as measured by shaded area of the orchard floor and trunk growth. Yield reductions, which were minimal after one season, were significantly greater in years two and three. However, the relationships between crop yield and applied water were linear for all deficit irrigation seasons. Upon a return to full irrigation, trunk (and presumably shoot) growth of the previously stressed trees accelerated to levels greater than the control. The subsequent increase in fruiting positions resulted in a return to full production after two years. This suggests that hedgerow walnuts have the potential to recover rapidly from drought-induced production losses if no secondary effects of tree water stress, such as disease or pests, occur.

031

PARTITIONING OF ¹⁴C-SUCROSE INTO SORBITOL UNDER WATER STRESS

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Previous results showed that active sorbitol accumulation occurs under water stress. We tested the hypotheses that sorbitol accumulation is due to reduced sorbitol export from leaves or from increased synthesis of glucose to sorbitol. To test the hypotheses, 230 μ l ¹⁴C-sucrose was introduced through the stems to detached 'Jonathan' apple shoots which had either water stress or no stress. Following uptake of ¹⁴C-sucrose, 0% or 10% PEG was applied to shoots for 24 hours. The results showed that 73% of ¹⁴C-sucrose in non-stressed leaves was broken down within 1 hour and 44% was recovered in sorbitol. PEG initially stimulated the breakdown of ¹⁴C-sucrose to glucose and fructose, but further conversion to sorbitol was reduced. However, the percentage of ¹⁴C-sorbitol in mature leaves increased gradually in 10% PEG until it exceeded that of control at 24 hours. In contrast to mature leaves, young leaves and stems showed significantly less sorbitol under 10% PEG 24 hours after treatment. These results supported the hypothesis that sorbitol accumulation under water stress was due to the reduced sorbitol transport.

033

OZONE GRADIENTS, PHOTOSYNTHESIS AND YIELD IN PLUM

D.A. Grantz*, W.A. Retzlaff, L.E. Williams, and T.M. DeJong, University of California, 9240 S. Riverbend Ave., Parlier CA 93648 USA

Models indicate that ozone inhibits carbon assimilation largely in the upper canopy, due to light and ozone gradients. We document yield reductions and ozone gradients in Casselman plum in open-top

ozone fumigation chambers. Ambient air (12 hr mean ozone = 0.050 ppm), charcoal filtered air (0.034 ppm) and ambient air plus added ozone (0.094 ppm) were circulated in the chambers. Additional trees grew outside the chambers (0.058 ppm). Outside the chambers large vertical and horizontal gradients in ozone within the canopy were documented, but these were absent in the chambers. Ozone decreased leaf photosynthesis by 31% and 58%, and fruit yield by 20% and 66%, in the ambient and ozone enriched relative to filtered chambers. Despite altered gradients, yield and photosynthesis of exposed leaves were similar inside and outside the chambers in ambient air. Compensatory changes in leaf function may be involved.

32

ORAL SESSION 5 (Abstr. 034-040)

Biotechnology:

Germplasm Characterization

034

RAPD MARKER DIVERSITY AMONG PAKISTANI APRICOTS

Y. Gogorcena and D.E. Parfitt*, Dept. of Pomology, University of California, Davis, CA 95616-8683

A number of 10 base primers were screened to identify RAPD polymorphisms among a population of semi wild apricot genotypes that had been collected by Maxine Thompson in 1988. 30 families collected from trees at 6 locations were analyzed. DNA from leaf tissue of 180 plants, ca. 6 genotypes per family, were isolated and tested against 20 primers. Seven primers were identified that produced consistent results with relatively few (thus, scoreable) and consistent bands. DNA was isolated using the cTAB method and the effects of additional CsCl centrifugation isolation were tested. No differences were found. Reaction conditions were tested to ensure consistent results. Considerable RAPD polymorphism was observed in this population. Parsimony analysis is being conducted to assess the relative variation among and within populations and to determine whether collection location had a more significant effect on DNA variation than other factors such as outcrossing or level of heterogeneity within populations.

035

SAMPLING VARIANCE FOR MOLECULAR MARKER DATA WITH RESPECT TO GENETIC DISTANCE

Jan Tiv ng*, Jim Nienhuis, and O.S. Smith

Dept. of Horticulture, University of Wisconsin 1575 Linden Dr. Madison, WI 53706 and Pioneer Hi-Bred International Inc. Johnston, Iowa 50131.

The sampling method was applied to a data-set generated by RFLP molecular marker analysis, representing 37 *Zea mays* cultivars. A total of 251 enzyme probe-combinations were used yielding a total of 1,205 scores per genotype. Genetic distance was calculated among all 37 entries from subsets of arbitrary and increasing sample size. Each score entry in the subset was selected at random from all possible scores with replacement following each selection. The variance for genetic distance was calculated among all subsets of equal size for all possible cultivar pairs. The pooled pair variance was plotted and compared to random simulation models. Additional comparisons were made contrasting closely vs. distantly related cultivars.

036

GENETIC FINGERPRINTING OF SNAP BEAN CULTIVARS WITH RAPD MARKERS

Paul Skroch* and Jim Nienhuis

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The genetic variation in a population of one hundred Snap Bean varieties, including processing and garden types, was studied using RAPD markers. All one hundred genotypes were distinguished by unique

combinations of banding patterns. These unique "fingerprints" were tested for repeatability. Certain bands were very reliable and can be used for varietal identification. The RAPD marker data was also used to estimate genetic relationships among a subset of the one hundred lines. The results of the analysis agreed with known pedigree information. These markers will allow more precise monitoring and control of germplasm by those who are involved with the breeding and production of superior seed.

037

RANDOM AMPLIFIED POLYMORPHIC DNA VARIATION IN THE CULTIVATED SPECIES OF PRUNUS
S. Arulsekhar* and F. A. Bliss, Department of Pomology, University of California, Davis, CA 95616

Studies of genetic variation at the DNA level in the tree fruit and nut crop species of *Prunus* have been very limited. Recently molecular markers based on random amplified polymorphic DNA (RAPD) markers have been shown to be highly useful and efficient gene markers in other plant and animal species. We have used a total of 50 primers (10-mers) with arbitrary nucleotide sequence to identify cultivars of cherry, plum, apricot, peach and almond. A total of 120 accessions of different cultivars were assayed. The variation revealed by RAPD markers was highly species specific in the five *Prunus* species examined. High levels of polymorphism were observed for almond cultivars whereas sweet cherry revealed the lowest levels of polymorphism for the RAPD primers examined. The implications of these results in the germplasm diversity in the cultivated species of *Prunus* will be discussed.

038

ANALYSIS OF RFLP LOCI IN WALNUTS: INHERITANCE, INTRA- AND INTERSPECIFIC VARIATION, AND CULTIVAR IDENTIFICATION.
R. Fiellstrom* and D. E. Parfitt, Dept. Pomology, Univ. California, Davis, CA 95616.

RFLP analysis was employed to study the inheritance of and genetic diversity identified by cloned walnut genomic probes. An interspecific backcross population of (*J. hindsii* x *J. regia*) x *J. regia* was used to determine the inheritance of thirty low copy number RFLP cloned probes. Of these probes, approximately 20% correspond to single copy loci, 40% correspond to single major loci with multiple minor loci, and 40% correspond to two major loci. Twenty of these probes were used to analyze variability within and between 13 walnut species (*Juglans* spp.). Substantial genetic variation was identified within many wild walnut species, while limited variation was identified within butternut (*J. cinerea*) and the widely cultivated English walnut (*J. regia*). Extensive polymorphism was found between walnut species, allowing a phylogenetic relationship of walnuts based upon RFLP markers to be developed. Identification of clonally propagated walnut cultivars by RFLP typing was readily performed in black walnut (*J. nigra*) accessions, was more difficult in English walnut accessions, and rarely possible in butternut accessions.

039

RANDOM AMPLIFIED POLYMORPHIC DNA (RAPD[™]) MARKERS FOR ESTIMATING GENETIC RELATIONSHIPS IN MANGIFERA INDICA L.
Raymond J. Schnell* and Robert J. Knight, U.S. Department of Agriculture, National Clonal Germplasm Repository, Subtropical Horticultural Research Station, 13601 Old Cutler Road, Miami, FL 33158 USA

Genetic relationships between commercial mango cultivars are often speculative, and only the maternal parent is generally known. RAPD[™] primers were used with the polymerase chain reaction (PCR) to provide markers useful in determining individual identity, family relationships, and linkage mapping analysis. In mango, 53 RAPD primers were screened for markers and 27 proved useful. Genomic DNA was isolated from 70 clones of mango maintained in the USDA germplasm collection. DNA from these clones was amplified with each of the 27 primers. Data were scored as the presence or absence of bands. Groupings of the clones using UPGMA based on Nei's genetic distance gave distinct clusters. RAPD clusters vs. clusters based on isozyme analysis are compared.

040

RESTRICTION FRAGMENT LENGTH POLYMORPHISM IN GENETICALLY RELATED ROSE CULTIVARS
Sriyani Rajapakse*, Albert Abbott, John Kelly and Robert Ballard, Departments of Horticulture and Biological Sciences, Clemson University, Clemson, SC 29634

The feasibility of using RFLP to distinguish genetically related Hybrid Tea rose cultivars for DNA 'fingerprinting' was examined with a group of cultivars related to 'Peace'. The following cultivars used in this study, 'Chicago Peace', 'Flaming Peace', 'Climbing Peace' and 'Lucky Piece', were derived from bud mutations (sports) of 'Peace'. We also investigated two additional cultivars, 'Perfume Delight' and 'Garden Party', in which one of the parents for each was 'Peace'. Genomic rose DNA probes, cloned in pUC8 plasmid of *Escherichia coli*, were hybridized with genomic DNA of these cultivars digested with different restriction enzymes. Although polymorphisms were observed among these related cultivars, only a few probe/enzyme combinations screened produced RFLPs due to the high degree of genetic relatedness of these cultivars. We have identified probes that can distinguish all of these related rose cultivars. This study demonstrates that RFLP markers can be used effectively in DNA 'fingerprinting' of genetically related rose cultivars, even though the level of detectable polymorphism is quite low.

33

ORAL SESSION 6 (Abstr. 041-046) Collegiate Branch Forum I

041

PHYTOTOXIC SIMAZINE CONCENTRATIONS IN TURF IRRIGATION WATER

F. C. Waltz* and Ted Whitwell, Department of Horticulture, Clemson University, Clemson, SC 29634-0375

Herbicides can runoff during storms or irrigation and contaminate ponds that are used for irrigation. Overseeded turf areas are particularly vulnerable to low concentrations of herbicides in irrigation water. A greenhouse study was conducted to determine the phytotoxic concentration of simazine in irrigation water perennial ryegrass (*Lolium perenne*), creeping bentgrass (*Agrostis palustris*), and fine fescue (*Festuca rubra*). Irrigation of 6.5 mm of herbicide contaminated and uncontaminated water was applied to seeded pots during a six week period. Concentrations of water containing simazine levels of 0.0001, 0.01, 0.1 and 1.00 ppm were used. Visual injury and number of live seedlings were evaluated every seven days after the beginning of the treatments and a threshold concentration was determined. An immunoassay kit was evaluated for practicality to the golf industry. Species varied in their response to simazine concentrations and immunoassay diagnostic kits have potential for use in detecting phytotoxic simazine concentrations.

042

ANALYSIS OF ATRIUM LIGHT ENERGY AS A MEANS OF RETRIFICATION FOR OPTIMAL PLANT HEALTH

Jamie M. Arnold*, LeeAnn DeWitt, David W. Simpson, Department of Horticultural Sciences, Texas A&M University, College Station, TX 77843-2133

In an original design for the Texas A&M University Horticulture/Forest Sciences Building Atrium an optimal lighting plan was devised. Budget cuts caused changes in the artificial light sources which resulted in a compromise in the design. As a result, plant quality has deteriorated. Photosynthetically active radiation (PAR) readings have been taken utilizing a grid technique at various points in the atrium. In an analysis in one particular site 94% of the light was artificial whereas in the other sites 35% was by artificial means. This shows the great inconsistency throughout the six sites, which explains the plants' rapid deterioration. The data of the study provides the means to retrofit the atrium to coincide with the design intent and original plan. Retrofitting the artificial light sources to obtain optimal light levels will be the means of correcting the problem. The need to retain the plant species is the driving force behind the changes.

043

THE EDUCATIONAL BENEFIT OF TWO DEMONSTRATION XERISCAPE GARDENS

Bobby Mottern* (Mary Haque and Judy Caldwell, Advisors), Department of Horticulture, Clemson University, Clemson, SC 29634-0375

Two xeriscape gardens have been designed for the purpose of educating the public about the importance of water conservation through xeriscaping. One was designed and implemented for a temporary exhibit at the South Carolina State Fair in October of 1991. The exhibit was cosponsored by the Clemson University Extension Service and Master Gardener programs.

The second garden has been designed for the Clemson University Botanical Garden. This will be a permanent addition to the botanical garden solely for display purposes. It is designed to be a model for students, professors, and the general public to observe and study principles associated with water conservation in the landscape.

044

STIMULATING LANDSCAPE AWARENESS FOR FUTURE GENERATIONS

Michael Hatchell* (Mary Haque and Judy Caldwell, Advisors), Department of Horticulture, Clemson University, Clemson, SC 29634-0375

The City of Clemson, South Carolina recently received funding from America the Beautiful to develop a community/government/educational partnership. The purpose of this project was to promote tree planting initiatives and awareness for future generations as well as to enhance our city and its roadsides. The project involved completing a tree inventory and landscape design for Highway 123, a major highway into Clemson. Presentations were made to city officials and approvals obtained by the highway department before implementation took place. Over 100 trees were planted and an educational pamphlet was published to illustrate the streetscape project and to serve as a guide for city officials. My presentation outlines the goals, methodology and results of this project.

045

AN EDUCATIONAL BOOKLET FOR HIGHWAY LANDSCAPE DESIGNS

Tracy K. Lee* (Mary Haque and Judy Caldwell, Advisors), Department of Horticulture, Clemson University, Clemson, SC 29634-0375

A program called "Writing Across the Curriculum" has been initiated in many universities across the nation. In response to this initiative, the Horticulture Department at Clemson University is promoting writing in all areas of study. As part of this effort, an independent study was conducted to produce an educational booklet providing an account of a major landscape project. The project involved a tree inventory, landscape designs, and tree plantings along Highway 123. This interdisciplinary effort was completed by the City of Clemson and Clemson University's Horticulture 308 Landscape Design class with funding from America the Beautiful.

Included in the booklet are student articles, concepts, and designs, as well as an account of the process they followed. Layout was completed on the Macintosh IIsi with Pagemaker software.

The South Carolina Forestry Commission is publishing the booklet, which will be used by local officials as they implement future phases of the project. It will also be distributed to communities throughout the South to be used as an educational tool, showing the process our city followed in enhancing our urban tree cover.

046

CERTIFICATION FOR PROFESSIONAL HORTICULTURIST

Mark e. Miller, Dept. of Horticultural Science Texas A&M Univ., College Station, Tx. 77843 (Dr. Benton Storey, Faculty Advisor).

Consumers of horticultural services deserve a standard to insure that practicing horticulturist have the necessary education, experience and continuing education to solve wide ranging problems from production horticulture to landscape management in an effective and environmentally conscious manner. A Certified Professional Sub-Board was established as a part of the American Registry of Certified Professionals in Agronomy, Crops, and Soils (ARCPACS) in November 1991. The ASHS support of certification of practicing horticulturist will primarily benefit those holding BS degrees. Forty percent of the American Society of Agronomy (ASA) 12,500 members highest earned degrees are BS and/or MS. By contrast only 5% of the 5,000 ASHS members are at the BS and/or MS levels. It is evident that ASA has been more perceptive of the needs of their undergraduate degree holders than ASHS. With the advent of CPH we can now begin to meet the needs of our BS and/or MS degree holders. Economic analysis reveals certification is beneficial to both the horticulturist and consumers.

34

ORAL SESSION 7 (Abstr. 047-054)

Floriculture:

Flowering Physiology

047

LONG DAYS PROMOTE FLOWERING OF *ARMERIA MARITIMA*

J.T. Lehmann and M.L. Albrecht*, Dept. Horticulture, Forestry and Recreation Resources, Kansas State Univ., Manhattan, KS. 66506-4002

Armeria maritima was studied to provide guidelines for flowering potted plant production. Seed and vegetatively propagated plants were exposed to 9-hr, 13-hr, or 17-hr photoperiods. Flowering was enhanced under the 13-hr and 17-hr photoperiods. Peduncle and leaf length were shorter, and plants were more compact under short days (SD, 9-hr photoperiod) than under long days (LD). When grown under SDs then moved at monthly intervals to LDs, the degree to which the compact growth habit (CH) was expressed was dependent upon the length of exposure to SDs. Plants with the CH produced fewer inflorescences than full growth habit plants.

Plants held in cold storage (4C) flowered more profusely under LDs, but had a delay in flowering. There was more uniform flowering for plants held in cold storage than those held in a cool greenhouse (7C night temperature).

048

INFLUENCE OF TEMPERATURE AND PHOTOPERIOD ON FLOWERING OF *ANIGOZANTHOS* HYBRIDS

Mark S. Roh*, Robert Griesbach, and Roger Lawson U.S. Dept. of Agriculture, ARS, PSI, Florist and Nursery Crops Lab., Beltsville, MD 20705, USA

Flowering responses of two *Anigozanthos* hybrids were investigated. Flowering of 20-week old 'Regal Claw' and *A. manglesii* x *A. flavidus* either from the main fan or the lateral fans was accelerated when plants received a night temp of 13 C, regardless of the photoperiod treatments. Temperature was the major factor controlling flowering of *Anigozanthos* hybrids. Flowering was accelerated from the lateral fans by treating plants at 15.5 or 18 C and a long day (LD) photoperiod. There were fewer than 2.5 branches in the stem at 18 C compared to more than 4.0 branches at 13 C. A night temp of 13 C was optimum for early flowering and for increased quality of cut flowers. At an inductive night temp of 13 C, *Anigozanthos* hybrids are day neutral while at 15.5 or 18 C they are quantitative LD plants.

049

GROWTH AND FLOWERING RESPONSE OF EASTER LILY CULTIVARS ACE AND NELLIE WHITE TO HID LIGHTS, BOTTOM HEAT, AND GROWTH RETARDANT TREATMENTS

Joseph Dallon, Jr.*, Ramapo College of New Jersey, Mahwah, NJ 07430

Easter lily cultivars Ace and Nellie White were treated with three concentrations of a-cyclopropyl-a-(p-methoxyphenyl)-5-pyrimidinemethanol [Ancymidol] and grown in a standard potting mix under normal greenhouse conditions and established cultural procedures with and without bottom heat and HID lights. A significantly greater number of flowers were produced in Cv. Ace when exposed to HID lights alone, and when given bottom heat in the absence of light. However, significantly fewer flowers were produced in this Cv. when exposed to combined treatments of light and heat. Bottom heat treatment resulted in significantly taller plants in Cv. Ace. Neither bud count, height, nor number of days to flower were affected in Cv. Nellie White as a result of exposure to supplemental light or bottom heat treatments. Neither concentration of Ancymidol resulted in increased flower production. However, it caused a reduction in flower production in Cv. Ace both in the presence and absence of HID lights, and in the heat plus light treatment. Ancymidol was most effective in height control when light was given and heat withheld. At concentrations of 125 and 250 ppm it was effective without regard for heat or light treatment combinations.

DETERMINATION OF SEASONAL FLOWERING PATTERNS FOR *HELICONIA* IN HAWAII THROUGH GROWER SALES RECORDS

R. A. Criley* and S. Lekawatana, Department of Horticulture, University of Hawaii, Honolulu, HI 96822

More than three dozen species of *Heliconia* have entered the cut flower trade since the expanded interest in bold tropical cut flowers began in the early 1980s. Most were wild-collected originally with little information on their habitats or season of bloom. A natural flowering season for some species can be found in the taxonomic literature, but it may be influenced locally by rainfall and drought periods as well as by photoperiod and therefore not reliable in indicating production periods in Hawaii. Sales records from 1984 through 1990 or several heliconia growers on Oahu reflected not only the quantities produced but also the time and duration of the blooming season. Such information is helpful in coordinating with the flower markets. Heliconia species of commercial interest with strong seasonal flowering periods are noted: *angusta*, *bihai*, *caribaea*, *caribaea* $\times$ *bihai*, *collinsiana*, *farinosa*, *lingulata*, *rostrata*, *sampaioana*, *stricta*, *subulata*, *wagneriana*.

051

ABSCISIC ACID LEVELS AND INFLORESCENCE ABORTION IN *HELICONIA STRICTA*

Setapong Lekawatana* and Richard A. Criley, Department of Horticulture, University of Hawaii at Manoa, Honolulu, HI 96822

Inflorescence abortion in heliconia contributes to an economic loss to growers. In an effort to determine the cause, we manipulated temperature, daylength and light intensity. Plants of *Heliconia stricta* cv. Dwarf Jamaican were grown in 4 day/night temperature regimes (15/10, 20/15, 25/20 and 30/25°C) under 14 hr daylength. In a separate experiment, plants were grown in full sun, 60% and 80% shade. Both experiments had been conducted after inflorescences were induced (4 weeks of short days). Apical meristems were dissected weekly to follow inflorescence development. Leaf abscisic acid level was detected by an indirect ELISA. Significantly more inflorescences were aborted in plants grown under high temperature regimes than in plants grown under low temperature regimes and under different light intensity. Abscisic acid concentration increased in heliconia leaves under regimes that induced inflorescence abortion. The results could provide a mean to improve heliconia inflorescence production.

052

A COMPARISON OF LEAF AND WHOLE PLANT NET PHOTOSYNTHESIS IN *ALSTROEMERIA*

E.D. Leonardos*, M.J. Tsujita, and B. Grodzinski, Dept. of Horticulture, Univ. of Guelph, Guelph, Ont., N1G 2W1, T.J. Blom, Hort. Res. Inst. Ont., Vineland Stn., Ont. L0R 2E0.

Gas exchange (net photosynthesis Pn, dark respiration, transpiration, and stomatal resistance) of 'Jaqueline' *Alstroemeria*, grown in pots in a greenhouse, were measured. Measurements were made under laboratory conditions using an open-flow infrared gas analysis system for leaf studies, and a semi-closed computer controlled whole plant photosynthesis system for whole plant studies.

Apical fully expanded leaves on non-flowering and flowering (at two stages) shoots had similar photosynthetic responses in respect to photosynthetically active radiation (PAR) and to CO₂ concentration. Light saturation occurred at 600 $\mu\text{mol}/\text{m}^2/\text{s}$ PAR with maximum leaf Pn rates ranging from 9 to 11 $\mu\text{mol}/\text{m}^2/\text{s}$. CO₂ saturation was estimated at approximately 1100 to 1200 ppm with maximum leaf Pn rates from 17 to 22 $\mu\text{mol}/\text{m}^2/\text{s}$.

Whole plant Pn rates increased with increased PAR. Maximum rates 4 to 5 $\mu\text{mol}/\text{m}^2/\text{s}$ (half that of individual leaves) occurred at approximately 1000 to 1100 $\mu\text{mol}/\text{m}^2/\text{s}$ PAR. CO₂ saturation was estimated at 1100 to 1200 ppm, with maximum whole plant Pn rates ranging from 7 to 8 $\mu\text{mol}/\text{m}^2/\text{s}$. These data will be discussed in relation to respiration and mutual shading at the leaf canopy.

(abstract withdrawn)

054

FACTORS INFLUENCING FLOWER BUD ABSCISSION OF POTTED *CAMELLIA*

Jong Suk Lee* and Cheon Young Song, Department of Horticulture, Chungnam National University, Daejeon 305-764, Korea

It has been a serious problem that flower buds of camellia (*Camellia* spp.) drop very easily when they are grown under unfavourable indoor conditions. To examine the factors affecting flower bud abscission, some cultivars of potted camellia (*Camellia japonica* L.) moved to various indoor conditions from greenhouse after flower buds were well developed. In general, double flowering cultivars showed more flower bud abscission than single flowering cultivars. Relative humidity (RH) severely influenced flower bud abscission. In 'Benidome' camellias, flower bud abscission reached to 90% under arid condition (30% RH) which resulted in very poor flowering (8%), whereas flower bud abscission recorded only 5% under humid condition (80% RH) which resulted in abundant flowering (90%). Flower bud abscission of camellias was little influenced by light intensity. Plants applied with 500 ppm ethephon produced a lot of ethylene and abscised all flower buds within a month. Ethylene accelerated the development of the abscission layer of camellia pedicels. Spray with 2 mM silver thiosulfate (STS) effectively prevented flower bud abscission of potted camellias. Polygalacturonase activity of abscission zones was correlated with the increase of flower bud abscission in camellias.

38

ORAL SESSION 8 (Abstr. 055–062)

Vegetable Crops: Seedling Establishment

055

INFLUENCE OF DRY-BACK TEMPERATURES AFTER SOLID MATRIX PRIMING ON SUBSEQUENT SEED PERFORMANCE

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The effects of the dry-back temperature on *sh2* sweet corn seeds primed via solid matrix priming combined with sodium hypochlorite (SMP_h) were studied. Seeds of two *sh2* sweet corn cultivars: Crisp N'Sweet 711 (CNS-711) and How Sweet It Is (HSII) were primed via SMP_h. After the treatment, the seeds were dried-back from 50-54% to 6-7% moisture content at 20, 30 or 40°C and 25% RH. The rate of dehydration was significantly lower in CNS-711 compared to HSII at all dry-back temperatures. In both cultivars, seed respiration after 4, 16, and 32h of imbibition was greater in those dried at 30 and 40°C compared to 20°C or non-primed seed. Enzyme activity (glutamic acid decarboxylase activity) was decreased in HSII seeds dried at 20°C. There were no differences among treatments in CNS-711. Leakage conductivity was significantly less when the seeds were dried-back at 30°C or 40°C compared to 20°C or non-primed seeds. Laboratory germination and seedling fresh weight were greater in seeds dried-back at 30°C compared to the others temperatures or non-primed seeds. The low rate of desiccation at 20°C (30h and 8h in CNS-711 and HSII, respectively) may not suppress germination events after priming, thus damaging the embryo during dry-back. This work demonstrated the importance of dry-back temperature to the efficacy of SMP_h seed treatment in *sh2* corn.

056

SEEDLING DEVELOPMENT OF SWEET CORN WITH LOW TEMPERATURE AND POTASSIUM

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Five supersweet cultivars of corn (*Zea mays* L. var. *rugosa*) were planted in fields and growth chambers to compare potassium effects on seedling development at low temperatures. In fields, seeds were planted at Urbana, IL, in 1991 when soil temperatures were 15°C (April) and 23°C (June). Potassium chloride (KCl) was banded at 0, 45 or 90 kg KCl/ha.

After 32 days 'Illini Gold', 'Florida Staysweet', and 'Crisp'n Sweet' were more developed than 'Honey'n Pearl' and 'How Sweet It Is' as indicated by emergence, height, leaf area and number, and weight in April. However for June, cultivar differences were observed only for emergence. KCl had no effect on any cultivars. In chambers, seeds were planted in trays (6x22x30 cm) of vermiculite mixed with 0, 5 or 10 g KCl/tray at 17 and 26°C. After 15 days, cultivar responses at both temperatures were similar to those at the April field planting except at 26°C where none differed for emergence. KCl only affected seedlings at 26°C when 10 g/tray slowed development. Thus more differences were found between cultivars at lower than higher temperatures, and potassium did not improve seedling development at low temperatures.

057

INDUCTION OF DORMANCY IN NONDORMANT LETTUCE SEEDS BY GA BIOSYNTHESIS INHIBITORS

Anwar A. Khan* and Claudinei Andreoli. New York State Agricultural Experiment Station, Cornell University, Geneva, NY 14456-0462.

Dormancy was induced in nondormant (germinate readily in light or darkness) seeds of several lettuce cultivars (Mesa 659, Emperor, Empress, Montello, Ithaca) by soaking in the dark in 5-100µM tetcyclacis (TCY) for 24h at 25°C as the seeds failed to germinate in the dark upon removal of TCY by washing. Higher concentrations of TCY was needed to induce dormancy in the light. Paclobutrazol (PP 333) was relatively less effective. No dormancy was induced in nondormant lettuce seeds soaked for 24h in 100µM ABA as the seeds germinated readily in the dark upon removal of the inhibitor by washing. Thus, contrary to popular belief ABA does not appear to be a dormancy factor. Dormancy induced by TCY was released by soaking seeds in petri plates in water at 25°C in the light, in the presence of 0.001-1mM GA₄₊₇, or by moist-chilling for 4-15d at 50°C. Dormancy was also released when dried dormant (dormancy induced by TCY) Mesa 659 or Emperor lettuce seeds were planted in a moist peat-lite mix in plastic containers and kept moist for 30d at 50°C, as indicated by emergence of normal, healthy seedlings upon transfer of the containers to 25°C. The significance of TCY induced dormancy in altering planting strategy in field plantings of lettuce and other crops will be discussed.

058

DORMANCY INDUCTION IN PEPPER SEEDS WITH TETCYCLACIS

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Seeds of six pepper (*Capsicum Anuum* L.) cultivars were treated with tetcyclacis (TCY), an inhibitor of the oxidative steps from *ent*-kaurene to *ent*-kaurenoic acid in the gibberellin biosynthetic pathway. Seeds were soaked in TCY solutions for 24h in darkness at 25° to 30°C, washed with water and then air-dried. Various concentrations of TCY were needed to induce dormancy in 'Yolo Wonder', 'Cayenne', 'California Wonder', 'Sweet Banana', 'El Paso' and 'Anaheim'. TCY-treated seeds were germinated in water and in various concentrations of GA₄₊₇ in darkness. Dormancy induced by TCY was released with 10 µM GA₄₊₇. The germination inhibitor, abscisic acid (ABA), failed to induce dormancy in pepper seeds even when treated at a concentration of 400 µM for up to 14 d. Similar results were obtained with tomato seeds and will be reported elsewhere. The results indicate that the absence or the unavailability of GA rather than the presence of ABA determines the dormant state in pepper seeds.

059

STORAGE OF TRUE POTATO SEED

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True potato seed of Atzimba x 104.12LB (intermediate dormancy) was dried to seed moisture contents ranging from 3.85 to 12.5% (dry wt basis) and was stored for 2 years at 30, 15 and 5°C. Seed was tested for various germination and seedling vigor criteria at 4 month intervals. Seed dormancy and viability were better preserved at seed moisture levels below 7% and as temperature decreased. High moisture (>9%) was lethal to seed stored at 30°C. TPS should be stored at <5% seed moisture content. Under this condition seed dormancy in the genotype studied was lost after about 12 months at 30°C.

060

LOCATION AND REMOVAL OF NATURAL-OCCURRING GERMINATION INHIBITORS FOUND IN PARSLEY SEED

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Germination inhibitors found in parsley (*Petroselinum hortense*) seed have serious effects on field establishment.

Studies have been conducted on chemical and physical attributes in relation to cultivar, age of seed and location of the seed on the seed stalk. Results indicate that the inhibitor is highly soluble in H₂O and can be removed with as little as a half-hour aqueous wash. Soaking 30 g (~500 seeds/g) of seed in an aerated graduated cylinder containing 100 ml distilled H₂O for 24 hours then applied to radish, lettuce, and parsley seeds revealed complete germination inhibition of these seeds. Decreasing the soaking time did not reduce the inhibitory effects of the solution. Location of the inhibitor within the seed was found to be specific to the seed coat. The amount of inhibitor present varied with the cultivar and seed lot within that cultivar. Size and age of the seed had little effect on the amount and strength of the inhibitor. Location of the developing seed on the seed stalk effected the amount of inhibitor present. Primary umbels contained the least amount of inhibitor when compared to the secondary and tertiary umbels.

061

ENHANCED GERMINATION OF CELERY AT STRESS TEMPERATURE VIA SOLID MATRIX PRIMING

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The high temperature severely reduces seed germination, emergence, and seedling uniformity in celery (*Apium graveolens* L.). Celery seeds were primed via solid matrix priming (SMP) using water or 1% sodium hypochlorite (NaOCl) solution at 1, 2, 3 or 4 ml rate for 2, 4, 6, 8, 10, 12 and 14 days. Moisture content of the seeds was calculated for each priming treatment and time interval. After priming, the seeds were dried back to the original dry weight. The germination percentage was calculated for each treatment at two different temperatures (15 and 30°C). The seed primed with NaOCl gained significantly less moisture during priming than the water treatment. Seeds primed with NaOCl had significantly greater germination at both 15 and 30°C, compared to seeds primed with water. The germination percentage of non-primed seeds was 83% and 2% at 15°C and 30°C, respectively. The final germination percentage at 30°C was increase to 85% when the seeds were primed with 3 ml of NaOCl for 14 days. The combination of SMP with NaOCl significantly reduced the negative effect of high temperature on celery seed germination.

062

EDAPHATIC FACTORS AFFECTING SEEDLING PERMANENT EMERGENCE

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Soil particle size was found to affect expansion and contraction of soil mass as moisture changed; thus all other seedling emergence stresses changed. Cohesion between soil particles is changed by soil type, content, and particle size, which in turn changes seed energy requirements for survival and emergence. The rates of germinating/emerging; seed/seedlings accelerated or stopped depending on moisture fluctuations and water degradation of aggregates. The same moisture content may be damaging in one soil and not in another. Many seedlings with developed radicals and hypocotyls did not emerge and were found in pockets of fine soil below 0.5mm; or as if their energy had been used up. Stands after emergence frequently varied greatly in vigor and survival by many units. Vigorized seed produced variable results depending on soil stress limitations during emergence. That is, laboratory differences did not always reflect in the field. The least critical stress period was between planting and the emergence of the radical--about 1/3 of the emergence time. Ideal seed beds often produced poor stands when water management and temperature were stressful. Packing density was found a good measure of seed-bed soil quality

39 ORAL SESSION 9 (Abstr. 063-070) Education and Extension

063

FAST, EFFECTIVE HANDS-ON ASSESSMENT OF STUDENTS IN HORTICULTURE CLASSES

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In an effort to improve higher education, most states now require non-graded assessment of students enrolled in publicly funded universities. Assessment may be across the

curriculum or within a major at graduation, yearly, or during individual courses or lectures. I have used two assessment techniques in my classroom that are effective and require a minimum of time. These techniques encourage student participation in class and allow for non-graded anonymous assessment in a manner that the students take very seriously. During the first class of the term students are handed filing cards and given 5 minutes to write their course objectives. By comparing their objectives with mine, I am able to react to student interests and needs in a constructive manner. At the end of one out of three lectures per week, students are given 1-2 minutes to write the "muddiest point" of the day's lecture. This enables the instructor to determine which points need further clarification. Discussion will focus on these techniques and their implications for learning horticulture at both the graduate and undergraduate levels.

064

USING EXPRESSIVE WRITING TO IMPROVE HORTICULTURAL EDUCATION

Doug S. Foulk* and Emily E. Hoover, Horticultural Science, University of Minnesota, St. Paul, MN 55108

Horticulture students in an entry-level course (Plant Propagation) and an upper-level course (Small Fruit Crop Production) were assigned brief writing tasks at the end of each class period based upon that day's lecture. Student writing was intended to be expressive in nature, i.e., for the author's use only. For the first five minutes of each class period, students divided into small groups to discuss possible responses to the previous day's task and to generate questions related to the task topic. The class then reconvened as a whole for a question-and-answer session before lecture was resumed. Students collected their writings in a workbook which they turned in for experimental evaluation only at the end of the quarter. When compared to previous and concurrent sections of the same courses, students engaging in the writing tasks asked more numerous and thoughtful questions in class and demonstrated increased ability to perform well on complex exam questions requiring integration and synthesis of information.

065

PROFESSIONAL EXCHANGE: A NEW EDUCATIONAL PROGRAM OFFERED BY THE CHICAGO BOTANIC GARDEN.

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In 1989, the Chicago Botanic Garden implemented the Professional Exchange Program for people employed in educational institutions, public gardens, and museums. Other institutional members of the American Association of Botanic Gardens and Arboreta are also beginning to develop similar programs. These "working sabbaticals" at public gardens provide private and commercial sector, as well as academic professionals in horticulture education, management, research, and botany with a unique career opportunity. Experiential education is an inexpensive, short-term, highly effective way to expand and strengthen one's present knowledge and skills and stay on the "cutting edge" of horticulture. Participants work and study with peer-professionals exchanging ideas and expertise in a one-on-one applied setting. Existing programs are reviewed and information provided on how to participate with public gardens and how to develop one in your own area.

066

QUILCHIHUACAYOTL, THE CHILDREN'S HORTICULTURE COURSE

Hernandez Z.*, C.C. & Balcazar S.T. Jardin Botanico del Instituto de Biología de la U.N.A.M. Apdo. Postal 70-614, C.P. 04510. Mexico, D.F. Mexico

QUILCHIHUACAYOTL is the name of the children's course that is given in the botanic garden of the Universidad Nacional Autónoma de México. This nahuatl name means "Orchard Culture". It was initiated 20 years ago as a summer's Course of 1 month duration. Both Horticultural activities and Mexican Cultural Aspects are stressed. In order to accomplish these objectives, we have designed several educational materials and games.

067

FARMER'S BOOKSHELF™: HYPERMEDIA INFORMATION SYSTEM TO RECOMMEND GROUND COVERS

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Hawaii has had a large growth in housing, and with the reduced lot sizes of single family dwellings has come interest in using ground covers to landscape limited areas. As residential areas are being located on less desirable lands, there is a need to select ground covers that do well in these areas. The objective of this study was to develop a hypermedia information system to recommend ground covers and to obtain information on individual ground covers. Using the software HyperCard® on the Macintosh® computer, we developed a system that uses the idea of index cards with information being stored on separate screens called "cards." Using a mouse, the user navigates from one card to another by clicking on a "button" on the card. The user may select up to four criteria from 33 criteria including plant height, elevation, soil moisture, flower color, erosion control, and shade. The program then finds which of 48 ground covers meet the desired criteria and provides information on these ground covers. This easy-to-use system requires no typing except to enter a word to search for. The user can quickly browse for the desired information and save it as a text file or print it. The Farmer's Bookshelf™ provides a tool for extension agents and growers to obtain easily vitally needed information. The program has further application for landscape companies, Master Gardener programs, and in horticultural courses.

068

AN ALGORITHM FOR COMPUTERIZED PERENNIAL FLOWER GARDEN DESIGN

Lauren E. Howell and Michael N. Dana*, Department of Horticulture, Purdue University, West Lafayette, IN 47907-1165

The use of perennials in the garden and landscape is an area of much confusion for the home gardener. A customer-interactive computer program for point-of-sale marketing of perennials in garden centers which assures horticultural and aesthetic success is a potential solution to this problem. Literature of herbaceous perennials and perennial garden design was surveyed and landscape design professionals were interviewed to develop a complete algorithm for designing perennial border gardens. The assembled data were incorporated into the algorithm in the form of plant selection and placement rules and plant attribute hierarchies. The planting plan algorithm was tested and the resulting test gardens were critiqued by landscape design professionals. The algorithm was successful in designing horticulturally correct and aesthetically pleasing perennial border gardens. This algorithm is ready to be coded into a computer program for use as a customer-interactive, point-of-sale marketing tool.

069

READ THE LABEL, A PESTICIDE SAFETY VIDEO TAPE

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The general public is in need of education regarding the responsible use of pesticides in home gardens. A 1990 California survey indicated that many individuals never read product labels and do not follow safety precautions when applying pesticides. A 1991 EPA study found that the most frequently detected pesticide in well water was a breakdown product of DCPA, a commonly used herbicide on home lawns. A 1988-89 National Gardening Survey found that 39% of US households purchased pesticide products. Excerpts of a video tape titled "Read the Label", which specifically targets the home gardening audience, will be presented. Because the subject of pesticide safety may be of little intrinsic interest to gardeners, actors were hired to lend a bit of light humor. Highlights feature Gordon Guardian, the Gardening Angel, who comes to Earth to guide Beth Homeowner through the proper selection, use, hazards, storage, and disposal of pesticides. Production methods, funding and budgeting of the video will also be discussed.

070

REACHING NEW EXTENSION AUDIENCES THROUGH RECERTIFICATION PROGRAMS

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Ten percent (10%) of all restricted use pesticide (RUP) applicators certified by the Fla. Dept. of Agric. & Consumer Serv. (FDACS) reside in Dade County, Florida. Through a joint agreement, the Fla. Cooperative Extension Service (FCES) provides training and testing and FDACS issues private, public and commercial RUP licenses. In 1991, the Dade County Pesticide Trainer analyzed licensing patterns for Dade County's 1454 applicators to determine training needs. She developed a Pesticide Advisory Committee which prioritized 3 of the 14 categories of licenses--Aquatics (weed

control), Ornamental & Turf (O&T), and Right-of-Way--for initial certification and recertification classes. It also coordinates programs to reduce duplicated efforts. During 1991, training for initial certification was offered once for Aquatics and twice for O&T. Classes for 1992 have been expanded, placing emphasis on recertification as well. Programs for recertification credits are an ideal way for the extension service to promote sound horticultural management practices which may be new to many commercial and public applicators since they are not part of traditional extension clientele groups.

40 ORAL SESSION 10 (Abstr. 071-077) Subtropical/Tropical Fruits: Stress Physiology

071 AROMATIC COMPOUNDS AND WATER RELATIONS OF SOUR ORANGE SEEDLINGS.

Dariusz Swietlik, Texas A&I University Citrus Center, Weslaco, TX 78596

Sour orange seedlings were grown in water culture to which one of seven aromatic compounds, associated with allelopathic effects, was added to produce concentrations ranging from 0.5 to 2.0 mM. Leaf water potential (ψ_l), leaf stomatal conductance (g_s), and whole plant transpiration (T) were measured during a 7-day treatment period. At the end of that period, the total and average leaf surface area, shoot elongation, and fresh weight gain of seedlings were determined. Solutions of vanillic, coumaric, and ferulic acids of 2mM concentration reduced ψ_l , g_s , and T. Reductions of g_s and T but not ψ_l occurred when vanillic acid of 1mM concentration was applied. Solutions of vanillic (0.5; 1.0; 2.0mM), coumaric (1; 2mM), cinnamic (1mM), or chlorogenic (1; 2mM) acids reduced fresh weight gain of seedlings. Only the coumaric and chlorogenic acids treatments of 2mM concentration reduced shoot elongation. No treatment affected total or individual leaf area. Gallic and caffeic acids had no effect on sour orange water relations and growth.

072 EXTRACTS FROM ASH ROOTS AND VELVETLEAF AFFECT WATER STATUS OF SOUR ORANGE SEEDLINGS

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Water extracts of cocklebur (CBX (*Xanthium spinosa* L.) and velvetleaf (VLX (*Abutilon theophrasti* Medic.) shoots and Mexican ash (AshX (*Fraxinus berlandieriana* A.DC.) roots were added to 9 month-old sour orange (*Citrus aurantium* L.) seedlings (SOs) in water culture. Final extract concentrations represented either 50 or 12.5 g. of plant material liter⁻¹ of culture solution, i.e. 1/20 or 1/80 dilutions. Leaf water potential (ψ); stomatal conductance (g_s); transpiration (T) and growth responses were measured for 13 days. After 1 day, SOs in AshX and CBX had lower ψ than controls. After 11 days SOs in CBX had higher ψ than the others. ψ responded similarly to both extract concs.. Thru day 5, AshX decreased g_s vs. the controls and VLX. By day 11, g_s of SOs in AshX was less than for VLX but not the others. On days 1 and 5, g_s for VLX at 1/20 was lower than controls but at 1/80, g_s 's were the highest of all treatments. These results supported by the T rates, growth responses and others findings suggest AshX and VLX induce water stress by reducing water absorption and/or transport in addition to possibly disrupting normal root/shoot communications

073 GROWTH, MINERAL NUTRITION, AND LEACHING LOSSES FROM SALINIZED CITRUS TREES

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Effects of salinized irrigation water on tree canopy and root growth, water use, foliar nutrition, and leaching losses below the rootzone were studied during a 2-year period using single tree lysimeters. Eighteen 6-year-old 'Valencia' orange trees on either Carrizo citrange (CC) rootstock or sour orange (SO) rootstock were each transplanted into 7.8 m³ drainage lysimeters and irrigated with water having an electrical conductivity of 0.3, 1.6, or 2.5 dS m⁻¹ from a 3:1 ratio of NaCl:CaCl₂. Six additional trees (3 on each rootstock) were transplanted into soil without tanks. Trees outside

the tanks were smaller, but nutritionally similar to the low salinity trees in lysimeters. Trees on CC were larger, had greater root densities, and were associated with less leaching of ions and nutrients into drainage water from the tanks than trees on SO. High salinity irrigation water reduced canopy growth and ET, but increased fibrous root dry weight. Trees on CC accumulated more Cl in leaves and in fruit juice than those on SO. Leaching loss of total N varied from 2-8% of that annually applied to trees, but up to 70% of the applied N and up to 80% of the applied K were leached from the blank tank with no tree. Salinized trees lost more N and K to drainage water, especially those on SO. Tree size, root density, and irrigation water quality can influence leaching losses beyond the rootzone.

074 CARBON ECONOMY IN SOUR ORANGE IN RELATION TO MYCORRHIZAL COLONIZATION AND PHOSPHORUS STATUS

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The effects of phosphorus (P) and of the mycorrhizal (M) fungus, *Glomus intraradix*, on the carbon (C) economy of sour orange (*Citrus aurantium* L.) were determined during and following active M colonization. There were four treatments: mycorrhizal seedlings grown at standard-strength P (M1) and nonmycorrhizal (NM) plants grown at 1, 2 and 5 times standard-strength P (NM1, NM2 and NM5). Mycorrhizal colonization, tissue dry mass, P content, root length, leaf area, ¹⁴C partitioning and rate of C assimilation (A) were determined in five whole-plant harvests from 6 to 15 wks of age. In contrast to the effects of P nutrition on C economy in sour orange, M effects were generally subtle. Mycorrhizae increased the root biomass fraction, the root length/leaf area ratio, and the percent of ¹⁴C recovered from belowground components. Mycorrhizal plants had a higher percentage of belowground ¹⁴C in the respiration and soil fractions than did NM plants of equivalent P status. Mycorrhizal plants tended to have enhanced A at 8 wks but not at 7 or 12 wks. This temporarily enhanced A of M plants did not fully compensate for their greater belowground C expenditure, as suggested by apparently lower relative growth rates of M than NM plants of equivalent P status. Problems of interpreting the dynamic effects of mycorrhizae on C economy that are independent of P nutrition are discussed.

075 OLIVE FREEZE DAMAGE IN CALIFORNIA

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Record low temperatures were experienced in California during the last 10 days of December, 1990. Olive trees in both the Sacramento and San Joaquin Valleys suffered damage from the freeze. The lowest minimum recorded in these areas was -11.6C at Willows (Glenn Co.). Types of damage included death of succulent growing tips, defoliation, bark split, and bark and xylem discoloration. Tree death to the ground was uncommon. Defoliation continued throughout the growing season, and many leaves that persisted became chlorotic. Major outbreaks of olive knot disease caused by *Pseudomonas savastanoi* were seen in damaged trees, especially in 'Manzanillo.' Anatomical studies showed evidence of ice nucleation events in the phloem, xylem, and leaves, but the cambium was usually left intact. Refoliation and healing of bark splits progressed rapidly once growth resumed in the spring, except in cases of olive knot infestation. Cultural practices that predisposed trees to freeze damage were those leading to late-season vegetative growth, namely fall pruning and late or excessive irrigation or fertilization. 'Manzanillo' is the least cold-hardy of California cultivars and the most susceptible to olive knot. 'Barouni' is the most hardy.

076 EFFECT OF WIND SPEED ON CARBON ASSIMILATION, WATER RELATIONS, AND GROWTH OF YOUNG CARAMBOLA AND SUGAR APPLE TREES

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The effect of wind stress on growth, net CO₂ assimilation (A), and leaf water potential of eighteen-month-old, containerized carambola (*Averrhoa carambola* cv. Arkin) and seedling sugar apple (*Annona squamosa*) trees was investigated. In a glasshouse, trees were exposed to fan-generated wind speeds of 0 (control), 4 (low wind; LW), or 7 (high wind; HW) m sec⁻¹ for 4 hr/day (1000-1400 hr) for 30 days. No differences in A, stomatal conductance, transpiration, and fresh and dry wt of mature carambola or sugar apple leaves or shoots were observed among treatments. In contrast, as wind speed increased, fresh wt of immature carambola leaves and shoots decreased. For carambola and sugar apple, no significant relationship was found between mid-day leaf water potentials and wind speed. However, after 30 days, leaf water potential of carambola subjected to HW (-1.2 MPa) was lower than those of LW (-1.1 MPa) and control (-1.1 MPa) trees. For sugar apple, leaf water potential of control trees was generally higher than those of trees in the LW and HW treatments. The data indicate that exposure to wind speeds of 4 or 7 m sec⁻¹ for as little as 4 hr/day for 30 days reduces new leaf and shoot growth of carambola trees.

ESTIMATION OF ACTUAL AND POTENTIAL EVAPOTRANSPIRATION OF MANGO IN BAJA CALIFORNIA SUR, MEXICO

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Mango (*Mangifera indica* L.) has been grown since the beginning of the century in Baja California Sur, one of the most arid states of México. Since water is a very scarce resource in this area, the estimation of water consumption by popular crops becomes a relevant aspect of hydrological research. Actual (ET_a) and potential (ET_p) evapotranspiration of mango c.v. Kent were estimated in the Experimental Station of CIB, located 17 Km west La Paz city. Trees under study were three years old; irrigation frequency was 14 days and depth of applied water was 0.15 m, a common amount in the region. Estimates for ET_p were carried out through two indirect methods (Blaney-Criddle and Penman equations), and ET_a by a direct method (a diffusive porometer). Data were fitted according to the total leaf area (TLA). Estimates from the indirect methods were 31 and 25% respectively greater than those given by the porometer. Main results ($ET_a = 0.5 \text{ cm day}^{-1}$, or $0.07 \text{ m H}_2\text{O}/14 \text{ days}$) suggest that a 40 to 50% reduction in the applied water depth is feasible in the region.

41 ORAL SESSION 11 (Abstr. 078-085)

Biotechnology:

Gene and Genome Mapping

EXPRESSION OF ETHYLENE BIOSYNTHETIC PATHWAY mRNAs DURING CARNATION FLOWER SENESCENCE

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The senescence of carnation (*Dianthus caryophyllus* L.) flower petals is associated with increased synthesis of the phytohormone ethylene. This ethylene serves to initiate and regulate the processes of programmed cell death. We are using molecular approaches to study the regulation of ethylene biosynthesis in various floral organs during development and senescence of flowers. We have isolated and cloned mRNAs which encode the ethylene biosynthetic pathway enzymes S-adenosylmethionine (SAM) synthetase, 1-aminocyclopropane-1-carboxylate (ACC) synthase and the ethylene forming enzyme (EFE) from carnation flower petals. These cDNAs have been used as molecular probes to determine the steady-state mRNA levels of these transcripts in senescing flowers. The increase in ethylene associated with petal senescence is accompanied by a dramatic increase in the abundance of transcripts for both ACC synthase and EFE. In striking contrast, the level of SAM synthetase mRNA decreases significantly with the onset of petal senescence. Genomic DNA Southern blots reveal both ACC synthase and EFE are encoded by multigene families. We have recently isolated several genomic clones from carnation which represent different ACC synthase genes. The structure and organization of these gene will be presented.

MOLECULAR CHARACTERIZATION OF A POLYGALACTURONASE INHIBITOR OF PEAR FRUIT

Henrik Stotz*, Ann Powell, Susan Damon, Audrey Hentzen, Carl Greve, Alan Bennett, John Labavitch, Department of Pomology and Department of Vegetable Crops, University of California, Davis, CA 95616.

Higher plant inhibitors of fungal polygalacturonases are potential contributors to plant defense. To test this hypothesis we have raised antibodies against the 'Bartlett' pear fruit polygalacturonase inhibitor (PGIP) and cloned a pear fruit PGIP cDNA. The pear PGIP cDNA was isolated by polymerase chain reactions based on our amino acid and nucleotide sequence information. Sequence analysis predicts a gene product of 34.5 kD with an isoelectric point of 6.02 in agreement with our biochemical data. Seven potential glycosylation sites are consistent with the glycoprotein character of these PGIPs. Southern blot analysis suggests the presence of 1 or 2 genes in the pear genome. Northern blot analysis indicates the presence of a transcript of 1.5 kb. Western blot analysis shows cross-reactivity of the anti-pear PGIP antibody to various dicot species as well as corn.

ANALYSIS OF THE NUCLEAR GENOME, AND CONSTRUCTION OF A GENETIC MAP FOR PEACH [*Prunus persica* (L.) BATSCH.].

Vance Baird¹*, L. Belthoff², R. Ballard², R. Scorza³, A. Callahan³, R. Moner⁴ and A. Abbott².

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Flow cytometric analysis of leaf nuclei from three cultivars, was used to estimate the DNA content of peach (~0.61 pg or ~0.59 x 10⁹ bp/diploid nucleus; 2x=16), and indicated that the peach genome is only slightly larger than that of *Arabidopsis*. This value was indirectly confirmed by measurements of nuclei from haploid, triploid and "tetraploid" (cytochimera) peach accessions. cDNA and genomic clones have been used to determine the level of polymorphism among various peach cultivars and related species. Overall, ~33% of the clones detected polymorphic loci. As expected, the highest level of polymorphism was found in interspecific hybrids (~50%); whereas in intraspecific populations, only 1 in 5 genomic clones, and 1 in 3 cDNA clones were able to detect polymorphisms (RFLPs). These clones, as well as RAPD primers, are being used to construct a genetic linkage map by analyzing their segregation in 3 intraspecific peach populations (an F1 from France and two F2s from the U.S.). Taken together, these populations are segregating for 12 Mendelian traits and a number of quantitative traits. Our results have enabled us to identify a number of linkage groups, some composed of both molecular and phenotypic markers. The current structure of the peach map is reported.

NUCLEAR DNA CONTENT IN BLUEBERRY DETERMINED BY FLOW CYTOMETRY

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DNA flow cytometry was used to determine nuclear DNA content in diploid blueberry species, and 3x, 4x, 5x, and 6x ploidy levels. Relative fluorescence intensity of stained nuclei measured by flow cytometry was a function of the number of chromosome sets (X): $Y = 3.7X - 2.3$ ($r^2 = 95.1\%$). DNA flow cytometry should be useful for ploidy level determination in the seedling stage. A significant linear relationship was established between nuclear DNA content and number of chromosomes (x); $\text{DNA (pg)} = 0.52 \times_1$ ($r^2 = 99.8\%$). Based on this equation the haploid genome DNA amount (1C) was calculated as $0.62 \pm 0.08 \text{ pg}$, with an approximate haploid genome size of 602 Mbp/1C. The results indicate that conventional polyploid evolution occurred in the section *Cyanococcus*, genus *Vaccinium*: the increase in DNA was concurrent with increase in chromosome number. DNA content differences among 2x species were correlated with Nei's genetic distance estimates based on 20 isozyme markers. Most of the variation was among species (49%), with 26% between populations within species, and 25% within populations.

CHANGES IN GENE EXPRESSION ASSOCIATED WITH CHILLING-UNIT ACCUMULATION IN DIFFERENT SPECIES OF BLUEBERRY

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There is evidence from several plant species that low, nonfreezing temperatures induce the accumulation of specific proteins in leaves and stems. Only recently, however, have attempts been made to identify changes in gene expression in dormant buds of woody plants in response to chilling. For our investigations, we have used dormant blueberry plants representing three different species, placed them in a room maintained at about 4°C, and collected buds after 0, 500, 1000, and 1500 hours. Proteins were extracted from bud samples and analyzed by SDS-PAGE. Results indicated that various cultivars and species responded differently to chilling unit accumulation. The most dramatic changes were noted in the V. corymbosum cultivar 'Bluecrop'. The concentration of about 6 polypeptides with molecular weights ranging from 60-115 kD increased by 500 hours. The concentration of a 17.5 kD polypeptide increased after 1000 hours and the concentration of a 114 kD polypeptide decreased throughout the treatment.

EXPRESSION AND PURIFICATION OF THE IPT GENE

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The *ipt* gene of *Agrobacterium tumefaciens* T-DNA encodes for isopentenyl transferase, which is an enzyme active in cytokinin biosynthesis. While it is known that cytokinins are associated with *in vitro* promotion of cell division and

stimulation of shoot production, little is known about their mode of action. As the first step in localizing cytokinin synthesis, we present a cloning and expression strategy for the *ipt* gene. The source of the *ipt* gene was *Agrobacterium tumefaciens* octopine Ti plasmid 15955. The *ipt* gene was amplified by the polymerase chain reaction (PCR) and cloned into pMal-c2 (New England Biolabs, Beverly, MA). This construct was transformed into *E. coli* and the *ipt* gene was expressed as a fusion protein. The protein was purified by affinity chromatography to serve as an antigen for polyclonal antibody production. These antibodies will be used to localize isopentenyl transferase in plant tissue.

084

USE OF RAPD TECHNOLOGY IN CUCUMBER

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Fruit yield in cucumber is limited by the nature of its fruiting habit. Manipulation of plant architecture is one way of increasing yield potential in cucumber. We are incorporating a multiple lateral (ML), sequential fruiting habit into a determinate (de) background. Misclassification of mature plants occurs because the de character is difficult to identify in a ML/de background. It would be valuable to develop an inexpensive laboratory test which would allow accurate classification of ML/de plant types. To develop such a test, we have begun the use of a new DNA marker system, random amplified polymorphic DNA (RAPD). We performed a series of experiments designed to test the reproducibility and predictability of RAPDs. Data indicated that RAPD patterns were not significantly affected by tissue age, infection with powdery mildew or bacterial wilt, or presence of fruit. F1 RAPD polymorphisms segregated in predicted 3:1 ratios. A survey of 6 ML lines and 1 de line with 400 primers identified 4 polymorphisms shared by all ML lines and diagnostic for the de line. No association was found between any of these markers and the de character.

085

THE ISOLATION OF FLAVONOL MUTANTS IN *ARABIDOPSIS THALIANA*.

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Depletion of the ozone layer is increasing the amount of UV-B radiation reaching the earth's surface. The enhanced aging and mutation associated with UV-B damage suggests that crop yields may be threatened. However, plants are protected by flavonols which absorb UV-B. Although a great deal of research has been done on the flavonols, progress has been hampered by their lack of color. To overcome this problem, a staining procedure that provided sensitive and specific fluorescence identification of flavonols in *Arabidopsis thaliana* was developed. Three T-DNA insertional mutants, which lacked flavonols were identified, and the heritability of each has been confirmed by its multiple occurrence in the parental line. The mutants are being outcrossed, and analysis of the F2 will test if any of the mutations are tagged by a T-DNA insert. If so, the tagged gene will then be cloned.

42 ORAL SESSION 12 (Abstr. 086-093) Collegiate Branch Forum II

086

USE OF A DOUBLE PHASE (LIQUID OVERLAY) CULTURE SYSTEM TO ENHANCE SHOOT QUALITY AND ROOTING RESPONSE IN MINIATURE ROSES

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Use of a liquid media during micropropagation has promoted improved proliferation and rooting response in several species. In this experiment, a double phase system (a combination of liquid and agar solidified medium) was applied to three cultivars of miniature roses (*Rosa chinensis* var. *minima*) to determine the effects on shoot quality and subsequent ex-vitro rooting. Applications of liquid media to the surface of agar solidified media were made at 0, 2, and 4 weeks. Evaluation via computerized image analysis after eight weeks of proliferation revealed equal or greater values for shoot length, area and weighted density

(equivalent to fresh weight) for cultures receiving overlay, regardless of timing, compared to the solid media control. Additionally, application of a liquid overlay improved rooting response by up to 20% over the control and resulted in a tendency for a greater number of roots of greater length and area than the treatment without liquid media overlay.

088

INFLUENCE OF SEED TREATMENTS ON GERMINATION OF *Aleurites fordii*

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The tung-oil tree (*Aleurites fordii*) was planted extensively in the southeastern United States in the 40's and 50's for their high quality oil used in jet engines and paint. Elimination of import tariffs destroyed the US industry. There is a possibility of a resurgence in popularity of this species as an ornamental because of its large leaves, spring flowers, and dense growth. If nurseries begin growing tung-oil trees they must have more information on the most efficient means of seed germination. One hundred percent of the seeds with intact shells germinated in 9 weeks if they received either 24 hr stratification or 24 hr. soak. Eighty-three percent of the untreated intact seeds germinated in the same period. Shell removal sped up germination as evidenced by 27% germination in 5 weeks. However the process left seeds susceptible since only 36% had germinated in 9 weeks.

089

THE EFFECT OF ALGAE AND ALGICIDAL TREATMENTS ON HYDROPONIC STRAWBERRY PRODUCTION

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Some countries have achieved success in growing strawberries hydroponically. These countries, however, attain a higher price for produce. Algae growth in strawberries and other hydroponic operations has been reported as a potential limiting factor. Three treatments were set up using a modified NFT system; a control in which algae was allowed to grow, a treatment physically covering all the nutrient solution to prevent contact with light, and a treatment of 1 ml metam-sodium in 100 liters nutrient solution. Measurements of yield, nutrient composition, plant survival, and runnering were taken. There was no significant difference in nutrient consumption among the treatments. There were significant differences in time to first fruit, yield, and runnering. Metam-sodium inhibited runner production. The treatment that excluded light from the nutrient solution resulted in prolific runnering and had larger fruit size.

090

EARLY SCREENING OF APPLE SEEDLINGS FOR CALCIUM UPTAKE.

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Seedling of "Cortland" and "Idared" apples (*Malus domestica*) were grown in hydroponics and the shoots and roots were evaluated for percent concentration of calcium. "Cortland" is reported to be efficient in calcium uptake in comparison to "Idared", reputed to be less efficient in calcium uptake and utilization. The seedlings were grown in hydroponic solutions containing calcium ranging from 0.5 ppm to 3.0 ppm concentrations. The shoots and the roots of the seedlings were analyzed for calcium content after 45 days. "Idared" seedling roots and shoots had higher calcium content at 0.5 ppm. However, at 1.5 ppm and at 3.0 ppm "Cortland" seedlings appear to be more efficient at calcium uptake. Early screening may be a useful tool in helping apple breeders select future cultivars that are more efficient at calcium uptake

091

MATURATION AND STORAGE OF FUJI APPLES (*Malus domestica* Borkh) Xuetong Fan*, J.P. Mattheis, M.E. Patterson, and J.K. Fellman

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Several strains of Fuji apples were harvested weekly from September through October in 1990 and 1991, and evaluated for maturation and quality after 1 and 7 days at 20 °C following harvest

and storage in atmospheres of 0.5%, 1.0%, 2.0% O₂ and air. Results showed that Fuji apples have very low ethylene production rates and little firmness loss during maturation. A change in the postharvest respiration pattern preceded the increase ethylene synthesis. Oxygen concentration during storage directly affected apple respiration rate after removal from storage. Ethylene production rates and internal ethylene concentrations indicated that the apples were still in the preclimacteric stage after 7 to 9 months storage at 0.5%, 1.0%, or 2% O₂. Fuji apples develop watercore and tend to have a particular type of corebrowning during maturation on the tree, or during and after storage. The cause is unknown.

092

POSTHARVEST CaCl₂ DIPS INCREASE Highbush BLUEBERRY FIRMNESS

Jane Beggs*, Dept. of Horticulture, Michigan State University, East Lansing, MI 48824 (E. Hanson and R. Beaudry, Faculty Advisors).

Deformed or damaged berries reduce the grade of frozen highbush blueberries (*Vaccinium corymbosum* L.). Before berries are frozen, immature fruit are commonly removed by density sorting in water tanks. Three studies were conducted to determine if the firmness or quality of highbush blueberries could be improved by the addition of CaCl₂ to sorting tank water. 'Bluecrop' and 'Jersey' berries were dipped in CaCl₂ solutions (0.0-4.0%) for periods of 0.5-8.0 minutes. The effect of rinsing the fruit after treatment was also studied. Berries were held at 2C for several days before evaluation. A 61.5 cm length of PVC pipe (4.0 cm. I.D.) was filled to a depth of 50 cm. with berries and dropped 4 times on to a hard surface from a height of 10 cm. The compression of the column of berries was measured and berries were removed and visually sorted according to the degree of damage. The amount of compression and number of damaged berries were inversely related to the CaCl₂ concentration. Rinsing berries immediately after dips negated the effects of CaCl₂. Treatment with CaCl₂ may result in objectionable flavors.

093

PHOTOSYNTHESIS STUDIES OF TOMATO TRANSPLANTS SUBJECTED TO VARIOUS LIGHT SOURCES.

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A photosynthesis study was conducted on seedlings of *Lycopersicon esculentum* L. cv. "Traveller 76" subjected to natural, clear, blue and red color irradiations to predict and evaluate harvest time and yield potential. Photosynthesis (PS) rates were higher on clear and red irradiated transplants with 16.1 and 12.4 $\mu\text{Mol/m}^2/\text{s}$, respectively, for two weeks of treatment. Blue irradiation showed lowest PS rate with 2.2 $\mu\text{Mol/m}^2/\text{s}$. For the third and fourth weeks of treatment, PS rate increased to 10.9 and 13.5 $\mu\text{Mol/m}^2/\text{s}$, respectively, on blue light treated transplants, while red, clear and natural light treatments decreased. CO₂ appears to be lowest at high PS rate under these treatments. Transplants treated with blue and red lights were taller and thicker around the stem. Clear and natural lights were shorter, but with a larger root biomass. PAR (Photosynthetically Active Radiation) was highest at noon under open natural light with 1108.8 $\mu\text{E/s/m}^2$, but also high for blue, red and clear lights when compared to earlier or later time. The lowest PAR was shown for blue and red lights.

51 ORAL SESSION 13 (Abstr. 094-100)

Floriculture: Nutrition

094

CORRELATION BETWEEN NUTRIENT CONCENTRATION AND TISSUE CONTENT OF MICRONUTRIENTS IN GERANIUM, MARIGOLD, AND PETUNIA

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and Jong-Myung Choi, Dept. of Horticultural Science, North Carolina State University, Raleigh, NC 27695

Correlations between the nutrient solution concentration and tissue content of micronutrients were determined for geranium, marigold and petunia. When nutrient solution contained 0.25, 0.5, 1, 2, 3, 4, 5, 6 mM of boron (B), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo) and zinc (Zn), the tissue content of each microelement increased linearly with increasing levels of the same micronutrient in the fertilizer. Equations for these correlations were established for the six micronutrients used for each species. Increasing levels of micronutrients did not influence tissue macroelement contents. Increasing levels of one micronutrient had little influence on the accumulation of other micronutrients in the tissue. Plant toxicity symptoms developed when the leaf content of microelements increased to a level 5-10 times that of plants grown with the control (Hoagland) solution.

095

EFFECT OF CONTROLLED-RELEASE AND CONSTANT LIQUID FERTILIZATION ON LEACHATE AND PLANT QUALITY

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Poinsettias (*Euphorbia pulcherrima* 'Gutbier V-14 Glory'), chrysanthemums (*Dendranthema grandiflora* 'Tara') and geraniums (*Pelargonium hortorum* 'Orbit') were grown using various ratios of controlled release:constant liquid fertilization as a percentage of recommended rates (%CRF:%CLF). While plants grown under the 100:0 CRF:CLF regime produced significantly less nitrates, phosphates and total soluble salts in the leachate than 0:100 or 50:50 CRF:CLF, quality rating, plant diameter, and leaf, bract and flower dry weight of poinsettias and chrysanthemums were reduced. Geraniums grown under 100:0, 50:50 or 0:100 CRF:CLF regimes were similar in quality rating, height, diameter, dry weights and days to anthesis. Poinsettias and chrysanthemums grown under 50:50 CRF:CLF were similar in height, days to anthesis, plant diameter, flower and stem dry weights and quality rating but produced less nitrates, phosphates and total soluble salts in the leachate than plants grown under 0:100 CRF:CLF. However, chrysanthemums grown under 50:50 CRF:CLF had lower leaf and root dry weights and poinsettias had lower leaf and bract dry weights than under 0:100 CRF:CLF regime.

096

GROWTH OF MULCHED GERANIUMS USING RECYCLED TOP- AND SUB-IRRIGATION.

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Recycled subirrigation systems are a possible solution to grower concerns over water use, ground water pollution, and regulations concerning these. The objectives of this experiment were to examine the differences between top- and subirrigated plants, with different fertilizer regimes and with mulches.

Six treatments of 'Crimson Fire' and 'Victoria' CVI geraniums were grown in 11 cm. pots. Treatments were: top irrigation, 100% N supplied with 20-10-20 soluble fertilizer; subirrigation, 100% N supplied with 20-10-20 soluble fertilizer; subirrigation, N supplied in equal portions of 20-10-20 soluble fertilizer and CRF, gel mulch; subirrigation, N supplied with CRF, gel mulch; subirrigation, N supplied in equal portions of 20-10-20 soluble fertilizer and CRF, wool mulch; subirrigation, all N supplied with CRF, wool mulch.

'Crimson Fire': fresh weight was not significantly different between top- and subirrigation; fresh weight at the same fertilizer level was not significantly different with either a gel or a rockwool mulch; all CRF resulted in the lowest fresh weights. 'Victoria': top irrigated fresh weight was significantly higher compared to subirrigated. Gel mulched plants resulted in significantly lower fresh weights than wool mulched plants. All CRF resulted in the lowest fresh weights.

097

EFFECTS OF CONTROLLED-RELEASE AND LIQUID FERTILIZATION ON LEATHERLEAF FERN AND NITROGEN LEACHING

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Established leatherleaf fern was grown for one year in a glasshouse in intact soil columns (Astatula fine sand, 21 x 61 cm) contained in drainage lysimeters. Columns were fertilized at rates of 224, 448, or 672 kg N ha⁻¹ yr⁻¹ using controlled-release (CR) fertilizer, either 360-day (360CR) or 180-day (180CR) term, or weekly applications of liquid (L) fertilizer. Water use, yield (number of harvestable fronds) and average

frond weight increased linearly with increasing fertilization rate and more fronds were produced using L than CR fertilizers. Frond color measurements paralleled yield results. During cool weather when vase life is greatest, fronds from L fertilizer lysimeters lasted longer than fronds from CR treated plots. During warmer weather, treatments had no effect on vase life. Nitrate nitrogen ($\text{NO}_3\text{-N}$) leaching increased with fertilization rate and exceeded 10 ppm in leachate from the L and 180CR treatments at all application rates. $\text{NO}_3\text{-N}$ in leachate from 360CR lysimeters never exceeded 8 ppm at any application rate.

098

NITROGEN LEACHING LOSSES FROM CONTAINER-GROWN ROSES. Raul J. Cabrera*, Richard Y. Evans and J. L. Paul. Dept. of Environmental Horticulture, University of California, Davis, CA 95616-8587.

Nitrogen leaching losses of 21, 40 and 49% were measured from container-grown 'Royalty' roses irrigated for one year with nutrient solutions containing 77, 154 and 231 mg N/l. There were no significant differences in number of flowers per plant or dry matter per plant. The N present in the harvested flowers accounted for 43, 27 and 17% of the N applied for the 77, 154 and 231 mg N/l treatments, respectively.

Plants receiving 154 mg N/l at leaching fractions of 0.1, 0.25 and 0.5 had corresponding N leaching losses of 22, 38 and 56%. In this experiment, however, the 0.5 leaching fraction produced yields significantly higher than those of the 0.1 and 0.25 treatments. The N recovered in the harvested flowers accounted for 28, 25 and 19% of that applied to the 0.1, 0.25 and 0.5 treatments, respectively.

The results of these studies suggest that modifications in current irrigation and fertilization practices of greenhouse roses would result in a considerable reduction of N leaching losses and enhance N fertilizer use efficiency, without loss of cut flower yield and quality.

099

THE EFFECTS OF LIGHT INTENSITY AND FERTILIZER RATE ON THE ACCLIMATIZATION POTENTIAL OF CHAMAEDOREA ELEGANS

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Effects of three light intensities (564, 306 and 162 $\mu\text{mol m}^{-2} \text{s}^{-1}$) and three fertilizer rates (220, 440 and 880 mg/15 cm pot, weekly) were evaluated on acclimatization potential of *Chamaedorea elegans*. Treatments were applied during four months under greenhouse conditions after which plants were placed indoors (20 $\mu\text{mol m}^{-2} \text{s}^{-1}$, $21 \pm 2^\circ\text{C}$ and 50% RH) for two months. Light compensation point (LCP) was significantly reduced by decreasing light intensity and increasing fertilizer rates. Leaf and root fresh and dry weights increased with irradiance while shoots were not affected. Chlorophyll a levels were higher in plants grown under the lowest light intensity. Carbohydrate content is being analyzed and anatomical examination of leaves studied. Plant performance indoors will be discussed. These studies demonstrate that *Chamaedorea*, a monocot, acclimatizes similarly to dicots.

100

REDUCTION OF NITROGEN FERTILIZATION REDUCES TISSUE NITRATE CONTENT IN POTTED CHRYSANTHEMUM

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Excessive supply of fertilizer N can lead to inefficient use of supplied N and consequently affect plant quality. Reduction of supplied fertilizer N can possibly increase plant N usage efficiency and improve quality. *Chrysanthemum morifolium* Ramat. cv. 'Yellow Favor' was grown single stem in 10cm pots on an ebb and flow benching system. All plants received 18.5 mM $\text{NO}_3^- \text{N}$, until the mid point of this ten wk crop, at which time the following NO_3^- concentrations (mM) were employed: 18.5, 15.5, 12.5, 9.5, clear water and clear water alternating with 18.5 mM NO_3^- . Plants were harvested at two wk intervals, cut in half and separated into leaves, stems plus petioles and inflorescence (when developed). Plant tissue from the lower half of the plant was analyzed for total and $\text{NO}_3^- \text{N}$, with reduced N being estimated as the difference between these two values. All growth parameters measured did not significantly differ, although termination of N fertilization (clear water) and reduction of NO_3^- level to 9.5 mM significantly reduced NO_3^- levels in the lower leaf and stem plus petioles, with a concomitant increase in reduced N in these tissues, over the 6-10 wk period. Total amounts of N accumulated in plant tissues analyzed did not differ significantly at flowering.

52 ORAL SESSION 14 (Abstr. 101-106)

Vegetables: Tomato Breeding

101

EVALUATION OF GERMLASM FOR RESISTANCE TO BACTERIAL WILT OF TOMATO

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Five strains of *Pseudomonas solanacearum*, collected from northwest Florida tomato fields, were inoculated onto 23 tomato (*Lycopersicon esculentum*) genotypes and one tomatillo (*Physalis ixocarpa*) genotype using a stem puncture technique. The strains represented a diverse group based upon pathogenic aggressiveness and profiles of their fatty acid content. Resistance was evaluated by comparing the response of each genotype to susceptible controls consisting of *L. esculentum* cv Bonny Best and Sunny. A differential response by the genotypes to the individual strains was observed. Germplasm from Hawaii (H7997 and H7998) exhibited some resistance to one of the strains while germplasm from Taiwan (CL 5915-93-1-0-C-1) was moderately resistant to another strain. However, no genotype was resistant to all five strains tested.

102

SESQUITERPENOID ACIDS DETERMITE COLONIZATION OF THE TOMATO RELATIVE, LYCOPERSICON HIRSUTUM

John C. Snyder* and Richard Thacker, Department of Horticulture and Landscape Architecture, N318 Ag. Sci. N., University of Kentucky Jan St. Pyrek and Jack P. Goodman, Life Sciences Mass Spectrometry Facility, College of Pharmacy, University of Kentucky, Lexington, KY 40546

Spider mites (*Tetranychus urticae* Koch) readily colonize the cultivated tomato, *Lycopersicon esculentum* L. However, mites have extreme difficulty colonizing the wild relative of tomato, *L. hirsutum* Humb. and Bonpl. When mites approach leaves of *L. hirsutum*, they often veer away, suggesting the presence of a deterrent or repellent. Initial experiments indicated that trichome secretions on leaflets of *L. hirsutum* deterred mites. *In vitro* bioassays indicated that at least four distinct compounds present in these sesquiterpenoid secretions of *L. hirsutum* P.I. 251303 were deterrent. At least two of the compounds were soluble in dilute NaOH. Based on mass spectra and ^1H and ^{13}C NMR the structure of two base soluble compounds were established as two related bisabolane derived carboxylic acids.

103

EFFICIENCY OF EMBRYO RESCUE FROM CROSSES BETWEEN TOMATO (LYCOPERSICON ESCULENTUM) AND TWO L. PERUVIANUM ACCESSIONS WITH HEAT-STABLE NEMATODE RESISTANCE

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Ten tomato cultigens were crossed with *L. peruvianum* accessions PI 126443 and PI 129152. Fruit (536 total) were harvested between 15 and 65 days after anthesis (DAA). Culturable embryos were obtained from 13% of the fruit. There were 140 embryos plated, from which 36 plants were obtained (7% of fruit, 26% of embryos plated). 'Campbell 28', Fla. 7217, and Fla. 7182 were the most efficient tomato lines for producing F_1 plants, there was no difference between the *L. peruvianum* accessions. No embryos were obtained beyond 57 DAA. No trend in embryo viability was detected between 15 and 56 DAA. Of 248 backcross fruit, 94 embryos were plated (38% of fruit) and 15 plants were obtained (6% of fruit, 16% of embryos plated). Female parents with the best percentage of plants per fruit crossed were Fla. 7217, Fla. 7215, and 'Campbell 28' with 15, 8, and 7%, respectively. No plants were obtained from 45 crosses on Fla. 7182.

GENETIC VARIANCES AND CORRELATIONS AMONG FRUIT QUALITY CHARACTERISTICS IN A *Lycopersicon. esculentum* x *L. pennellii* BACKCROSS POPULATION. James Nienhuis*, Steve Schroeder and Gretchen King, Dept. of Horticulture, Univ. of Wisconsin, Madison, WI 53706; H.J. Heinz, Stockton, CA 95201; and AgraDync, Salt Lake City, UT 84108

An accession of the wild species of tomato, *L. pennellii* (Cor.) D'Arcy, LA 1077 is much more water-use efficient (WUE) than the cultivated tomato. The F1 hybrid between *L. esculentum* cultivar UC82 and LA 1077 was backcrossed to UC82 and selfed. S1 families (BC1S1) were evaluated for fruit quality characteristics at the Heinz Research Farm, Stockton, CA. Broad sense heritabilities were estimated as follows: Fruit weight, $0.52 \pm .28$; Soluble solids $0.56 \pm .27$; viscosity $0.63 \pm .27$; pH $0.43 \pm .29$ Color L $0.59 \pm .27$ and Color A/B ratio $0.50 \pm .28$. The following phenotypic correlations were observed in the BC1S1 generation between expression of soluble solids and fruit quality characteristics: Fruit weight (g), 0.15; viscosity, -0.65; pH -0.52; Color L, -0.53 and Color A/B ratio 0.02.

105

GENETIC AND PHYSIOLOGICAL ANALYSIS OF SUCROSE ACCUMULATION IN TOMATO FRUIT John R. Stommel*, USDA, ARS, Vegetable Laboratory, Beltsville, MD 20705

Fruit of the cultivated tomato, *Lycopersicon esculentum*, accumulate the reducing sugars glucose and fructose as the primary storage carbohydrates. In contrast, fruit of several wild green-fruited species store high concentrations of sucrose. Analysis of invertase, sucrose synthase (SS) and sucrose phosphate synthase (SPS) enzyme activity throughout fruit development in the sucrose accumulating species *L. peruvianum*, indicated low levels of invertase and SS during the period of significant sucrose accumulation. Increased SPS activity was noted during the sucrose accumulation phase but was not coincident with maximum rates of sucrose accumulation. The percent soluble solids in ripe *L. peruvianum* fruit was more than twice that present in *L. esculentum* and attributed primarily to the high level of sucrose accumulated in *L. peruvianum*. Analysis of fruit sugar content in F₁, F₂ and backcross populations derived from an initial cross between plants of sucrose and hexose accumulators suggests that recessive gene(s) are responsible for sucrose accumulation.

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GENETIC ANALYSIS OF THE TOMATO POLLEN BEHAVIOUR IN VITRO UNDER LOW TEMPERATURES

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The genetics of the ability of tomato pollen to germinate and grow *in vitro* under low temperature was investigated in two crosses namely "Resista" X "Hilda" and "Resista" X "Monita". In each cross the following generations were utilized: F₁, F₂, BC₁ and BC₂, and their reciprocals, along with the parents. Pollen was placed on microscope slides having cavities filled with a liquid nutrient medium (water, 10% sucrose and 50 ppm boric acid) and allowed to germinate and grow for six hours at 15°C and then killed with acetocarmine. Germination rates and pollen tube length were determined and analysed on a genetic model allowing only for additive and dominance gene effects.

For pollen germination rate both additive and dominance gene effects were significant while for tube length only the additive effects were. Dominance was towards lower rates of germination. At least three genes control pollen germination rates while seven or more are involved in pollen tube length determination.

53 ORAL SESSION 15 (Abstr. 107-113)

Cell and Tissue Culture: Ornamentals

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SOMATIC EMBRYOGENESIS AND ORGANOGENESIS OF EASTERN BLACK WALNUT (*JUGLANS NIGRA*)

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Cotyledon explants were harvested from immature walnut fruits during July and August 1991. Media consisted of either WPM with 0.1 µM 2,4-D, 5.0 µM TDZ and 1.0 g/liter casein hydrolysate or DKW with 4.4 µM BA, 0.05 µM IBA, 9.3 µM Kinetin and 250 mg/liter l-glutamine. Treatments were arranged factorially with 2 gelling agents, 7 g/liter Sigma agar or 2 g/liter Gelrite and were incubated in light or in darkness. After 4 weeks, all explants were placed on basal DKW with no growth regulators and were cultured in darkness. The best treatment tested was from seeds collected 14 weeks post-anthesis on WPM, agar, and incubation in light (22 embryos/explant, 78% embryo-genesis). Use of DKW and gelrite in darkness resulted in 1 embryo/explant and 38% embryo-genesis. Up to 90% shoot organogenesis also occurred on cotyledon explants from seeds collected 16 weeks post-anthesis and placed on WPM. Shoots elongated on stationary liquid DKW with 10 µM BA.

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ADVENTITIOUS SHOOT ORGANOGENESIS IN WHITE ASH (*FRAXINUS AMERICANA* L.)

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Dissected white ash seeds were placed on a MS basal medium containing 10 µM TDZ and 1 µM 2,4-D. Adventitious buds formed directly and indirectly on cotyledons and hypocotyls that were in contact with the medium. Histological observations after 7 days from initiation indicated early divisional events originated directly in subepidermal layers on adaxial portions of the cotyledons. As these cells divided, the growth ruptured the epidermis. Bud-like structures were seen at 3 weeks. After transfer to a secondary medium containing 3 µM TDZ, 1 µM BA, and 1 µM IBA, some of adventitious buds elongated. Efforts (gibberellin, etiolation, ABA, and silver nitrate treatments) to increase the number of elongated buds have been unsuccessful. Excised adventitious shoots were rooted under mist and established in the greenhouse.

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SHOOT REGENERATION FROM LEAF TISSUES OF AMERICAN ELM AND SIBERIAN ELM.

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Shoot regeneration was obtained from leaf tissues of American (*Ulmus americana*) and Siberian elm (*U. pumila*) seedlings germinated *in vitro* and in greenhouse. Murashige and Skoog (MS, 1962) media supplemented with 4 levels of BA (0, 5, 10, 15, 20 µM) and 3 levels of IBA (0, 2.5, 5.0 µM) were tested in a factorial design to find an optimal hormonal combination for shoot regeneration. Shoot regeneration was obtained from both species within 3-4 weeks in a wide range of media. The highest regeneration rate (50%) of American elm was in the medium containing 10 µM BA and 2.5 µM IBA. Incubation under the light was essential for a higher rate of regeneration. Gelrite was found as a better solidifying agent than agar. The progress is under way to achieve transgenic elms by combining this regeneration system with *Agrobacterium*-mediated transformation.

INFLUENCE OF CULTURE AGE, CYTOKININ LEVEL IN CULTURE, AND "RETIPPING" ON GROWTH AND THE INCIDENCE OF VARIATION IN TISSUE-CULTURED RHODODENDRONS

Virginia M. Keith* and Mark H. Brand, Department of Plant Science, University of Connecticut, Storrs, CT. 06269-4667.

Significant occurrences of phenotypic variation have been noted in micropropagated *Rhododendron*. Studies were undertaken to determine what aspects of micropropagation lead to variation. *Rhododendron* 'Molly Fordham' was used to evaluate growth parameters and the incidence of variation in plants that originated from 3 month and 54 month old cultures. Plants from 3-month-old cultures were significantly wider than plants from 54-month-old cultures. *Rhododendron* 'Aglo', 'Molly Fordham', and 'Scintillation' were used to evaluate growth and the incidence of variation in plants grown from microcutting bases and rerooted microcutting tips (retips). Three-month-old retips were significantly taller and wider than bases of the same age, but possessed fewer branches. The influence of in vitro N^6 -[2-isopentenyl]adenine (2-iP) concentration on the growth and phenotype of regenerated plants of 'Aglo', 'Molly Fordham', and 'Scintillation' was examined. Data taken 3 months post-acclimation indicate that growth and the incidence of variation in response to 2-iP concentration is cultivar dependent.

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STABLE TAXANE PRODUCTION IN *TAXUS* SHOOT CULTURES.

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Taxol, a promising anticancer drug, is limited by inadequate supply. The production of taxol and related compounds (taxanes) by *Taxus* tissue cultures has been reported, yet sustained production has not been demonstrated. One theory is that cell differentiation and/or tissue organization is required to sequester taxol and avoid autotoxicity. To investigate this, *T. cuspidata* shoot cultures were established and the taxane content of various culture stages compared to that of field needles. HPLC analysis identified two peaks which comigrated and had UV spectra identical to taxol and 10-deacetyl taxol. The levels of 10-deacetyl taxol were similar in all samples. Cultured shoots contained much less taxol than field needles, and the level of a third peak which migrates closely to taxol was inversely related to that of taxol. Taxol content was restored in the first flush out of culture. Shoot cultures of *T. brevifolia*, *T. x media*, and *T. canadensis* have also been analyzed. In addition to shoot cultures, nodule cultures, a biological unit that may be suitable for production of taxanes in plant bioreactors, have been initiated and characterized.

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PHOTOAUTOTROPHIC MICROPROPAGATION OF *CYMBIDIUM* PLB

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Cymbidium (cv. Lisa rose) PLB (protocorm-like bodies) were cultured in liquid 1/2 MS medium with/without 20 mg g⁻¹ sucrose under continuous lighting conditions. The vessels were shaken at 100 rpm under PPF (photosynthetic photon flux) of 20 and 140 $\mu\text{mol m}^{-2} \text{s}^{-1}$ and CO₂ concentrations outside the vessel (Cout) of 450 and 2000 $\mu\text{mol mol}^{-1}$ conditions. Photoautotrophic growth was obtained at high PPF and high Cout. The chlorophyll content of the PLB in the medium without sucrose at high PPF and high Cout was almost 3 times that with sucrose at low PPF and low Cout. The number of newly developed PLB with sucrose at low PPF and low Cout was 1.6 times that without sucrose at high PPF and high Cout; the dry weight per unit PLB with sucrose at low PPF and low Cout was almost 3 times that without sucrose at high PPF and high Cout. Photoautotrophic growth of the PLB might be further promoted at higher CO₂ concentration (> 1%).

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IN VITRO PROPAGATION OF PATUMMA (*CURCUMA ALISMATIFOLIA* GAGNEP.)

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Patumma, a native of Thailand, is a new ornamental crop. Its increased demand for export make the species vulnerable to extinction. Cloning methodology is thus needed for the production of both existing and newly developed clone. Young inflorescent segment and lateral bud from rhizome can be used as explants. For

decontamination of the lateral bud, the success was depended both on pre-treatment and disinfection procedure. The bud from dried rhizome was better than one from fresh rhizome. Prior to disinfection with sodium hypochlorite, pre-treatment of rhizome in 52°C water for 5 minutes could replaced the use of antibiotic. Plantlet were placed on modified MS media with 0, 6.67, 13.32, 19.98 and 26.64 $\mu\text{mol/l}$ benzyladenine (BA) or 0.19, 0.56, 1.67 and 5 $\mu\text{mol/l}$ kinetin. The best multiplication rate of 4.83 fold was obtained when longitudinally-divided rhizome was on the medium with 13.32 $\mu\text{mol/l}$ BA. The result also showed that wild-collected and selected clones responded to the media similarly. When the MS media modified with 13.32, 15.54, 17.76 and 19.98 $\mu\text{mol/l}$ BA in combination with 15, 30 and 45 g/l sucrose were tested, the multiplication rate of non-divided plantlets were all the same. Acclimatization by open the culture vessel for 3 day improved plantlet survival rate ex vitro.

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ORAL SESSION 16 (Abstr. 114-120)

Floriculture:

Breeding and Genetics

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INTERSPECIFIC HYBRIDIZATION OF *IMPATIENS*

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An interspecific hybridization program involving five species of *Impatiens* was initiated to delineate incompatibility barriers. With the exception of one cross, no viable hybrid seed was recovered. Fluorescence microscopy revealed foreign pollen tubes to reach ovules in all crosses, although not all ovules were approached. A histological study involving *I. auricoma* Baill. and *I. walleriana* Hook f. ensued to confirm the presence of hybrid embryos. Developing *I. walleriana* x *I. auricoma* and reciprocal hybrid embryos were compared to self embryos. Development of hybrid embryos was delayed as early as five days post-pollination. *I. walleriana* x *I. auricoma* embryos continued to develop for 8 days post-pollination, but did not reach a size greater than a 5-day self embryo. Excessive endosperm was observed in the hybrid. *I. auricoma* x *I. walleriana* embryos continued to enlarge up to ovary abortion but did not reach a size greater than a 7-day self embryo and little to no endosperm developed. Disintegration of ovules included disorganization and collapse of the endosperm, and vacuolization and loss of turgidity of the embryo.

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INTERSPECIFIC HYBRIDIZATION IN *BEGONIA*

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An interspecific hybridization program involving ancestral species of the *Begonia* Semperflorens Cultorum Group was initiated to expand the genetic base of this group. Viable seeds were recovered from four reciprocal crosses. F₁ progenies were sterile and phenotypically intermediate between parental types. Fluorescence microscopy revealed evidence of both sporophytic and gametophytic incompatibility. Post-pollination responses of flower petals were positively correlated with pollen tube growth in stigmatic, stylar, and ovarian tissue. A digital image analyzer was used to facilitate seed counts and to determine the percentage of ovules that developed into seeds. Seed germination percentages ranged from 0-91 for crosses to 80-99 for selfs.

(abstract withdrawn)

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CHARACTERIZATION OF ISOZYME DIVERSITY WITHIN AND AMONG PURPLE LOOSESTRIPE POPULATIONS (*LYTHRUM* SPP.).
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Purple loosestrife populations have developed into a highly aggressive and invasive weed in several Northern states (MN, NY, NJ etc.). How these populations arose is a key question in developing control strategies. Therefore, we initiated a study to elucidate the origin and genetic structure of invasive populations using isozyme analysis. The germplasm examined included invasive populations found in MN, NY, NJ, WI and MD, populations of *Lythrum alatum*, populations of *L. virgatum* and 22 cultivars of *L. salicaria*, the suspected progenitor of the invasive populations.

Unique isozyme patterns for most cultivars was observed and these were consistently indicative of that clone over repeated sampling. Clones of putative "*salicaria*" origin could not be distinguish from those of putative "*virgatum*" origin. Significant isozyme polymorphism was observed within and among the 26 *Lythrum* populations. Indicating that isozymes can be an important tool in studies on the structure and evolution of invasive loosestrife populations.

To date, our isozyme analysis indicates that *L. salicaria* and *L. virgatum* are not distinct species. It appears that the decision by the MN Department of Agriculture to add all horticultural lines to the noxious weeds list regardless of origin was a prudent decision.

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EFFECTS OF INBREEDING ON FLOWER YIELD IN GERBERA
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Inbreeding depression is found in most flower crops. Limited population size can cause inbreeding even in outcrossed populations. The Davis population of *Gerbera hybrida* has been selected for increasing flower yield for 15 generations. The mean yield per plant of the population has been increased from 14.2 to 28.0 flowers per winter six-month period. In each generation 23 to 80 selected parents have been crossed at random. Inbreeding coefficients were estimated from the pedigrees of each of the 6199 plants in the 16 generations. The inbreeding level in this population was found to increase in each generation and currently is 16.5%. Mean yield and inbreeding per family have a statistically significant negative correlation in generations 13 to 16. The results indicate that inbreeding is increasing in this randomly outcrossed population because of its finite number of parents, and that yield is reduced by 3.9 flowers per six-month due to inbreeding.

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AN ORNAMENTAL PASSION VINE FOR TEMPERATE ZONE CONDITIONS
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Efforts to obtain edible-fruited passion vines through hybridization of *Passiflora edulis* and *P. incarnata* produced a population of tetraploid plants that survive freezing winters in central Georgia belowground, and grow aboveground in warm weather. One selection from this population blooms from late June or early July through October, yielding quantities of flowers from 8.5 to 9.6 cm diameter that have deep blue-colored sepals and petals surmounted by a disc of heavily-crippled filaments that are white at the outer margin. The nectar has proven a good food resource for the ruby-throated hummingbird, which breeds in much of the southeastern U.S. This clone is highly self-incompatible and sets no fruit when grown apart from cross-compatible clones. Its vines are vigorous, growing to 5 meters or more, and have dark green, markedly denticulate trilobed leaves 13 to 24.5 cm long by 15 to 25 cm wide. These afford a nursery habitat for caterpillars of 3 native butterflies, the zebra and the Gulf and variegated fritillaries. Because of its ease of culture and wide adaptation, this vine is recommended to plant in the continental U.S. for environmental enhancement.

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KARYOMORPHOLOGICAL STUDIES ON HIPPEASTRUM SPECIES
Ahsan A. Vahidy* and Farzana A. Shafiq
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Chromosome morphology of locally available cultivars of *Hippeastrum* (Basionym: *Amaryllis*) was studied from the root tips of 60 bulbs. Optimum contraction with good resolution of chromosomes was obtained when a mixture of 0.01g colchicine, 0.005g 8-hydroxyquinoline and 5 drops of DMSO in 20ml of distilled water was used as pretreatment. A count of 2n=22 was confirmed in all the bulbs except ten in which the diploid chromosome number was 55. Chromosomes of 2n=22 cytotype were very long to medium, while those in 2n=55 cytotype were long to small. Very long chromosomes were submetacentric, long chromosomes substantially heterobrachial or acrocentric, and medium to short chromosomes mainly metacentric. Karyotyping revealed nonhomology in different chromosomes which may be due to aneuploidy. The results are documented by photomicrographs and karyograms.

55 ORAL SESSION 17 (Abstr. 121-127) Vegetable Crops: Water and Irrigation

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DRAINAGE WATER MANAGEMENT OF DIRECT-SEEDED PROCESSING TOMATOES.

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An irrigation water study was conducted in the West side of Fresno County to evaluate the impact of recycled drainage water nitrogen and salinity content in the growth of direct seeded processing tomatoes to reduce nitrate-ground water pollution. Four canal water treatments (0.4 dS/m) received 0, 67.5, 101.2, and 168.7 kg of nitrogen per hectare and four saline water treatments (7.01 dS/m) received 0, 33.7, 67.5 and 135.0 kg nitrogen per hectare. All treatments were established with fresh canal water, and at first flower half of treatments were switched to saline water. The nitrogen content of water had an average of 283 ppm N-NO₃ for the canal water and the drainage water contained 4489 ppm N-NO₃. There was no significant yield differences between the irrigation methods and the two N-fertilizer sources applied to the tomatoes. However, drainage water produced a significant increase in fruit soluble solids (5.05 Av.) in comparison to canal water and synthetic fertilizer (4.3 Av.). The overall fruit quality and maturity was better in the drainage water treatments than it was in the fresh canal water with synthetic N-applied treatments.

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A SUSTAINABLE PRODUCTION SYSTEM FOR TOMATOES USING A CONTAINERIZED GRADIENT CONCEPT.

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The purpose of this study was to evaluate the commercial feasibility of a containerized gradient concept with relevance to water requirement, pollution potential, and production efficiency. Basic components included one-half cu ft of media/plant with 2 plants/rigid plastic container. Phosphorous, liming material and micronutrients were mixed in the media and the N-K was banded on the surface at both ends of the container which was protected by a plastic cover. Intermittent micro-irrigation was used to maintain either a lateral or vertical nutrient/moisture gradient. Variations in the media, the size and shape of the container, and the frequency and time of water applications were included in the evaluations. In the spring of 1991, 65 gallons of water was utilized to produce 22.9 lbs of marketable tomatoes/plant. Leaching was insignificant and the water required on an acre basis was projected as 4.8 acre inches with a 2000 plant population. The results indicate that the containerized gradient concept is potentially feasible as a sustainable production system.

YIELD AND QUALITY OF ONION VARIETIES TO THREE SOIL MOISTURE REGIMES IN LYSIMETERS AND FIELD CONDITIONS IN NIGER, WEST AFRICA. CHIT RK PRASHAR* AND GOVIND C. SHARMA. Univ. of Nebraska, USAID Project 683-0256 Lincoln, Nebraska 68583; Alabama A&M University, Normal, AL 35762.

Yield and quality responses to Galmi Violet, Galmi White and Sumrana Violet were studied during 1990-91 and 1991-92 in Maradi region in Niger. Three regimes comprised of irrigating when the soil moisture depletion in 20 cm of soil depth was 40%, 60% and 80%. Investigations were carried out both under field conditions and in the lysimeters. The soil was sandy loam to loam. The lysimeters were 2mx2mx1m drainage type and well set over the past twenty years. The crop was raised during the dry season from October to March with no rainfall. Despite the low temperatures the radiation levels were high. Onion yield was higher under low irrigation regime. The mean yield was 32.5 tons/ha. However, the bulk density was higher under higher moisture regimes. The keeping quality over eight month period was not affected by soil moisture regimes. The bulbs of Sumrana Violet were of medium size whereas the bulbs of Galmi Violet and White were larger size. From a market acceptability standpoint violet onions were preferred over the white ones.

A MOISTURE CAPTURE SYSTEM FOR REDUCING SUPPLEMENTAL WATER REQUIREMENTS FOR CANTALOUPE PRODUCTION IN SEMI-ARID REGIONS.

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Trenched beds covered with plastic mulch was used to capture and retain precipitation for dryland cantaloupe production. Two trenches were formed in the fall in raised beds. Plastic mulch was laid over the beds and slitted at ca. 1 meter intervals over the trenches. Soil was placed over the slits, conforming the plastic to the shape of the trenches and channeling precipitation into the beds. Cantaloupes were seeded in the spring and grown with no supplemental irrigation. Planting moisture was significantly greater under the capture system than in unmulched beds. Seedling emergence time was reduced from 18 to 6 days and vine growth in the first 6 weeks was almost doubled. Total and marketable yields were doubled and fruit size significantly increased when water was limiting. Elevated soil temperatures under the mulch enhanced plant growth and yield even when moisture was not limiting. Combining a moisture capture system with supplemental irrigation could allow commercial production of cucurbit crops under limited water conditions in semi-arid areas.

EFFECT OF ORGANIC AND SYNTHETIC MULCHES ON YIELD OF BASIL UNDER DRIP IRRIGATION

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Small-scale herb growers in the U.S. Virgin Islands traditionally water their crops with sprinkler cans and garden hoses. This method is inefficient and consumes large amounts of water, a scarce resource in the islands. Introduction of drip irrigation has reduced water use in vegetable production. Integrating this system with mulches may further cut water use, making herb production more profitable. Basil (*Ocimum basilicum*) was grown in plots with organic (compost or straw) and synthetic (black plastic or weed barrier) mulches. A no mulch control plot was also included. All plots were drip irrigated to maintain soil moisture at -30 kPa. Total plant fresh weight and leaf fresh and dry weights were highest in the compost mulch treatment. Fresh and dry basil yields in black plastic mulched plots were almost identical with those in compost mulch, but did not differ from other treatments. Black plastic mulch reduced water use 46% compared with 27% for compost or straw mulch. All mulch treatments resulted in increased water use efficiency. Organic mulches reduced surface soil temperature, while synthetic mulches increased soil temperature 2-5°C.

MANAGEMENT AND CULTURAL PRACTICES OF IRISH POTATO AND SWEET POTATO AND THEIR EFFECT ON SOIL LOSS

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The cultural and management practices for Irish Potato and Sweet Potato were monitored, along with various plant growth parameters.

Data was collected on row width, plant spacing, irrigation, root mass, plant population, vegetative dry matter, canopy height, yield, above ground biomass, root depth, canopy cover, leaf area index, and stem diameter. Climatic parameters such as rainfall, average daily temperatures, and growing degree days. The data was imputed into the erosion prediction model WEPP (Water Erosion Prediction Project) and the annual soil loss was compared between the crops. Results suggest that Irish Potato is better crop for conserving soil.

PRODUCTION OF INTEGRATED GREENHOUSE CUCUMBER AND FISH SYSTEM

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Several crops of "Fidelio" greenhouse cucumbers were grown in an integrated system with tilapia fish throughout a year. Cucumbers were irrigated with water containing fish waste, that was filtered through the 0.3 m deep sand and returned to the fish tank 8 times daily. Biofilter to fish tank volume ratios of 0.67 to 2.25 were compared. As biofilter volume increased fish growth increased and yield per plant and plant weight decreased. Larger biofilter systems required more water and less pH adjustment because they contained more plants and filter area.

Turfgrass:

Culture and Management

EFFECT OF DITHIOPYR, SEED PLACEMENT, AND SOIL ORGANIC MATTER CONTENT ON GROWTH OF TOLERANT AND SUSCEPTIBLE WEEDS
Nanik Setyowati* and Leslie A. Weston, Department of Horticulture and Landscape Architecture, University of Kentucky, Lexington, KY 40546

Dithiopyr (Dimension, Monsanto) is a turfgrass herbicide currently under evaluation for use in ornamentals. Granular herbicide depth and seed placement were evaluated in greenhouse studies with tolerant or susceptible weeds. Dithiopyr was applied preemergence to weeds at the rate of 2.24 kg/ha to Maury silt loam soil. Weed seeds were planted routinely at 0.64 cm depth. Dithiopyr placed at the soil surface or 0.64 cm in depth caused the greatest injury to seedlings, followed by dithiopyr at 1.28 cm depth. Dithiopyr at 2.54 and 3.81 cm below the surface had no effect upon seedling growth. When seeding depth was investigated, seed placed at 0.64, 1.28 or 1.91 cm below the surface showed greatest seedling injury when dithiopyr was routinely applied at 0.64 cm depth. Seed placement on the soil surface resulted in the least injury to weeds.

Peat moss was added to Maury silt loam soil and to sand to investigate the influence of organic matter upon activity. Soil with 2% peat resulted in the least injury to selected weed seedlings while sand, and sand plus up to 3% peat showed greatest injury. Sand amended with 5 and 6% peat also resulted in less injury to weed seedlings. Ivy leaf morningglory and KY 31 fescue were most tolerant of dithiopyr while barnyardgrass and large crabgrass were most sensitive. Dithiopyr uptake, translocation and metabolism studies will be conducted with susceptible and tolerant weed and woody ornamental species.

THE USE OF CORN GLUTEN MEAL AS A NATURAL "WEED AND FEED" MATERIAL FOR TURF

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Field and greenhouse studies on the use of a byproduct of the corn (*Zea mays* L.) wet-milling process, corn gluten meal, have shown that this high-protein fraction of corn grain contains an organic compound that inhibits root formation of a variety of monocotyledonous and dicotyledonous species. Seeds that germinate in a soil media to which corn gluten meal has been added form normal shoots, but no roots. The seedling quickly dies as the media dries. This inhibition of root formation can be timed to prevent the establishment of weeds in turf areas and other plant systems. Corn gluten meal also

contains approximately 10% nitrogen and can be used as a natural fertilizer material. Repeated field trials have shown no detrimental effect of the corn gluten meal on mature grass plants. This combination of a natural fertilizer with a natural weed inhibiting compound may result in a 'weed and feed' product for those who do not wish to use synthetic fertilizers and pesticides. A patent on the use of corn gluten meal as a weed control was issued in 1991.

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EFFECTS OF HYDROPHILIC POLYMERS AND ORGANIC AMENDMENTS ON ESTABLISHMENT OF KENTUCKY BLUEGRASS.

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Three polymers (a polyacrylamide, polyacrylate and a propenoate-propenamide copolymer) and three organic amendments (peat moss, wood shavings, and composted yardwaste) were incorporated at five rates in a sandy soil to 15cm depth. Soil moisture content was determined by time domain reflectometry and gravimetrically. Only the highest polymer rates (2928kg/ha [60#/1000sq.ft.]) produced significant increases in soil moisture content and reductions of soil bulk density. Peat moss and yardwaste increased soil water content while shavings decreased water content. Turf quality scores were not affected by polymers but were initially reduced by yardwaste and shavings.

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ALTERNATE SOD PRODUCTION SYSTEM FOR ZOYSIAGRASS

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A limitation to distribution of some field-grown sod is the time required to produce a saleable product rooted sufficiently to retain its shape when removed from the ground. Research for a more efficient sod production process was examined using sod segments planted at a 1:100 plant:planting area ratio in an aboveground soilless, root-restricting system. Combinations of 3 growth media, 2 rooting stimulants, and 2 fertilizers each at 2 rates were evaluated to determine the most rapid and optimal sod development for zoysiagrass. Treatments were rated weekly for percent cover, rate of stolon development, and rooting. Although treatments with rooting stimulants generally scored higher than other treatments for rooting and percent cover, these differences were not consistently significantly different from week to week. No significant differences occurred among treatments for stolon development ratings. After 16 weeks of growth, sod strength was greatest when the growth medium was a peat and vermiculite mixture.

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THE EFFECTS OF SALINITY ON NITROGEN UPTAKE BY TALL FESCUE TURF

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An experiment was conducted in nutrient solution culture to examine the effects of salinity on N uptake by tall fescue (*Festuca arundinacea* Schreb.) turfgrass. The cultivars 'Finelawn' and 'Monarch' were chosen for study, representing a salt-sensitive and salt-tolerant tall fescue. Nitrogen treatments were imposed to produce N-replete turf (no N stress) and moderately N-deficient turf. Rootzone salinity was increased gradually over four weeks to final salt concentrations of 0, 40, 80 and 120 mM using a combination of NaCl and CaCl₂ at a molar ratio of 8:1. Uptake of both NO₃-N and NH₄-N, each labeled with 99.8% enriched ¹⁵N to determine N partitioning, was measured over a 24 hr period as depletion from solution. Nitrate and ammonium uptake by N-replete tall fescue turf were similarly affected by salinity in both cultivars, with moderate inhibition (10-25%) at 40 and 80 mM and severe inhibition (60-70%) at 120 mM salt. Uptake by the N-deficient turf was much faster than by the N-replete turf, with the controls absorbing all the added N by 8-12 hours. Inhibition of uptake by 'Monarch' tall fescue was roughly 30% at both 40 and 120 mM salt, whereas 80 mM salt had essentially no effect. Nitrogen uptake by 'Finelawn' was progressively inhibited by higher salt concentrations. It is possible that these differences are related to the relative salt tolerances of the two cultivars, but the mechanism is presently unknown.

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A MODEL SYSTEM FOR DETERMINING CHEMICAL MOVEMENT THROUGH GOLF COURSE GREENS

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Lysimeters were developed in the greenhouse for simulating golf course greens with 'Tifdwarf' bermudagrass and 'Penncross' bentgrass overlying USGA specified rooting substratum. The lysimeters were constructed by subtending wooden flats containing turfgrass (38 x 38 x 14 cm deep) with polyvinyl chloride tubes (15 cm diam. x 52 cm deep) containing USGA-recommended rooting mixture for each turfgrass. The base of the tubes was capped with a closure containing an exit port for collecting the effluent drainage. An automatic irrigation system was developed by mounting flat fan nozzles on a cable driven roller 55 cm above the grass sod. The automatic water system is calibrated to irrigate at a rate of 0.1 cm min⁻¹ for predetermined time-periods and volumes. The water flow through the lysimeters is uniform with a coefficient of variation less than 10% for 36 lysimeters. Data on chemical movement following treatment with three herbicides and weekly applications of fertilizer will be presented.

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COLLOQUIUM II (Abstr. 135-142)

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OPPORTUNITIES FOR OPTIMISM: GLOBAL HORTICULTURE

H. M. Cathey, National Chair for Florist and Nursery Crops
Review, USDA, ARS, NPS, Bldg. 5, RM 112, Beltsville, MD 20705

Horticulture has entered the 90's with a different set of priorities and opportunities for its crops and knowledge. We no longer pursue science solely for the knowledge acquired and published, we are now permitted to receive compensation for our intellectual properties. Unique plants and processes thus have potential for marketing internationally. These shifts in professionalism will affect the decisions as to which crops and disciplines our scientists select to follow. Applications of the new technology must be redefined to avoid whimsical use of the techniques. Our programs must be directed toward products which are truly exceptional with high quality and performance. Until horticulturists have the information relating to the consumer preferences in new markets, plants cannot be created, exported and marketed successfully overseas. The U. S. industries have climate, transportation, and skilled technicians available to support our global export of our horticultural excellence. I will discuss a specific program under review for florist and nursery agriculture.

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EXPORTING GRAPEFRUIT TO JAPAN: THE FLORIDA EXPERIENCE

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Florida has been exporting grapefruit to Japan since that market opened up in the 1970's. Since that time, Japan has become the largest single export market in the world for Florida grapefruit. Taking primarily white grapefruit, Japan has been the savior of the white grapefruit industry in Florida. Florida's success in Japan is the result of a number of factors, including an aggressive generic marketing program, extensive market research, close cooperation with local importers, marked increases in product quality, Fruit Fly protocols with the Japanese government, development of cold-treatment shipping technologies, and strong US government financial and administrative support. The Florida success story is a case study of how a major market can be developed for the export of citrus products.

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1989-90 VEGETABLE PRODUCTION IN MEXICO FOR U.S. EXPORT

Jose F. Gomez*, Asgrow Seed Co., 3012 Hawk Ave., McAllen, TX 78504

The proposed free trade agreement (FTA) between U.S. and Mexico may open opportunities for a new economic relationship with our nearest international trading partner. Understanding Mexico's vegetable exports will become important for estimating the economic impact of the FTA on the U.S. vegetable business.

In the 1989-90 season, Mexico farmed approximately 20 million ha of which 3.5% or 700,000 ha were dedicated to vegetables including 246,000 ha for export. National vegetable production was 8 million tons with 1.5 million tons or 17.6% exported. Of the 100 different vegetables produced in Mexico many are major crops in the Rio Grande Valley of Texas. About 72% of the vegetables exported to the U.S. were produced in three states: Sinaloa, Sonora and Baja California. Nearly 83% of the vegetable imports into the U.S. occurred during the winter and spring months. Based on importation figures at seven main points of entry, Reynosa was the second, most important entry point after Nogales. If the FTA is signed, all ports of entry will most likely experience increased activity.

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NEW ZEALAND HORTICULTURAL EXPORTS

D. H. Turner, Managing Director, Turners and Growers LTD, P. O. Box 56, Auckland, New Zealand

New Zealand horticultural exports expanded rapidly during 1970-1990. These increases did not occur without some difficulties. Details of the export expansion including main products and major markets (such as the U. S. and Pacific Rim Countries) will be discussed. Key factors such as: 1) marketing strategies of the past, present, and future; 2) the impact of new marketing technology; and 3) importance of New Zealand image will be detailed. The role of education and technology and the skill level of New Zealand horticulture will be reviewed. This will include the New Zealand tertiary education system as well as relevant examples of how universities can assist.

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GLOBAL HORTICULTURE AND THE QUEST FOR SEED VARIETIES

Francois Korn, SeedQuest, 1353 El Centro Avenue, Oakland, CA 94602

During the eighties, the large consumer markets in the northern hemisphere have come to expect a year round supply of high quality fresh vegetables. This has given farmers in many countries in the southern hemisphere and the tropics an opportunity to diversify into lucrative export crops. However, finding cultivars adapted to the local growing conditions is often difficult because commercial seed varieties are usually bred for highly sophisticated growing and farming conditions. As a result, local horticultural research institutes are playing a crucial role in reselecting or adapting overseas germplasm to the specific conditions of each production area.

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INTELLECTUAL PROPERTY RIGHTS IN A GLOBAL MARKET

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Intellectual property rights issues relating to horticultural species will be addressed. Some current industry concerns include: 1) importing cut flowers of protected plants which compete directly with the plant patent holder; 2) obtaining adequate protection for newly developed varieties; and 3) providing an incentive for private research to develop new varieties. Different forms of plant protection will be reviewed, including the Plant Patent Act, utility patents, breeder's rights, the Plant Variety Protection Act, contracts, licensing and trade secrets. The role that universities can play in assisting the horticultural industry will also be discussed.

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THE NEED FOR STRATEGIC MANAGEMENT IN FLORICULTURE

William H. Carlson, Department of Horticulture, Michigan State University, East Lansing, Michigan 48864

There are over 11,000 greenhouse growers in the United States. Of this number, 8,000 produce less than \$500,000 per year in total sales. Less than 1% of the 11,000 have a strategic business plan. Many may have a yearly budget, but they have not developed a formal written analysis of their business in relation to internal and external factors. A sample of 10 growers indicated that their profitability increased significantly when they understood a formal strategic business plan. The information developed from this sample indicates

the entire greenhouse industry could benefit greatly from increased use of strategic planning. The marketing component of the business plan and how university personnel can facilitate this effort will be discussed.

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HORTICULTURE AND THE GLOBAL MARKET

Ricardo E. Gomez* Extension Service, U. S. Department of Agriculture, Washington, DC 20250

The future competitiveness of any nation, including its agriculture, is inextricably tied to understanding and effectively participating in global markets. Major opportunities exist for farmers to produce, process, and export agricultural products, especially value added products, if they had knowledge of global opportunities. Most of the information and services are available for them to achieve this objective. The Cooperative Extension System (CES) can provide a mechanism to deliver educational programs on global marketing opportunities and training on procedures for capitalizing on these opportunities. County agents from Virginia and California working with their mushroom producers helped them respond to a year round shitake order from the United Kingdom. This has resulted in an ongoing market for these producers. Other similar examples in horticulture will be discussed.

81 ORAL SESSION 19 (Abstr. 143-149) Culture and Management of *Prunus*

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DORMANT SEASON CARBOHYDRATE LEVELS OF PEACH STIONS ON A SHORT LIFE SITE

Gregory L. Reighard*, Danielle Ellis, and Charles Graham, Clemson University, Sandhill Research and Education Center, P.O. Box 23205, Columbia, SC 29224-3205

'Redhaven' and 'Springcrest' peach cultivars were budded to 12 rootstock selections and planted on a non-fumigated peach tree short life site. After 2 growing seasons, 2 shoots/tree (20 trees/stion) were collected in late November 1990 and again in early March 1991. Samples were immediately frozen in liquid nitrogen and later freeze dried and prepared for analysis. Total soluble sugars and starch were extracted from the shoot and quantified. No significant differences among rootstocks or cultivars were found for total soluble sugars and starch. No significant correlations were found between stion carbohydrates in fall and spring and the incidence of bacterial canker in April 1991. Total soluble sugars and starch averaged 110 and 120 mg/g dry tissue for fall and spring sample times, respectively. Cultivars on the hybrid plum rootstock 'Edible Sloe' had the highest soluble carbohydrates in both fall and spring.

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COMPETITIVE VEGETATIVE ORCHARD COVERS REDUCE PEACH ROOTING

Michael L. Parker* and John R. Meyer, Departments of Horticulture and Entomology, respectively, North Carolina State University, Box 7609, Raleigh, NC 27695-7609

Peach trees ('Biscoe'/Lovell) were planted in March, 1988 in ten different ground cover management systems. The trees were planted at the Sandhills Research Station in Southeastern North Carolina on a Candor sand and Eunola sandy loam. In December, 1991 the trench profile method was used to evaluate root distribution under the six orchard floor management systems of nimblewill, bare ground control, centipedegrass, brome, bahiagrass, and weedy control. Trenches were dug parallel to the tree row 60 cm from the center of the row on both sides of the tree. Grids 1 meter square, sectioned into 10 cm squares, were placed on the profile walls and root distribution (in three size categories) was recorded for 1 meter on each side of the tree in each trench. Root numbers were greatly reduced under the vegetative covers that provided the greatest suppression of vegetative tree growth. Total root densities under the trees in the vegetative covers were ranked into three size categories which were correlated with the amount of vegetative tree growth.

ECONOMIC COMPARISONS OF TWO HIGH-DENSITY CLING PEACH TRAINING SYSTEMS.

Wesley K. Asai, University of California Cooperative Extension, 733 County Center III Ct., Modesto CA, 95355.

In an effort to maximize early return on investment and labor efficiency, cling peach growers in California are using two different types of high-density plantings; the perpendicular-V (1.8m x 4.8m = 930 Trees/ha), and the cordon (2.4m x 4.2m = 925 Trees/ha). The V has the advantage of being more traditional in its establishment, where the cordon has the advantage of higher yields and no need for wires, props or ladders to prune, thin and pick.

This study evaluated the cultural and economic considerations of the two systems with respect to their yields during the orchards' establishment years. The cumulative labor costs, specific to the style of training for the first 3 years was \$1258 and \$901 per hectare for the cordon and V respectively.

Cumulative yields were 40.4 tons/ha for the cordon and 22.0 tons/ha for the V. When contrasting the net returns per hectare, the cordon, in spite of its higher labor input (due largely to higher thinning and harvest costs), had a net profit advantage of \$3362.50 per hectare during the first 3 years of establishment.

EVALUATION OF OWN-ROOTED AND JUNE-BUDDED 'REDHAVEN' PEACH TREES AT TWO HEADING HEIGHTS

Dwight Wolfe and Gerald Brown*, Research and Education Center, University of Kentucky, Princeton, KY 42445

'Redhaven' peach [*Pyrus persica* (L.) Batsch] trees which were either own-rooted (OR) or June-budded (JB) the previous year were headed back at planting to either (1) 70-85 cm above the soil surface (CH, conventional heading) or (2) the first bud 20-30 cm above the soil surface (LH, low heading). Propagation method had no effect on fruit yield in 1988 or trunk cross-sectional area; however, total yield in 1987, and the cumulative yield for 1987 and 1988 were significantly greater for JB trees than for OR trees. LH reduced survival of OR trees, but not the JB ones. Cold injury was greater for the OR trees than for the JB ones. Neither propagation nor heading height influenced bloom density, fruit set in 1987, or fruit size in 1988. However, OR trees which were conventionally headed produced larger fruits in 1987 than did JB trees the same year.

COMPARISON OF GIRDLING TECHNIQUES FOR EARLY SEASON FRESH-SHIPPING NECTARINES

Kevin R. Day* and Ted M. DeJong, University of California Cooperative Extension, Ag. Bldg., County Civic Center, Visalia, CA 93291-4584, and Department of Pomology, University of California, Davis.

Girdling has been shown to increase fruit size and soluble solids concentration and advance fruit maturity. Performed improperly, girdling can also have a debilitating effect on trees. To minimize this, growers often use alternatives to the standard complete girdle. However, the efficacy of these alternative techniques has not been evaluated. Three methods of girdling: 1) complete girdle of all scaffolds, 2) complete girdle of all but one "nurse" scaffold, and 3) spiral (overlapping) girdle of all scaffolds, were compared to ungirdled trees to determine their effect on fruit and tree performance. All of the girdling treatments increased fruit size and marketable yield, and advanced maturity over ungirdled trees. Fruit on ungirdled nurse limbs were similar in size to fruit on ungirdled trees, while the fruit on the remaining girdled limbs were slightly larger than fruit on the trees which had all scaffolds girdled. Overall fruit size and yield of trees with a nurse limb were similar to the other girdle treatments.

EARLY THINNING OF PROCESSING PEACHES COSTS MORE BUT IS PROFITABLE

T.M. DeJong*, K.R. Day, R. Beede, and R.S. Johnson, University of California, Department of Pomology, Davis, CA 95616

Current recommendations for fruit thinning of processing clingstone peaches in California suggest that growers delay thinning until an assessment of fruit size is made at reference date (10 days after first indications of pit hardening) and then adjust the crop load according to the fruit size attained. Recent research on modelling peach fruit growth indicates that delaying thinning until reference date (usually mid-May) can substantially limit final fruit size potential and crop yield when initial fruit set is heavy. In 1991 we initiated a field study to test these model predictions and evaluate the yield response and economic feasibility of fruit thinning within 50 days of bloom to a specific crop load. The experiment was conducted in commercial orchards of the extra-early maturing cling peach cultivars Loadel and

Carson. Three thinning treatments involved thinning different sets of trees on April 10, April 30, (~30 and 50 dafb) and May 23 (reference date). Although costs of thinning at the earlier dates were 140-290% of thinning at reference date the increase in yield resulting from early thinning more than compensated for the higher thinning costs. There were no major effects of thinning treatment on the occurrence of split pits or other quality characteristics. This research has stimulated a re-evaluation of commercial fruit thinning practices used for clingstone peaches in California.

SKIN DISCOLORATION IN PEACH AND NECTARINE FRUIT

Guiwen Cheng*, Carlos Crisosto, David Garner, Scott Johnson, and Bob Beede, Kearney Agricultural Center, University of California, 9240 S. Riverbend Ave., Parlier, CA 93648.

The roles of genetic makeup and 'orchard environment' on fruit skin discoloration (SD) were studied on peaches and nectarines. Our data showed that the SD incidence (SDI) varied among cultivars in the same orchard and orchards with the same cultivar. Differences in SD susceptibility were examined on whole fruit and skin disks by using SD-inducing treatments including combinations of physical injury and dipping in different solutions (pH, and metal ions). High SDI was associated with physical injury, high pH, and high metal ion concentration. With the exception of N, the amount of macro- and micronutrients in unwashed fruit skin was not correlated with the SDI. Preharvest sprays influenced the SDI. The peach variety with the highest SDI had the highest total soluble phenols. Total soluble phenols and anthocyanins, however, did not show a strong relationship with the SDI among all cultivars studied. Lack of correlation with total soluble phenols does not exclude the possibility that SD may relate to specific phenol(s).

82 ORAL SESSION 20 (Abstr. 150-156) Vegetable Crops: Growth and Development

CO₂ AND TEMPERATURE INTERACTION ON GROWTH OF THREE POTATO CULTIVARS

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Plants of three potato (*Solanum tuberosum* L.) cultivars, Denali, Norland, Russet Burbank, were grown under CO₂ concentrations of 500, 1000, 1500, 2000 ppm at each of 16 and 20C temperature levels. In all three cultivars, total plant dry weight on day 35 after transplanting was greater under 1000, 1500, and 2000 ppm CO₂ than under 500 ppm CO₂ at both 16 and 20C, and greater at 20C than at 16C under each of the CO₂ concentrations. At 20C total dry weight was highest under 2000 ppm CO₂ for all cultivars whereas at 16C total dry weight was highest under 1000 ppm CO₂ for Denali and Norland, but highest under 1500 ppm CO₂ for Russet Burbank. The similar pattern was seen with tuber dry weight except that in Russet Burbank the weight was greater at 16C than at 20C under 500, 1000, and 1500 ppm CO₂. Also, for all cultivars specific leaf weight (SLW) under 1000, 1500, and 2000 ppm CO₂ was much higher than under 500 ppm CO₂ at 16C, but only slightly higher than under 500 ppm CO₂ at 20C. The SLW was higher at 16C than at 20C under all CO₂ concentrations. This study demonstrates that growth responses of potatoes to CO₂ concentrations differ with temperature.

INFLUENCE OF SITE OF PRODUCTION ON LEVELS OF TUBERIZING STIMULUS IN SEED POTATOES

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Single nodal cuttings were used to study the degree of tuberizing stimulus found in Norland and Russet Burbank seed tubers produced at latitudes ranging from 40 to 52°N. Seed tubers were planted in the greenhouse under an inductive 8 h or a non-inductive 18 h photoperiod. Single leaf cuttings taken at several

intervals after planting were grown under a 12 h photoperiod and the tuberization characteristics of the cuttings were rated 21 days later. Cuttings derived from seed grown at low latitudes produced more tubers under both photoperiods than cuttings from northern seed. The tuberizing stimulus increased with age of the cutting and/or association with the mother tuber. It appears that previously observed differences in yield potential of seed tubers from varying latitudes may be related to differences in an endogenous tuberizing stimulus derived from the mother tuber.

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COMPOSITIONAL CHANGES IN SWEETPOTATO ROOTS DURING DEVELOPMENT

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Six sweetpotato cultivars were evaluated for changes in individual sugar concentration, dry weight, and alcohol insoluble solids (AIS) during growth and development. Measurements were taken at weekly intervals from 7 to 21 weeks after transplanting. Sucrose, the major sugar during all stages of development, generally increased in concentration throughout development for 'Heart-o-gold', 'Travis', and 'Jewel', but peaked at 17 weeks for 'Beauregard' and 'Whitestar'. The high-dry matter white flesh cultivars of 'Rojo Blanco' and 'Whitestar' contained the lowest sucrose concentration. The monosaccharides glucose and fructose generally decreased in concentration up to 17 weeks in 4 of 6 cultivars, followed by an increase from 17 to 21 weeks in all cultivars. Glucose concentration was marginally greater than fructose at all stages of development in each cultivar. Little or no increase in total sugar concentration occurred during development in 'Whitestar' and 'Rojo Blanco'. A substantial increase in total sugars occurred during development with 'Jewel', 'Beauregard', 'Heart-o-gold' and 'Travis'. Cultivars differed widely in their individual sugar concentrations during development. Percent dry matter increased in all cultivars from 7 to 14 weeks. Dry matter and AIS decreased during the later stages of development.

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SUGAR METABOLIZING ENZYMES IN CARROT ROOTS FROM POPULATIONS VARYING IN SUGAR TYPE AND CONCENTRATION

Philipp W. Simon, USDA, ARS, Dept. of Horticulture, University of Wisconsin, Madison, WI 53706.

Four carrot populations with low total sugar/low reducing sugar concentration, low total sugar/high reducing sugar concentration, high total sugar/low reducing sugar concentration, and high total sugar/high reducing sugar concentration were compared for pH 4.5 invertase, pH 7.5 invertase, sucrose synthase, and sucrose phosphate synthase activity. Invertase activities correlated well with reducing sugar concentration. Sucrose synthase and sucrose phosphate synthase activities were low in all populations. Total sugar level was not well-correlated with the activity of any enzyme measured. Developmental analysis indicated some reduction in enzyme activity as roots grew.

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ROOT RESTRICTION AND SHADING EFFECTS ON SUMMER SQUASH

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Summer squash (*Cucurbita pepo* L.) was grown under greenhouse conditions in 0.35, 2.00, or 7.60 liter containers with full light or with 50% full light to determine the effects of root restriction and reduced light on crop growth and development. Leaf area was determined nondestructively over the course of the experiment, and destructive plant samples were taken weekly to determine dry matter accumulation and partitioning. The experiment was repeated to validate results. There was a decline in production of plant leaf area and dry matter accumulation in response to increased root restriction under full light conditions. However, under 50% light, root restriction had less impact on plant growth when comparing the 2.00 and 7.60 liter container plants. Under the most severe root restricting conditions, light level had little impact on leaf area production and dry matter accumulation. There were no consistent differences in leaf chlorophyll attributable to root restriction or reduced light; however, there was a trend for decreased leaf weight per unit of leaf area under low light conditions. Fruit dry matter production was notably diminished under severe root restriction in full light, and under all root environments under 50% light.

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CHANGES IN PLASTID ULTRASTRUCTURE AND PROTEINS DURING THE DEVELOPMENT OF SQUASH FRUITS

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We first investigated the ultrastructural changes of plastids of two fruit pigment genotypes of squash with isogenic backgrounds (YY and BB). In YY ovaries at anthesis chloroplasts contained granular osmophilic bodies and a few thylakoids, having two features of chromoplasts and chloroplasts in the same organs. After anthesis grana structure gradually disappeared and the typical membranous chromoplasts formed at fruit maturity. On the other hand, proplastids observed in BB ovaries transformed directly into chromoplasts as fruits matured. The same fruits at different developmental stages were also used for protein analysis to provide the relationship between changes in ultrastructure and in protein profiles during plastid differentiation. SDS-PAGE showed that qualitatively similar total plastid polypeptides for two lines at all stages of growth even though there were quantitative decreases or increases in the contents of a few polypeptides. Soluble and membrane associated proteins were extracted from total tissue of subepidermis of squash and showed remarkable differences regarding the relative amounts of many protein species from ovaries and mature fruits. Reduced amounts of the large and small subunits of RuBPCO were obvious especially in immature fruits compared with LS and SS of RuBPCO of squash leaves.

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THE EFFECT OF TRANSPIRATION ON THE ACCUMULATION OF CARBOHYDRATES IN TOMATO FRUIT.

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Previous studies suggest that transpiration from fruit surface drives the inflow of phloem sap into fruits. In those studies, the increment of the size of fruits was restricted mechanically to avoid the effects of changes in fruit size on the import of water. In this experiment, the influence of transpiration on the accumulation of carbohydrates was investigated in intact tomato fruits. Tomato fruits, 7 days after flowering, as attached to the plants were enclosed in the chamber of low humidity (LH) or high humidity (HH) and they were sampled 38 days after flowering. The enlargement of LH fruits was smaller than that of HH fruits. The accumulation of dry matter and total sugars on a fruit basis was lower in LH fruits than in HH fruits. There was no difference in the content of dry matter between LH and HH fruits. The concentration of total sugars of LH fruits was slightly lower than that of HH fruits. Lower accumulation of carbohydrates in LH fruits shows that transpiration flow of phloem sap is not the predominant factor that controls the inflow of photosynthetic assimilates in intact tomato fruit.

83 ORAL SESSION 21 (Abstr. 157-163) Cross-commodity: Growth and Development

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BLOOM THINNING OF FUJI, ROYAL GALA, AND BRAEBURN APPLE WITH MONOCARBAMIDE DIHYDROGENSULFATE

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Foliar applications of monocarbamide dihydrogensulfate (D-88, Unocal Chemicals Division) at rates of 0, 2.5 ml/l, 3.75 ml/l or 5.0 ml/l were made to mature apple trees of "Fuji", "Royal Gala" or "Braeburn" on MM106 rootstock. Treatments were applied dilute when spurs were at 95% full bloom. D-88 was applied at 5.0 ml/l to "Fuji" at three different times during the day (0730, 1400 or 1810) with and without surfactant in an attempt to evaluate the effect of different atmospheric and drying conditions. Fruit set (number of fruit per 100 flower clusters) was determined after natural fruit drop.

D-88 had no effect on fruit set of "Royal Gala" or "Braeburn". There was a linear effect between D-88 rate and fruit set on "Fuji", with the 5.0 ml/l rate reducing set by 30%. D-88 affected the number of fruit at individual fruiting sites, most significantly the percentage of flower clusters setting 3 fruits decreasing with increasing rate. Timing and surfactant had no effect.

Fruit finish, mean fruit weight, seed number and soluble solids concentration were measured at harvest.

AN EVALUATION OF BENZYLADENINE AS A POSSIBLE CHEMICAL THINNER OF 'EMPIRE'

V.E.Emoncor*, D.P. Murr, J.T.A.Proctor and E.C.Lougheed, Horticultural Science Department, University of Guelph, Guelph, Ontario, N1G 2W1, Canada. Field trials at Cambridge Research Station, Ontario, Canada, studied the thinning effect of benzyladenine (BA) on eighteen-year-old "Empire" apple trees. At 16 days after full bloom (fruit diameter 12.87 mm) whole trees were hand sprayed to drip point with BA (0, 100, or 200 mg.l⁻¹). Untreated control trees were compared with treated and hand thinned trees. BA significantly reduced crop load on "Empire". The thinning response to BA was linear, with recommended thinning occurring at 200 mg.l⁻¹. At harvest, fruit weight, size (diameter and length), flesh firmness and soluble solids concentration, chlorophyll and anthocyanin contents, and seed number were increased by BA treatments. BA had no effect on fruit L:D ratio, internal ethylene concentration, maturity, and the onset of the respiratory climacteric, but significantly reduced respiration at harvest. BA also reduced ethylene production and ACC content at harvest, though the reduction was not significant. Although firmness of BA-treated fruit was significantly higher at harvest, upon storage for 1 month at 0-0.5°C and 90-95% RH the firmness advantage was lost. BA shows potential as a thinner of "Empire" apple and has advantage of increasing fruit weight and size, since "Empire" is a relatively small apple compared to other commercial cultivars.

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EVIDENCE FOR REDUCTION OF ABSCISSION IN 'MCINTOSH' APPLE FRUITS AND FOR ENHANCING THE RIPENING AND COLOR UNIFORMITY BY LYSOPHOSPHATIDYLETHANOLAMINE

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We have demonstrated that postharvest treatment of McIntosh apple fruits with Lysophosphatidylethanolamine (LPE) delays the loss of firmness. In the present study, McIntosh apples were preharvest treated by hand spray to the run off point. Fruits were sprayed on August 28, 1991 and harvested two weeks later. One half of the tree was sprayed with LPE (100 ppm) and the other half was the control. Three trees were used in this study. Periodical samples for starch test, internal CO₂ and ethylene, total soluble solids and evolved CO₂ and ethylene were taken to monitor the progress of ripening. At harvest, on average, LPE treated apples abscised 26% while the control trees abscised 55%. LPE treated apples colored earlier and had more uniform and intense color than the control. In a related study, we have found the LPE can delay senescence of tomato leaf and fruit tissues. The delay of the abscission of apples by LPE, found in the present study, might be due to the effect of LPE on delaying senescence of cells in abscission zone of apple fruit pedicle. These results suggest that LPE has the potential to substitute for the use of NAA on apples before harvest and at the same time LPE can improve color uniformity and density of McIntosh apples.

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ROOT AND SHOOT GROWTH AS INFLUENCED BY OVERHEAD AND FLOATATION IRRIGATION IN JALAPEÑO PEPPER TRANSPLANTS

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This study was conducted to investigate how irrigation systems alter root elongation, root morphology, shoot growth characteristics and yield of "TAM-1" jalapeño pepper seedlings. Transplants were grown in containerized trays (18 cm²/cell) for 6 weeks in a greenhouse in Spring 1991. Irrigation systems were: a) floatation (FI), b) 4-week floatation plus 2-week overhead (FI+OI), c) alternate floatation and overhead (FI/OI), and d) overhead (OI). The growing media was maintained between 50 and 20% of its water holding capacity. Between 20 and 41 days after seeding (DAS), FI and FI/OI transplants maintained a constant lateral root length increase. In both FI+OI and OI transplants, lateral root elongation response tended to a 'plateau' at ~ 31 DAS. However, between 31 and 41 DAS, OI transplants had a root growth compensation, increasing the number and length (33%) of basal roots. In FI+OI transplants, basal root growth compensation occurred later in the field. At planting, OI transplants had higher shoot/root ratio (S:R=5) and maintained a higher shoot water potential ($\psi = -0.58$ MPa) than FI transplants (S:R=3; $\psi = -0.69$ MPa), respectively. Overhead-irrigated transplants had higher early fruit yields than floatation-irrigated transplants, but total yields were unaffected.

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FOUR NON-CIRCULATING, HYDROPONIC METHODS FOR GROWING GREENHOUSE TOMATOES

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Total salable yields of 'Vendor' greenhouse tomatoes produced with 4 non-circulating, hydroponic methods were not significantly different from yields produced with conventional soil bed culture (5.69 kg/plant).

Three methods employed a capillary, sub-irrigated system wherein the plant container rested in a shallow, covered, polyethylene-lined tank containing 5 cm of nutrient solution. Plant containers consisted of 7 and 25 liter plastic pots containing a 1 hapuu:2 cinder medium plus 1 and 2 plants, respectively, and rockwool blocks (7.5 x 7.5 x 6.5 cm) resting on larger rockwool blocks (15 x 15 x 7.5 cm).

The fourth method consisted of rockwool blocks (7.5 x 7.5 x 6.5 cm) resting on a screen placed in a covered, 20 cm deep, polyethylene-lined tank filled with nutrient solution.

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INTERACTION BETWEEN PINCHING TECHNIQUE, LEAF NUMBER, AND CULTIVAR ON LATERAL SHOOT DEVELOPMENT OF CUT ROSES.

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Rose plants (cvs 'Royalty' and 'Lovely Girl') in an established canopy were cut back to node 1, 3, 5, 7, 9, 11, or 13 from the base of the stem at harvest. Harvest was defined as the reflexing of the outermost petal. Most rose stems were composed of 13 nodes, therefore, pruning to the 13th node involved removing the flower only. Three leaf removal techniques were evaluated: 1) no leaf removal, 2) removing the node leaf only, or 3) removing all leaves on the stem. Total break number increased as the node position which stems were cut back to increased. For instance, break number increased on 'Lovely Girl' from 1.8 to 2.6 breaks as node position increased from 1 to 13. The number of lateral breaks which developed into marketable flowers also increased as the node position which stems were cut back to increased. 'Lovely Girl' flower number increased from 0 to 2.6 flowers per stem as node position increased from 1 to 13. Leaf removal reduced the number of marketable flowering shoots. For instance, flowering shoots decreased from 2.6 to 1.4 per stem on stems cut at the 13th node following removal of all leaves on that stem. 'Royalty' had more lateral breaks than 'Lovely Girl' but also had more non-flowering lateral breaks following pruning. Commercial implications of this research will be discussed.

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EFFECT OF NEGATIVE DIF REGIMES ON CARBOHYDRATE LEVELS IN LILIAM LONGIFLORUM

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Commercial greenhouse operators are increasingly using "negative DIF" temperature regimes for crop height control. A negative DIF exists where the night temperature (NT) is greater than day temperature (DT). Large differences in DT-NT strongly suppress stem elongation in many crops, and have been used to reduce labor and material costs for chemical growth regulator applications on Easter lily. We have explored some of the biochemical effects of negative DIF temperature regimes. 'Nellie White' Easter lilies were grown (1989 and 1991) at Purdue under a +10 or -10 DIF regime with temperatures adjusted so that daily averages were equal. Plants were harvested at visible bud (VB) and anthesis. Carbohydrates in stems, leaves and flowers were analyzed by HPLC. With both temperature regimes, timing data indicated equal daily temperature averages were achieved. Negative DIF severely reduced stem length, and leaf and stem dry weight. Negative DIF reduced leaf and stem total soluble carbohydrate (TSC) content 39-46% at VB and anthesis, while flower TSC was reduced 10-13%. These results indicate negative DIFs have potentially detrimental biochemical effects on Easter lilies. Other techniques, such as early morning temperature drops, were not a part of this study, and their physiological effects should be evaluated as well.

84 ORAL SESSION 22 (Abstr. 164-170) Postharvest Physiology of the Apple

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DETERMINATION OF LOW OXYGEN TOLERANCE LIMITS FOR SEVERAL APPLE CULTIVARS

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The oxygen partial pressure associated with the respiratory quotient (RQ) breakpoint (ie., lower oxygen limit) was determined for fruits of several apple cultivars stored at 0°C. Fruits were sealed

in low density polyethylene pouches of various thicknesses and known permeability to determine O₂ uptake, CO₂ production, and respiratory quotients (RQ) at various O₂ partial pressures. There were differences in the shape of O₂ uptake versus steady state O₂ curves between cultivars. While some cultivars showed steady declines in respiration rate from 8 kPa O₂ to < 1 kPa, other cultivars showed no decline in respiration until O₂ levels fell below 3 to 4 kPa. Fruits having elevated RQ values had greater levels of headspace ethanol in the polyethylene pouches, which confirmed anaerobic respiration. The lower oxygen limit ranged from a low of approximately 0.75 kPa for cultivars Northern Spy and Law Rome to high of 1.5 kPa for McIntosh.

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EFFECTS OF HYPOXIA ON RIPENING OF GALA APPLES

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In the past four years the effects of levels of O₂ from 1% to 100% on ripening of Gala apples were studied. It was observed that oxygen concentrations larger than 8% did not delay the onset of the climacteric rise in ethylene evolution and respiration, and had no effect on any parameters of ripening, such as texture, acidity and soluble solids. The timing of the onset in the rise of ethylene evolution differed with the year. Low O₂ environments of 1-2% did not induce any rise in ethanol concentration. One hundred percent O₂ was highly detrimental in that it induced visible symptoms akin to low O₂ injury and enhanced the accumulation of ethanol. Hypoxic environments induced a novel 61 kd polypeptide whose quantity was inversely related to the levels of O₂. The data also indicate that the effect of low O₂ environments on respiration is a function of the physiological stage of the fruits.

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CONTROLLED ATMOSPHERE STORAGE OF 'DELICIOUS' APPLES IN HIGH CARBON DIOXIDE

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'Delicious' apples were held in controlled atmosphere (CA) storage at various carbon dioxide (CO₂) levels for 9 months. CO₂ levels were either 1, 3, or 5% with an additional treatment that was increased by 1% every 6 weeks to a maximum of 5%. For each treatment oxygen was 1%, and storage temperature was 1°C. Little quality difference was noted for the 'Delicious' apples immediately after storage or after an 8 day ripening period. Firmness, external or internal color, titratable acidity and amount of scald showed no difference among the different storage treatments. Total carbohydrates and fructose were higher in apples stored at CO₂ levels above 1%. Sensory panelists found no flavor difference in 'Delicious' apples regardless of CO₂ storage level atmospheres. If one considers the substantial cost savings that are possible with increased CO₂ in the storage system, there is good reason to increase the CO₂ storage level in long term storage.

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DELAYS IN REFRIGERATION AND CONTROLLED ATMOSPHERE (CA) STORAGE ALTER APPLE QUALITY

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A two year study of 'Golden Delicious' and 'York Imperial' apple responses to delayed cooling and CA storage imposition after harvest was completed in 1991. Apples from six to eight commercial orchards were harvested at an acceptable maturity level for long-term storage, subjected to a delay in refrigeration (0, 3, or 6 days) followed by a delay in CA storage imposition (0, 14, or 28 days), and then stored at 0°C, 2.4% oxygen, and 1.6% carbon dioxide for up to eight months. Fruit acidity, soluble solids content, bitter pit incidence, scald, internal breakdown, and the development of low oxygen injury were not influenced by the delays. Delays often resulted in more rot and excessive weight loss during storage. Delays in both cooling and CA storage imposition had an additive effect on fruit softening, such that the longest delays resulted in the softest fruit.

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INTERACTIVE EFFECTS OF COOL TEMPERATURES AND RIPENING ON SCALD RESISTANCE IN APPLES

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Apples generally become less susceptible to scald as the season progresses and the fruit ripen. However, ripening effects may be confounded with effects of low temperature. Over 3 seasons we tested interactive effects of hrs < 10°C and ripening on scald susceptibility on Cortland apples. Ripening was induced by 500 ppm ethephon. In 1989, ethephon advanced ripening, increased endogenous antioxidant concns, and reduced scald incidence by 30% when 62 hrs < 10°C had occurred before harvest. In 1990 no hrs < 10°C had accumulated at harvest. Ethephon increased endogenous antioxidants and advanced ripening, but had little effect on scald development (>90% incidence). Low temps during ripening may be needed for ripening to induce scald resistance. In 1991, ethephon was applied once to apples at 6 different stages of development. Fruit were harvested a week later, after 14-156 hrs < 10°C. Ethephon advanced ripening at the first 4 applications, but at the first 3 insufficient cool temperatures had occurred to expect scald reduction unless ripening had an independent effect. Results will be presented and discussed.

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CHANGES IN NON-ETHYLENE VOLATILE SYNTHESIS DURING PHYSIOLOGICAL DEVELOPMENT OF 'BISBEE DELICIOUS' APPLES.

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Synthesis of non-ethylene volatiles (NEV) undergoes significant alterations during the transition from vegetative growth to senescence in apple fruit. This change results in a substantial increase in the production of esters characteristic of ripe apples. The relationship between changes in NEV synthesis and other indicators of physiological and horticultural maturity were investigated using 'Bisbee Delicious' apples. Analysis of NEV was conducted using headspace sampling and GC-MS. Aldehydes and alcohols were the largest NEV components from pre-climacteric fruit although several esters were detected. The concentration of all NEV components declined to a minimum prior to the onset of the climacteric rise in ethylene synthesis. Initial detection of 2-methyl butylacetate, the major ester in ripening 'Bisbee Delicious' fruit, occurred several weeks prior to the onset of the climacteric. The increase in ester synthesis accelerated during the post-climacteric period and the amount of total aldehydes also increased.

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REGIONAL DIFFERENCES AND THE IMPORTANCE OF HARVEST MATURITY ON 'ROYAL GALA' FRUIT QUALITY

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The apple growing districts of New Zealand are spread across a wide range of latitudes. Differences in growing conditions associated with these various districts may influence the way fruit mature on the tree. In this study, the relationships between background colour and physiological maturity of Royal Gala apples have been compared in four major production areas. Royal Gala apples were strip picked from trees in three orchards during the commercial harvest period Hawkes Bay, Canterbury, Nelson and Otago. The maturity of these fruit was assessed, and fruit stored at 0°C for 12 weeks. Following removal from storage, the quality of the fruit was assessed paying particular attention to greasiness. Results from this trial indicate that the relationship between background colour and fruit maturity is not consistent. Indeed, the maturity of apples of a particular background colour may differ according to district and harvest date. Greasiness of fruit was related to harvest maturity in Hawkes Bay. However, fruit from Canterbury and Otago became severely greasy even when harvested at early maturities.

85 ORAL SESSION 23 (Abstr. 171-177)

Temperate Fruit Crops: Nutrition

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TEMPORAL CHANGES IN BORON CONTENT OF SELECTED APPLE AND PEAR TISSUES

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Boron (B) deficiency symptoms often appear in the reproductive tissues of apple (*Malus domestica* Borkh.) and pear (*Pyrus communis* L.) without attendant vegetative symptoms. The primary symptoms are blossom blast, and internal and external cork in fruit. Leaf analysis is the principal diagnostic procedure for evaluating tree B status in Washington orchards. Because flower cluster and fruitlet B contents are influenced by soil moisture availability during the previous autumn, variability in fall precipitation limits the ability of leaf analysis to accurately predict tree B demands the following spring. In the 1960s, Woodbridge and Crandall of Washington State University reported that the B content of apple and pear buds was constant during the winter. The objective of the current study is to determine if winter bud analysis is an accurate predictor of flower and fruitlet B status. Temporal changes in bud, flower cluster, and fruit B are presented for two apple orchards and one pear orchard during the period 1988 to present, as well as the relationships between bud, flower cluster and fruit B concentrations.

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UPTAKE AND PHLOEM MOBILITY OF FOLIAR-APPLIED, LABELLED BORON IN VARIOUS TREE FRUIT SPECIES

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Factors affecting the phloem mobility of foliar-applied B have received little study. The purpose of this experiment was to evaluate foliar retention of B solutions, foliar uptake kinetics, and phloem mobility of foliar-applied B among four tree fruit species. Leaves on current-year shoots of nonbearing 'Red Delicious' apple, 'Bartlett' pear, 'French' prune, and 'Bing' cherry were immersed in 1000 mg/liter B solutions (supplied as ^{10}B -enriched boric acid) in midsummer. Export of the applied label from leaves was monitored between 0 and 24 h, and throughout the following 20 days by ICP-mass spectrometry. Uptake by leaves increased steadily in all species between 0 and 24 h, and reached 80% to 95% of the applied quantity within 24 h. By 24 h, 62% to 75% of the applied label, depending on species, had been exported from the treated leaves. Apple leaves retained, absorbed, and exported over twice the amount of labelled B as prune and pear leaves, and nearly four times the amount of cherry leaves. Foliar retention largely controlled the capacity for uptake and export.

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BORON TOXICITY AND SALINITY INTERACTIONS IN PRUNUS SPECIES.

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Excessive soil and water boron (B) occur widely in California, often in conjunction with high soil salinity. Descriptions of the symptoms of B toxicity and quantification of its impact on *Prunus* species are not available. In these experiments we describe the impact of high B and saline conditions on uptake, distribution and growth depression in almond, peach, plum and peach/almond hybrid rootstocks

A series of experiments are described that indicate an important additive effect of B on sensitivity of *Prunus* species to salinity. Boron concentrations in excess of 1ppm in the irrigation solution, significantly impair plant growth under moderate (non-limiting) salinity conditions and lead to plant death at higher salinity levels. Symptoms of B toxicity in *Prunus* include stem necrosis and vascular occlusion. Unlike most other species, B does not appear to accumulate in the leaf margins and leaf symptoms are generally not observed. Differences in sensitivity of a range of *Prunus* species to B toxicity are described.

Initial results suggest that differences in rootstock sensitivity to B and salinity are the result of differential uptake and partitioning of B, Na and Cl within the plant.

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CALCIUM ALLEVIATION OF BORON TOXICITY IN PRUNUS SPECIES.

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Boron toxicity is a wide spread problem especially in arid and semiarid areas of the world. Boron toxicity can result in yield loss of many crop plants, especially stone fruits which are sensitive to high boron concentration.

This study was designed to follow the effect of Ca+2 supplementation on partitioning of B at the plant organ level (leaves, stem, roots) and the subcellular level (the cell wall) using the stable isotope ^{10}B .

Results demonstrate that calcium supplementation reduced B accumulation in plum and peach leaves by 31% at the low level (0.25 mM) and by 12% at the high B level (0.50 mM). Results indicate an effect of Ca on the uptake and distribution of ^{10}B between plant organs.

Symptoms of B toxicity in peach (Lovell) include stem die back, necrotic brown spots on the stem and gum formation on the nodes, whereas in plum (Mariana), stem die back and gum formation, as droplets, on the lower leaf's surface were the main symptoms.

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PEACH TREE RESPONSES TO AMMONIUM AND CALCIUM SPRAYS

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A field experiment was conducted to assess the effects of several foliar nutrient sprays on the vegetative growth of 'Jefferson' peach budded on 'Nemaguard' and 'Lovell' rootstocks planted on a site with a history of Peach Tree Short Life. The trees received foliar applications of 2 mM solutions of ammonium citrate, calcium citrate, calcium lactate, calcium phosphate, or a water control at 3 week intervals from April to August. Vegetative growth measurements were taken after one growing season. Trunk cross-sectional area (TCSA) was significantly increased by ammonium citrate (TCSA=20.35 cm²), calcium citrate (TCSA=20.03 cm²), and calcium lactate (TCSA=19.91 cm²) when compared to controls (TCSA=16.75 cm²). Trees on 'Nemaguard' responded more to treatments than those on 'Lovell'. All nutrient sprays increased TCSA, lateral growth, terminal growth, and total tree growth on 'Nemaguard' rootstock. Terminal growth increased 12-36%, and total tree growth increased 18-51% compared to control trees, but only ammonium citrate applications were significantly greater. Lateral growth and TCSA of treated trees increased 65-168% and 17-28%, respectively.

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FOLIAR POTASSIUM SPRAY TIMING EFFECTS ON SEASONAL LEAF POTASSIUM AND PRODUCTIVITY OF FRENCH PRUNE (*PRUNUS DOMESTICA*)

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Soil applied potassium (K) may not alleviate K deficiency in fine textured California soils when high numbers of prunes per tree are produced leading to leaf necrosis and limb death. Because K demand is increased by fruit, K nitrate (KN) sprays appear to be a corrective option for growers in this situation. Our objectives were to determine best seasonal KN spray timing strategies to minimize K deficiency, quantify K uptake into leaves after spray and to evaluate spray effects on productivity. Results indicated that regardless of spray timing leaf K was increased by approximately 0.3% and three weeks later decreased 0.2%. Average leaf K in sprayed trees was 0.7% higher than untreated trees at harvest. Fruit fresh to dry weight ratios were lower (better) from summer sprayed trees than spring. Summer KN sprayed trees had yield efficiencies equal to those having soil applied K. Fruit size was similar regardless of K application method. Foliar KN sprays may be a viable K augmentation to soil application in heavy crop years on fine textured soils.

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EFFECTS OF NITROGEN RATE AND APPLICATION DATE ON GROWTH, YIELD, AND MINERAL COMPOSITION OF NECTARINE LEAVES AND FRUIT

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Mature trees of Stark Redgold nectarines grown in silt loam soil in the Po Valley were tested at five fertilization regimes and compared to untreated control: N₁ (100 kg N/ha), N₂ (100 kg N/ha, split 60% in spring and 40% in postharvest), N₃ (200 kg N/ha), N₄ (100 kg N/ha) + K (150 kg K₂O/ha), N₅ (200 kg N/ha) + K (150 kg K₂O/ha). The annual distribution in spring was equally split before full bloom and at fruit set.

The data collected over the three trial years show no differences as compared to control in yield and fruit size. N₂ delayed ripening and decreased fruit quality. Leaf mineral composition was affected by potassium; maximum N induced leaf accumulation of N-NH₄. The high concentration of K in leaf tissues was correlated to the yellow color of the leaf blade. Total leaf chlorophyll

content was measured by an Spad-502 chlorophyll meter (Minolta Corp.) and compared to that measured by conventional technique (Arnon method). The overall findings suggest the amount of N used in peach fertilization can be reduced.

92 ORAL SESSION 24 (Abstr. 178-185) Subtropical/Tropical Fruits: Growth, Development, Nutrition

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NITROGEN UPTAKE AND ALLOCATION IN TWO CITRUS ROOTSTOCK SPECIES.

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The objectives of this greenhouse study were to determine the rate of nitrogen (N) uptake over a 30 day period, use efficiency and N partitioning within two citrus rootstock species. Sixteen-week old seedlings of Cleopatra mandarin (*C. reticulata* Blanco) and Swingle citrumelo (*C. paradisi* x *P. trifoliata*) were assigned to treatments (harvest day x rootstock species) in a completely randomized design, grown in a Candler fine sand for 6 weeks and fertilized weekly with a N:P:K (5:1:5) plus minor elements solution at 200 mg N·liter⁻¹. A single application of ¹⁵NH₄¹⁵NO₃ (20% ¹⁵N) was substituted for a normal weekly fertigation. Six replicate plants of each rootstock species were harvested at ½, 1½, 3½, 7½, 10½ and 30 days after ¹⁵N application. Uptake of ¹⁵N was more rapid in SC over the first 7½ days (17% of applied) than in CM (11%), but uptake over 30 days was similar (52-53%) for both species. A higher proportion of ¹⁵N was found in the photosynthetic tissues of CM (74%) than in SC (48%), whereas a lower proportion was found in the fibrous roots of CM (9%) than SC (22%).

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FERTILIZER EFFECTS ON EARLY GROWTH AND YIELD OF 'HAMLIN' ORANGE TREES

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The growth response of newly-planted 'Hamlin' orange (*Citrus sinensis* L. Osbeck) on Carrizo citrange (*C. sinensis* x *Poncirus trifoliata* L. Raf.) trees to N-P-K fertilizer rates was studied to determine the minimum fertilizer required to bring trees into maximum early production. The highest fertilizer rate applied was 2.72, 5.45, and 8.17 kg·tree⁻¹ of an 8-1.8-6.6 N-P-K fertilizer in 1989, 1990, and 1991, respectively. Additional fertilizer treatments equalled 50, 25, or 13% of the maximum rate. The response of trunk cross-sectional area, tree canopy volume, and fruit yield to fertilizer rate was described by a linear plateau model. The model predicted a fruit yield of 22.6 kg·tree⁻¹ at the estimated critical rate of 48% of maximum. Fruit yield at 50% of maximum rate averaged 21.2 kg·tree. As fertilizer rate increased, total soluble solids (TSS) in juice and ratio (TSS:acid) decreased, but weight per fruit and TSS per tree increased. A fruit yield above 21 kg·tree⁻¹ from 31-month-old trees was indicative of vigorous growth.

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COPPER PHYTOTOXICITY TO YOUNG CITRUS TREES AS INFLUENCED BY SOIL pH

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The aim of this study was to investigate soil pH and copper (Cu) interactions affecting Cu phytotoxicity to young citrus trees on different rootstocks. Hamlin oranges on either Carrizo citrange, sour orange, or rough lemon

rootstocks were grown on Candler fine sand at varying soil pH (5.0, 5.5, 6.0, 6.5) without additional Cu or soil applied Cu (liquid form; 240 kg Cu/ha; nine pre- and five post-planting applications over a period of 43 months). Increasing soil pH increased tree height, canopy volume and trunk diameter of trees on all three rootstocks, regardless of Cu treatments. Tree growth response to an increase in soil pH was greater in Cu amended as compared to unamended treatments. Response to pH increase above 6.0 was marginal as compared to that for pH increase from 5.0 to 6.0. Leaf Cu concentrations showed negligible differences in response to Cu treatments; however, Cu concentrations in fibrous roots increased by 126 to 152% in Cu amended as compared to unamended treatments.

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PHOSPHORUS AS AN OLIVE FRUIT LOOSENING AGENT

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Olive fruit harvest by mechanical shaking continues to be limited by poor fruit removal - less than 60% removal for most varieties. Whereas foliar spray of ethylene releasing compounds such as ethephon increases fruit removal percent, excessive leaf loss following treatment precludes commercial acceptance of the treatment. A classic case of serendipity has led to the testing of phosphorus as an olive fruit loosening agent. Na₂HPO₄ at 25 mM applied via the cut stem of explants leads to massive leaf and fruit abscission. When the P source is applied at 100 mM foliar spray, fruit removal is accomplished with minimal leaf loss. Results of this investigation will cover P source, concentration, genera with abscission response and some indication of mechanism of action.

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FLOODWATER OXYGEN CONTENT, ETHYLENE PRODUCTION AND LENTICEL HYPERTROPHY IN FLOODED MANGO TREES

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The influence of floodwater dissolved O₂ content on stem lenticel hypertrophy and endogenous ethylene evolution from mango trees, and the influence of exogenous ethylene on mango stem lenticel hypertrophy was examined. In general, floodwater O₂ contents of 1-7 ppm resulted in lenticel hypertrophy within about 6 days of flooding, whereas floodwater O₂ contents of 15 ppm delayed hypertrophy until about day 9. After 14 days of flooding, there were more than twice the number of hypertrophied lenticels per tree with floodwater O₂ contents of 1-7 ppm than with O₂ contents of 15 ppm. Ethylene evolution from aerobic stem tissue increased 4- to 8-fold in trees exposed to floodwater with 1-2 ppm O₂, increased 2-fold for trees exposed to 6-7 ppm O₂, but remained constant with 15 ppm floodwater dissolved O₂ content. During a 10-day flooding period, trees in floodwater with 15 ppm dissolved O₂ content, and given exogenous ethylene, developed extensive stem lenticel hypertrophy, whereas no hypertrophy developed on stems of trees receiving no exogenous ethylene and maintained in floodwater with 15 ppm O₂. These data suggest that ethylene plays a role in promoting stem lenticel hypertrophy in flooded mango trees.

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FRUIT AND FLOWER INDUCTION AND MANIPULATION OF CARAMBOLA (*AVERRHOA CARAMBOLA* L.)

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In January of 1990, 72 axillary bud were labeled on each of 6 carambola (*Averrhoa carambola* L.) trees. Six (6) buds per tree were harvested on a monthly basis and examined to determine their developmental state, which was classified as: reproductive, vegetative or undifferentiated. The number of reproductive buds peaked in July, October and November. The percentages of buds being reproductive during these 3 months ranged from 86% for October to 94% for November, with July intermediate at 91%. Vegetative bud production peaked during the period from February through June with 45% of buds vegetative, and again in August with 33% vegetative and December with 39% vegetative. More than 50% of buds examined were undifferentiated during the period from December through April and again in September. Periods with high percentages of undifferentiated buds preceded times with high percentages of either reproductive or vegetative buds. When a high percentage of buds were reproductive, the percentage of both vegetative and undifferentiated bud was low.

DEVELOPMENT AND ABSCISSION OF 'MAURITIUS' LITCHI FRUITS AND THE DECREASE OF ABSCISSION BY AUXIN 2,4,5-TP.

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The rate of 'Mauritius' litchi fruit development and abscission was studied over three consecutive seasons. Two pronounced abscission waves were observed. The first started at the end of the female bloom and ended about four weeks later. Female flowers abscised at a rate of 85-90% during this period. Most of the abscised fruitlets were devoid of embryo and/or endosperm. After a lull of about a week, the second abscission wave began, lasting about two weeks. Approximately 5% of the female flowers survived this wave. Most of the abscised fruitlets had embryos. The second wave coincided with the period of rapid replacement of endosperm by embryo. Auxin (2,4,5-TP) was very effective in increasing marketable fruit yield when applied during the lull between the two abscission waves. At that time fruitlets weighed about 2 g. A longitudinal cut revealed an embryo already visible to the naked eye, at the micropylar end of the seed cavity.

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CARBOHYDRATE CONTENT ASSOCIATED WITH BUD DIFFERENTIATION

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Lack of carbohydrate has long been held to be a factor contributing to poor return bloom when fruits are "stored" on the tree for a prolonged period or after an "on" year crop. It is well-documented that in a number of nodes sited along a fruiting branch basipetal to a growing fruit, no bloom occurs in the following season.

During a year's monitoring buds from an "on" year of 'Shamouti' orange and Murcott mandarin had the same level of soluble sugars and starch as from "off" year. While, leaves of 'Shamouti' did not show any differences in soluble sugars and starch with "on" and "off" years, Murcott had twice as much starch in the leaves from "off" year. Sucrose has been found to be the major sugar, with glucose up to 1/10 of sucrose and very minute amounts of glucose. Reproductive buds contained less soluble sugars than vegetative with no significant differences between basal and top buds from either type of branches. Results will be discussed in terms of carbohydrate effects on bud differentiation toward flowering. Supported by BARD No. I-1643-89.

93 ORAL SESSION 25 (Abstr. 186-193) Vegetable Crops: Stress Physiology

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SOIL WATER DEFICIT EFFECTS ON PLANT WATER RELATIONS AND LEAF GROWTH OF CUCUMBER

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Cucumber (*Cucumis sativus* L. cv. Marketmore 80) plants were exposed to a soil water deficit and subsequently rewatered. Maximum stress intensity was -1.5 MPa midday leaf water potential compared to -0.6 to -0.8 MPa in the well watered control, eight days after withholding water. Midday stomatal conductance (ks), leaf turgor potential and water potential decreased in the stress treatment compared to the control beginning at the first sampling, two days after withholding water. The decrease in all three was approximately linear with time over the stress. Decreased leaf elongation was observed at the second sampling, three days after the initial decline in ks and five days after withholding water. At similar relative water content (RWC), osmotic potentials of the stress and control treatments were the same throughout most of the stress. Further, there was no difference in osmotic potential, at the same RWC, between the stress and control treatments 12 - 16 hours after rewatering. Split-root experiments were also conducted to examine a possible role of a non-hydraulic signal from roots in drying soil in the regulation of ks and leaf elongation in cucumber. No conclusive evidence of a signal was found despite significant decreases in soil water potential of one-half of the root system of the stress plants. However, fluctuating vapor pressure gradients (vpgr) may have obscured evidence of a signal.

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GROWTH, WATER RELATIONS, AND PHOTOSYNTHESES ARE REDUCED BY DECREASING SOIL MOISTURE IN 'MARY WASHINGTON' AND 'SYN 4-56' ASPARAGUS SEEDLINGS

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Seedlings of the asparagus cvs Mary Washington (MW) and Syn 4-56 (4-56) were grown at minimum soil matric potentials (SMP) of -0.05, -0.10, and -0.30, -0.50 or -1.5 MPa. Decreases in shoot dry weight leaf area, storage and fibrous root dry weights, and total root and plant dry weight were an exponential function of soil moisture in both cvs. Most of the growth inhibition occurred between the -0.05 and the -0.30 MPa levels of soil moisture, with little further response to SMP drier than -0.30 MPa. Consistent differences between the two cvs, regardless of SMP were apparent in leaf area, shoot dry weight, storage and fibrous root dry weights and root/shoot ratios. MW produced greater leaf area and shoot dry weights than did 4-56 at high SMP and exhibited greater inhibition of shoot dry weight by low SMP than did 4-56. Conversely, 4-56 produced greater storage root dry weight than MW at all SMP, although in mature field-grown plants, 4-56 produced greater fern weight, crown weight and number and stem numbers than MW. Root/shoot ratios generally increased with decreasing SMP. However, the root/shoot ratio of 4-56 was greater than that of MW over the entire range of soil moisture and increased more with decreasing SMP than did MW. Stomatal conductance (gs), fern xylem potential (), and net CO₂ assimilation rates decreased with decreasing SMP in a similar manner in both cvs. were

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HIGH NIGHTTIME TEMPERATURES DECREASE FRUITSET AND YIELD OF GREENHOUSE TOMATOES

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In the southern U.S. and other mild winter areas, the length of the harvest season for greenhouse tomatoes is limited by high night temperatures. The purpose of this study was to determine the extent of this limitation by installing mechanical refrigeration to provide nighttime cooling in two of four computer-controlled greenhouses. For three crops of greenhouse tomatoes, nighttime temperatures in cooled houses were not allowed to rise above 20°C. Sixteen-week old transplants were placed in greenhouse treatments starting Mid-April ('91), mid-July ('90) and mid-August ('89). Fruit weights were significantly increased by nighttime cooling on all three planting dates, with weights increasing 11%, 28% and 53%, respectively. For the mid-July and mid-August plantings, fruitset, fruit size and % uncracked fruit were also increased significantly by nighttime cooling. Data collected in '90 showed that plants in the cooled houses required only an additional 2.4 days to mature and were only 10-15% taller, suggesting there were no significant plant-related disadvantages to nighttime cooling. Lack of stored heat and nighttime heat load in the greenhouses resulted in low cooling costs and refrigeration requirements, so nighttime cooling may also be commercially feasible.

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MITIGATION OF HEAT STRESS EFFECTS ON POTATO GROWTH BY CALCIUM AND NITROGEN APPLICATION DURING STRESS

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The optimum temperature regime for *Solanum tuberosum* cv. Russet Burbank is usually 20/15°C day/night. We studied the impact of heat stress (30/25°C, day/night) on the growth of this heat sensitive cultivar under controlled conditions (UW-Biotron). Plants were grown in sandy-loam soil which tested at 1500 Kg/ha Ca. Plants were at the maximum temperature for 6h during the middle of the day with a photoperiod of 14 hrs. All pots received identical amounts of total N (rate: 225 Kg N ha⁻¹). The treatments were: (1) NSN: non-split N (N application 1/2 emergence, 1/2 two wks later); (2) SPN: split-N (1/2 emergence 1/6 at 2, 5 and 8 wks later); (3) SPN+Ca: Split-N+Ca (Ca at 2, 5 and 8 wks after emergence, total Ca from CaNO₃ was 113 Kg ha⁻¹). Total leaf FWT and DWT was significantly reduced in NS treatment by heat stress at 13 wks as compared to optimum conditions. However, this was not reduced in SPN and SPN+Ca. Under heat stress: (a) SPN + Ca gave the highest leaf FWT and DWT, stomatal conductance, transpiration rate, and leaflet tissue Ca content; (b) Young expanding leaflets gave higher growth rate with SPN and SPN + Ca than NSN; (c) Ca content of mature leaflet decreased progressively in both NSN and SPN but not in SPN + Ca. Our results show that application of Ca and N during heat stress can mitigate stress effects and that maintenance of a certain level of calcium in leaf tissue is important under heat stress.

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ENHANCED SYNTHESIS AND ACCUMULATION OF ACC AND MACC DURING RELIEF OF THERMOINHIBITION WITH KINETIN IN LETTUCE SEED

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The level of 1-aminocyclopropane-1-carboxylic acid (ACC) was 0.55 nmol.g⁻¹ in dry lettuce (*Lactuca sativa* cv. Emperor) seeds. After 4h soak at 25°, 35° and 35°C+ KIN (kinetin, 50µM), the levels were 0, 0.2 and 1.14 nmol.g⁻¹ seeds, respectively. The level of ACC was higher at

35°C+KIN than at 35°C for up to 16h soak. No ACC was detectable at 25°C during 2 to 16h soak. In the presence of 50µM ABA, ACC level decreased to 0.2 nmol.g⁻¹ at 4h soak and to zero level during 8 to 16h soak. The level of 1-(malonylamino) cyclopropane-1-carboxylic acid (MACC), in dry seeds was 14 nmol.g⁻¹. Exposure to 35°C in the presence or absence of KIN increased the level to 40-42 nmol.g⁻¹ within 2h soaking, while at 25°C only a slight increase (23 nmol.g⁻¹) occurred. As in the case of ACC, the level of MACC was higher at 35°C+ KIN than at 35°C or 25°C for up to 16h soak. When seeds were soaked in ABA, the pattern of MACC produced was similar to that produced at 35°C. The results indicate that ACC synthase activity is enhanced by the addition of KIN at 35°C resulting in increased synthesis and/or accumulation of ACC and MACC. The relationship of ethylene biosynthesis to changes during stress imposition and alleviation by various factors will be discussed.

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SALT TOLERANCE OF A SELECTED LINE FROM THE CROSS BETWEEN A WILD, TOLERANT TOMATO SPECIES (LYCOPERSICON CHEESMANII, ECOTYPE LA 1401) AND A CULTIVATED SPECIES (L. ESCULENTUM MILL.)

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A salt-tolerance selected F₅ generation from a cross between the wild tomato species, *Lycopersicon cheesmanii*, ecotype LA 1401, and the cultivated species, *L. esculentum* Mill. (cv Heinz 1350) was compared to the wild parental line in a solution culture experiment to determine the effects of selection on salt tolerance, and ion discrimination and accumulation characteristics in the selected line. Seedlings were transplanted to nutrient solutions at the 3 to 4-leaf stage of growth and after a 1-week period of adjustment, were salinized at 25 mM NaCl day⁻¹ (approximately -1 bar osmotic potential) to final salt concentrations of 0, 50, and 100 mM. Plasmalemma and tonoplast vesicles were isolated from fresh root samples, and ATPase and Na⁺/H⁺ antiport activity was determined using fluorescence assays. The selected line restricted Na uptake into the shoot and maintained higher shoot K⁺ than did the wild parent. Growth rate under salinity was greater in the selected line than in the wild species, but relative salt tolerance was higher in the wild parent. Interspecific hybridization appears to be a useful process for the transfer of salt tolerance characters from wild to cultivated tomato.

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EFFECTS OF PHOTOPERIOD ON *ALLIUM CEPA* SEEDLINGS

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The onion crop in Georgia is often damaged by suboptimal winter temperatures. Proper acclimation of seedlings is a way of limiting freeze damage. Because photoperiod is among the factors involved in plant acclimation, the effects of photoperiod on the acclimation of short-day *Allium cepa* seedlings was investigated. A single short-day cultivar, 'Granex 33', was greenhouse grown under an eleven hour photoperiod. After ten weeks of growth, four photoperiod treatments (8, 11, 14, and 24 hrs.) were administered during a two week hardening period at 3° C. Plants were then frozen in an ethylene glycol bath. Degree of acclimation was determined based on regrowth and visual observation. Acclimation of seedlings was completely inhibited by the 24 hour photoperiod. Varying degrees of acclimation were achieved with the other photoperiod treatments.

94 ORAL SESSION 26 (Abstr. 194-201)

Vegetables:

Breeding for Disease Resistance

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HERITABILITIES OF SEED TRANSMISSION AND LEAF AND POD REACTIONS TO COMMON BLIGHT, LEAF REACTION TO WEB BLIGHT, PLANT ARCHITECTURE, AND THEIR ASSOCIATIONS IN DRY BEANS (*PHASEOLUS VULGARIS*)

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Heritabilities (H) of seed transmission and leaf and pod reactions to common bacterial blight (CBB) *Xanthomonas*

campestris pv. *phaseoli* (Xcp) and to web blight (WB) *Thanatephorus cucumeris* (Tc) were studied. The reaction to CBB was quantitatively inherited. H values of .36, .46, and .34 for leaf reaction, .14, .12, and .27 for pod reaction, .53, .26, and .36 for seed transmission were estimated based on variation of F₂ lines derived from bean crosses 'PC-50' x XAN-159, 'PC-50' x BAC-6, and 'Venezuela 44' x BAC-6 (greenhouse, NE). No significant correlations were detected between leaf and pod reactions or between pod reaction and seed transmission. Quantitative inheritance patterns were observed for leaf reactions to Xcp, Tc, and architecture (AR) in F₂ lines from the cross BAC-6 x HT 7719 (field, Dominican Republic). H values of .23 (CBB), .14 (WB), and .30 (AR) were obtained. No significant correlations were detected between CBB with WB or AR. A low correlation (+.22) was found between WB and AR.

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INHERITANCE OF RESISTANCE TO HAWAIIAN BEAN RUST (*UROMYCES APENDICULATUS* (PERS.) UNGER VAR. *APENDICULATUS*) IN SNAP BEANS (*PHASEOLUS VULGARIS* L.)

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Four races of bean rust were identified from Oahu and Maui by testing on nineteen differential cultivars. All Hawaiian bean cultivars were very susceptible to the four races. F₂ segregations of crosses between the differential cultivars and the local cultivars have identified one or more dominant genes for resistance to one, 2, 3 or 4 rust races as well as other genes which do not give qualitative ratios. F₃ families are being evaluated to further identify the inheritance of these genes.

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DEPLOYMENT OF ARCELIN GENES FOR BRUCHID RESISTANCE IN COMMON BEANS

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The discovery of bruchid resistance in wild beans and the demonstration that the Arcelin protein is responsible for the resistance, provide an opportunity to develop resistant cultivars of common bean, *Phaseolus vulgaris* L. Arcelin expression is controlled by multiple alleles, which impart different levels of insect resistance. In field tests in Honduras and Brazil, backcross-derived lines with the Arl-1 allele were most resistant, especially to Mexican bean weevil. Seed mixtures of 0.80 Arl-1:0.20 susceptible and equal amounts of Arl-1, Arl-2, and Arl-3, and Arl-4 containing seeds showed resistance levels and seed yields similar to lines homogeneous for Arl-1. Breeding lines uniform for appearance and agronomic performance, but heterogenous for resistance genes are being tested as potential new dry bean cultivars having stable insect resistance.

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SCREENING FOR RESISTANCE TO FRUIT ROT IN CUCUMBER CAUSED BY *RHIZOCTONIA SOLANI*

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Significant loss in yield of cucumber (*Cucumis sativus* L.) due to fruit rotting caused by *Rhizoctonia solani* (Kuhn) is frequently observed in the Southeastern United States. Chemical controls are costly and provide only partial control. Currently there are no resistant cultivars. The objective of this study was to identify potential sources of resistance and develop efficient screening methods for use in a breeding program. In the summer of 1991, 105 cucumber cultigens representing a range from resistant to susceptible were grown in Clinton, NC. Those cultigens were screened using field and detached fruit methods. Resistant cultigens chosen for further study were PI 165509, PI 197086 and PI 197088, with 2 to 4 % of the fruit surface damaged. Susceptible cultigens were PI 419108, PI 178886 and PI 432855, with 13 to 16 % of the fruit surface damaged. Five methods were then evaluated on greenhouse grown cucumber seedlings to identify an efficient screening method. The methods evaluated were a soil drench, a leaf dip using a mycelium suspension, syringe inoculation, and potato dextrose agar disks of *R. solani* placed on the third true leaf or against the hypocotyl at the soil line.

SEEDLING AND DETACHED LEAF SCREENING METHODS FOR RESISTANCE TO GUMMY STEM BLIGHT IN CUCUMBER

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Gummy stem blight (*Didymella bryoniae* (Auersw.) Rehm) is one of the major cucumber diseases, causing the second highest loss of any disease in North Carolina. Published methods of screening for resistance to this fungus are poorly correlated with field resistance. The objective of this study was to develop seedling or detached-leaf screening methods that are correlated with field resistance. Seedling tests examined the effects of: seedling age (1, 2 or 3 true leaves), days in humidity chamber, inoculum concentration (1×10^5 , 1×10^6 or 1×10^7 spores per ml), time of inoculation (am vs. pm), fungal isolates, and cultivars. Detached leaf tests examined the effects of leaf age (1st, 2nd or 3rd true leaf), inoculum concentration (1×10^4 , 1×10^5 or 1×10^6 spores per ml), and light levels during incubation (dark vs. 12h light/12h dark). Correlations between seedling tests and field data were moderate to high ($r = 0.5$ to 0.7). However, the coefficients of variation were also high. Correlations between detached leaf tests and field data were very low or negative.

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FIELD INOCULATION TESTS TO QUANTIFY RESISTANCE IN SPINACH TO RACES 3 AND 4 OF DOWNY MILDEW

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Resistance to race 3 and 4 of downy mildew (*Peronospora farinosa* f.sp. *spinaciae*) was examined in separate field inoculation tests. Three Arkansas cultivars and three other commercial spinach cultivars were compared by periodically scoring individual leaves for disease severity 7 to 28 days after inoculation. Leaves were scored on a 0 to 6 scale with 0 = 0% of the leaf surface being covered with sporulation and 6 = 90-100%. Resistance was evaluated by comparing disease ratings on a given day as well as the area under the disease progress curve. Arkansas spinach cultivars exhibited significantly lower disease severity ratings in field inoculation tests for all sample dates for both races 3 and 4 when compared to known susceptible cultivars.

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JALORO¹ - A NEW MULTIPLE VIRUS-RESISTANT HOT YELLOW JALAPEÑO PEPPER. Benigno Villalón, Texas Agricultural Experiment Station, Weslaco, TX 78956

JALORO is a multiple virus resistant (MVR) open pollinated pepper cultivar developed by Texas Agricultural Experiment Station at Weslaco. This pungent, cylindrical (fruit with blunt end) yellow jalapeño cultivar possesses high levels of resistance to several isolates of Texas tobacco etch virus, potato virus Y, pepper mottle virus, tobacco ringspot virus, cucumber mosaic virus and tobacco mosaic virus. The genotype combines desirable characteristics of commercial hot yellow wax 'Caloro' (TMR), the jalapeño genome from 'Jalapeño-L' and Jalapeño 1158, and MVR genes from AC2207 (hot serrano) and PI 264280. 'Jaloro' has the ability to set fruit at temperatures above 35C. It has a concentrated flower setting habit, sets fruits earlier and matures more uniformly than 'Caloro'. The singlestem plant will support a heavy set of large thick yellow jalapeño fruit which can be mechanically harvested. It is suited for fresh market in salads or as a processed product, pickled whole, sliced as 'nacho' rings or diced in picante sauces.

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INCORPORATION OF RESISTANCE TO PHYTOPHTHORA CAPSICI INTO KOREAN CULTIVARS OF PEPPER (CAPSICUM ANNUUM L.)

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Three Korean cultivars, Pungkak, Kalmi, and Subi, were crossed with PI 201234, which has resistance to *P. capsici*. A backcross breeding program was initiated to incorporate the *Phytophthora* resistance into the Korean cultivars, but the level of resistance decreased as the backcross round in-

creased. Highly resistant plants occurred frequently in the BC_1F_2 populations but were rare in the BC_2F_1 populations. Resistant plants selected in BC_1F_3 populations had nearly enough recovery of the growth and fruit characteristics of the Korean recurrent parents. Crosses were made between resistant selections in each BC_1F_2 population. The F_1 hybrids showed a considerably increased level of resistance.

55 ORAL SESSION 27 (Abstr. 202-209) Subtropical/Tropical Fruits: Postharvest Physiology

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TEMPERATURE CONDITIONING, INTERMITTENT WARMING, VAPOR HEAT, AND FILM WRAPPING AFFECT GRAPEFRUIT WAX

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It has been reported that temperature conditioning (TC), intermittent warming (IW), and film wrapping (FW) reduce chilling injury (CI) on grapefruit. Our objective was to determine if IW, FW, and vapor heat (VH) affected the composition of the epicuticular wax of grapefruit similar to the effects we previously reported with TC. Waxes were analyzed by gas chromatography. C_{25} to C_{34} aldehydes and alkanes decreased in all treatments in 5C storage for 21 days. Squalene increased in both the TC (7 days at 21C) and VH (43.5C for 4 hr) treatments. Terpenoids increased in both the TC and IW (4 cycles of 5 days at 5C and 2 days at 21C) treatments, and the greatest increase in C_{24} aldehyde occurred in the TC treatment. A VH-TC sequential treatment kept C_{27} to C_{34} aldehydes at fresh fruit levels following 5C storage. FW did not cause any wax increase. It is possible that these wax changes may have a role in reducing CI.

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SURFACE TREATMENTS AND TEMPERATURE CONDITIONING AFFECT GAS DIFFUSION OF GRAPEFRUIT

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The effects of temperature conditioning (7 days at 21C), application of safflower oil, squalene or squalene (all 10% in hexane spray), and a commercial wax (Flavorseal) on gas diffusion of 'Marsh' grapefruit (*Citrus paradisi* Macf.) were studied. Gas diffusion was determined by either ethane influx or ethylene efflux. Less ethane diffused into fruit that were temperature conditioned compared with nonconditioned, and into squalene-treated compared with nonsqualene-treated fruit. As a percent of non-treated controls, ethane influx was 83, 60, 25, and 14 for the surface treatments Flavorseal, safflower oil, squalene and squalene, respectively. Surface treatments were also applied to fruit that were producing ethylene due to previous chilling injury. Squalene was the most restrictive of ethylene efflux followed by safflower oil, squalene, and Flavorseal. All of the surface treatments used have been reported to reduce chilling injury in grapefruit. Perhaps, their molecular structure influences the expression of chilling injury.

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PHYTOTOXIC RESPONSE OF LEMONS TO HOT WATER

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Hot water immersion of citrus fruit is a potential postharvest quarantine treatment for insect disinfestation. Little is known about fruit injury in the temp. ranges/exposure times required to control surface insects. We immersed lemons in water at 25, 50, 52.5 or 55C for 5, 7.5 or 10 min. Fruits were held overnight at 20, 25 or 30C before hot water immersion. Fruits were stored at 10C for 4 wk after treatment. We compared (1) fresh-picked late-season (July-Aug.) coastal "silver" maturity lemons with (2) fresh-picked ripe but green-colored early/mid-season (Oct.) desert lemons and (3) similar desert lemons commercially degreened 7 days with ethylene to attain desirable yellow color prior to heat treatment. Heat injury symptoms were small-large light-dark brown necrotic lesions

or discoloration which developed on peel surface within 2-3 wk after treatment. Order of sensitivity to heat was: most sensitive = coastal silver ($\geq 90\%$ of fruit injured at 55C/10 min) > degreened desert > green ($\geq 34\%$ of fruit injured at 55C/10 min) desert lemons. Up to 50C/5 min could be used on coastal and 52.5C/5 min on desert lemons without appreciable injury. There were no differences between fruit cured overnight at 20, 25 or 30C before heat treatments.

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MECHANICAL INJURY IN SOLO PAPAYA FRUIT

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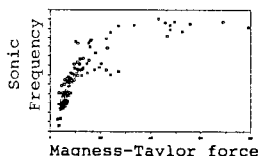
Ripe yellow papaya fruit in the markets frequently show green sunken areas called "green islands" (GI). This disorder seems to be caused by mechanical injury in a commercial postharvest handling system. Fruit at different stages of ripeness (5 to 50% yellow) were dropped from different heights (0 to 100 cm) onto a smooth steel plate to try to create GI. The injury sustained was not the same as GI seen in fruit from the handling system. Fruit (10 to 15% yellow) dropped on different grades of sandpaper (220 mesh to 36 mesh) from a height of 10 cm had injury symptoms similar to those seen on fruit from the handling system. These results suggest that abrasion damage was more important than impact damage in papaya fruit. Heating fruit at 48°C for ~6 hours or until fruit core temperature (FCT) reached 47.5°C aggravated the severity of GI. Delaying the time of heating from the time of dropping did not significantly lower the severity of GI, except for fruit heated 24 hours after dropping. Waxing fruit alleviated the severity of GI. The results indicate that avoidance of abrasive surfaces such as the plywood walls of field bins is the best approach to avoiding the unsightly GI blemishes on papaya peel.

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NONDESTRUCTIVE FIRMNESS MEASUREMENT OF KIWIFRUIT

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Firmness is a critical quality attribute for kiwifruit, as it is for most commodities. Firmness is related to flesh elasticity and rigidity which, along with geometry and density, determine vibrational behavior. Firmness changes in kiwifruit were followed during storage at 0C by three methods: sonic vibrational spectra from 0 to 2000 Hz, dynamic force/deformation (F/D) in the range 40 to 440 Hz, and Magness-Taylor puncture (MT) on an Instron. Frequencies of sonic resonances and dynamic F/D peaks, as well as MT maximum force, decreased as storage time increased. Sonic resonance frequencies were highly correlated with MT maximum force and apparent elasticity ($r=0.79$ and 0.88). Frequencies of peaks in the dynamic F/D traces were correlated with MT maximum force and apparent elasticity ($r=0.68$ and 0.72) and with resonance frequency ($r=0.81$). Further data processing improves the ability of the nondestructive vibrational measurements to estimate the destructive MT test values.



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CONTROLLED ATMOSPHERE STORAGE OF 'HASS' AVOCADOS

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Optimum controlled atmosphere (CA) storage conditions were evaluated over a two year period for California-grown 'Hass' avocado (*Persea americana*). Fruit harvests corresponded to early, middle and late season commercial harvests. Various temperatures and CA conditions were tested. The results indicate that the storage life of 'Hass' can be extended from 3 to 4 weeks in 5C air, to 9 weeks in 5C CA if they are held in 2% oxygen and 2 to 5% carbon dioxide. Loss of quality as determined by chilling injury expression and flesh softening was greatly reduced in these conditions. Fruit maturity influenced the response to CA storage. Late season fruit had greater loss of quality in storage than earlier fruit. In 2% oxygen and 2.5% carbon dioxide, continuous exposure to ethylene levels as low as 0.1 ppm significantly increased quality loss. Delays in cooling and CA atmosphere establishment of up to three days after harvest did not effect quality.

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EFFECT OF HOT WATER TREATMENT AND FILM PACKING ON MARKET QUALITY OF MANGOS FOR EXPORT.

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México is an important producer of mangos for exportation. Losses occurring during postharvest due to poor handling practices, spoilage and injury during transportation reduces the quality of the fruit for shipment overseas. A hot water immersion treatment of 46C for 90 min and film wrapping of the fruit were studied to evaluate losses that occur during the sorting and packing of the fruit for market abroad. Cultivars of mangos included in the study were Tomy Atkins, Hayden, Kent, and Keitt. Fruits were selected from different points in the packing line before and after the hot water treatment and were stored at 10C and 20C for 30 days. Additionally, fruits were divided in subgroups and packed individually in low density polyethylene bags. Fruits were evaluated every 10 days for color, weight, firmness and injuries. Most severe losses occurred when the fruits were selected later in the packing line. Hot water treatment caused severe discoloration on the fruits. Film packing decreased weight loss, improved firmness, and retarded ripening and onset of spoilage.

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RESPONSE OF DATE PALM (PHOENIX DACTYLIFERA L.) SEEDLINGS TO SODIUM CHLORIDE IN IRRIGATION WATER

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The study was carried out at the Experimental Station of Agric. Sci. College at Al-oha region. Eight hundred seedlings (7 months old) were chosen for each following cultivars, Lulu, Boman, Barhee and Khalas. The seedlings for each cultivars were irrigated weekly with 0, 6, 12, 18 g l⁻¹ NaCl solution.

The results revealed fresh weight of stems, roots and number of leaves/plant of Lulul, Barhee and Khalas cultivars progressively reduced with increasing NaCl concentration in irrigation water, while dry matter percentage of stems and roots increased and increasing salinity in irrigation water. The results also declared that the seedlings of four date palm cultivars has similar behavior, when exposed to high NaCl concentration in irrigation water during long term.

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ORAL SESSION 28 (Abstr. 210-216)

Small Fruits/Viticulture: Culture and Management

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PACLOBUTRAZOL, DAMINOZIDE, AND NUTRICAL EFFECTS ON SHELF-LIFE AND FRUIT QUALITY OF RABBITEYE BLUEBERRY

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Applications of paclobutrazol (PP333), Daminozide (DZ), and Nutri-cal to rabbiteye blueberry (*Vaccinium ashei* Reade) was studied. The application of these chemicals at different concentrations was made in the fall and throughout the growing season. PP333, DZ and Nutri-cal induced variable effects on yield, internal and external fruit qualities. Shelf-life of hand-harvested fruits responded favorably to each of these chemicals.

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QUANTITATIVE MEASUREMENT OF CLUSTER COMPACTNESS IN SEVERAL TABLE GRAPE CULTIVARS.

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Cluster compactness can affect fruit quality by influencing pesticide spray penetration into clusters and by predisposing berries to cracking and subsequent decay. Compactness of clusters can be altered through gibberellic acid sprays, flower cluster thinning and pruning severity. Assessment of cluster compactness has often been performed using a visual rating system which may not provide

adequate quantitative measurement. Evaluation of cluster compactness by insertion of wedges between randomly chosen pairs of berries on a cluster revealed a high correlation with a visual rating system and a more sensitive measure of cluster compactness than the visual rating system. Several pruning severity treatments were applied to table grape cultivars to determine their influence on cluster compactness. It was possible to measure statistically significant differences in cluster compactness among these treatment using this wedge measurement technique.

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FRUIT CLUSTER THINNING, SHADING, AND DEFOLIATION ON FRUIT COLOR DEVELOPMENT OF RELIANCE GRAPES

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Significant differences in fruit color were created with fruit cluster thinning (20, 40, and 60 clusters/vine), cluster shading (full sun as control, 55% shading, and 95% shading using shading cage constructed of shade cloth), and defoliation (3, 6, 9, 12, and 15 leaves/cluster). Fruit cluster shading and defoliation treatments decreased red fruit color (characterized by Hunter Color a). Fruit cluster thinning increased red fruit color. Anthocyanin profile of Reliance grape was characterized as cyaninidin-3-glucoside and delphinidin-3-glucoside using Paper Chromatography and Thin Layer Chromatography. Analyses of total anthocyanin content (pH shift method), individual anthocyanin and soluble carbohydrates content (High Performance Liquid Chromatography), are being conducted to determine effects of carbohydrate allocation to fruit and sun light on fruit color of Reliance grapes.

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INITIAL EFFECT OF CROP CONTROL METHOD ON GROWTH, YIELD, AND FRUIT COMPOSITION OF ZINFANDEL GRAPEVINES IN CALIFORNIA.

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Crop control methods were evaluated for two seasons in a commercial Zinfandel vineyard. The vineyard was trellised using a vertical two wire system and cane pruned. Vines were third-leaf when the experiment began. Treatments included control, cluster thinning, and shoot thinning. Cluster thinning consisted of removal of all clusters except the oasal cluster, while shoot thinning consisted of removal of 50% of shoots on canes. Treatments were imposed two weeks postbloom. Yield was not significantly affected by crop control method. Cluster thinning tended to increase berry weight and cluster weight. Crop control method had little effect on fruit composition. Vine growth, as indicated by dormant pruning weight, was not influenced by treatment in 1990 but showed a significant increase during 1991 for cluster-thinned vines. These results indicate little negative effect of high crop level on young Zinfandel vines when intensive management is practiced. Treatments will be monitored until equilibrium treatment effects are observed.

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IN-ROW SPACING AFFECTS GRAPEVINE PRODUCTIVITY AND TRELLIS FILL FOLLOWING A SEVERE WINTER

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'Seyval blanc' and 'Vidal blanc' grapevines were planted in 1983 at in-row spacings of 1.8, 2.4, 3.0, 3.6 and 4.8 m. Vineyard location is in the southcentral Missouri Ozark region, an area characterized by shallow soil and fluctuating winter temperature. A temperature of -28°C in January 1985 severely damaged the vines, which required retraining from the roots. Less time was needed to retrain close spaced vines to a single curtain cordon. Close spaced vines also yielded more in their first production year (1987). Wide spaced vines had increasingly higher pruning weight, yield, and cluster number per vine in later years. Juice soluble solids, pH and titratable acidity showed few differences among the spacing

treatments. Close spaced vines were the most productive on a per meter of cordon basis. Competition between these vines has not yet reduced their productivity.

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A COMPARISON OF THREE MECHANICAL HARVESTERS AND HANDRAKING FOR WILD BLUEBERRIES

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Hand raking was compared to a non-mechanized machine and to two self propelled harvesters for yield and harvest time. Experimental design was split-plot replicated six times with four harvesters/plot with each raker using each machine in each plot. The machines were operated adjacent to one another. Hand raking resulted in the highest yield recovery of all harvesters. Average yield varied by raker from a high of 4831 kg/ha to a low of 3884 kg/ha. The Bluevester harvester recovered 91% of hand harvest and was 1.6 times faster than hand raking while the Darlington machine harvested one half of hand harvest in one quarter of the time. The Easy Pick recovered 81% of hand harvest but was twice as fast. Mechanical harvesters took less time but recovered fewer berries. A economic analysis is needed to fully evaluate these machines.

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EVAPORATIVE COOLING AND CYANAMIDE ON BUDBREAK AND MATURATION OF GRAPEVINE, CV. PERLETTE.

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Chilling accumulation influence dormancy of grapevines and determines budbreak. Under desert conditions, hydrogen cyanamide (H_2CN_2) improve bud opening. To increase even further the quantity and uniformity of bud break, the effect of fall evaporative cooling (EC) alone or in combination with H_2CN_2 (2.5%v/v) was evaluated. Microsprinklers operated for 40 seconds at 10 min intervals from 10:00 h to 17:00 h, from 20 oct to 18 dec 1990. H_2CN_2 was applied on 21 dec, one day after pruning.

Cyanamide treated plants or with the chemical + EC, had 19% and 32% budbreak, respectively, by jan 15. Control or EC vines opened until feb 20, and reached 40% and 57% final values by mar 25. Therefore, cyanamide and EC acted synergistically to open buds earlier and uniformly, although not on final budbreak.

Harvest started may 8 with cyanamide + EC, five days earlier than cyanamide alone; by may 13, accumulated harvest was 39% and 13% respectively, and of 92% and 77% by may 28. Control vines with or without EC, were harvested early may to mid june.

104 ORAL SESSION 29 (Abstr. 217-222)

Small Fruits/Viticulture: Breeding and Genetics

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GENETIC VARIATION FOR VEGETATIVE TRAITS IN STRAWBERRIES GROWN AT DIFFERENT TEMPERATURES

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The extended production season of strawberries raised in mediterranean environments depends on plant development that occurs during the winter months. Seedling genotypes from 20 bi-parental crosses and their nine parent genotypes were fully vernalized and grown at 11, 14, and 17°C, to test for adaptation to growth at minimal temperatures. Genetic variance parameters were estimated and tests for genetic x temperature interactions were conducted for five vegetative growth traits. Highly significant ($P < 0.01$) genetic effects were detected for all traits, and broad-sense heritability estimates ranged from 0.09 to 0.41. None of the genetic x temperature interactions were significant for seedling genotypes, and interactions were significant only for leaf dry weights for parental genotypes. These results indicate a genetic basis for variable vegetative growth rates, but provide no evidence for specific adaptation to growth at low temperatures.

VARIABILITY IN CHLOROPHYLL, RUBISCO, AND FOURTH DERIVATIVE SPECTRA AND THEIR RELATIONSHIP TO CO₂ ASSIMILATION RATES OF EIGHT *FRAGARIA CHILOENSIS* GENOTYPES

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Gas exchange rates were measured in the field on middle leaflets of *Fragaria chiloensis* (L.) trifoliates which were then used for Rubisco quantity and activity assays. Side leaflets of the same leaf were utilized for fourth-derivative spectroscopy, chlorophyll extraction, and specific leaf weight data. Differences of CO₂ assimilation (A) rates were highly significant between genotypes ranging from 16.2 to 27.6 $\mu\text{mol CO}_2 \cdot \text{s}^{-1} \cdot \text{m}^{-2}$. Chlorophyll a and b, and total chlorophyll per unit area were positively correlated to A ($r=0.48^{**}$, 0.45^{**} , and 0.49^{**} , respectively). Total chlorophyll per unit dry weight had a correlation coefficient with A of 0.6^{**} .

Fourth-derivative analysis of in vivo leaf attenuation spectra showed a positive correlation between A and Ca693 peak amplitude and a negative correlation of A and Ca677 peak amplitude. Peak amplitude of Ca693 was also correlated with chlorophyll content.

Activity per unit Rubisco was not a significant factor influencing A, but Rubisco quantity on either a leaf area or a dry weight basis was positively linked to A ($r=0.40^{**}$ and 0.44^{**} , respectively).

219

OPTIMUM ALLOCATION OF OBJECTIVE COLOR MEASUREMENTS FOR EVALUATING FRESH STRAWBERRY FRUIT

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To determine the best sampling strategies, components of variance were estimated for 10 color traits of strawberry (*Fragaria x ananassa*) fruit. Over three dates in one growing season, 2000+ fruit from 47 genotypes were observed. Within-fruit, among-fruit within genotypes, and harvest date variances were compared. Variances for harvest dates were non-significant or small (0-8% of the total variance). Genotype x date variances were highly significant but small ($\leq 6\%$ of the total) for all color traits except internal hue (14% of the total). For external color traits, the within-fruit variance was greater than the among-fruit variance (16-64% and 0-14% of the total, respectively). For internal color traits, the among-fruit variance was greater than the within-fruit variance (20-37% and 9-19% of the total, respectively). Obtaining two observations per fruit for multiple fruit on one harvest date is an efficient strategy for determining a genotype's fruit color. With two observations per fruit, 7 to 22 fruit are needed to estimate a genotype's value within 2 units (CIELAB or degrees) with 95% confidence.

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ORIGIN AND CHARACTERISTICS OF THE UNIVERSITY OF CALIFORNIA DAY-NEUTRAL STRAWBERRY CULTIVARS

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Ten day-neutral strawberry cultivars were released by the University of California between 1979 and 1990. All were derived from a 1955 hybrid between 'Shasta' and a staminate *Fragaria virginiana* glauca clone from the Wasatch Mountains near Salt Lake City, Utah. The first backcrosses to standard cultivars were made in 1958, the second in 1965 and the third in 1969-70. The first three releases came from the third backcross generation in 1979: 'Aptos', 'Brighton' and 'Hecker'. The second group of releases came from the fourth backcross generation: 'Fern' and 'Selva' (1983); 'Muir', 'Mrak' and 'Yolo' (1987). Of these eight, 'Selva' has a proven commercial performance record in California, presently ranking second. The third group of releases all come from the fifth backcross generation: 'Irvine' (1988); 'Seascape' and 'Capitola' (1990). Relative day-neutrality strength and fruiting and vegetative responses to plant conditioning are compared.

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REPRODUCTIVE EXPRESSION OF GENETIC INCONGRUITY IN F1 PROGENY OF INTERSPECIFIC CROSSES OF *VITIS*

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Three classes of crosses using four genotypes of *V. riparia* (wild Riverbank grape) as maternal parents were evaluated for evidence of reproductive expression of genetic incongruity. The classes were: I *V. riparia* x *V. vinifera* cultivars (European domesticated grape); II *V. riparia* x French Hybrids (complex interspecific hybrids); III *V. riparia* x *V. riparia*. Percent fruit set and seeds per berry were recorded for two years. If incongruity is a factor in interspecific grape crosses, then the values for these traits would be expected to be lower in classes I and II than in class III. Analysis of variance indicated significant differences for some half-sib families. Fruit and seed set were lower in classes I and

II than in class III, suggesting that incongruity is operative in wide grape crosses. In the process of creating French hybrids, genomes of several species came together over generations of hybridization. In concert with selection for fertility, repeated interspecific genomic exposure would be expected to have ameliorated the effects of initial incongruity between American species and *V. vinifera*, increasing their value as genetic bridges in breeding programs.

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ROOTSTOCK/SCION COMPATIBILITY IN GRAPEVINE NURSERY PRODUCTION

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All possible grafting combinations of seven rootstocks and six scion cultivars were made to evaluate the rootstock/scion compatibility in grapevine nursery production. Percentage of takes was variable from 20.5% (Ugni Blanc/161-49 C.) to 87.3% (K 188-2/161-49 C.). Among scion cultivars, mean percentage of takes varied from 82.5% (K 188-2) to 37.5% (Ugni Blanc) while rootstocks with all scion cultivars varied from 69.9% (R 110) to 52.8% (101-14 Mgt.), indicating the greater effects of scion on percentage of takes. Variation in rooting index (0: none to 4: profuse rooting scale) was from 3.48 (SV 5276/Rip. Gloire) to 1.63 (SV 5276/161-49 C.). Mean rooting index of rootstocks with all scion cultivars varied from 3.10 (101-14 Mgt.) to 1.95 (161-49 C.) while that of scion cultivars varied from 3.07 (SV 5276) to 2.44 (Ugni Blanc). In rooted grafting, rootstock had a greater effect than scion cultivars.

105 ORAL SESSION 30 (Abstr. 223-229)

Woody Ornamentals:

Culture and Management II

223

TIME-RELEASE FERTILIZERS AND MEDIA AFFECT GROWTH OF CONTAINER-GROWN *LAGERSTROEMIA* AND *LIGUSTRUM*

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One-year-old liners of Firebird crape myrtle (*Lagerstroemia indica* L. 'Firebird') and Vicary golden privet (*Ligustrum X vicaryi*) were planted in 7.6 liter containers. The growing media consisted of 3 pinebark: 1 Canadian peat moss: 1 sand (v/v/v). Both media were amended with NH₄NO₃ and dolomite. Several controlled release fertilizers at varying rates were incorporated into each medium prior to planting. Thirty, 60 and 90 days after planting, leachate samples were collected and tested for E.C. and pH. Fertilizer Sierra (17-6-10) and Osmocote (18-7-13) resulted in maximum shoot dry weight with both species and media types followed by Osmocote (24-4-8) and Escote (20-4-11). Plants grew equally well in pinebark and sawdust medium. After 30 and 60 days leachate from Sierra (17-6-10) had highest E.C. levels. Osmocote (18-7-13 and 24-4-8) recorded highest E.C. at 90 day sampling date. The sawdust medium had higher pH values than the pinebark.

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SUPERABSORBENT POLYMER-AMENDED MEDIA FOR CONTAINER-GROWN WOODY ORNAMENTAL CROPS

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Rooted cuttings of *Photinia X fraseri* and *Podocarpus macrophyllus* were grown in Metro-mix 500 amended with 0.0, 0.25, 0.50, 0.75, or 1.0% (w/w) Stockosorb 300, a K-based superabsorbent polymer. All 3-liter containers were irrigated with 500 ml of 100, 200, 300, or 400 ppm 20N-8-7P-16.72K Peters fertilizer solution once every 3, 6, 9, or 12 days, respectively. In comparison with the unamended media, *P. X fraseri* had equal or better growth (shoot and root fresh and dry weights, increased height, and branch and leaf numbers) with 3, 6, and 9 day irrigation in all but the 1% amended medium. Growth of *P. macrophyllus* was not noticeably affected by the polymer amendment. This is not unexpected

since *P. X. fraseri* is a broad-leaf plant while *P. macrophyllus* is a slow growing, narrow-leaf conifer. Nitrogen, P, and K tissue levels for *Photinia* and *Podocarpus* decreased for the 12 day irrigation treatment regardless of amendment rate. Except for Fe, which was highest at nine day irrigation intervals, micronutrients remained more or less constant in both species. The amended media had a greater water holding capacity at termination of the project (144 and 192 days for *Photinia* and *Podocarpus*, respectively) than at the start. Thus, K-based superabsorbents may be used successfully to reduce irrigation frequency.

225 DESIGN AND TESTING OF A NURSERY BLOCK FOR WATER RUNOFF RESEARCH

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Water quality has become a significant issue in the nursery industry. Local testing of runoff contamination from nursery production is, however, of little value to other growers because of the variation in management practices and nursery layouts. Two nursery blocks have been designed and constructed to test runoff from production with sprinkler and drip irrigation systems in combination with constant liquid fertilization and controlled release fertilizers. Management practices using various combinations of irrigation systems with fertilizer application rates are being tested in a small area with reasonable control of inputs. Preliminary data has shown no difference in plant response to irrigation method, but runoff was significantly reduced with drip irrigation. Plant quality was better with controlled release fertilizer, which generally yielded less N and P contamination in runoff, than constant liquid fertilization except during extremely hot weather.

226 COMPARISON OF ALTERNATIVE IRRIGATION SYSTEMS FOR CONTAINER NURSERY STOCK PRODUCTION

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A study was designed to ascertain the efficacy, water use efficiency, runoff potential, and cost effectiveness of four container irrigation systems: overhead sprinkler irrigation, in-line trickle irrigation, capillary mat with leaky hose, and sub-irrigation. Results were species dependent. Plant growth was best under capillary mat and trickle irrigation treatments, however, differences in plant growth and performance between irrigation treatments were minimal. Differences in water use, however, were quite significant. Overhead irrigation was inefficient regarding water use while capillary mat and trickle systems used much lower volumes of water. Conservative irrigation systems which maintain acceptable plant growth using less water and reduce runoff from container production areas can clearly benefit growers by reducing production and environmental costs.

227 NAPROPAMIDE LEACHING IN CONTAINER NURSERY MEDIA.

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Three commonly used nursery media were packed into 10x40 cm long PVC plastic columns. Two treatments of aqueous applied napropamide [2-(α -naphthoxy)-N,N diethyl propionamide] were used including: 1) 13.44 kg/ha, 2) 20.16 kg/ha. Two water treatments were applied to the columns: 1) 2.54 cm/.405 ha, 2) 5.08 cm/.405 ha. Leachate from the columns was collected every three days for a period of two weeks. Quantitative bioassay testing using a napropamide sensitive plant species *Hordeum vulgare* L. (barley) have indicated a downward linear trend in the growth of roots and shoots when exposed to increasing concentrations of napropamide in controlled petri dish experiments. Preliminary leachate studies indicate that napropamide concentrations in the leachate collected are below levels detectable by the barley bioassay (< .25 ppm) at the label recommended rate of 6.72 kg/ha. Gas chromatography studies will be conducted to confirm napropamide concentrations in the collected leachate.

228 FIRST-YEAR FIELD PERFORMANCE OF 60 MICROPROPAGATED SILVER MAPLE CLONES IN SOUTHERN ILLINOIS.

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Four selected clones from each of 15 provenances were clonally micropropagated and established in plastic mulch in both upland and lowland plantations in southern Illinois. Despite a severe drought, survival in the field was 95%. The plastic mulch controlled weeds, reduced erosion, and supplemental irrigation was not necessary. Although clonal differences in field mortality were statistically significant, the lower survival of some clones may be attributable to plantlet size and planting technique rather than to genetic differences among clones. There was a longer growing season for trees from the midwest and southern provenances as evidenced by date of bud set. As a group, trees from the IL, IN, KS, and MS provenances set bud 26 days later in the upland site and 19 days later in the lowland site than the trees from the northern provenances of MN, NH, Ontario, and VT. The shorter growing season resulted in reduced height and caliper growth of trees from the northern provenances.

229 THE INFLUENCE OF FOLIAR APPLICATIONS OF BA AND GA3 ON BRYOPHYLLUM PLANTS

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Foliar spray of either BA or GA3 alone or in combinations of the two growth regulators were tested for their effects on Bryophyllum plants. Neither BA nor GA3 alone succeeded in stimulating lateral branching or flowering. GA3 totally inhibited bulbils formation. In a panel evaluating the ornamental quality, plants treated with GA3 at 100 ppm ranked top. The combination of BA and GA3 enhanced growth, branching, flowering and bulbils formation. The combinations of BA and GA3 at 50 ppm each, significantly improved the propagative qualities of the bulbils. Chemical names used: N-(phenylmethyl)-H purin-6-amine (BA), Giberllic acid (GA3).

106 ORAL SESSION 31 (Abstr. 230-236) Cross-commodity: Postharvest Physiology

230 POSTPRODUCTION CHARACTERISTICS OF 'FREEDOM' POINSETTIA AS AFFECTED BY PRODUCTION AND POSTPRODUCTION CONDITIONS

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Postproduction characteristics of the new poinsettia cultivar 'Freedom', as influenced by production and postproduction treatments, were evaluated. In one study, plants were grown under three production irradiance levels consisting of 450, 675 or 900 $\mu\text{mol s}^{-1}\text{m}^{-2}$ at 18/24C or 22/28C night/day temperatures and moved at anthesis to postproduction conditions (10 $\mu\text{mol s}^{-1}\text{m}^{-2}$ for 12 hr/day, $21 \pm 2\text{C}$). Anthesis was delayed, plant height and diameter decreased, and a reduction in the number and development of cyathia occurred when maintained at low production temperature and irradiance. Leaf drop, which was minimal after 30 days postproduction (< 25%), was unaffected by production treatments, while cyathia drop was accelerated by low production irradiance and temperature, but not reduced after 30 days.

Leaf retention and quality in postproduction conditions are excellent. Cyathia drop averages 40 to 50% after 2 weeks in postproduction conditions. Bracts and leaves maintain their color well, with only slight fading after 30 days. Plants exhibit slight epinasty after shipping, but recover within a couple of days. These characteristics of 'Freedom' make it a promising variety for the future.

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POTTED MINIATURE ROSE LONGEVITY AFFECTED BY FLOWER RESPIRATION

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Five cultivars of potted miniature roses ('Candy Sunblaze', 'Lady Sunblaze', 'Orange Sunblaze', 'Red Sunblaze' and 'Royal Sunblaze') were grown until stage 1 (bud showing color with sepals starting to unfold). At this stage one half of the plants were moved to interior conditions (12 $\mu\text{mol s}^{-1} \text{m}^{-2}$ from cool white fluorescent lights for 12 hr daily and $21 \pm 1^\circ\text{C}$) and the other half were maintained in the greenhouse at recommended production conditions. Stage 1 bud respiration, flower respiration at flowering and at 2, 4, 6 and 8 days after flowering were assessed for plants in the greenhouse and under interior conditions. Also, flower interior longevity was assessed for all the cultivars and the correlations between flower longevity and flower respiration at the different stages were analyzed. At flowering and under interior conditions 'Red Sunblaze' lasted the longest (23 days) followed by 'Orange Sunblaze' (18 days), 'Lady Sunblaze' and 'Candy Sunblaze' (16 days), and 'Royal Sunblaze' (13 days) and flower respiration was 2.08, 2.74, 3.91, 3.59 and 3.94 $\text{mg CO}_2 \text{g}^{-1} \text{hr}^{-1}$, respectively. In miniature rose, flower longevity was negatively correlated with flower respiration rate ($P=0.01$).

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LOW-TEMPERATURE STORAGE OF BEDDING PLANT PLUGS

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Ageratum, begonia, marigold, and salvia seedlings in plug cells were stored in coolers to determine the effects of temperature, light, and storage time on growth and forcing time of seedlings after transplanting, and to determine the optimum storage temperatures for each crop. Photosynthetic photon flux densities of 0, 1, and 5 $\mu\text{mol m}^{-2} \text{s}^{-1}$ were combined with temperatures of 0.0, 2.5, 5.0, 7.5, 10.0, and 12.5°C to create 18 storage environments. Sample plants were removed from each treatment at 1-week intervals for 6 weeks, and were forced into flower. In all four species, temperatures of 0.0 and 2.5°C caused chilling injury and then death as plants were stored for progressively longer periods. Storage at 0.0 and 2.5°C also delayed flowering when chilling injury was not severe enough to cause death. In general, plants stored better in the light than in darkness. Darkness tended to limit the time seedlings could be stored, but for each crop, the addition of just 1 $\mu\text{mol m}^{-2} \text{s}^{-1}$ extended the storage durations to 6 weeks at one or more temperatures. Storage of all four species was possible for 6 weeks, but there were significant variations between the temperatures and storage durations each species could tolerate. Optimal temperatures were 5-7.5°C for begonia, 5°C for marigold, and 7.5°C for salvia and ageratum.

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VIBRATION OF TOMATO FRUIT CAUSES ABNORMAL RIPENING.

Najib Assi*, and M. Joseph Ahrens, Department of Vegetable Crops, Mann Laboratory, University of California, Davis, CA 95616-8631.

Previous investigations have shown that severe injury and bruising result from impacts, compression, and vibration scuffing during transport. Work specifically on vibration has focused on damage caused by "micro impact" and not true vibration. Our study looked at true vibration-imparted energy and analyzed the effects of force and frequency.

Mature green tomato fruit were secured to a platform and energized with a vibration cell at different frequencies and force for 0, 10, 20, 30, 40, 50 and 60 minutes. The fruit were then allowed to ripen at 20°C. Ethylene and respiration rates were determined along with general condition for two weeks.

Ethylene production and respiration rate increased initially and remained high with increasing force and length of treatment. Fruit vibrated for 40, 50, and 60 min developed an uneven ripening pattern. When the control fruit were red, the vibrated fruit showed blotchy ripening. In addition, the ripening rate was slower, although respiration and ethylene production were higher. However, when the control fruit were full red to overripe, the blotchy ripening disappeared in the treatments, but they never developed as deep a red as the controls. We are continuing to investigate vibrational effects on gel breakdown and membrane integrity

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MODE OF CARBON DIOXIDE ACTION ON METABOLISM OF ORGANIC AND AMINO ACIDS IN CRISPHEAD LETTUCE

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Leaf tissues of crisphead lettuce (*Lactuca sativa* L.) were kept in air or in air enriched with 5% to 20% CO_2 at 0°C

for 2 to 9 days followed by transfer to air or to CO_2 -enhanced atmospheres at 20°C for 1 day to study the mode of CO_2 action on metabolism of organic and amino acids. The 20% CO_2 treatment caused a decrease in intracellular pH, which alone or, in combination with other CO_2 effects, inhibited succinate dehydrogenase but activated glutamate decarboxylase. This resulted in an accumulation of succinate and γ -aminobutyrate and a reduction in concentrations of malate and glutamate. Elevated CO_2 atmospheres did not affect other organic and amino acids. These effects of CO_2 were influenced by temperature and concentration/duration of exposure to CO_2 , while type of tissue (green vs. white) and cultivars of lettuce generally had no influence.

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A PACKAGING SYSTEM FOR PEELED WHOLE BABY CARROTS

M. Joseph Ahrens, 103 Mann Laboratory, Department of Vegetable Crops, University of California - Davis, Davis, CA 95616-8631

Fresh, peeled, whole baby carrots are fast becoming the driving force in sales of fresh carrots. In 1991, 200 million tons were marketed to food service and retail outlets. "Peeled whole baby carrots" are mature carrots cut to 5 cm lengths and peeled in a modified potato peeler. Two problems have developed which are limiting the expansion of this market: 1) the product as currently packed develops a slimy rot in 10 days and 2) a "white bluish" forms on the exposed surface of the product after 5 days.

Tests on the atmosphere of the bag indicated that the product was generating a low O_2 environment, causing the growth of anaerobic rots. Evaluations of several film materials were undertaken to find a formulation which would provide an O_2 level above 5% and CO_2 below 7%, a level above which some cultivars are injured. Sucrose ester and cellulose based edible films and anti-oxidants were applied to the product to help eliminate white bluish, which could be the product of dehydration or lignin formation.

A cellulose-base edible film supplied from the USDA and a mineral impregnated single ply low density polyethylene 1.5 mil bag were selected as the optimum packaging combination. Storage at 5°C was improved to 50 days, with white bluish and decay greatly reduced. Studies on the logistics of the edible film application are continuing.

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ACTION OF REDUCED OXYGEN AND ELEVATED CARBON DIOXIDE ON ANAEROBIC METABOLISM OF 'BARTLETT' PEARS

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Fruits of 'Bartlett' pear (*Pyrus communis* L.) at green (preclimacteric) and yellow (postclimacteric) stages were kept in 0.25% O_2 (balance N_2), 80% CO_2 (balance O_2), or 0.25% O_2 + 80% CO_2 (balance N_2) for 1, 2, or 3 days followed by transfer to air at 20°C for 3 days to study the effects of these controlled atmosphere (CA) treatments on anaerobic products and enzymes. All the three CA treatments caused greater accumulation of ethanol, acetaldehyde, and ethyl acetate than the air control. The postclimacteric pears were more sensitive to CA treatments as indicated by occurrence of skin browning, enhanced activity of pyruvate decarboxylase, and higher concentrations of the anaerobic volatiles. For the preclimacteric pears, the 0.25% O_2 treatment dramatically increased alcohol dehydrogenase (ADH) activity, which was associated with the induction of one ADH isozyme. Exposure of preclimacteric pears to 80% CO_2 slightly increased ADH activity while treatment with 0.25% O_2 + 80% CO_2 resulted in lower ADH activity than 0.25% O_2 alone.

107 ORAL SESSION 32 (Abstr. 237-243) Subtropical/Tropical Fruits: Culture and Management

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EFFECTS OF IRRIGATION RATE WITH RECLAIMED WATER ON GROWTH AND LEAF MINERAL CONTENT OF YOUNG CITRUS TREES

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Highly treated sewage effluent water increasingly is being used for agricultural irrigation. This reclaimed water is presently being used in a large citrus irrigation project in central Florida. The purpose of this study was

to determine the effects of high application rates of reclaimed water on growth and leaf mineral content of young citrus trees. High application rates (1270 and 2540 mm per year) of reclaimed wastewater were compared to a normal recommended rate of 406 mm per year of either reclaimed or well water. Tree growth was greater at the higher application rates, but these rates also promoted greater weed growth. With reclaimed water, leaf Na, Cl, and K contents generally increased with increasing irrigation rate, but these levels remained well below levels that would cause plant damage. Leaf Cl accumulation was much higher in 'Hamlin' orange than 'Orlando' tangelo. Rootstock also affected leaf Na and Cl accumulation. Reclaimed water appears to be a useful alternative to well water for citrus irrigation.

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RECLAIMED WATER AND MICROSPRINKLER IRRIGATION OF ONE- AND TWO-YEAR-OLD GRAPEFRUIT TREES

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Field studies conducted over two growing seasons were designed to study the effects of reclaimed water on the development of 1- and 2-year old 'Redblush' grapefruit trees (*Citrus paradisi* Macf.) on Swingle citrumelo rootstock. Experiments were conducted at two locations on Kanapaha and Arredondo fine sands and treatments were arranged in a 3X3 factorial experiment. Treatments included reclaimed water, well water plus fertigation and reclaimed water plus fertigation, which received <0.023, 0.23 and 0.23kg N/tree/yr in 1990, and <0.034, 0.34 and 0.34kg N/tree/yr in 1991, respectively. In addition irrigation was applied at 20% soil moisture depletion, 1.5 cm/wk and 2.5 cm/wk for 31 weeks in 1990 and 39 weeks in 1991. Tree growth and vigor were greatest for the reclaimed water plus fertigation based on visual ratings and trunk diameter measurements and lowest for reclaimed water alone, where leaves exhibited visual signs of N deficiency. No differences in tree growth or vigor were observed among irrigation rates. Similar results were observed at both experimental locations.

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THE RELATIONSHIP BETWEEN LIGHT INTENSITY, LEAF SPECIFIC WEIGHT, LEAF NITROGEN LEVELS, AND FRUIT SIZE AT HARVEST FOR MANZANILLO OLIVE.

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The relationship between changes in Photosynthetically Active Radiation (PAR), specific leaf weight, nitrogen per leaf area and fruit size at harvest were investigated within the canopy of Manzanillo olive. Increasing PAR in the tree canopy related linearly to increasing: specific leaf weight, nitrogen per leaf area and fruit size at harvest for samples collected adjacent to where the light measurements were made. From these results it appears as though specific leaf weight, and nitrogen per leaf area may be useful indicators for determining if light intensity is a limiting factor on fruit sizing within the canopy of Manzanillo olive. These and additional data will be discussed.

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EVALUATION OF ORCHARD PERFORMANCE OF THE HASS AVOCADO ON THREE *Phytophthora cinnamomi* Rands RESISTANT AND ONE SUSCEPTIBLE ROOTSTOCK

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The experiment compared productivity and vegetative growth of the Hass avocado on three avocado root resistant rootstocks and one susceptible rootstock. Hass trees on Duke 7 reported the largest number of fruit per tree and on G 755c the smallest five years after planting. Trees on Topa Topa and Duke 7 reported the highest average production four years after planting. Trees on G 755c were significantly lower in the amount of leaf N. Trees on Toro Canyon and G 755c showed significantly lower amounts of Na. Trees on Duke 7 showed a significantly higher level of Mn. Trees on G 755c were significantly

smaller two years after planting. Trees on Topa Topa and Duke 7 showed a significantly larger canopy diameter than those on G 755c four years after planting. Trees on G 755c showed the smallest mean shoot growth four years after planting. Trees on G 755c had significantly larger trunk circumferences three and four years after planting. No statistical differences were found among rootstocks as to freeze damage to the Hass scions.

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FEASIBILITY OF GROWING GUAVA IN MIDDLE GEORGIA

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Seeds of a pink flesh test line of guava (*Psidium guajava* L.) from India, were germinated in a greenhouse. In April 1988, 6-month-old guava seedlings were set 3 m apart in a field row while an equal number of plants in 15 liter containers, were held in the greenhouse. The field plants were more vigorous than those held in the greenhouse. However, the field plants could not survive severe winter conditions outdoors and were totally destroyed by winter freezes of 1989-90. In spring 1990, the plants held in greenhouse were transplanted in the field under a 6-mil polyethylene protective cover where they flowered during February-April 1991. Trees were productive with 52 fruits per tree, most of which reached maturity without a drop or pest problems. Fruit ripening on trees began in late August 1991. Values for such parameters as fruit weight, height from blossom end to stem end, circumference and volume were 269.3 g (± 10.6), 7.3 cm (± 0.1), (25.6 cm (± 0.3), and 279.7 ml (± 11.4), respectively. Actual values ranged from 117 to 597 g, 5.5 to 10.1 cm, 19.3 to 33.2 cm, and 131 to 639 ml, respectively. Tree-ripe fruits had pink tinge on yellow-green skin and pink colored thick flesh had mild aroma and good flavor. Guava can be successful in Middle Georgia with proper care for cold protection.

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Kiwifruit storage performance is related to position on vine, fruit weight, and fruit mineral content.

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Positions of every individual kiwifruit were mapped on each of five eight-year-old vines on a T-bar training system before harvest. The proportion of excessively soft kiwifruit (< 1.0 kgf penetrometer reading at 20C) after 130 days coolstorage at 0C on individual vines ranged from 7 to 45%. Fruit at the distal ends of fruiting canes were significantly heavier and firmer (mean wgt 108.5 gms, mean firmness 1.22 kgf) than fruit closest to the main leader (105.6 gms, 1.18 kgf). Conversely, for multiple clusters, fruit on spurs adjacent to the fruiting cane were heavier than those at the terminal end (109.9 and 103.8 gms), respectively, though firmness of these fruit did not differ significantly. The firmest fruit had less nitrogen, less potassium, less phosphorus and more calcium than the soft fruit. Potential means by which this information could be used to improve fruit storage quality will be discussed.

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THE CACTACEAE FAMILY – A POTENTIAL CANDIDATE FOR THE EXOTIC FRUIT INDUSTRY

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Numerous species of cacti were introduced in an attempt to diversify the types of fruit trees cultivable under the conditions of the Israeli Negev Desert. The new species were tested in five introduction orchards varying in type of soil, climate and irrigation water. Fruits of the *Hylocereus* genus, which must be grown on a trellis system under netting, were found to be of an attractive shape, color, appearance and taste. *Cereus peruvianus*, which grows outdoors, produced beautiful tasty fruits which varied in color from yellow to deep red. Fruits of these species are of the nonclimacteric type and are capable of withstanding long-distance transportation. Some have to be cross-pollinated while others can be self-pollinated. They flower twice or three times a year, bearing fruits from June to November. These types are characterized by a CAM photosynthetic pathway, pointing to high water use efficiency.

108 ORAL SESSION 33 (Abstr. 244-250)

Fruit and Nut Crops: Pests and Diseases

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A CONTAINERIZED METHOD OF SCREENING FOR RESISTANCE TO ROOT ROT CAUSED BY *PHYMATOTRICHUM OMNIVORUM*

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Phymatotrichum Root Rot, caused by *Phymatotrichum omnivorum* (Shear) Duggar, imposes severe losses upon dicotyledonous horticultural crops in the southwestern United States and northern Mexico. Rootstock resistance could benefit pecan (*Carya illinoensis*) production in affected growing areas; however, erratic growth habit of this pathogen and site variability prevents effective field screening. We have developed a containerized screening method for horticultural crops, using a commercial soilless growing medium. In sterile cultures, 2.5 x 60 cm glass tubes containing Metro Mix 500 yielded more grams of *P. omnivorum* sclerotia than cultures grown in Houston Black Clay, a traditional medium for cotton research. Preliminary screening with Okra (*Abelmoschus esculentus*) in non-sterile Metro-Mix 500 resulted in 75% mortality of inoculated plants in 30-35 days. Preliminary screening with 12-week-old, open-pollinated 'Apache' and 'Moore' pecan rootstocks has resulted in 25% mortality of inoculated plants in 150 days. Pecan seedlings with visible taproot infection appear to delay mortality by adventitious root formation.

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MORPHOLOGICAL ALTERATIONS IN PECAN ROOTS INDUCED BY ROOT-KNOT NEMATODES

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Root-knot nematode infection of pecan trees results in reduced growth and vigor of above ground plant parts and gall formation on roots. One-year-old roots parasitized by nematodes were collected and examined by light and scanning electron microscopy for structural anomalies. The root's injury response to nematode feeding was dependent on the location of the nematode in the root. Location in the root exterior to the vascular cambium resulted in hyperplasia forming a burrow for the nematode. Root penetration interior to the vascular cambium resulted in giant cells contiguous to the anterior region of the root-knot nematode. The giant cells occupied extensive regions of the root disrupting the xylem and obliterating cells in the penetration pathway. Giant cells were multi-nucleate with dense cytoplasm and thickened cell walls.

(abstract withdrawn)

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THE IMPACT OF ROSE BLOOM DISEASE (*Exobasidium oxycocci*) ON THE PHOTOSYNTHETIC BIOLOGY OF CRANBERRY

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Gas exchange measurements were made on healthy and rose bloom infected branches of cranberry on 31 May 1991 during the middle of the sporing period. CO₂ assimilation rates of infected branches were reduced 89% on a leaf area basis and 95% on a dry weight basis compared to healthy tissue. Stomatal conductance was 12x higher in infected tissue, while mesophyll conductance was reduced by 92%. Transpiration was 4x higher in diseased tissue reducing water use efficiency by 96%.

Total chlorophyll content of diseased tissue was 81% less than that of healthy tissue but chlorophyll a/b was unchanged. Fourth derivative profiles of chlorophyll action spectra were altered in diseased tissue. Rose bloom leaves were found to lack stomata and have no discernable mesophyll layer.

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IMPROVED DOWNY MILDEW CONTROL IN WINE GRAPES WITH VOSSSEN BLUE

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Downy Mildew, *Plasmopara viticola*, causes major damage and economic loss to many wine grape cultivars grown in the Northeast. The purpose of the experiment was to test the efficacy of Vossen Blue (VB; iron pigment) in association with fungicides for the control of Downy Mildew disease of wine grapes in New Jersey. The experimental plot was a planting of 'Seyval Blanc' (5th leaf). Treatments (applied via back-pack sprayer) included no fungicide (control I), full fungicide (FF) (RCE commercial recs; control II), FF + 4%VB, FF + 8%VB, 8%VB, Half Rate Fungicide (HF) + 4%VB, HF + 8%VB. There were no significant differences between treatments for total yield, average cluster weight, average berry weight, Brix %, and pH. Spectrophotometric (Hunter's Lab) analysis of foliage samples revealed that leaf samples from the VB treatments had greater green color (correlate: increased chlorophyll). Analysis of subjective (1-9) disease incidence data: FF8 significantly lower disease score than FF; FF4, HF4, HF8, and FF no difference. Compared to normal full fungicide: superior Downy Mildew control was achieved by adding VB to full fungicide; equal control was achieved with half fungicide and VB.

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DEFINING ACTION LEVELS FOR LEAFHOPPERS ON THOMPSON SEEDLESS RAISIN VINEYARDS IN THE SAN JOAQUIN VALLEY OF CALIFORNIA

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In the San Joaquin Valley of California, leafhoppers (*Erythroneura elegantula* and *Erythroneura variabilis*) can severely damage the foliage of grapevines resulting in economic loss. Most Thompson Seedless raisin vineyards, however, don't require treatment for leafhoppers every year. To help make the correct treatment decision, monitoring guidelines and action levels are important. This study provides information on monitoring techniques and action levels for this leafhopper complex. A sustained population of 20 nymphs per leaf during summer broods results in 20% to 30% visible damage to the canopy by harvest in early September. Populations higher than this may require chemical intervention to prevent an economic loss. The photosynthetic activity was reduced in proportion to visible leaf damage. Methods of estimating damage to the canopy from leafhopper activity are presented.

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ORCHARD FACTORS AFFECTING TREE PRODUCTIVITY AND MITE INFESTATIONS IN ARKANSAS

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Twelve apple orchards and an experimental orchard were evaluated in 2 years for weed population and diversity, primary pests (codling moth, oriental fruit moth, plum curculio and mites), primary diseases, soil water content, and 37 horticultural attributes describing

tree growth, fruit growth, productivity, tree nutrition, and management intensity. Data were collected at 2 week intervals. The experimental orchard contained three apple cultivars grown in three orchard floor management systems.

Increased weed ground cover related to earlier and increased mite predator populations in trees, decreased pest mite-days, but reduced tree and fruit growth. Grass weed species appeared more detrimental to tree growth than broadleaf species. Tree training intensity was negatively related to canopy density, and incidence of pests and diseases. Reductions in fruit size and quality were more closely linked to weed competition, and earliness and degree of pest mite infestation than to crop load.

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Cross-commodity: Marketing and Economics

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THE U.S. CUCUMBER PROCESSING INDUSTRY STUDY:
MARKETING POTENTIAL FOR CARIBBEAN EXPORT
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The Caribbean has been considered as a potential region for the winter production of processing cucumbers (*Cucumis sativus* L.). The industrial framework, transportation considerations, production costs, and marketing strategies are evaluated by utilizing pertinent studies, trade journals, and industry interviews. Three marketing strategies will be discussed: brined, fresh green stock, and attracting the processor to the region. Of these, producing fresh green stock has the greatest short term potential. This can be achieved through securing grower contracts and competitive backhaul rates, market proximity, and reduced production costs. These factors justify the Caribbean as a viable alternative to established areas for the export of cucumber products to the U.S. market during the winter season. The development of this market can be enhanced by improvements in the Caribbean transportation networks and stable governments.

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CONSUMER MARKETING PREFERENCES OF NURSERY STOCK

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The main purpose of this study was to determine consumer preferences as influenced by type of packaging, size of container, and price when purchasing ornamental plants. From February to May 1991 over 1000 questionnaires were completed through personal on site interviews conducted at Flower/Garden shows and Garden Centers.

Forty one percent of participants preferred to purchase their trees as balled in burlap form and 47% chose to buy their shrubs in containers. Shoppers purchased 60% of their nursery plants from Garden Centers followed by 22% at discount outlets such as K-mart.

The most important factors in purchasing nursery stock were the price and quality of the plants followed by its size. Packing was an important factor but ranked much lower than price and quality.

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CONSUMER PREFERENCE FOR LEAF VARIEGATION, FLOWER COLOR, PRICE, AND USE OF NEW GUINEA IMPATIENS

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Determining consumer preferences for specific plant attributes and plant use can assist in the development of

breeding program objectives and marketing strategies. Consumers in Ames, Iowa participated in an intercept-survey to determine their knowledge of, use of, and preference for several varieties of New Guinea Impatiens (*Impatiens x hawkeri*). Of the population surveyed, 44% had never seen New Guinea Impatiens. Of those that had previously purchased New Guineas, 40% purchased their plants from a retail greenhouse. Outdoor container plantings were the preferred use of New Guinea Impatiens. Mother's Day was chosen by 88% of the respondents as the most appropriate holiday for a gift purchase. Considering plant characteristics, consumers rated condition of the plant as the most important attribute, followed by flower color, flower number, and price. Consumers were asked to rate plants on display comprised of three factors: flower color, leaf variegation, and price. MANOVA was used to determine the most important factor and the trade-off consumers made when expressing a preference for one plant over another.

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CHARACTERISTICS OF THE HERBACEOUS PERENNIAL PLANT INDUSTRY IN THE UNITED STATES

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There are indications that the U.S. herbaceous perennial plant industry has grown substantially in the last decade. Government census data on perennials is sparse, very general, and collected infrequently. The objective of this research was to define characteristics of the herbaceous perennial plant industry. Questionnaires were sent to members of the Perennial Plant Association in 1990. We requested that the person who made decisions on a daily basis, the owner or active manager, respond. Of 439 surveys distributed, 147 were returned for a 33.5% response rate. The average owner or active manager had a high education level (16 years) which was combined with management experience in at least one other company. Firms sold a mean of 30 genera of perennials. Firms selling primarily perennials were younger and more likely to have less total sales than firms selling primarily other plant products. Firms marketing primarily perennials were more likely to sell products by mail and offer a wider selection of genera.

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Vegetable Crops: Crop Protection

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EVALUATION OF FUMIGANTS AND NEMATOCIDES FOR THE CONTROL OF ROOT-KNOT NEMATODES ON CARROT

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A study was conducted to investigate the effectiveness of soil fumigants and oxamyl nematocide on root-knot nematode, *Meloidogyne hapla*. A loamy sand carrot field of Danvers 126 carrots with a high population of root-knot nematodes was used for the test. Treatments included: 1,3-dichloropropene, oxamyl, sodium methylthiocarbamate, and the combination of 1,3-dichloropropene and oxamyl or sodium methylthiocarbamate and oxamyl. All treatments were replicated 4 times in a randomized complete block design. Carrots were evaluated for plant stand, vigor, root length, galling, marketable yield, and total yield. Tremendous differences in plant vigor of young plants were observed among treatments. All of the fumigant treatments were significantly better than the other treatments and resulted in high plant stands and increased root length. Only the fumigated treatments, with or without foliar applications of oxamyl, resulted in significant marketable yield increases. Oxamyl foliar applications are beneficial in reducing root-knot nematode populations levels and damage when applied 6 weeks after initial treatment but not when they are initiated 10 weeks after initial treatment.

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The microclimate of Great Northern (GN) dry bean lines with diverse plant architecture was investigated in terms of white mold (WM) incidence and yield. A split-plot design was used with protected (3 weekly sprays of benomyl 0.9 KG HA⁻¹ after flowering) and unprotected treatments as main-plots and GN lines as sub-plots in a WM nursery (1990, 1991). Canopy density, erectness, leaf area index, and plant characteristics were measured. 'Starlight' (upright) and 'Tara' (prostrate) were selected for detailed microclimate studies. An infrared thermometer, humidity sensor, and a thermistor were placed within the canopy at the advent of flowering. Leaf wetness and its duration were estimated by the leaf temperature in combination with air temperature and dewpoint temperature. 'Starlight' showed later and shorter duration of leaf wetness, lower humidity, and WM and higher yield than 'Tara'. Severe WM and reduced yields occurred also on all other susceptible entries with dense prostrate plant habits in the unprotected plots. Fractal analysis was done on the images of the canopy to quantify the light interception within the canopy.

EVALUATION OF NONIONIC SURFACTANTS FOR CONTROL OF CLUBROOT OF CABBAGE USING BARERoot AND PLUG TRANSPLANTS OF TWO CULTIVARS

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'Market Prize' and 'Bravo' cabbage (*Brassica oleracea* Var. capitata L.), transplanted as peat plug and bareroot plants into a field naturally infested with *Plasmodiophora brassicae*, Woronin, were treated immediately after planting with a liquid or a granular surfactant. APSA 80 TM, applied in transplant water, significantly reduced percent clubbing and discase severity index (DSI) compared to control treatments. Miller Soil Surfactant

Granular TM did not significantly reduce percent clubbing or DSI. There was a significant effect of cultivar on percent clubbing and DSI. There was no significant effect of transplant type on percent clubbing or DSI. This year's study culminates five years of investigation of surfactants for clubroot control. Specific surfactants have proven to be an effective control of clubroot in cabbage. Chemical names used: nonylphenoxypolyethoxyethanol (APSA 80 TM); alpha-alkanoic-hydro omega-hydroxy poly (oxyethylene) (Miller Soil Surfactant Granular TM).

SILICA SLAG AND BARK SLAG INFLUENCE INFECTION OF PLASMODIOPHORA BRASSICA INFECTION IN AN INTENSIVE CHINESE CABBAGE PRODUCTION SYSTEM.

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Race 1 of *Plasmodiophora brassicae* isolated from high altitude of vegetable production district induced clubroot on cabbage, and Chinese cabbage. Inoculation of race from northwestern coast of Taiwan resulted clubroot of Chinese cabbage neither in cabbage. The addition of bark slag or silica slag significantly decreased clubroot infection and increased the weight of Chinese cabbage in the infected field. The addition of 3 gram slaked lime +1 gram KCl +1.78 gram ammonium sulfate +1 gram calcium superphosphate at 500 gram soil 2 month after transplanting increased dry weight of cabbage and decreased infection root hair followed by inoculation of race 1.

127 ORAL SESSION 36 (Abstr. 259-262)

Woody Ornamentals: Propagation

A NEW ROOTSTOCK AND CONTAINER SIZE AFFECT PROPAGATION AND SUBSEQUENT GROWTH OF ROSE BUSHES IN AN ALKALINE SOIL

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Cuttings of a thornless mutation of *Rosa odorata* (RO) and *R. multiflora* (RM) were rooted in Feb., budded with *Rosa* 'Queen Elizabeth' on 21 Apr. 1987, and planted in 2.6- or 5.2-liter containers. Five weeks after budding, over 50% of the buds on the thornless RO had developed into shoots, while only 4% of the buds on the RM were growing. After an additional 10 weeks, 80% and 60% of the buds on the thornless RO and RM, respectively, had development into shoots. Six months after budding, plants in the 5.2-liter pots produced 1 to 2 folds more flowers than those in 2.6-liter pots. Plants from all four production treatments were planted in a field with alkaline soil on 3 Nov. 1987. During the next four years, plants on RM showed severe chlorosis and had 5% and 45% survival for those produced in 2.6- and 5.2-liter pots, respectively. Those on the thornless RO had 85% and 100% survival when produced in 2.6- and 5.2-liter pots, respectively after four years. Leaves of plants on the thornless RO rootstock had higher concentrations of chlorophyll than those on the RM. However, analyses of leaves did not reveal differences in elemental concentrations among treatments.

HORTICULTURAL PROPAGATION TECHNIQUES APPLIED TO SOFTWOOD CUTTINGS OF JUVENILE LOBLOLLY PINE (*PINUS TAEDA* L.), A SOUTHERN FOREST SPECIES

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Clonal propagation of recalcitrant conifers like loblolly pine depends on producing juvenile cuttings on hedges sheared several times annually. Although dormant cuttings root well, it will be economically important to also root softwood shoots produced between shearings. Several variables were therefore evaluated in a factorial experiment to enhance rooting and handling of summer cuttings. Rooting percentages were equivalent for 3 media after a 5-week hardening period (56% overall), but open flats of 1 perlite:1 vermiculite induced larger root systems at the end of rooting and hardening phases. Extending the rooting period from 10 to 14 weeks increased rooting from about 45% to 58% by the end of hardening. Primary root length per cutting increased 12-63% during hardening, depending on medium. After transplanting, overwintering survival was 98%. Foam rooting wedges produced smallest root systems, and resulting plants were consistently shortest through the following growing season. Weekly applications of soluble fertilizer during the last 6 weeks of rooting did not improve rooting or subsequent growth.

EFFECTS OF K-IBA AND RADICLE-CLIPPING TREATMENTS ON ROOT DEVELOPMENT OF NORTHERN RED OAK

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To increase root fibrosity, acorns of northern red oak (*Quercus rubra* L.) were germinated and subjected to several radicle clipping (+/-) and K-IBA concentration treatments combinations prior to planting. Taproots and laterals ≥ 1 mm in diameter at the point of origin were counted. Low concentrations of K-IBA (0-4000 ppm) resulted in four root morphologies: 1) a single taproot and 3-6 laterals (no clipping/no K-IBA), 2) 4-5 taproots and 1-3 laterals (clipped only), 3) a single taproot and 5-12 laterals (not clipped/K-IBA) and 4) 6-12 taproots and 1-2 laterals. High concentrations of K-IBA (4000-10,000 ppm) 'clipped' unclipped radicles resulting in root systems similar to those clipped by hand. Stem height was unaffected by treatment. Radicle-clipping may increase stem caliper. K-IBA treatments may decrease root dry weight.

SEQUENCING OF FORCING SOLUTION PLANT GROWTH REGULATORS ENHANCES MACROPROPAGATION OF *LIGUSTRUM VULGARE* L. BY SOFTWOOD CUTTINGS

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A forcing solution containing 200 mg 8-hydroxyquinoline citrate per liter and 2% sucrose has been demonstrated to extend the season for obtaining softwood growth suitable for use as explants in micropropagation (Yang & Read 1989). Forcing dormant woody stems in the off-season in this fashion also enhances the macropropagation of woody plant species by providing softwood outgrowth that can be rooted as softwood cuttings. GA₃, IBA, IAA and NAA were incorporated into softwood growth which was later used as cuttings for rooting by adding plant growth regulators at various concentrations to the forcing solution. GA₃ incorporated into the forcing solution hastened bud break, increased shoot elongation, but inhibited rooting of softwood cuttings taken from stems forced in this manner. IBA, IAA and NAA in the forcing solution exhibited typical auxin effects on rooting of cuttings by increasing root number per cutting and root elongation. In order to expedite macropropagation of woody plants, GA₃ and IBA were added SEQUENTIALLY to the forcing solution. Addition of IBA to fresh forcing solution following initial use of GA₃ in the forcing solution counteracted the negative effects of GA₃ and stimulated rooting. This protocol is proposed as a method to assist propagation in rooting difficult species by softwood cuttings in the off-season.

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Vegetables: Breeding and Genetics

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AN EVALUATION OF THREE PUTATIVE PREDICTORS OF *PHASEOLUS VULGARIS* FIELD PERFORMANCE UNDER HIGH TEMPERATURE

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184 random F₂ plants from a high temperature (HT) sensitive X HT tolerant snap bean cross were advanced to the F₅ by single seed descent. At anthesis and after HT pre-treatment, all plants in each generation were evaluated in the laboratory for leaf ethylene evolution (EE), % viable pollen (VP), and leaf cell membrane thermostability (CMT). Population means among generations differed significantly for VP and CMT in a paired t-test, while EE means in the F₃, F₄, and F₅ were similar. Correlations among traits were very low ($\leq .25$) with a consistent negative correlation between VP and the others (high VP is a positive trait while low EE and CMT are considered positive). VP and total pollen were highly correlated ($r \leq .81$). To determine if the 3 traits might predict HT tolerance in the field, F₅-derived F₆ lines were grown at Becker, MN (control), and Isabella, PR (HT environment). Yield component data were collected at both locations. Tolerance may be computed as % yield of the lines in the HT vs. the control environment for any or all of the yield components. Regression analysis showed a very low r^2 ($\leq .16$) when EE, VT, and CMT were used to predict tolerance as estimated by pod production. However, as expected, the F₅ best predicted F₆ performance. Further results from Minnesota field and greenhouse and from Puerto Rico field data will be discussed.

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PHOTOPERIOD AND TEMPERATURE INFLUENCES ON COMMON BACTERIAL BLIGHT DISEASE IN DRY BEANS AND IMPLICATIONS

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Some dry bean lines (L) *Phaseolus vulgaris* resistant (R) (compatible reaction) to *Xanthomonas campestris* var. *phaseoli* (Xpc) developed in the temperate zone express susceptibility (S) in the field in the tropics and tropical lines (S) express moderate R in the temperate zone. There is only limited information on the influence of P on Xpc reaction in dry beans. Experiments were conducted in growth chambers (GC) and in the field (NE, Dominican Republic, Puerto Rico) to investigate the influence of P and P x temperature (T) on the reaction of L to Xpc. A split-plot design was used with T as the main-plots and P and L as sub-plots in the GC experiment and with P as main-plots and L as sub-plots in the field experiments. The disease reactions were more severe on L under short P and under higher T than under shorter P and lower T. No interactions were detected among these treatments. PC-50 showed

moderate R, delayed flowering, flower bud abortion, and increased branching under long P (field, NE). These results have implications for breeders in the evaluation of field R of L from different latitudes and for their value in breeding.

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INHERITANCE OF SOME MORPHOLOGICAL CHARACTERS IN LETTUCE (*Lactuca* L.)

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The segregation of three characters not previously reported in lettuce and loci involved in anthocyanin production were observed to segregate in crosses within and between the closely related *Lactuca* species *L. sativa* L., *L. serriola* L., and *L. aculeata* Fisch. & Mey. as well as in crosses with the more distantly related *L. saligna* L. Pollen color segregated 3 yellow to 1 white. Basal branching was controlled by two loci with epistasis. One of the loci was linked to a leaf-lobing locus. Anthocyanin production in several crosses seemed to be controlled by three loci rather than two loci as previously reported. The distinctive pappus bristle type of *L. saligna* (one row of vertical cells) was recessive to the bristle type of the other three species (two rows of vertical cells).

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CHLOROPHYLL DEFICIENCIES IN LETTUCE

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Three chlorophyll deficiency traits in lettuce (*Lactuca sativa*) are reported. One, *chlorophyll deficient-3* (cd-3), is quite yellow in the seedling stage, and controlled by a single recessive allele. *Chlorophyll deficient-4* (cd-4) has sectors of yellow-green and green in the true leaves. It is inherited as a single recessive, and may be allelic to *chlorophyll deficient-2* (cd-2). *Sickly* (si) is stunted, yellow, and partially necrotic, and is also controlled by a single allele. *Virescent* (vi) is epistatic to cd-4 and the latter is partially lethal. Linkage and additional epistatic relations with previously named chlorophyll deficient genes and other traits are discussed.

129 ORAL SESSION 38 (Abstr. 267-270)

Cross-commodity: International Horticulture

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HORTICULTURAL RESEARCH IN AUSTRALIA

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Australian horticultural research and development is now co-ordinated by an industry supported, federal government statutory body - the Horticultural Research and Development Corporation (HRDC). The Corporation, constituted in 1987, co-ordinated project funding to the value of just over \$10 million in 1991/92. More than 300 projects are now supported, covering all sectors of horticulture.

Federal government funds are available to match industry contributions to a value of up to 0.5% gross value of product.

Traditional funding organisations are reducing commitments to research and development, thus placing increasing pressure on industries to help themselves on a user-pays basis.

Examples will be provided of completed projects which are proving of great value to Australian horticultural domestic and export opportunities.

TRANSPORTATION ROUTES FOR LATIN AMERICAN PRODUCE IMPORTS INTO THE UNITED STATES

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The origin and distribution of counter-seasonal fresh fruit and vegetable imports from Latin America into the U.S. was evaluated. Infrastructure comparisons were made among various U.S. ports of entry capable of receiving perishables. Economic comparisons were made utilizing different transportation routes. Market boundary analyses indicated significant cost savings would result from changing existing transportation routes to certain final U.S. destinations. Currently the port of Philadelphia receives the majority of South American fruit which is mostly shipped break bulk or palletized. South Florida ports (Miami and Port Everglades) receive the majority of Central American and Caribbean fruits and vegetables which are mostly shipped containerized. Interest exists among Latin American exporters to diversify their U.S. ports of entry in order to avoid distribution bottlenecks. Future trade routes will likely see an increased utilization of more economical U.S. Gulf of Mexico ports.

IMPORTING PLANT GERMPLASM INTO THE UNITED STATES

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International plant germplasm resources are an invaluable source of information, and bringing viable plant materials into the United States is a necessity for many researchers.

Quarantine regulations vary based on the plant pests and pathogens occurring in the country of origin to prevent the introduction of injurious plant pests and diseases. These regulations also depend on the type of germplasm (such as live plant, cuttings, or seeds), size and age of specimen, and the media grown in. Plants in soil are prohibited, while those in agar, or bare root may be allowed to enter.

Procedures to follow for bringing plant germplasm of international origin (including CITES species), forms and permits, ports of entry, delays to expect or avoid along with other information on successfully bringing plant germplasm resources into the United States will be discussed.

Orchid cut flower production in Singapore and neighbouring countries

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Orchid cut flower industry has contributed substantially to the economy of Singapore, Thailand, Malaysia and other Asean countries. Singapore exports US\$13 million dollar worth of orchid cut flower in 1990 and Thailand's export was at least 3 to 4 times higher. Germany and Japan are the major markets for tropical orchid cut flowers. Economically important orchid genera are Aranda, Dendrobium, Mokara, Oncidium and Vanda. This paper will review the agronomic practices in orchid cultivation, the current status and development of orchid industry and the research and development made towards the improvement of the orchid industry in Asean countries.

130 ORAL SESSION 39 (Abstr. 271-273) Cross-commodity: Modeling

SIMULATION OF TRANSPIRATION OF CITRUS GOVERNED BY LEAF CONDUCTANCE

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A water flow model was developed which uses irradiance, leaf-to-air vapor concentration difference, and soil water

potential to establish stomatal conductance. Water flow to the roots was computed using a linear approximation of radial flow through the soil toward the axis of the roots across concentric shells. Root length density and soil rooting volume within four separate layers or compartments were included in the model. The simulation was executed in small time step iterations. A small increment of transpiration was translated to a water content deficit at the root and then sequentially through the concentric shells to simulate water uptake and change of soil water potential. The change in soil water potential was used to increment changes in stomatal conductance and transpiration. The output of the model simulated the pattern of diurnal stomatal behavior observed in other types of experiments, as well as the total soil water extraction patterns of young potted citrus trees.

MODELING CHILLING INFLUENCE ON CUMULATIVE FLOWERING OF RABBITEYE BLUEBERRY

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A Weibull distribution function was used to develop a model for estimating cumulative flowering and the distribution of flowers of 'Tifblue' rabbiteye blueberry (*Vaccinium ashei* Reade) as a function of growing degree days (GDD) after chilling for chill hours ranging from 300 to 1200. Controlled chilling and flowering conditions were imposed on blueberry plants to obtain data for model development. Once developed the model was validated using independent data sets which were available in the literature. Given information concerning chilling and historical GDD, the model can be used to predict the onset of flowering, cumulative flowering, total number of flowers, and flower frequency at discrete intervals. It is expected that the techniques developed will be applicable to a range of fruit species in which chilling influences flowering habit.

PREDICTION OF ROSE FLOWERING SHOOT DEVELOPMENT

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Temperature affects the rate of rose shoot development. In this study heat units were used to quantify "physiological age". The objective was to determine whether rose shoots require the same number of heat units to reach various stages regardless of climatic conditions. The dates of occurrence of "bud break" (BB), unfolding of each leaf, "visible flower bud" (VFB), and harvest (H) were observed for 126 shoots of 'Cara Mia' roses growing under 5 different temperature and light regimes. Average air temperature (T) and photosynthetic photon flux density (PPFD) levels were recorded hourly. Heat units, defined as the sum of the difference $T - T_b$ (units: $^{\circ}\text{C hr}^{-1}$) where T_b is the base temperature, were found to be a suitable for tracking most phases of rose crop development. The duration of the phase from H to BB showed considerable variation and thus could not be predicted this way. The duration from BB to VFB or H could be predicted reasonably well to occur at 5900 ± 670 and 12300 ± 1000 $^{\circ}\text{C hr}^{-1}$ (Mean $\pm$ Std. dev.), respectively, assuming $T_b = 6$ $^{\circ}\text{C}$. The occurrence of unfolding of each leaf can be predicted similarly. PPFD integrals had no significant effect on any development rates.

139 ORAL SESSION 40 (Abstr. 275-281) Fruits: Breeding and Genetics

RESISTANCE TO LEAF SCALD IN PLUM

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Forty eight cultivars and seedlings of plum involving the species *Prunus americana*, *P. augustifolia*, *P. cerasifera*, *P. munsoniana*, *P. salicina*, *P. simoni*, and *P. triflora* were evaluated for the presence of xylem limiting bacteria (*Xylella fastidiosa*) and tree longevity. Plum leaf scald (PLS) ratings, based on the percent of scalded leaves

in the tree were correlated with the concentrations of bacteria in the twigs and leaf petioles. Observations of symptoms of PLS and monitoring of progeny from interspecific crosses, cultivars, and seedlings indicate that resistance to the PLS organism is present in the Auburn material and heritable. Uniform infection of seedlings was made by double budding of one year whips with buds from infected trees. Resistance to PLS has been incorporated into horticultural types and seedlings are currently being evaluated for possible release for commercial and home use.

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THE USE OF A TESTER CLONE FOR SOUR CHERRY GERMPLASM EVALUATION

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Progress in sour cherry breeding in the U.S. is severely hampered by the limited germplasm available. Importing *Prunus* germplasm into the U.S. as budwood from the center of diversity in Eastern Europe, is impractical because of the lengthy quarantine period required. Instead it is proposed that pollen collection and the use of a tester clone would be the most efficient way to import and use sour cherry germplasm. Sour cherry pollen can be imported and used directly without a quarantine period. When the pollen is used in crosses with an appropriate tester clone, the breeding value of the germplasm can be assessed relatively easily because both parents are known as opposed to one parent as is the case with open-pollinated seed. Once a germplasm source has been identified as having a desired breeding value, pollen can again be imported or requested from the Plant Introduction Station where presumably the clone is still in quarantine, and used in routine breeding crosses. For a clone to be a good tester, it must induce precocity in the progeny and behave in a recessive manner for traits of importance. Data is presented to illustrate the use of the sour cherry cultivar English Morello as a tester clone for sour cherry germplasm evaluation.

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PEACH CULTIVAR DEVELOPMENT BY THE LOUISIANA AGRICULTURAL CENTER BREEDING PROGRAM

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The peach breeding program in Louisiana was initiated in the late 1940's to develop adapted cultivars for Louisiana. The objectives of the program have been to develop large fruited disease resistant fresh market cultivars for all areas of Louisiana. The state is divided into three climatic zones in reference to the breeding program (north, south, and coastal). Cultivars have been developed that are adapted specifically for each zone. A few cultivars produce marketable fruit in all three zones. The annual chill units vary from 350 to 1000+ over the three zones. Seventeen cultivars have been released since 1969 and these are used throughout the southeast U.S. in production areas. A primary breeding objective is to develop a sequence of cultivars to service the market from late April through September. Also equally important is development of genetic disease resistance to bacterial spot, *Xanthomonas campestris* pv *pruni*.

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STONY HARD GENE OF PEACH ALTERS ETHYLENE BIOSYNTHESIS, RESPIRATION, AND OTHER RIPENING-RELATED CHARACTERISTICS

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The stony hard gene in peach is a recessive gene which increases fruit firmness and shelf-life. Five progenies segregating for the stony hard trait were scored for several ripening-related characteristics. Fruit from stony hard segregants produced little or no ethylene, had lower respiration rates, and tended to ripen later than 'normal' fruit. Stony hard fruit also had a lower percentage red overcolor in three of the five progenies. Stony hard fruit, harvested when firm-ripe, maintained their firmness after five days storage at 20°C. Firmness of stony hard fruit decreased significantly if the fruit were sprayed with ethephon (2-chloroethylphosphonic acid) at 250 ppm prior to storage. Fruit firmness of 'normal' freestone or clingstone varieties was not significantly affected by the application of ethephon. The conversion of ethylene precursors to ethylene in stony hard fruit will also be discussed.

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BREEDING FOR COLD HARDINESS OF MEI HUA (*PRUNUS MUME*)

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On the basis of investigating pollination habits of 45 cultivars of Mei Hua, interspecific hybridization between Mei Hua and apricot (*Prunus armeniaca*), David's peach (*P. davidiana*) as well as siberian apricot (*P. sibirica*) were made from 1982 to 1991. With total number of pollination flower 17,050, 168 hybrid seed and 75 hybrid seedlings were obtained. Embryo culture in vitro was used for undeveloped young hybrid embryos. Test of freezing resistance both in artificial freezing and in overwintering for the hybrid seedlings showed that there were 5 hybrids with double and nice flower to be very hardy to low temperature. They were able to tolerate as low as -35°C for 30 days in open ground, and now they were planted in northwest China's Gansu province and northeast China's Liaonin province without cold injury.

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A STUDY ON VARIETY RESOURCES OF *PRUNUS MUME* IN HUNAN II. THE STATUS OF HYBRIDIZATION

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Abstract results showed that many germplasms of *P. Armeniaca*, *P. persica* and a few germplasms of *P. Salicina* had immersed into those of *P. mume*. Some cultivars (strains) possessed species characteristics coming from 2 or 3 of the 3 species in a single plant. All of the plants tested were transition types of the related varieties such as var. *bungo* and so on. Some new characteristics of *P. mume* were found in a few strains. The resources were classified into highly, mediumly and lightly backcrossed types. The mean yield index and fruit weight of highly back-crossed type (HB) were significantly higher than those of the other 2 types. The setting rate of HB was higher and significantly higher than that of lightly and mediumly type, respectively. There were no significant differences in mean bitter index and flower index among them.

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THE ABNORMAL MEIOSIS OF PMC IN FEICHENG PEACH

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Feicheng peach is a famous cultivar of *Prunus persica*. Not only the fruits which are giant with superfine flavour are out of ordinary, but also the meiotic behaviour of PMC is abnormal.

1. About 40–100% of the anthers were found to have a few binucleate microsporocytes in company with normal single ones. The binucleate microsporocyte is about 2 times as large as single microsporocyte. It is neither an end product of cytotoxicity nor a giant microsporocyte and is characterized by having two nuclei in a common elliptical cell wall. The two protoplasts divide independently and consequently to give octads instead of tetrads.

2. Poly-nuclei and poly-nucleoli were observed in some microsporocytes at prophase I. At telophase I, II, nearly all the microsporocytes contained poly-nuclei and poly-nucleoli. This is also true in some of the microspores. Both the number and the size of poly-nuclei in each microsporocyte and of poly-nucleoli in each nucleus were diverse.

3. At telophase II, about 74% of single microsporocytes produced tetrads, and the rest formed diads, triads, unequal tetrads, pentads, hexads, heptads or octads. The microspores formed were unequal in size except those formed from diads. Most binucleate microsporocytes produced octads, and a few formed hexads, heptads or decads. Their microspores are nearly equal in size.

140 ORAL SESSION 41 (Abstr. 282–288)

Vegetables:

Breeding and Genetics II

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VARIABILITY AND SELECTION IN AN INTERSPECIFIC HYBRID POPULATION OF *PACHYRRHIZUS EROSUS* X *P. AHIPA* (YAM BEAN)

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F₃ seeds from a cross of *P. erosus* (indeterminate, day-length sensitive) X *P. ahipa* (determinate, daylength insensitive) were received from M. Sorensen of the Royal Veterinary and Agricultural University in Copenhagen, Denmark and sown

in Hawaii in April, 1989 to increase the seed. The F_4 seed were planted in March, 1990 and in October, 1990 (the normal time). All F_4 progeny included both bush and vine plants in the summer planting, with more bush plants in the progeny of F_3 bushes than vines. Likewise, the progeny of earlier-flowering F_3 plants had a higher percentage of plants in flower in June than progeny of later-flowering ones. Root sizes and shapes were variable. The F_4 progenies of the lines with the highest percentage of bushes and early-flowering plants were regrown in the summer of 1991 and selected for summer-flowering bush plants with acceptable root size. The selections were then grown in the winter of 1991 to test for performance during the normal growing season.

283 UNREDUCED POLLEN: PROPOSED MECHANISM OF POLYPLOIDIZATION OF SWEETPOTATO (*IPOMOEA BATATAS*)

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Previous work in this laboratory identified high levels of unreduced (2n) pollen in the tetraploid (4x) *Ipomoea* spp. Acc. 81.2. This work provided indirect evidence that 2n pollen was involved in the evolution of the 6x ploidy level of the cultivated sweetpotato (*I. batatas*). To further study the role of 2n pollen in sweetpotato evolution, we examined plants of Acc. 81.2, plants of five sweetpotato cultivars, and 100 randomly selected heterozygous sweetpotato seedlings. The 4x Acc. 81.2 was determined to be *I. batatas*. High levels of large 2n pollen were confirmed in Acc. 81.2, and low levels of 2n pollen were observed in 'Sulfur' and in 16% of the sweetpotato seedlings. Presence of monad, dyad, and triad sporads confirmed that the large 2n pollen grains were the result of nonreduction in the sporad stage. These new findings are direct evidence that 2n pollen was involved in the evolution of the 6x ploidy level of sweetpotato. This is the first report of a 4x accession classified as *I. batatas*; it is also the first report of 2n pollen in 6x *I. batatas*. The widespread presence of 2n pollen in sweetpotato suggests that the trait can be used to advantage in breeding programs to introgress genes from wild 4x *Ipomoea* spp. into cultivated 6x sweetpotato without adverse effects on genetic stability or fertility.

284 INHERITANCE OF CHILLING RESISTANCE IN CUCUMBER

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Cucumber (*Cucumis sativus* L.) is one of the more chilling sensitive crops. Chilling resistance could provide growers with protection against late spring frost. Significant differences for chilling resistance were observed among a set of 9 diverse cucumber cultigens when grown at 22 C to 1st true leaf stage, then given a chilling treatment of 4 C for 7 hours in full light (PPFD 500 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$). Two populations, NCWBP and NCES1, were used to measure narrow-sense heritability (estimated as twice the parent-offspring regression coefficient) for chilling resistance. Sets (256/population) of parents and offspring were evaluated in separate tests for seedling resistance. Plants were rated for damage 0 (none) to 9 (dead) on the cotyledons and 1st true leaf, 3 and 5 days after chilling. Ratings were corrected for position in the Phytotron chamber, and log transformations used to normalize the data. Generally, correction reduced the heritability estimates and transformation improved them. Heritability was highest for cotyledon ratings made 5 days after chilling, ranging from 0.35 for NCWBP to 0.70 for NCES1. Ratings of the 1st true leaf were more difficult to make, and produced lower estimates of heritability. Breeders should be able to make good progress in selecting for chilling resistance using this seedling test.

285 FLOWERING HABIT AND YIELD OF CALABAZA GENOTYPES

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The flowering habit and yield potential of seven calabaza [*Cucurbita moschata* (Duchesne), Poir.] genotypes were studied in the fall 1991 season. Earliest flowering and mature fruit were produced on bush plants developed from 'Burpee Butterbush'. Time of flowering and distance from the crown was intermediate in time in the Florida developed varieties 'La Primera' and 'La Segunda' and latest in the Puerto Rican developed entries 'Borinquen', Linea C Pinta, and Soler. Highest yields were produced by 'La Primera' and 'La Segunda',

whereas, lowest yields were produced by the bush lines because of very small fruit size. Fruit size of 'Borinquen' and Linea C Pinta was mostly in the desirable range of 2.3 to 4.5 kg. Most 'La Primera' and 'La Segunda' fruit were round, 'Borinquen', Linea C Pinta, and Soler fruit were flat, and the bush lines produced variable shaped fruit. Further backcrossing to round types is required to overcome the problem of small fruit size and variable fruit shape in the bush lines.

286 MOLECULAR ANALYSIS FOR INTROGRESSION OF *ALLIUM FISTULOSUM* INTO *ALLIUM CEPA*

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The edible Alliums are economically important world-wide. The bulb onion (*Allium cepa*) is the most widely grown. The Japanese bunching onion (*A. fistulosum*) has many desirable characters, e.g., resistance to pink root, Thrips, smut, maggot, and Botrytis. Transfer of pink root resistance from *A. fistulosum* into *A. cepa* has been attempted for over 60 years. However, sterility of the F1 hybrid is a barrier and there is little evidence of gene introgression during backcrossing to *A. cepa*. Dr. Corgan has made crosses between *A. fistulosum* as the seed parent and *A. cepa*. He backcrossed the F1 hybrids to *A. cepa* and generated BC2 progenies which showed excellent pink root resistance. RFLPs in the chloroplast genome showed all BC2 progenies had either the normal or sterile cytoplasm of *A. cepa*. This may be due to not strictly maternal inheritance of the chloroplast DNA or a seed mixture during backcrossing. Other interspecific hybrids and their BC1 progenies had the cytoplasm of *A. fistulosum*. Nuclear RFLPs show hybrid patterns in the F1 plants. BC1 progenies possess some *A. fistulosum* markers as evidence of DNA introgression from *A. fistulosum* into the backcross progenies.

287 PHYLOGENETIC ASSESSMENT IN THE GENUS *ALLIUM* USING RESTRICTION FRAGMENT LENGTH POLYMORPHISMS

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The genus *Allium* contains about 500 species, several of which have been cultivated for millennia. Despite its long history of cultivation and its worldwide economic importance, little is known phylogenetically about *Allium*. Identification of the likely progenitor of *A. cepa* (the bulb onion) will focus future collection efforts on wild germplasm that may be useful in the genetic improvement of the bulb onion. Several classification schemes based on morphological characteristics have been proposed for *A. cepa* and its presumed closest relatives. None of these schemes has been definitive. Nuclear restriction fragment length polymorphisms (RFLPs) were identified among *Allium* species in sections *Cepa* and *Phyllodon*. These were used to unbiasedly estimate phylogenetic relationships.

288 SEARCH FOR THE FERTILE GARLIC CLONES AND THE PERFORMANCE OF HYBRIDS BETWEEN FERTILE CLONES

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To find fertile garlic clones to be used in the cross breeding program, 213 accessions were subjected to cytological study at meiosis I. Most accessions (185 clones) showed abnormal chromosome configurations of ring of four, six or eight, which are ascribed to single or multiple translocations. Two clones showed asynaptic behavior forming 16 univalents from zygotene to metaphase I, and 26 clones revealed regular chromosome pairing of 8 bivalents.

Only six of 26 clones showing normal meiosis produced viable pollen grains, while the rest were male sterile. From the segregation of crosses between male sterile and fertile clones, the male sterility is presumed to be governed by single recessive gene.

Hybrid plants between the fertile clones appeared, in general, intermediate of the parents in field performance.

141 ORAL SESSION 42 (Abstr. 289–295)

Small Fruits/Viticulture:

Nutrition and Stress Physiology

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SEASONAL MAJOR ELEMENT PATTERNS IN FIELD-GROWN CRANBERRY.

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Levels of major elements (N, P, K, Mg, Ca) in 'Early Black' cranberry (*Vaccinium macrocarpon* Ait.) tissues changed during the season (April to October). A distinct pattern was associated with each tissue type (old leaves, woody stems, new shoots, roots, fruit) and each element. However, the pattern for a given element in a given tissue was similar from year to year. For example, nitrogen levels in old leaves rose early in the season and then declined in old leaves as new shoot tissue was produced. The early-season rise in nitrogen levels in old leaves coincided with a decline in nitrogen in woody stem tissue. Changes in the amount of applied nitrogen led to changes in nitrogen levels in new shoots after a 2 year lag. While N, K, Ca, and Mg content (% dry weight) in roots is lower than that in other tissues, there is great biomass of root tissue, so that root tissue represents a large pool of these elements. Roots, along with woody stems and old leaves may represent a reservoir of major elements for new shoot development early in the season, prior to fertilizer application. Levels of the major elements in new shoot tissue achieved a steady state in August, an indication that this is a good time to collect tissue for routine testing.

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Phosphorus Fertility in the Strawberry Nursery
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The phosphorus content is usually high in soils on which strawberry production occurs in west central Florida because of moderate P levels in the virgin soil and yearly applications of P by the growers. A F rate study was conducted to test the calibration of P for strawberry nursery production, and a randomized complete block design with four replicates was used. Rates of 0, 11, 22, and 33 kg/ha P were applied to a Seffner sand which had an initial soil P level of 86 mg/kg using the Mehlich II soil extractant. Soil tests routinely show P soil concentrations up to 250 mg/kg or greater with 86 mg/kg rated in the high range. In this study the P applied to the beds was cultivated into the soil and six plants of two strawberry clones (Fl 87-210 and Fl 85-4925) were set in each plot on 28 May 1991. All nutrients except P were applied as needed during the season. Leaf P content of daughter plants on 20 Aug 1991 varied from 0.23 to 0.25% among P treatments and were not different because of P rates. All marketable size daughter plants were harvested on 8 Oct 1991. The number, total wt, and average wt of daughter plants were not different because of applied P rates.

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TWO PRUNE-YEAR APPLICATIONS OF PHOSPHORIC ACID INCREASE PHOSPHORUS UPTAKE BY LOWBUSH BLUEBERRIES.

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Liquid phosphorus (23% phosphoric acid) was applied preemergence at 0, 22.4, 44.8, 67.2, or 89.6 kg ha⁻¹ to 9 fields: 3 commercial blueberry fields having plants with very low (<.111%), 3 low (.111-.125%), and 3 adequate (>.125%) leaf phosphorus concentrations. Years of application ('89, '89+'91, '89+'91+'93) were assigned in a split-block RCB design with 4 replications at each location. A linear increase in leaf phosphorus concentration with increasing rates of P application was found in both 1989 and 1991. Differences in response were found among locations. A second application in 1991 was effective in raising leaf P levels at most locations to higher levels than the application in 1989. Also, there were higher levels of leaf P in treatment plots that only received P fertilizer in 1989 compared to controls, indicating a carry over effect.

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SEASONAL VARIATION IN LOW-TEMPERATURE TOLERANCE OF FRUIT-BUDS OF VACCINIUM ANGUSTIFOLIUM.

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Lowbush blueberry (*Vaccinium angustifolium*) is a major fruit crop in coastal, Northern New England and Atlantic Canada. One of the factors affecting production is low temperature damage of flower primordia. In addition to mid-winter damage, much of the damage occurs in spring due to late frosts. A study was designed to examine the seasonal variation in the LT₅₀ of fruit buds and to determine the location of the tissue damage.

Field-collected stems were exposed to controlled temperature drops and examined for damage. Three types of damage were identified; destruction of flower primordia, browning of vascular tissue within the fruit-bud, and browning of stem tissue at the base of the bud. The seasonal variation of the occurrence of this damage will be discussed.

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SURVEY OF RUBUS COLD HARDINESS

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Stem and bud tissues of promocanes from more than 260 *Rubus* genotypes were evaluated for mid-winter cold hardiness after laboratory freezing in January 1990. T₅₀ values were calculated for cane samples of red, yellow, black and purple raspberry, and blackberry cultivars, hybrids and species. Red raspberries exhibited the hardest stem tissue, although several purple raspberries (*Rubus* sp. cvs. Brandywine, Royalty) survived as low as -33 C. Fall fruiting red raspberries, such as *R. idaeus* L. cvs. Zeva Remontante, Indian Summer, St. Regis, and Fallred, survived from -23 to -25 C. Summer-bearing cultivars, Canby and Puyallup, survived to -30 C. Stems of several black raspberries (*R. occidentalis* L. cvs. New Logan, Bristol) survived to -27 C. Stems of the hardest blackberry cultivars, (*R. sp.* cvs. Black Satin, Smoothstem) survived to -22 C. In most genotypes the region of the bud at the axis of the stem was less hardy than tissues within the bud scales. Buds tissue was 2 to 10 C less hardy than stem tissue. Field plants were also visually rated for cold injury following record low temperatures occurring in 1989, 1990, and 1991.

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EFFECTS OF CROP LOAD AND LOW-SOIL MOISTURE ON PHYSIOLOGY AND ROOT DYNAMICS IN SEYVAL GRAPEVINES.

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An experiment was conducted to evaluate interrelationships between differing crop loads and water stress on physiology and root dynamics of 3 year old Seyval grapevines grafted to 5-BB, Seyval and Seyval own-rooted stock grown under a rain exclusion shelter. Treatments were: 1) cropping level, either 0 (defruited) or 6 clusters/vine (heavily cropped) and 2) irrigation level, either 2.5 (stress) or 10 liters (control) of water/plant/week. Vines had significantly different root dynamics in regards to crop load, water status and rootstock. Water stressed vines had significantly fewer and smaller leaves (area cm²), lighter trunk weights (g) and shorter shoot length compared to control vines. Heavily cropped vines had significantly fewer mature nodes, shorter shoot growth and higher bud mortality (winter injury) compared to defruited vines.

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ABA AS A ROOT SIGNAL IN GRAPEVINES UNDER WATER STRESS

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ABA implication in root signals of water stress has been suggested by several authors. To verify this hypothesis in grapevines, this experiment has been carried out. One-year-old own rooted cuttings of grapevine cultivar Cabernet Sauvignon were exposed to water stress. After three months of growth, water was

completely withdrawn for nine days, till the plants reached the wilting point. The plants were then rewatered. During the whole period, root hydraulic conductivity was measured with a pressure bomb; xylem sap samples were collected, as well as leaf and root samples. ABA concentration in these samples was measured using Radio Immuno Assay with DBPA1, a monoclonal antibody for ABA. The concentration of xylem sap ABA was 68.2 mg m⁻³ at the start of the experiment. After eight days of stress it was 1863.6 mg m⁻³, 27 x higher. On the ninth day the plants were rewatered, and the xylem sap ABA decreased at 100.2 mg m⁻³, keeping this level for eight more days. Leaf ABA showed high levels of this inhibitor, with a peak in correspondence with the maximum stress. A similar behaviour was attained by roots. In grapevine, ABA seems to be involved in a water stress root signal directed to the canopy.

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Fruits:

Growth and Development I

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METABOLIC HEAT RATES OF BREAKING GRAPE PRIMARY BUDS

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The increasing respiration of breaking 'Pinot Noir' buds was measured by Differential Scanning Calorimetry. Bud development was classified into ecodormant, initial swelling, fully swollen, and breaking buds. Metabolic and CO₂ evolution heat rates increased as the buds developed. Activation energy decreased steadily as development proceeded, which implied that less energy was required for metabolism to continue at later bud stages. A decrease in metabolic efficiency noted by a low calorimetric ratio was observed during the transition from ecodormant to the initial swelling stage. From the second stage on, metabolic efficiency increased. The responsive nature of grape buds to warm temperatures was explained by increasing Q₁₀ (10-20°C) values from 2.8 to 3.8, 3.2, and 3.6 for the four developmental stages described above.

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PHYSICAL AND BIOCHEMICAL STUDIES OF DORMANCY IN APPLE BUDS

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Membrane lipids and cellular water states were studied in endodormant and paradormant apple buds. Paradormancy was overcome by thidiazuron while endodormant buds were forced to break after a certain period of chilling. Nuclear magnetic resonance imaging was used to determine water states in buds of different stages of dormancy. In endodormant buds, the changes in water states from a more tightly-bound to a more free form were correlated with changes in membrane fatty acid composition. The ratio of saturated/unsaturated fatty acids decreased with chilling, especially in C18:1/C18:3 molecular species of phosphatidylcholine and phosphatidylethanolamine. Bud lipase activity, which was assayed by *in vitro* hydrolysis of triglycerides, showed an abrupt increase after chilling treatments.

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OSMOTIC POTENTIAL IS RELATED TO SINK STRENGTH IN VEGETATIVE AND FLORAL BUDS OF APPLE AND PEACH

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The osmotic potential and development of apple and peach floral and vegetative buds and tissue were determined pre-

and post-bloom. Apple and peach floral and vegetative buds were removed pre-bloom and the osmotic potential and bud development measured pre- and post-bloom. The osmotic potential of vegetative and floral buds was related to the phenology of bud development. Developing buds had a lower (more negative) osmotic potential than dormant buds. Removal of peach floral buds lowered osmotic potential and increased vegetative bud development and early leaf growth rate. Removal of peach vegetative buds, however, reduced fruit bud development, fruit growth, and embryo survival. Osmotic potential was an index of sink activity during the pre- and post-bloom stages of development.

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NITROGEN, POTASSIUM, AND CARBOHYDRATE PARTITIONING IN FIELD-GROWN GRAPEVINES OVER A TWO-YEAR PERIOD

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Entire Thompson Seedless grapevines (to include the root system) were harvested at regular intervals over a two year period. Dry matter, soluble carbohydrates, N and K were quantified on an individual organ basis for each date. The pattern of dry matter partitioning to the roots and trunk were similar from one year to the next. Decreases in dry weight in the roots and trunk were accompanied by decreases in soluble carbohydrates. The concentration of K in the roots remained almost constant over the two year period while that of N fluctuated from less than 1% (dry wt basis) to more than 2.5% depending on the time of the year. The dynamics of N and K within the trunk on a concentration or content (g vine⁻¹) basis were similar to one another. N and K were remobilized from the trunk early in the growing while only N was remobilized from the root system. Remobilization of N from the roots took place from berry set until harvest.

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LEAF EMERGENCE, PHYSIOLOGICAL AND PHOTOSYNTHETIC CHARACTERISTICS IN FRUITED AND DEFLOWERED STRAWBERRY

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After anthesis, date of leaf emergence was recorded in fruited plants (F) and deflowered plants (DF) of 'Totem' strawberry (*Fragaria x ananassa*), which were grown in a randomized block design with four blocks in a greenhouse. Two different regression models were fitted to describe leaf emergence rate (LER) after anthesis for F and DF (R² = 0.826 and 0.916, respectively). The LER of F decreased during the fruit development, and accelerated and exceeded DF after fruit maturity, then both dropped when the growth season was ending.

Physiological and photosynthetic characteristics were measured on leaves from F and DF at green fruit, red fruit, and after fruit maturity stages. Newly expanded leaves had significantly higher gas exchange rates, specific leaf weight, chlorophyll a and b contents but lower a/b ratio than the older leaves both during and after fruit development. They also had higher amplitudes of Ca 693 but lower peaks at Ca 684 and Ca 649 in their fourth-derivative chlorophyll spectra. Leaf chlorophyll a content and CO₂ assimilation rate decreased after fruit maturity. Plants at red fruit stage had higher chlorophyll b content than at green fruit and after fruit maturity stages.

The LERs of the second and third leaves emerged after anthesis were most seriously affected by fruit development. They showed greater photosynthetic activity than other leaves in the canopy during fruit development and were thus important to fruit yield.

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FRUITING IN SOUTHERN Highbush BLUEBERRIES: POLLEN SOURCE AND HONEY BEE POLLINATION EFFICIENCY

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'Gulfcoast' southern highbush blueberry (*Vaccinium corymbosum* x *V. darrowi*) plants were placed in 3 x 6 x 2.5 m net cages with one colony of honey bees per cage and one of three pollinizer treatments: "self" (other 'Gulfcoast' plants), "cross/highbush" (other southern highbush cultivars), or "cross/rabbiteye" (various rabbiteye blueberry cultivars). In addition to unlimited pollination, bee foraging was controlled on individual flowers by placing small bags over corollas after 0, 1, 5, or 10 visits. Fruit set, fruit weight, fruit development period, and seed number data were taken, as well as data to relate floral morphology to duration of bee foraging. All measures of fruiting increased significantly with increased bee visitation; the threshold for significant gains in production occurred between 1 and 5 visits. Ten visits generally

provided a good approximation of unlimited pollination. Set, weight, and earliness of ripening was as good, or better, for fruit derived from rabbiteye pollen compared to fruit from self- or cross/highbush-pollination.

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SEASONAL CHANGES OF ASPARAGINE AND ARGININE CONTENTS IN SPUR BUDS, LEAF BUDS, AND FLOWER BUDS INDUCED BY SUMMER PRUNING IN 'FUJI' AND 'JONAGOLD' APPLE TREE.

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Asparagine and arginine contents in spur buds, leaf buds and terminal buds of shoot were compared in Fuji and Jonagold apple trees during dormant and growing season. Amino acid contents in dormant spur buds were significantly higher in Jonagold than in Fuji, whereas the amino acid contents in shoot bark were not different in two cultivars. Asparagine and arginine contents were considerably higher in leaf and terminal buds of shoot. This phenomenon was quite obvious in Fuji than Jonagold but there was no significant difference in asparagine and arginine contents in spur buds. Flower buds differentiated on summer pruned shoots had higher contents of asparagine and arginine as compared with weak spur buds in Fuji but this was not quite obvious in Jonagold. It suggested that the irregular spur size and poor development of spur buds in Fuji cultivar might be caused by the poor translocation of amino acids as well as nitrogen compounds from shoots and other vegetative organs.

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Vegetables: Nutrition

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SAP NITRATE TESTING FOR IMPROVED NITROGEN MANAGEMENT ON POTATOES

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A procedure for rapid determination of nitrate in the fresh petiole sap using an ion specific electrode was developed. A highly significant correlation ($R^2=0.92$) was obtained between the nitrate measured by the sap test and the conventional oven-dried tissue method.

The effects of five nitrogen(N) rates ranging from 0 to 268 kg ha⁻¹, and five dates of sampling dates beginning at tuber initiation, on the sap nitrate concentration were investigated. The nitrate level increased in proportion to N fertilizer rate. The nitrate level was generally higher at tuber initiation and decreased as the season progressed. The rate of decrease was related to the N supply in the soil. At N rates of 0 and 67 Kg ha⁻¹, the average weekly decrease in the nitrate level was greater than 100 ppm. Based on yield response, the nitrate levels were partitioned as deficient, adequate and excessive, and a critical nutrient range was established. The sap test offers a tactical approach for corrective in-season fertilization and a means to increase the efficiency of both fertilizer and available soil N.

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BROADER pH RANGE FOR POTATOES WITH MIXED N THAN WITH EITHER NH₄ OR NO₃

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Three nutrient culture experiments were conducted to determine the responses of potatoes (*Solanum tuberosum* L.) to various solution pH levels with NO₃, NH₄, and mixed NO₃/NH₄ (1/1) at the same total N of 4 mM. The pH levels were maintained at 4, 5, 6, and 7 with NO₃ or NH₄, and at 4, 4.5, 5, 6, 6.5, 7 with mixed N. In each of the experiments, Norland plants were grown for 28 days after transplanting. With mixed N, plant growth as total dry weight, leaf area and tuber number was essentially similar at pH 4.5 to 7, and decreased only at pH 4. However, with either

NO₃ or NH₄ growth peaked at a particular pH level, pH 5 and 6 respectively, and was significantly reduced at other pH levels with severe stunting at pH 7. With mixed N, the concentrations of total N in shoots were similar at pH 4 to 7 whereas, with either N form, the concentrations of total N were higher at particular pH levels, pH 4 and 5 with NO₃ and pH 7 with NH₄. The concentrations of P, S, Ca, Mg, and Mn in shoots were similar at pH 4 to 7 with mixed N, but varied at certain pH levels with either NO₃ or NH₄. The results indicate that the useful pH range for nutrient uptake and plant growth is broader with mixed N than with either NO₃ or NH₄.

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PHOSPHORUS UPTAKE BY SIX POTATO CULTIVARS

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Six potato cultivars (Atlantic, Sebago, Onaway, Russet Burbank, Lemhi Russet, and Norland) were evaluated for phosphorus uptake efficiency in solution culture. Individual rooted cuttings of each cultivar were transferred from a standard 1/5 Hoagland's solution into solutions containing one of six P concentrations (0.05, 0.1, 0.22, 0.5, 1.1 and 2.3 mg/l). After a 24h adjustment period P uptake was followed over a 6h period by collecting solution aliquots every two hours. All cultivars depleted the two lowest initial P concentrations to similar stable P concentration. The P uptake rate per unit length of root showed a sigmoidal relationship to the initial P solution concentration. The general nature of the P uptake relation to solution P concentration was similar among the cultivars, although the actual values varied. In general, P uptake rate increased from 5.0 X 10⁻⁴ at the lowest concentration to 7.0 X 10⁻² µg · cm⁻¹ · h⁻¹ at the highest P solution concentration.

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CALCIUM FERTILIZATION INFLUENCE ON POTATO YIELD, TUBER MINERAL CONCENTRATION, AND QUALITY.

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In a 3-year study on a fine sandy loam soil, potato (*Solanum tuberosum*) cvs. 'Atlantic' (1989), 'Frontier' (1990, 1991) and 'Russet Burbank' (1989-1991) response to rate and time of Ca fertilization was evaluated. Calcium was applied preplant at 0, 90, 180, and 270 kg·ha⁻¹ as CaSO₄ and side-dress at lay-by at 0, 67 and 134 kg·ha⁻¹ as Ca(NO₃)₂, with treatments combined in a complete factorial. Preplant Ca fertilization increased soil Ca each year. Calcium fertilization had little effect on yield or grade distribution. Tuber P, K and S concentrations increased with increasing preplant and side-dress fertilization rates in 1989. Concentrations of S and Ca in Russet Burbank and Frontier increased linearly with preplant CaSO₄ application rate in 1990 and 1991. Little or no internal brown spot (IBS) occurred in Atlantic or Russet Burbank, but in Frontier IBS was reduced both years by pre-plant and/or side-dress Ca application. The incidence of IBS did not change after storage for 4 months for any cultivar. In 1990, Russet Burbank fry color improved as pre-plant Ca fertilization rate increased.

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EFFECTS OF AMENDING SOIL WITH PROCESSED MUNICIPAL WASTE ON GROWTH AND YIELD OF TOMATO

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The effects of amending soil with processed municipal waste (PMW), and the interaction of PMW with trenching, irrigation rates, and fertilizer rates on growth, and yield of tomato plants were tested. In a series of experiments, two rates of each of the following PMWs were incorporated into calcareous limestone soil: 1) Agrisoil (processed trash), 2) Daorganite (processed sewage sludge), 3) Eweson compost (processed trash and sludge), and 4) no PMW (control). In some experiments, secondary applications of PMW were applied to the beds at either a high rate, a low rate or not applied (control). There was no effect of secondary PMW applications on growth or yield. Generally, plants grown on trenched plots had greater growth and yield than plants on non-trenched plots. Plants grown in Daorganite had greater growth and yield than plants grown in the other PMWs. Plants in Daorganite tended to have higher photosynthetic and transpiration rates than plants in the other treatments. For all treatments, plants grown at one-half the standard fertilizer rate had less growth than plants receiving higher fertilizer rates. There was no interaction between irrigation rate and PMW for photosynthesis, growth, or yield. Plants grown in Daorganite had the greatest growth and tended to have greater yields, regardless of the fertilizer or irrigation rate. Processed trash composts (Agrisoil and Eweson) did not increase growth and yield, which may have been due to suboptimal application rates of these materials. Further studies are underway incorporating higher rates of these materials into the soil.

EFFECT OF K RATE AND SOURCE ON TOMATO YIELDS

Stephen M. Olson*, University of Florida, NFREC, Rt. 3 Box 4370, Quincy, FL 32351 and Sal J. Locascio, George J. Hochmuth, and Robert C. Hochmuth, Vegetable Crop Department, University of Florida, Gainesville, FL 32611

Experiments were conducted in the spring of 1990 at Quincy and Live Oak, Florida and 1991 in Quincy to study the effect of 3 K sources (KCl, K_2SO_4 and KNO_3) and 5 K rates (0, 75, 150, 225 and 300 kg ha⁻¹) of yield of 'Sunny' tomatoes. Preplant soil test K values were 37 and 54 ppm in 1990, respectively, and 44 ppm in 1991. These K concentrations are considered medium (36-60) for Florida mineral soils. K source had no effect on yield, fruit weight or percent marketable fruit in all studies. In 1990, total yields, yield of extra large (> 7.0 cm) fruit and percent marketable fruit were increased with application of 75 kg ha⁻¹ of K but there was no further response to applied K at both locations. In 1991, total yield increased with applied K up to 150 kg ha⁻¹ then decreased. Fruit size and percent marketable fruit increase with 75 kg ha⁻¹ of K but no further response occurred. There was no interaction of K source and K rate.

DIAGNOSIS OF NUTRITIONAL STATUS OF CUCUMBER PLANT BY RAPID BIOCHEMICAL TEST, XYLEM SAP ANALYSIS, AND COLORIMETRIC PETIOLE ANALYSIS.

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In order to diagnose the nutritional disorders caused by various environmental stress, biochemical test, xylem sap analysis and colorimetric petiole analysis were used to assay symptoms well before the severe development. Among the various enzymatic analysis, alkaline phosphatase activity was highly specific to calcium deficiency while in vivo nitrate reductase activity was not stable parameter in response to nitrogen deficiency. Determination of nitrogen, phosphorus and magnesium by colorimetric petiole analysis was sensitive to induced deficiencies. The status of potassium in the plant, however, could be better determined with the xylem sap analysis. Salinity stress induced by low osmotic potential of the nutrient solution increased the activity of alkaline phosphatase, showing similar results as calcium deficiency. Magnesium and phosphorous contents by the colorimetric petiole analysis were particularly low when the roots were in anoxia.

162 COLLOQUIUM III (Abstr. 310-318)

STATUS OF TRANSPLANT TECHNOLOGY IN THE USA

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The containerized transplant commercial industry started in the United States in the 1960's. Since then, several different types of growing containers have been developed for the vegetable, tobacco, ornamental and forestry seedling industries. Two basic irrigation methods have developed including overhead and sub-irrigation systems. The irrigation system used depends on the crop needs, value, availability of water, and the need to reduce pesticide use and risk of disease. Sub-irrigation systems have reduced the spread of seed-borne and naturally occurring diseases. Overhead irrigation systems were predominantly used during the early years, but at present, both systems are used and selected for their respective advantages. Future developments in the transplant industry include reduction of production risks and to improve cost per production unit by reducing both nursery and farm labor requirements.

STATUS OF TRANSPLANT TECHNOLOGY IN AUSTRALIA: A COMMERCIAL OVERVIEW

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Transplant production utilizing cell containers has been practiced commercially in Australia for fifteen years, with Todd flats the predominant type in use. Many methods of transplant production have evolved in Australia which due to its unique climate and the needs of the horticultural industry, which grow a diverse range of crops throughout the year. Current growing practices include nutrient programs, pre-shipping treatments, and methods of transporting plants over long distances. Current production costings will be discussed. A number of areas will be discussed that warrant more research to reduce costs and also expand the concept of cell production to encompass a wider range of plant species.

COMMERCIAL TRANSPLANT PRODUCTION PRACTICES AND RECENT RESEARCH IN JAPAN

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Commercial transplant production in Japan has been increasing rapidly since 1985. Transplant production began with plug seedlings for bedding plants, followed by carnation and Chrysanthemum plug transplants vegetatively-propagated using cuttings. Next, production more recently includes plug seedlings of lettuce and cabbage, and micropropagated tubers of potato plants and grafted transplants of tomato, eggplant, cucumber, and watermelon plants. The reasons for the rapid increase in commercial production of transplants will be reviewed. The current "cutting edge" practices include hardening before shipping or planting. The pros and cons of current transplant production systems in Japan will be discussed. Recent research advances in production of micropropagated, grafted and seedling transplants are reviewed with special reference to environmental control for hardening or acclimatization. Research on robotic or automated systems for micropropagation, grafting, and transplanting currently developed in Japan are described.

LONG-TERM CONSEQUENCE AND SIGNIFICANCE OF SHORT-TERM PRETRANSPLANT NUTRITIONAL CONDITIONING

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Pretransplant nutritional conditioning (PNC) is defined as select fertilization practices used during greenhouse transplant propagation, condition or predispose the seedlings to tolerate and recover from transplant shock in the field and promote earliness. PNC differs from standard greenhouse fertility practices in many ways. Each crop may require a unique, prescribed NPK PNC regime, rather than "one size fits all" approach. PNC regimes are chosen for crops based on long-term yield superiority in the field and not on the visual appeal of transplants to the human eye. Conditioned seedlings are not hardened with nutrient withdrawal. Research has accumulated over recent years providing new insights to PNC. This will be condensed and reviewed to point out the "pros and cons" of PNC. Possible constraints to commercialization and needs for future research will be discussed.

UTILITY OF DIF TO REGULATE VEGETABLE TRANSPLANT STEM ELONGATION

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Seedling stem elongation increased as the difference (DIF) between day (DT) and night (NT) temperatures increased from 10 to 26C (DIF=DT-NT). Stem elongation was primarily dependent on DIF on all crops studied except spring bulb crops. Internode lengths decreased in tomato (68%), watermelon (80%), squash

(32%), sweet corn (68%) and snap bean (26%) as the difference between day and night temperatures decreased 12 degrees (C). Cucurbit internode length decreased by 84% as DIF decreased 16 degrees (C). The ratio of male to female cucumber flowers decreased from 14 to 1, as DIF decreased 12 degrees (C) from 23 DT/17 NT to 17 DT/26 NT. Stem elongation was very sensitive to cool temperatures during the first 3 hours of the morning. Stem elongation was almost the same if the seedlings were cooled for the first 3 hours of the day versus cooling the plants all day. The interactions between temperature on stem elongation and light quantity and quality, and photoperiod will be discussed. Application of DIF in both northern and southern greenhouses will also be discussed.

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MECHANICAL CONDITIONING OF GREENHOUSE-GROWN TRANSPLANTS

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Since chemical growth retardants are no longer labelled for use on vegetable transplants, mechanical conditioning provides an alternative method of controlling excessive stem elongation under greenhouse conditions. Mechanical conditioning includes brushing or shaking treatments that physically impact or displace the plant and generally reduce plant growth, increase stem and petiole strength, and improve overall plant quality. The resulting transplants have less breakage during postharvest handling, may be more stress tolerant, and are faster to establish in the field. However, only minor effects on crop yield have been identified. Brushing reduced broccoli transplant size, but improved shoot dry weight gain during field establishment but had no effect on head yield. Brushing is a labor intensive practice for large-scale operations. Current attempts to mechanize brushing require that the plants are uniform in height and treatment tolerant. Additional research in non-contact treatments like shaking or vibration of benches is necessary. The effects of the treatments on stress tolerance and predisposition to disease need to be clarified.

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POST HARVEST HANDLING OF TRANSPLANTS

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Transplants are grown and shipped locally or over long distances. Shipping conditions and time in transit depend on the distance travelled. Local growers may receive transplants in trays they were grown in while those shipped long distances are pulled and packed in boxes. Plant field performance is directly correlated with seedling vigor at the time of transplanting. Factors which can affect transplant vigor during growing and shipping include the plant hardening techniques employed, mechanical injury at any stage of plant growing, shipping and planting, length and conditions of transit, and storage prior to transplanting. Mechanical injury begins as soon as the plants are removed from the tray, while reduced watering and/or nutrition during hardening may have a long term effect on plant productivity. High temperature during shipping, packing plants too densely, and prolonged storage in the dark can reduce subsequent yields. Knowledge of proper conditions for transplant pre- and post-harvest handling and shipping are not clearly understood by many transplant producers and growers. Such knowledge can greatly improve transplant vigor and potentially give growers better yields.

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WHAT'S NEEDED IN THE GREENHOUSE TO HELP AUTOMATE TRANSPLANTING

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The use of containerized transplants will increase in the future because of greater survival rates and improved yields. Many transplant operations are already mechanized. Fully automatic field transplanting is highly feasible in the future for several vegetable crops and may become a common practice with most commercial crops. Technology is developing that uses the greenhouse growing trays as magazines to be loaded into the transplanting machines. Automatic field transplanters will then set plants into the soil at rates of 3 to 4 per second. To accomplish this, the following are required: highest quality uniform seedlings; greater seedling tolerance to handling stresses; no dead or missing plants in transplant trays; standardized cell containers; and precise cell arrangement to allow whole rows of plants to be mass removed

simultaneously to reach the highest transplanter machine capacity. Plant production and greenhouse growing systems need to be modified to facilitate automatic field transplanting.

163 ORAL SESSION 45 (Abstr. 319-325)

Floriculture:

Postharvest Physiology

319

PRE-STORAGE HYDRATING SOLUTION: EFFECTS ON FLOWER LIFE OF ROSES AFTER DRY STORAGE

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Freshly harvested *Rosa hybrida*, 'Kardinal' flowers were used to evaluate vase performance after hydration and storage at 37°F. Flowers were placed in one of six solutions for 24 hours and in dry storage for 3 additional days. After storage, half of the roses were cut before placement in vase solution containing 1% dextrose and potassium salts but without an anti-microbial agent.

Roses hydrated in aluminum sulfate had the shortest life followed by roses hydrated in CHRYSLAL RVB. Flowers hydrated in CHRYSLAL RVB and cut lasted as well as roses hydrated in HYDRAFLOR-100, 60 ppm sodium hypochlorite (naocl), citric acid, or citric acid with Tween 20 for one hour followed by 60 ppm maocl solution. Roses stored in naocl solution performed as well without, as with, cutting before placement in the vase solution. Results will be discussed in terms of microbe and particulate blockage of hydration pathways.

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THE CAUSE AND CURE OF LEAF CRISPING IN CUT ROSE STEMS

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Roses are grown in Minnesota in the winter in closed greenhouses with the aid of HID lamps, and carbon dioxide enrichment. Although productivity is good, consumers often complain of a rapid dehydration or crisping of the leaves. Through a series of experiments using controlled environment chambers and known vase solutions we have determined that the crisping is due to the deposition of high levels of sucrose in the leaf cell walls due to transpiration from the leaves. The sucrose dehydrates the cell protoplast causing cell collapse and tissue death. Crisping is reduced by lowering the sucrose in the vase solution or reducing transpiration from the leaves. Absciscic acid added to the vase solution effectively reduced transpiration and crisping.

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PROTEA LEAF BLACKENING

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Leaf blackening in *Protea neriifolia* R. Br. is influenced by sink demand and nectar production. Maximum nectar production occurred when the flower was in the cylindrical shape. C¹⁴-sucrose applied to a postharvest flower stem leaf moved preferentially into the nectar (65%). Darkness increased the rate of leaf blackening. Covering an individual leaf on a postharvest flower stem with aluminum foil lead to leaf blackening in 3 days while removing the inflorescence or girdling the stem just below the inflorescence prevented this leaf blackening. Girdling the stem around a leaf base and covering this leaf with foil resulted in leaf blackening in 5 days, but removal of the inflorescence influence did not prevent blackening. Sucrose 2.5% (w/v) in the vase solution prevented leaf blackening in both girdled and non-girdled leaves covered with foil. Polyphenol oxidase apparently plays an important role in protea leaf blackening. *Leucospermum*, another genera in the family of Proteaceae, did not show any PPO activity and did not blacken in the dark, while high PPO activity was detected in leaf extract of *P. neriifolia*.

INFLORESCENCE SINK DEMAND AND LEAF BLACKENING IN *PROTEA NERIIFOLIA*

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A major postharvest problem of *Protea neriifolia* is premature leaf blackening. Carbohydrate stress, due to floral sink demand, may lead to cellular disorganization and leaf blackening. Leaf blackening, nonstructural carbohydrates, ethylene, carbon exchange rates, stomatal conductance and lipid peroxidation were measured on leaves of vegetative and floral stems preharvest, and during a 7 day dark postharvest period. Postharvest treatments were: 0 or 0.5% sucrose in the vase solution, 20% sucrose pulse, or floral decapitation. Leaf blackening was significantly reduced in vegetative stems and floral stems in the 20% pulse treatment, in comparison to all other treatments. Ethylene production and lipid peroxidation were not associated with leaf blackening in any treatment and leaf respiration rates declined for all treatments over time. The magnitude and rate of leaf blackening was inversely related to leaf starch concentrations, with greatest carbohydrate depletion occurring within 24 h of harvest (by 75-85%). Leaf starch from the 20% pulse treatment increased by 300%, in contrast to declining starch concentrations in all other treatments. The data suggest that the flowerhead functions as the major sink for carbohydrate depletion leading to subsequent leaf blackening.

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CYTOKININ DIPS AND SUCROSE HOLDING SOLUTIONS INCREASE THE POSTHARVEST LONGEVITY OF 'NITTA' ANTHURIUMS AND PINK GINGERS.

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The effect of postharvest dips on the longevity of *Anthurium andraenum* cultivar Nitta and *Alpinia purpurata* was evaluated. The inflorescences were dipped in a 200 ppm benzyladenine (BA) solution, an antitranspirant, or water for 10 minutes. After dipping, anthuriums were placed directly in water and gingers were placed in either water or a 2% sucrose solution and placed in interior conditions ($10 \mu\text{mol m}^{-2}\text{s}^{-1}$ for 12 hr/day, $21 \pm 2^\circ\text{C}$). Ginger longevity was increased by 10 days or more by the sucrose solution. The greatest longevity of gingers was obtained when dipped in either BA or the antitranspirant and held in the sucrose solution. Anthurium longevity increased 10 days when dipped in BA, while the other treatments had little effect.

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POSTHARVEST QUALITY OF ALSTROEMERIA CUT FLOWERS AFFECTED BY PREHARVEST SOIL AND AIR TEMPERATURE

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Low root zone temperatures in summer stimulate generative development of Alstroemeria, resulting in a higher flower production in winter. The effects of greenhouse soil and air temperatures on vase life and ornamental value were evaluated. Preharvest treatments were two locations (field stations), four air temperatures (9, 12, 15, 18°C), four root zone temperatures (11, 14, 17°C , uncontrolled) and three varieties ('Flamengo', 'Jubilee', 'Wilhelmina') in a factorial design. The flowers were placed in a commercial pretreatment solution for 24 hours immediately after harvest. After a two day transport simulation and rehydration for 3 hours at 5°C , flowers were kept at 1.5 W.m^{-2} PAR (12hr/day), 20°C and 60% RH. The experiment was done three times. Results from the first harvest showed that lowering the soil temperature increased the number of stems that had two whorls of flowers opening after harvest. Average vase life was two weeks. Low air temperatures increased whirl opening as well, and increased vase life by one or two days. Ornamental value and number of flower branches per stem were not affected.

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THE EFFECT OF POLYAMINES ON THE SENESCENCE OF CARNATION PETALS.

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The interaction between polyamines and ethylene is still not clear for floral tissues. The aim of the present paper is to examine the senescence on the isolated petals of carnation (*Dianthus caryophyllus* cv. Desio) but not the whole flower in an attempt to clarify the exact role of polyamines. Petals were treated with putrescine (Put; 0.0, 1.0, 10mM), spermidine (Spd; 0.0, 1.0, 10mM), spermine (Spn; 0.0, 1.0, 10mM), Put+Spd (1.0mM), Put+Spn (1.0mM). The fresh

weight of petals in all 10mM treatment was decreased less than those in the other treatments at all times but there were no significant differences. The differences in ethylene production were significant. In petals maintained in 10mM of polyamines, ethylene production was completely inhibited until 13 days and senescence was considerably retarded. However, ethylene productions in 1.0mM polyamines treatments were delayed 2-3 days with reduced amounts. These results suggest that high concentrations of polyamines retard senescence and completely inhibit ethylene production. ACC content, activities of ACC synthase and SAM decarboxylase were analyzed. Finally, the role of SAM in ethylene and polyamines biosynthesis will be discussed.

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Cross-commodity: Cell and Tissue Culture

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PROTOPLAST REGENERATION OF *IPOMOEA CORDATOTRILoba*, A SPECIES CLOSELY RELATED TO SWEET-POTATO.

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The use of wild *Ipomoea* species in sweetpotato improvement may be facilitated by the use of in vitro techniques such as somatic hybridization. Plant regeneration from callus cultures is essential to the successful application of these in vitro techniques. This is the first report of plant regeneration of *I. cordatotriloba* from protoplast derived calli. Protoplasts isolated from petiole and stem tissues of in vitro grown *I. cordatotriloba* were initially cultured on KM8p media. All calli cultured regenerated roots after 1 month on regeneration media. Approximately 13% and 19%, respectively, of the calli cultured regenerated shoots after 2 months on media containing 10 and 100 μM parachlorophenoxy isobutyric acid (PCIB). Regenerated shoots developed into whole plants when transferred to MS media without hormones. The regenerated plants closely resembled the parent's morphology.

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CPPU IN THE MEDIUM FOR SEED GERMINATION PROMOTES EMBRYOGENESIS FROM SEEDLING EXPLANTS IN COMMON BEAN.

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Few studies on embryogenesis in common bean (*Phaseolus vulgaris* L.) have been reported and only the early stages of somatic embryogenesis were observed. Dry seeds from two common bean lines were germinated in darkness on L-6 medium containing 4% sucrose, 0.2 g casein hydrolysate/liter and 2.0 g phytagel/liter. The medium for seed germination was supplemented with 0, 2, 4 or 6 μM forchlorfenuron (CPPU). Explants from cotyledonary leaves, petioles, hypocotyls and shoot apices were prepared from 14 day-old seedlings. Callus was derived from explant cultures incubated in darkness at 26°C on the medium containing 4 μM 2,4-D and 1 μM Kinetin. The callus was transferred after 4 weeks into 125 ml Erlenmeyer flasks containing 50 ml liquid medium and placed on a gyrotary shaker (120 rpm) under cool-white light ($12 \mu\text{mol.m}^{-2}\text{s}^{-1}$). The liquid medium was used with 2, 4 or 6 μM of 2,4-D alone or with zeatin supplements at relative concentrations of 0.25 and 0.5. Up to 200 somatic embryos from 40 to 50 mg callus inoculations were induced after 4 to 5 weeks. Callus derived from seedlings grown on CPPU-containing medium gave more repetitive somatic embryos. Cotyledonary stage embryos with clear bipolar structure were observed only from callus derived from seedlings grown on CPPU when transferred to suspension cultures containing 2,4-D and zeatin. All somatic embryos differentiated strong roots and some developed leaf-like structures on conversion medium.

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HYPOCOTYL ORIENTATION AND HORMONE INFLUENCE IN VITRO REGENERATION OF ROOT AND SHOOT OF CAULIFLOWER (BRASSICA OLERACEA L. VAR. BOTRYTIS) 'PUAKEA'.

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Hypocotyl sections of cauliflower were cultured in horizontal, upright or inverted positions on Murashige and Skoog medium with different concentrations of 6-benzylaminopurine (BAP) and α -naphthylacetic acid (NAA). Inverted position gave the highest differentiated score and greatest fresh weight of

the two month-old tissues, followed by upright and horizontal positions respectively. Combination BAP and NAA caused synergistic effect on tissues. The best treatment for getting callus was combination of 5 mg/liter BAP, 2 mg/liter NAA and upright position, whereas for getting tissue differentiation was combination of 5 mg/liter BAP, 1 mg/liter NAA and inverted position.

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MONOTERPENOID SYNTHESIS IN CALLUS INDUCED FROM STEM SEGMENTS

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Callus of *Rosmarinus officinalis* L. 'Lockwood de forest' was induced from stem segments (3 mm long) using different concentrations of thidiazuron (TDZ). The original stem segments used as explants were found to have a higher level of linalool than was found for leaf segments. Linalool is one of the monoterpenes identified in rosemary plants and it has a pleasant aroma. TDZ has a significant effect on callus formation and callus texture. The callus formed was light green to yellow and/or had some meristematic dark green cells. TDZ had a significant linear effect on the callus fresh weight. The meristematic green cells formed on all calli except those proliferated on the lowest concentration of TDZ (0.5 mg/l). No callus was induced from stem segments cultured on TDZ-free medium. The fresh calli from other treatments were soaked in hexane as a solvent for monoterpene analysis using GC/MS. No monoterpenes could be detected in the callus induced on the medium containing the lowest concentration of TDZ. Comparing to the stem segments taken from the parent plants only 4 of 10 monoterpenes identified were found in the callus: α -pinene, β -pinene, 1,8-cineole, and camphor.

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ENGINEERING FOR MICROPROPAGATION OF SUGARCANE

Paul N. Walker*, Penn State University, Department of Agricultural and Biological Engineering, 223 Ag. Engineering, University Park, PA 16802, Joan P. Harris, Hawaiian Sugar Planters' Association, Aiea, HI 96701-1057, and Loren D. Gautz, University of Hawaii, Dept. of Agricultural Engineering, Honolulu, HI 96822.

Four engineering studies on optimization of sugarcane micropropagation are summarized. The optimum environmental conditions based on the cost of production were found to be with two medium changes per multiplication period, 6 initial shoots per vessel and a photosynthetic photon flux of 200 $\mu\text{mol}/\text{m}^2$ even though greater production was obtained for more light, fewer shoots per vessel and more medium changes. A cost model for comparing production treatments under steady state production and a linear programming model for unsteady state production are discussed. Preliminary results on mechanization of the transfer process are also presented.

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EFFECT OF EXPLANTS AND GROWTH REGULATORS ON SOMATIC EMBRYOGENESIS AND ADVENTITIOUS ORGANOGENESIS IN *CAPSIUM ANNUUM*
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Hot pepper is the most important vegetable in Korea in terms of both acreage and product value. Morphogenic response in tissue culture of hot pepper varied greatly with explant source and growth regulators. Somatic embryogenesis, which we believe had not been reported yet, was only induced from 5-month-old callus derived from anther culture. Embryogenic callus was solely observed in the MS medium supplemented with 2 mg/l of NAA and 2 mg/l of BA. Better somatic embryogenesis and plant regeneration was observed on hormone free medium. Adventitious organogenesis was well induced from both hypocotyl and cotyledon. Polarity of explant for shoot regeneration was observed. Success rate of regeneration has been continuously improved mainly due to combinations of growth regulators. The best combination so far was 2 mg/l of zeatin and 1 mg/l of IAA, resulting in 92% of regeneration from cotyledon explant.

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ASYMBIOTIC GERMINATION OF *CYPRIPEDIUM CALCEOLUS* VAR. *PARVIFLORUM* (ORCHIDACEAE) IN VITRO.

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Seeds from mature seed pods of *Cypripedium calceolus* var. *parviflorum* were germinated on 1/4 MSMO (Sigma) + 100ml/l coconut water + 1% sucrose +/- 8g/l agar (pH 6.0), and with or without prechilling at 5C for 8 weeks. Protocorm with apex (stage 3) was used as an index of germination. Seeds sown on agar medium without

chilling treatment resulted in a 40% germination rate in 120 days but the germination was very uneven. Seeds germinated on agar medium with prechilling developed more synchronously with 92% germination in 60 days (ie. about 120 days after sowing). Suspension culture of seeds without prechilling resulted in 85% germination after 90 days. The synchronization of seed germination in suspension culture was intermediate between that on agar with and without prechilling. Protocorms germinated in suspension culture appeared morphologically identical to those germinated on agar medium. All stage 3 protocorms developed further on the same agar medium in darkness.

Both agar and suspension culture in media containing coconut water provided reliable seed germination methods for this orchid species.

165 ORAL SESSION 47 (Abstr. 333-339)

Nut Crops:

Culture and Management

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THE POTENTIAL OF *CARYA* X *LECONTEI* (LITTLE) AS A ROOTSTOCK FOR PECAN.

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'Oconee' pecan (*Carya illinoensis* (Wangenh.) K. Koch) was grafted on seedling rootstocks from nine open-pollinated seedstocks. Rootstocks included three seedstocks each of pecan, water hickory (*C. aquatica* (F. Michaux.) Nutt.) and their hybrid, *Carya* X *lecontei* (Little). Pecan seedlings had the largest basal diameter, water hickory seedlings the smallest, and hybrid seedlings were intermediate. Seedlings of 'Elliott' and 'Curtis' seedstocks were larger than seedlings from 'Moore' seedstock. Pecan and hybrid seedlings were more successfully grafted than water hickory. Graft success varied between seedstocks of the hybrid, with some as high as pecan. Foliage color of seedlings, indicative of iron nutrient status, was influenced by the species of rootstock: pecan seedlings were darker green than water hickory seedlings, but were inseparable from hybrid seedlings. 'Oconee' scions on pecan seedlings were darker green than when grown on hybrid seedlings.

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HYDROGEN CYANAMIDE ALLOWS EARLY HARVESTING OF PECAN

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Pecan growers often receive substantially higher prices for nuts if they can be marketed early in the harvest season, sometime doubling their profit as a result. Time of nut ripening (shuck dehiscence) is the primary limiting factor to the realization of early harvesting. It is now possible to advance shuck dehiscence by 10 days or more using hydrogen cyanamide (formulated as Dormex). A three year study using young 'Cheyenne' trees (6th leaf) indicated that budbreak, flowering, and shuck dehiscence could be advanced when treated with hydrogen cyanamide during the winter dormant season. The degree of advancement varied with the application date and concentration utilized. Results we most desirable when treatments were applied about 60 days before budbreak and application was at the 2% and 4% (480 and 960mM) levels. Hydrogen cyanamide had no detectable adverse effects on any growth, quality or production parameter.

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EFFECT OF GROWING SEASON TEMPERATURES ON THE FATTY ACID PROFILE AND OF PECAN KERNELS

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'Cheyenne', 'Mohawk', 'Pawnee', and 'Osage' grown in different locations in the United States were analyzed for fatty acid composition. The effect of heat units accumulated 12 weeks prior to shuck split were studied. Growing area affected the fatty acid profile for all cultivars. 'Cheyenne' and 'Mohawk' showed a positive correlation between heat units and oleic/linoleic acid ratios ($r = 0.905$ and $r = 0.720$ respectively), a positive correlation between heat units and oleic acid content ($r = 0.863$ and $r = 0.773$ respectively), and a negative correlation between heat units and linoleic acid content ($r = -0.871$ and $r = -0.792$ respectively). However, no correlation was obtained between heat units and the fatty acid profiles for 'Osage' and 'Pawnee'.

COMPARISON OF PRUNING TECHNIQUES TO INVIGORATE LOW-VIGOR ALMOND TREES

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Some precocious almond varieties often produce little vegetative growth once they reach full maturity. A pruning trial was established using 11 year old 'Harvey' trees that were healthy but making little or no new growth. The four treatments were: 1) severe heading or dehorning trees to six foot in height (first year only), 2) heading one third of the tree for three years, 3) making 20 small heading cuts all over the tree each year, and 4) normal thinning cuts (or control). All heading treatments caused more shoot growth than did the conventional thinning cuts (or control). The dehorning treatment (#1) responded with the most vigorous growth but much lower yields during the next two years compared to the control (#4). Yields were comparable between the two treatments during years three to five however. The heading treatments #2 and #3 had comparable yields with the control by the second year. They also showed more shoot growth. Tree yields from treatment #2 tended to lag below treatment #3 and the control, even though they were statistically the same. This trend may indicate that three years of moderately severe pruning is too much. Treatment #3 may be the best technique for invigorating healthy low vigor trees while minimizing yield losses, but will be the most expensive.

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PRUNING VS. TREE REMOVAL OF CROWDED 'HARTLEY' (*JUGLANS REGIA*) TREES
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Two management systems were initiated in a 10 year old *Juglans regia* cv. Hartley orchard planted 8 m. x 8 m. in 1977. Annual dormant selective pruning was practiced for the next 8 years on all trees within one treatment (pruning) compared to dormant severe pruning on alternate temporary trees with no pruning on adjacent permanent trees (thinning). Temporary trees were removed in the thinning treatment in 1985.

Yield, trunk cross sectional area, pruning weight and nut quality factors were evaluated each year from the 5 replicate, completely randomized trial.

Yield and nut quality factors did not differ between the two treatments during the 15 years.

In 1990 the pruned trial was again pruned causing a 20% drop in production ($p=.06$). With no additional pruning yield returned to slightly above the thinned treatment in 1991.

This trial demonstrates that Hartley walnut trees (terminal bearing habit) continue to produce satisfactory crops under crowded canopy management but a tree thinning program offers other advantages which also should be considered.

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EFFECTS OF POLLEN LOAD ON PISTILLATE FLOWER ABSCISSION (PFA) OF ENGLISH WALNUT UNDER FIELD CONDITIONS

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Preliminary studies with controlled pollinations have shown that pistillate flower abscission (PFA) in walnut (*Juglans* spp.) is associated with heavy pollen loads on the flowers. This study measured percent pistillate flower abscission (PFA), pollen grains per flower, yield and yield efficiency on Serr walnut from trees adjoining pollinizing cvs and at sequential intervals up to 197m away in twelve orchard locations. A highly significant, negative correlation in PFA existed as distance from the foreign pollen source increased. Pollen grains per flower were highly correlated with percentage PFA. Yield and yield efficiency, measured in two of the test orchards, were positively correlated with distance from the pollen source.

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DELAYED COSTS OF REPRODUCTION, DEFOLIATION, AND SHADING IN *PISTACIA VERA* L. CV. KERMÁN : BUD ABSCISSION AND DRY WEIGHT ALLOCATION TO BUDS, LEAVES, CURRENT AND PREVIOUS-YEAR SHOOTS.

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Trees that fruited during 1990 retained 67.3% of the inflorescence buds produced per branch in 1991 compared to 63.1% for trees that were defoliated immediately after harvest in 1990 and 21.3% by trees that were fruiting in 1991. Shading reduced bud retention similar to fruiting.

Defoliation after nut harvest accentuated the delayed costs of reproduction caused by previous season's fruiting whereas shading produced significantly greater immediate costs. Shading effects on the allocation of carbon to buds, leaves and shoots were similar to those of fruiting. Leaf net photosynthesis under shade conditions was reduced to 14.27% of control trees and this led to a significant reduction in the relative growth rates of all the organs surveyed.

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Culture and Management of Apples

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PRODUCTIVITY IN APPLE PRODUCTION SYSTEMS: THE ROLE OF LIGHT INTERCEPTION BY DIFFERENT SHOOT TYPES.

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A 14-year-old trial of 'Empire' apple production systems (Slender Spindle/M9, Central Leaders on M7 and 9/111 interstems, and Y-trellis/M26) had shown significant yield differences that were primarily related to total light interception, but yield of fruit/MJ light interception, however, was still higher in the Y-trellis. The hypothesis tested was that in healthy orchards yields are related primarily to total light intercepted by the spur canopy. In 1991 seasonal leaf area development, exposed leaf photosynthesis, fruit growth, total light interception (by image analysis of fisheye photos) and relative light interception by different shoot types (by a laser sunbeam simulator) were estimated. The results reflected the mature, spurry nature of these trees. The final LAI values were $CL/7=1.8$, $CL/9/111=2.3$, $SS/9=2.6$ and $Y/26=3.6$. Exposed leaf photosynthesis showed few differences. Yields of the pyramid forms were 40-42 t/ha while Y-trellis gave 59 t/ha, with similar fruit sizes. Again, yields were primarily related to % total light interception (48-53% for pyramid forms versus 62% for the Y). Laser analyses showed that the Y intercepted more light with the spur canopy than the pyramid forms, supporting the hypothesis. Yields were better correlated with spur canopy LAI and spur canopy light interception than with shoot canopy LAI and light interception.

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EFFECT OF "V"- AND CONESHAPED CANOPIES ON VEGETATIVE AND REPRODUCTIVE GROWTH OF 'GOLDEN DELICIOUS'/M. 9 APPLE.

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Beginning in 1986 in Bonn, trees growing in 120 liter lysimeters spaced 2.0 x 3.4 m apart were trained to either "V"- or spindle-shaped canopies. During the 4th and 5th leaf half of the trees in each training form were covered with shade fabric to reduce insolation to 42% of overhead PAR. In the 4th leaf both canopy shapes produced 26 mt apples/ha (1470 trees/ha, basis) in full sun, and shading reduced yields by 23%. But the 5th leaf yields reached 54 and 39 mt/ha under full sun in the "V"- and spindle-shaped canopies, respectively; furthermore the "V"-shaped trees under shade fabric had 25% greater yield efficiency than the spindle in full sun whereas the spindle trees under the same shade had 41% less yield efficiency than those in full sun. These differences in yield could be partially explained by differences measured in the pattern of distribution of shoots, wood and fruit in the canopies caused by tree training. Training to the "V"-shape increased dry matter partitioning to fruit on the shaded trees at the expense of the stem fraction in contrast to the opposite effect on spindle trees.

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PERFORMANCE OVER 10 YEARS OF 4 APPLE CULTIVARS IN INTENSIVE ORCHARD SYSTEMS

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In 1981, four apple cultivars were established as a low trellis hedgerow on M.9 or free-standing central leaders on M.7 at the recommended or half the recommended spacing with the close planted trees either root pruned or hedged. The trellis had a higher trunk area (TCA)/ha (31%), yield/ha (41%) and tree efficiency (19%). 'Lawspur Rome Beauty' had the highest TCA/ha, cumulative yield/ha and greatest tendency toward biennial bearing of the 4 cvs. 'Smoother Golden

Delicious' trees in the central leader system were less efficient (kg/cm²) than in the trellis system. Hedging increased cumulative yield/ha compared to standard spaced trees with root pruned trees intermediate. Training trees to the trellis increased the density of both spurs and shoots and resulted in a higher leaf area index. Central leader trees of 'Smoother' and 'Red Chief' had higher light transmission levels than the trellis, while the trellis trees had higher light levels with 'Lawspur'. Return over total cost was negative for years 1-10 for all systems. Cumulative NPV for 'Redchief' hedged on central leader equaled 'Lawspur' at the standard spacing on trellis and exceeded all other combinations.

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EFFECTS OF TREE SUPPORT AND TRAINING SYSTEM ON APPLE TREE GROWTH AND PRODUCTIVITY

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'Empire' (E) and 'Marshall McIntosh' (MM)/'Mark' trees planted in 1986 were trained to the freestanding central leader (CL), central leader with annual extension-shoot heading (HCL), slender spindle (SS) or vertical axis (VA). Support with a full tree stake (SS & VA) had little effect on shoot growth. HCL increased shoot number and mean length. Fewer pruning cuts were made on supported trees, while more were made on HCL trees. Dry weight of prunings 1989-91 was the same for all MM trees, while in E trees, CL and SS had lower pruning weights than HCL and VA. Bloom density was uninfluenced by support or training. Fruit set was greater in 1990 and 1991 on supported E trees, and in 1990 on supported MM trees. Yield was greater on supported systems in 3 out of 4 production years. Total yield after 6 years of age was 26-38% greater for supported trees of both cultivars. Bienniality was reduced about 15% by support in MM trees but unaffected by support or training in E trees. Net total crop value (estimated annual crop value minus annual harvest cost and support cost, if applicable, annual 10% discount rate) in 1991 was approximately \$1600 per ha greater for supported E trees and \$270 per ha greater for supported MM trees.

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FERTIGATION EFFECTS ON APPLE TREE GROWTH, CROPPING, AND DRY WEIGHT PARTITIONING

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In two field studies with 'Redchief Delicious'/MM.106, 'Empire'/M.9/MM.106 and 'Mutsu'/M.9/MM.106 trees on fertile silt loam soils, trickle irrigation increased vegetative growth during the first three years and resulted in a 16%-20% increase in cumulative yield over the first five years. When fertilizer was injected into the irrigation water weekly from mid-April until the end of June, tree growth was further increased and cumulative yield was improved an additional 11%-15% for a total of 27%-35% greater yield than the non-irrigated trees. In these studies, ground fertilization did not improve growth or yield unless trickle irrigation was also applied. However, ground fertilization was not as effective as fertigation.

Irrigation and fertigation increased the dry weight of roots by 23% and that of shoots by 36% in the first year resulting in a 10% reduction in the root/shoot ratio. Total tree dry weight was increased by 30% if trees were planted early (April 14) but only 14% if trees were planted late (June 10).

Early planting resulted in 17% greater cumulative yield than trees planted late. Initial tree caliper also had a significant effect on early growth and yield with large caliper trees yielding 12% more than the small caliper trees. The interaction of planting date, tree caliper and fertigation resulted in a 50%-70% increase in yield during the first five years.

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ALTERNATIVE ORCHARD GROUND COVER MANAGEMENT SYSTEMS AFFECT APPLE QUALITY AND MATURITY INDICES

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Alternative groundcover management systems (GMS) beneath establishing 'Jonagold' apple trees have been evaluated since 1986 in an orchard field test. Tree-row GMS being studied include post-emergence herbicide (glyphosate) "killed sods," pre-emergence herbicides (norflurazon and diuron), a crownvetch "living mulch," hay-straw mulch, monthly cultivation, and a closely mowed sodgrass. Trees in herbicide and straw-mulch plots produced the most fruit in 1990, but in 1991 there were no GMS-related differences in crop load. Fruit were larger in herbicide and straw-mulch plots in 1990 and

1991, and red color development was better in sod and crownvetch GMS.

Starch-to-sugar conversion was advanced in apples from sodgrass and straw mulched plots. The ethylene climacteric was delayed in fruit from crownvetch and straw-mulch GMS, and peaked rapidly as mean starch indices approached 4.0 in all GMS treatments. Differences in soil moisture and nutrient availability under alternative GMS may have influenced fruit quality and maturity.

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COMPARISON OF DORMANT APPLICATIONS OF PETROLEUM AND SOYBEAN OIL ON APPLE BUD DEVELOPMENT.

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Treatments of 0, 10, 20, 30, or 40% (v/v) refined (salad) or crude soybean oil or 0, 5, 10, 15, or 20% petroleum (dormant) oil at 0, 5, 10, 15, or 20% were sprayed until drip on 'Smoother' apple trees on 27 February 1991. The internal carbon dioxide concentration was elevated and the oxygen content reduced within one day in buds-twigs treated with oil and remained influenced for up to 12 days. All oil treatments delayed fruit bud development. The lowest tested concentration of soybean oil (either crude or refined) resulted in the greatest delay in bud development and the greatest delay in bloom (approximately 4 days). Crude soybean oil treatment resulted in less damage to flower buds than petroleum oil.

167 ORAL SESSION 49 (Abstr. 347-353)

Biotechnology:

Genetic Transformation

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INCORPORATION OF THE GUS GENE INTO ORCHIDS VIA EMBRYO ELECTROPHORESIS

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The apical meristems of *Calanthe* orchid embryos were exposed to 1 mg/ml pBI-121 DNA in an electric field. pBI-121 contains the GUS marker gene glucuronidase under the control of the 35 S cauliflower mosaic virus promoter. A pipette containing 0.3% agarose and acetate buffer containing the DNA was placed on one end of the embryo; while the opposite end was in contact with a pipette containing only buffer and agarose. Uptake of the DNA into the meristem was monitored by 4',6'-diamidino-2-phenylindole (DAPI) fluorescence. Optimal uptake occurred after 10 min of electroporation at 10 volts and 0.5 milliamps. Under these conditions, 55% of the embryos survived the treatment and 57% of those which survived were transformed as measured by GUS-positive staining. Leaves from 6 month old plants which developed from the transformed embryos expressed specific patterns of GUS staining.

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SUPERIOR REGENERATION AND AGROBACTERIUM INFECTABILITY OF BROCCOLI AND CAULIFLOWER TISSUES AND THE IDENTIFICATION OF A PROCEDURE FOR THE GENERATION OF TRANSGENIC PLANTS.

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Broccoli and cauliflower are among the most regeneratively intractable genotypes found in the brassicaceae. To develop a method for transfer of the gene encoding S-adenosylmethionine hydrolase (SAMase) into inbred broccoli and cauliflower germplasm, we investigated the morphogenic competence and Agrobacterium susceptibility of a wide range of tissues of varied source. Appropriately controlled expression of the SAMase gene should, theoretically, reduce the plant's capacity for

Through examination of the *in vitro* response of a wide range of tissues we identified procedures which support caulogenesis from 100% of explants, each producing more than 30 shoots which readily convert to plantlets. Studies with several wild type and disarmed *Agrobacterium* strains, and utilization of the binary vector system and appropriate marker and reporter genes, led to the identification of methods for high frequency T-DNA transfer to explants and the flow frequency of transgenic plants containing SAMase gene.

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VIRAL PROTECTION IN TRANSGENIC TOBACCO PLANTS
EXPRESSING THE TOMATO SPOTTED WILT VIRUS N GENE
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53706

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TRANSIENT GENE EXPRESSION IN SPINACH CALLUS
TRANSFORMED WITH *AGROBACTERIUM TUMEFACIENS*
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The objective of this study was to determine the efficacy of *Agrobacterium tumefaciens* in transforming spinach (*Spinacia oleracea* L.) callus. Callus was induced from leaf disks of 'Baker' on Murashige and Skoog (MS) medium supplemented with 2 mg L⁻¹ kinetin and 0.5 mg L⁻¹ 2,4-D. Callus was cut into 2-mm pieces, and 0.5 g of callus was placed in each 250-ml flask which contained 20 ml of MS liquid medium. The suspension cultures were inoculated with 100 µl of an overnight culture of *A. tumefaciens* harboring pMON 9749 (provided by S. Rogers, Monsanto Co., St. Louis), a plasmid cointegrated with kanamycin resistance and β -glucuronidase (GUS) genes. After coculturing for 2 days at 22°C with shaking at 100 rpm, the medium was replaced with selection medium containing (in µg/ml) 75 kanamycin, 100 cefotaxime, and 200 carbenicillin and maintained for 3 weeks. Transient expression of GUS gene in transformed cells was detected with X-glu assay. This method resulted in a high level of transformation and provides the first report of transformation in spinach. This study was funded by a grant (92-B-32) from the Arkansas Science & Technology Authority.

Genetically transformed *Vaccinium macrocarpon* 'Stevens' and 'Pilgrim' plants have been obtained using electric discharge particle acceleration. Three foreign genes, *kan* encoding a selectable marker, *gus* a reporter gene, and *B.t.k.* conferring lepidopteran resistance, were incorporated into the genome. Expression of *kan* was assayed by culturing shoots in vitro on media with several concentrations of kanamycin. Expression among transformed clones (transclones) varied from high resistance (normal growth at 300 mg/L kan) to no resistance. Histochemical analyses for *gus* expression revealed variability among transclones. Some transclones exhibited no *gus* expression, others had consistent area-specific expression while others displayed random expression. In preliminary feeding trials with blackheaded fireworm larvae, *B.t.k.* expression was found to be ineffective at controlling insect development. We have recovered plants transformed with a different promoter driving the *B.t.k.* gene in an effort to enhance expression.

β-Glucuronidase (GUS) gene of *Escherichia coli* was introduced into ginseng cells by an *Agrobacterium* binary vector system and expressed in somatic embryos derived from the cells. A binary vector pBI121 carrying CaMV 35S promoter-GUS gene fusion and a neomycin phosphotransferase gene as selection marker was transferred into *Agrobacterium tumefaciens* LBA4404. Zygotic embryo cotyledonary segments were co-cultivated with *A. tumefaciens* and transferred to the medium containing 1 mg 2,4-dichlorophenoxyacetic acid/liter, 0.5 mg kinetin/liter, and 100 mg kanamycin/liter. Kanamycin-resistant calli were formed after 3 to 4 weeks of culture. Southern analysis confirmed the resistant calli were transformed with GUS gene. High GUS activities were detected in somatic embryos developed from the calli.

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ON - FARM COMPARISON OF CONVENTIONAL AND
ORGANIC FRESH - MARKET TOMATO PRODUCTION
SYSTEMS IN CALIFORNIA.

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Twenty commercial tomato production systems were compared in a multidisciplinary on farm study. The aim was to determine if organic (ORG) and conventional (CNV) systems differed in terms of agronomic criteria or indicators of underlying ecological characteristics. Field level measures of inputs, yields, fruit quality, arthropod abundance and management operations were made. Also, multiple samples within each field were taken to measure soil chemical and physical properties, root pathogen populations, disease incidence, and pest damage levels for multivariate analysis. Management effects on agronomic criteria (yield, fruit quality, pest damage) were small, whereas differences in soil N pools, microbial activity, pathogen populations and arthropod communities between ORG and CNV sites were sufficiently robust to be distinguished from site to site variation. Relationships between management, crop productivity and fruit quality will be discussed.

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Hairy vetch, subterranean clover, polyethylene black mulch (PBM), and Horto paper were evaluated in field-grown fresh market production of tomatoes (*Lycopersicon esculentum* Mill.), cv 'Sunny'. Plant mulches were grown in beds in the fall, mowed immediately before planting, and the tomato seedlings were planted without tillage in a low input system. Yields (t.ha⁻¹) for hairy vetch, subterranean clover, PBM, Horto paper, and no mulch were 72.1, 46.6, 59.9, 54.0, and 29.8, respectively. Although the tomato plants grown under plant mulches received 50% of the recommended fertilizer application, they produced more vigorous plants than those in other treatments. Plant mulches were effective in controlling growth of weeds and infestation by Colorado potato beetle.

PRODUCTION OF DWARF RAPID-CYCLING BRASSICA UNDER OPTIMIZING ENVIRONMENTAL CONDITIONS

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Due to its short time to flower (14-18 days) and rapid maturation cycle (50-55 days), dwarf rapid-cycling brassica (*Brassica napus*) is under consideration as a candidate oilseed crop for NASA's Controlled Ecological Life Support Systems program. Recent work has focused on defining a set of optimum environmental conditions which permit increased crop yield in terms of $\text{g} \cdot \text{m}^{-2} \cdot \text{d}^{-1}$ of edible biomass. A wide range of environmental variables have been considered including lamp type, CO_2 level, nutrient solution pH, and planting density. In addition, nitrogen nutrition regimes have been manipulated with respect to nitrogen concentration (2 to 30 mM), source (NH_4^+ and/or NO_3^-), and time of stepwise changes in nitrogen level (day 14 to 28). The highest seed oil content (42% DW basis) has been found under limiting nitrogen levels (2 mM). However, the low nitrogen inhibits overall seed production potential. Different cultural techniques also have been compared, including solid-substrate, passive wicking hydroponics versus liquid culture systems. Trials are underway to assess crop growth and development under the "best set" scenario of environmental conditions. At present, the highest seed yield ($10.6 \text{ g} \cdot \text{m}^{-2} \cdot \text{d}^{-1}$) has been obtained using solid-substrate hydroponic systems under a combination of metal halide and high-pressure sodium lamps. Constant CO_2 enrichment to $1000 \mu\text{mol} \cdot \text{mol}^{-1}$ did not increase crop yield rate.

Research supported in part by NASA grant NAGW - 2329.

GROWTH RESPONSE OF SELECTED VEGETABLES TO GUAR RESIDUES

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Greenhouse and field studies indicate that guar (*Cyamopsis Tetragonoloba* (L.) Taub.) residues stimulate growth of three different vegetable species: spinach (*Spinacia oleracea* L. variety "Polka" watermelon (*Citrullus vulgaris* Schrad. variety "All Sweet", and cucumber (*Cucumis sativus* L. variety "Poinsett 76"). Growth response was greater than that contributed by nitrogen from guar residue, suggesting that an allelochemical may be responsible. Significant differences were found in growth response of spinach to separated components of the guar plant. No significant differences were found between partially decomposed and non-decomposed guar residue. A stimulated growth response was observed in two media: a pasteurized mineral soil and a sterilized sand.

PERFORMANCE OF GREEN AND BLANCHED ASPARAGUS CULTIVARS IN NEBRASKA

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Fourteen asparagus cultivars were established in 1988 in eastern Nebraska on a heavy silty clay soil to determine suitability for Nebraska production. Total & marketable yields differed among cultivars with highest total & marketable yields obtained with "UC157-F₁", "Jersey General", "Jersey Knight", 44Px22-8, 51x22-8 & Md10x22-8. Production of the cultivars "Jersey Gem", "Jersey Giant", & "Jersey General" was additionally compared as green &

blanched (white) production under white-on-black plastic blanching frames. Lowest ratio of culls to marketable spears & highest marketable weight was obtained with "Jersey General" for both blanched & green spears. Although total weight was greater for green asparagus, use of blanching frames reduced the number of culls for each cultivar and increased the weight of marketable spears to exceed that of green asparagus.

ULTRASONIC AEROPONICS - SOILLESS CULTURE OF THE FUTURE

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Aeroponics, as a method of soilless culture, has been in intermittent use since the 1950's. Early Russian and Italian research suggested that productivity and use of space was optimized with this technique. Prior to the introduction of ultrasonic techniques, aeroponics utilized spray nozzles or spinning disks. In addition to the need for frequent cleaning, the first results in the formation of a boundary layer on the root surface, similar to that formed in hydroponics, which results in nutrient and aeration gradients. The second results in significant physical disturbance to the root system and, except under very controlled conditions, also develops a boundary layer. Ultrasonic fogs avoid these side effects and allow the use of carbon dioxide enrichment of the root zone as well as reduced nutrient concentrations. Initial results with commercially available equipment are very promising. Commercial implementations of ultrasonic aeroponics promise to be far less energy and manpower intensive than any other method of plant culture. Lettuce, corn, tomato, soybean, dry bean, and geraniums have all been cultured with this method.

THE EFFECTS OF CROP ROTATIONS AND NITROGEN RATES ON PROCESSING TOMATO YIELDS

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The influence of various crop rotations on the marketable yield of processing tomatoes (*Lycopersicon esculentum*) in southwestern Ontario was investigated. The study was conducted for three years using nine and eight crop rotations at Leamington and Dresden, respectively. Four rates of nitrogen, 0, 45, 90, and 135 kg/ha were applied to each rotation. The treatments were arranged in a split-plot experimental design. Tomato yields were generally higher at both locations for all rotations compared to continuously grown tomatoes (control). The highest yields were obtained when tomatoes were grown in an alfalfa (*Medicago sativa*) rotation and rotations involving rye (*Secale cereale*) or winter wheat (*Triticum aestivum*). Tomato yields from the soybean (*Glycine max*) rotation and from continuously grown tomatoes were similar. At both locations, yields from continuously grown tomatoes increased with increasing rates of nitrogen fertilizer. Optimal yields for each rotation varied with each individual rate of nitrogen. Tomatoes grown in the alfalfa rotation showed the least response to higher rates of applied nitrogen. Our data indicates that certain crop rotations and nitrogen fertilization rates can be used together to enhance the yield of processing tomatoes.

CHEMICAL EFFECT ON SQUASH FRUIT SETTING

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Squash is grown in the field and in tunnel type greenhouses in Saudi Arabia. To satisfy the demand for squash, additional production in controlled greenhouses would be desirable. The Jedida cultivar was treated with growth regulators. Seedlings were sprayed with Ethrel at 400 ppm. At flowering, six treatments were made: Agriton (60g/100L), sprayed at 10 day intervals; IAA (1%), IBA (1%), and Rootone, dusted on stigmas; hand pollination; and control. Fruits were harvested when they were 12 cm long. Ethrel increased the number of female flowers by 96% and changed the female: male ratio from 1:2 to 8:1. Highest marketable yield was obtained with the hand pollination, IBA, and IAA treatments. Yield in the Control treatment was low due to low insect activity. The results suggest that treatment with IAA or IBA will permit production of squash on a commercial scale in controlled greenhouses.

175 ORAL SESSION 51 (Abstr. 362-368)

Vegetables:

Postharvest Physiology

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ACETALDEHYDE AND ETHANOL INHIBITION OF TOMATO FRUIT RIPENING

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The content of acetaldehyde (AA) and ethanol (EtOH) increases in ripening climacteric fruit. Application of EtOH inhibits tomato (*Lycopersicon esculentum*) fruit ripening without affecting subsequent quality, and AA enhances organoleptic quality. AA inhibited ripening of mature-green tomato discs (MGTD) at about 30% conc of EtOH. The relationship between EtOH and AA inhibition of tomato fruit ripening is unclear. The inter-conversion of AA and EtOH is catalyzed by alcohol dehydrogenase (ADH) which is inhibited by 4-methylpyrazole (4-MP). No adverse physiological effects upon ripening were observed in MGTD receiving 20 μ L of 4.0 mM 4-MP. Treating MGTD with 0.5 to 4.0 mM 4-MP in concert with AA (≤ 2.0 μ L/g FW) or EtOH (≤ 8 μ L/g FW) was not deleterious to ripening. A rapid, efficient method for the analysis of tissue AA and EtOH was linear ($r^2=0.97$) for discs spiked with 0 to 45 μ L EtOH. No temporal (0 to 42 h) changes in tissue AA and EtOH were detected in MGTD receiving 2.0 mM 4-MP. MGTD treated with 2.0 mM 4-MP and 8 μ L/g FW EtOH had a 360-fold increase in AA after 6 days of ripening, but had no differences on EtOH conc. These conditions maximally inhibited ripening as determined by lycopene content.

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RESPIRATORY CLIMACTERIC IN ATTACHED AND HARVESTED MELON FRUIT

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The CO₂ and C₂H₄ conc in the internal cavity of three melon (*Cucumis melo* L., var. *reticulatus* and *inodorus* Naud.) cultivars was periodically measured in fruit attached to the vine and in fruit harvested 30 days after pollination (DAP). Gas samples were withdrawn through sterile serum stopper sampling ports aseptically installed near the equator of each fruit at ca. 20 DAP. Sampling continued until either 60 DAP or until fruit abscised. Internal CO₂ and C₂H₄ conc increased in harvested fruit as they ripened (i.e., increased percent soluble solids, decreased flesh firmness, characteristic external color change). Fruit allowed to ripen on the vine also exhibited a rise in C₂H₄, but lacked a ripening associated climacteric rise in respiration. CO₂ conc in attached fruit remained constant or declined as the C₂H₄ conc increased around 40-fold and the fruit ripened. The increase in CO₂ conc, so commonly observed in ripening climacteric fruit, was observed in harvested melons, but not in fruit ripening on the vine. In melons, the respiratory climacteric may be an artifact of harvest. Implications of these observations will be discussed.

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ETHANOL INHIBITS RIPENING OF MELON FRUIT

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Exogenous application of ethanol (EtOH) vapor to whole tomato fruit or excised pericarp discs inhibits ripening without affecting subsequent quality. Inhibitory EtOH levels are induced in whole tomatoes by a 72 h exposure to anaerobic atmospheres at 20°C. In contrast to tomatoes, exposure to EtOH vapor (0 to 6 ml EtOH/kg FW, for 3 to 6 h at 20°C) did not retard ripening (e.g., changes in external color, flesh firmness, and soluble solids) of avocado, banana, cucumber, melon, peach, or plum fruit. When the blocked replicates for nectarines were sorted by the firmness of the control fruit, higher levels of EtOH vapor appeared to delay softening of the firmer fruit. From 0 to 4 ml EtOH/kg FW was injected as 95% EtOH into the seed cavity of melon fruit through a surface sterilized area near the equator of the fruit with a plastic syringe fitted with a 7.5 cm long hypodermic needle. Injection of 1 to 4 ml EtOH/kg FW inhibited the softening of 'Honey Dew' and muskmelons. Slight tissue necrosis near the site of injection was noted in a few fruit. Unlike the ripening inhibition of tomatoes which is relatively insensitive to the stage of maturity, the inhibition of melon ripening by EtOH appeared to be significantly affected by the maturity of the fruit.

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PHYSIOLOGICAL CHANGES DURING MATURATION OF NEW MEXICAN-TYPE PEPPERS

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New Mexican chile peppers were harvested at weekly intervals beginning 105 days after planting (DAP), and evaluated for ethylene (C₂H₄) production, respiration rates, chlorophyll content, beta-galactosidase activity, polygalacturonase (PG) activity, and fruit firmness. Physiological changes were most apparent in peppers harvested 139-154 DAP. Beta-galactosidase activity increased rapidly beginning 147 DAP, and reached a peak of 24.5 mmol·gfw⁻¹ when peppers were harvested 160 DAP. Polygalacturonase was not detectable at any stage of maturation. Fruit firmness was greatest (35.8 N) at 139 DAP and decreased significantly at 160 DAP. Carbon dioxide production and chlorophyll content were highest in young pods harvested 105 DAP, and decreased steadily thereafter. Ethylene production peaked (0.185-0.202 nl·gfw⁻¹·h⁻¹) in peppers harvested between 146-154 DAP.

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EFFECT OF ETHYLENE AND ABSICISIC ACID ON THE FORMATION OF PITHINESS IN CELERY (*APIUM GRAVEOLENS*)

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Ethylene induces arenchyma formation in corn roots and other plant tissues, and abscisic acid (ABA) induces arenchyma in celery petioles. Pithiness (i.e., arenchyma) in celery can be measured as a decrease in density. Density was calculated for two cm long petiole segments by dividing their weight by their volume as calculated from the weight of water displaced upon immersion. The relationship between density (g/ml) and subjective pithiness rating (1 = none, 9 = severe) was linear ($r^2=0.87$). Petiole segments exposed to 0 to 200 ppm ethylene in air at 5°C for two weeks did not exhibit any significant differences ($p = 0.05$) in density among the treatments. Entire petioles were treated with 0, 1, 10, and 100 μ M ABA in water for 96 h at 25°C. The petioles were cut into thirds and the center 2 cm from each portion was excised and the density measured. Although density decreased in the top to the bottom portions over all ABA conc, the differences were not significant. Density was significantly reduced in segments excised from the bottom and middle of petioles treated with 10 and 100 μ M ABA, compared to 0 and 1 μ M ABA. There also was a decrease in density with ABA conc in the top portion, but the decrease was only significant for the 100 μ M ABA conc.

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EFFECT OF LOW O₂ ON THE INDUCTION OF THE ALTERNATIVE OXIDASE, AND CHANGES IN INVERTASE IN POTATOES AT CHILLING TEMPERATURES

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It has been demonstrated previously that 1.5% O₂ suppresses the rise in respiration and appreciably diminishes the accumulation of sugars associated with the transfer of potatoes to chilling temperatures. The temporal relationships between respiration and the capacities of the terminal mitochondrial oxidases, and between sucrose metabolism and invertase activity were studied in tubers kept in air and under 1.5% at 1°C. Chilling temperatures induced *de novo* synthesis of the alternative oxidase. Initially there was a close temporal relationship between rise in respiration and capacity of the alternative oxidase. With time the rate of respiration declined while the capacity of the AO continued to increase. Low oxygen inhibited by 94-97% the rise in the AO. Paralleled with the rise in glucose and fructose there was an increase in invertase activity which increased by twofold after 20 days at 1°C. Four isoforms of invertase were identified with PI values of 5.8, 5.6, 5.4 and 5.17 from chilled tubers. Low O₂ suppressed the rise in invertase.

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INCREASED PEROXIDATIVE DAMAGE AND DECREASED PROTEIN SYNTHESIS ARE FEATURES OF AGING POTATO SEED-TUBERS.

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The physiological mechanisms leading to a decline in sprout-vigor, root growth potential and apical dominance during long-term aging of potato seed tubers are currently under investigation. Malondialdehyde (MDA) and ethane, products of peroxidative degradation of PUFA increase

in seed-tuber tissues with advancing age (from 2 to 32 months of storage). MDA is known to react with free amino acids to produce lipofuscin-like fluorescent compounds (FC), which build-up in aging/senescent tissues of plants and animals. With advancing seed-tuber age, an increase in free amino acids, MDA and FC concentrations was evident. Moreover, high levels of MDA have been shown to reduce protein synthesis in both plant and animal cells. We therefore examined the extent to which seed-tuber age affects protein synthesizing capacity of tuber tissues during sprouting. Tissue disks from 6- and 18-mo-old seed-tubers at various stages of sprouting, were compared for their protein synthesizing ability by monitoring the incorporation of radiolabelled amino acids into TCA precipitable products. The rate of incorporation (dpm mg protein⁻¹ min⁻¹) was 1.8 to 5.4-fold higher in tissue from 6-mo-old, as compared to that from 18-mo-old seed tubers, at similar stages of sprout development. Loss in protein synthesizing ability (possibly due to direct peroxidative damage) may be an important factor contributing to loss of sprout-vigor from aged potato seed-tubers.

(abstract withdrawn)

176 ORAL SESSION 52 (Abstr. 369-375) Subtropical/Tropical Fruits: Breeding and Genetics

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STABILITY ANALYSIS OF YIELD AND THE COMPONENTS OF YIELD AMONG COFFEE GENOTYPES.

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Thirteen coffee genotypes (*Coffea arabica*) were evaluated for yield stability in fourteen environments within Hawaii. The yield components (fruiting nodes, fruits/node, and fruit size) were also evaluated for stability in four environments. Genotype yield and component were regressed against environmental mean yield and yield component to determine the stability of yield and the components of yield.

Cultivars with means above the grand mean, regression coefficients ≤ 1 , and the coefficients of linear determination $\geq 50\%$ were considered to be superior and have phenotypic stability. Stable and superior genotypes are less sensitive to environmental changes and are more adapted to favorable and unfavorable conditions than unstable genotypes.

'Catuai' was stable for both yield and the components of yield (fruiting nodes, and fruits/node) which directly contribute to the yield. The genotype 'SL 28' was unstable but highly responsive to favorable environments for yield as well as yield components. Selection for the stability of yield should be considered in coffee breeding programmes to develop genotypes adapted to diverse environmental conditions in Hawaii.

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GENETIC DIVERSITY IN PUMMELO (*CITRUS MAXIMA* [BURM.] MERRILL), CITRON (*C. MEDICA* L.), AND TRIFOLIATE ORANGE (*PONCIRUS TRIFOLIATA* [L.] RAF) EVALUATED USING RFLPS

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To assess genetic diversity in the UC Riverside Citrus Variety Collection, all accessions of pummelo (59), citron (24), and trifoliolate orange (48) were studied for RFLP variation using 11-18 cDNA probes that had previously been shown to reveal polymorphism in a broad range of citrus germplasm. Inheritance studies have shown that these probes hybridize to at least 20 loci. The taxa studied are believed to represent biological species rather than hybrids. Citrons were nearly monomorphic and most appeared homozygous at all of the loci studied. Pummelos were very polymorphic and highly heterozygous. Trifoliolate orange, an important source of disease resistance in rootstock breeding, was nearly monomorphic but moderately heterozygous (17% of loci). Most accessions of trifoliolate orange have evidently differentiated only by mutation. One multilocus probe separated trifoliolate orange accessions into 3 groups. Two new trifoliolate orange accessions had novel alleles at some loci. The use of genetic markers to recognize hybrid accessions classified as members of species will be discussed.

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ESTIMATES OF POLLEN FERTILITY AND ISOZYME PROFILES OF STAMINATE KIWIFRUIT PLANTS IN SELECTED CALIFORNIA ORCHARDS

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Kiwifruit (*Actinidia deliciosa*) is a functionally dioecious plant where fruit size is dependent on number of seeds set. Pollen fertility was estimated in 1990 and 1991 by percentage stainability and percentage germinability *in vitro*. Profiles of the isozymes AAT, GPI and PGM were used to assess if any large differences in pollen fertility could be attributed to genotypic variation. Based on these three isozymes, eight different genotypes were discovered. Although significant differences were found among vines within orchards and among orchards, all vines can be considered good pollenizers (stainability $> 87\%$). A positive correlation was found in 1991 between percentage stainability and percentage germination.

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SOME NEW PAPAYA CVS FOR ST.CROIX U.S VIRGIN IS. Chris Ramcharan* and Paul Hepperly, University of Virgin Islands Agric. Expt. Station, P.O. 10000, Kingsthill, St.Croix, USVI 00850

Twelve cvs. of Papaya were evaluated for yield and tolerance to drought, high soil pH and disease incidence under a non-pesticide low-input system. Superior yields were obtained from Barbados Solo (BDX 584-1) - 67.1 Kg/tree (tr) and 987 g/fruit (fr), Guanica (GU 2-1) - 60.7 Kg/tr and 888 g/fr, PR 6-65 x Cariflora (CF) - 46.6 Kg/tr and 700 g/fr, and CF - 48.5 Kg/tr and 607 g/fr. Most cvs. survived 19 months with peak yields at 15 months. Pencil top was major disease and only the Palau cv. exhibited St.Croix decline symptoms. Vigorous cvs. included GU 2-1, CF, PR 6-65 x CF and Criolla (CR) several plants of which are fruiting 26 months after planting. Chlorophyll data indicated that CF and CR cvs. had best tolerance to high pH conditions. Cvs. with large pulp size included GU 2-1 (3.7 cm) and SRS x CF (4.2). Brix analyses indicated sweetest fruits were from CF (14.2), SRS x CF (13.4), GU 2-1 (13.7) and PR 6-65 x CF (12.9).

374

DETERMINATION OF THE POLLEN PARENT AND ITS EFFECT ON LYCHEE FRUIT CHARACTERISTICS BY ISOZYMIC ANALYSIS.

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Fruits produced in two commercial lychee (*litchi chinensis* Sonn.) orchards consisting of adjacent blocks of 'Floridian' and 'Mauritius' were analyzed for pollen parentage by phosphoglucose isomerase (PGI) isozyme system. 'Mauritius' and 'Floridian' were found to possess distinguishable homozygous isozyme phenotypes in PGI, thus allowing the unequivocal identification of their progenies as originating from self- or cross-pollination. The rates of hybrids produced in the two orchards were 69% and 87% for 'Floridian' and 17% and 65% for 'Mauritius'. In both cvs a significant correlation was found between pollen parent and the

weights of fruits and seeds. Fruits originating from cross-pollination were heavier and contained heavier seeds than selfed fruits. The most pronounced effect of the pollen parent on seed weight was found in 'Floridian', which appears to exhibit inbreeding depression.

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DIVERSITY OF *NEPHELIUM* SPECIES IN BRUNEI DARUSSALAM

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Nephelium spp. are abundant in Brunei Darussalam. Their trees bear fruits of various sizes and colors and are highly ornate, but only a few are known and cultivated for their edible fruit. The best known is the rambutan (*Nephelium lappaceum* Linn) which is extensively cultivated in parts of SE Asia & N. Australia. The commercial rambutan cultivars evolved from years of natural & artificial selection, resulting in wide variations of fruit sizes, colors & tastes. Malaysia, Thailand, Indonesia, Philippines, Singapore and Brunei each have their own favorite cultivars & clones. One of the most formidable research challenges of rambutan is to extend the shelf life of the fruit. The soft spinterns and fragile skin deteriorates rapidly, becoming dull brownish & dry within four days of harvest. The white translucent flesh also rapidly becomes soft and watery. A potential research direction is to breed for 'spintern-less' rambutan. This strategy may be feasible within the genetic resources of *Nephelium* in Brunei Darussalam where there are spintern-less types. The diversity of *Nephelium* species found in Brunei Darussalam will be elaborated on.

177 ORAL SESSION 53 (Abstr. 376-383) Fruits: Growth and Development II

376

CARBOHYDRATE PARTITIONING TO ROOTS OF 'FRENCH PRUNE' TREES AS RELATED TO CROP LOAD AND POTASSIUM NUTRITION.

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Effects of crop load and potassium on seasonal trends in root starch concentrations were studied in a commercial orchard. Treatments were a factorial combination of fruit thinning and potassium fertilization. Root samples were divided into <10mm and >10 mm diameter categories. Large crop load was associated with lower starch concentrations in the >10 mm roots after stage III of fruit growth. Highest root starch concentrations occurred in low crop trees that had been fertilized with potassium. Roots <10mm diameter also accumulated starch throughout the season but the concentrations were much lower than found in the >10 mm roots and there was little difference among treatments at any sampling date. On the basis of these results, roots >10mm appear to be more important than smaller roots as storage organs and therefore are more affected by stresses and competition with other organs. Continuation of the project will seek relationships between early season root starch concentrations and tree performance including alternate bearing.

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THE EFFECT OF CROP LOAD ON FRUIT DRY WEIGHT AND DRY WEIGHT CONTENT, SPECIFIC LEAF WEIGHT, AND LEAF CARBON EXCHANGE.

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Mature apple trees (*Malus domestica* Borkh.) were studied in the 1989 and 1990 seasons to explore the effect of differential crop load on fruit dry weight (DW), DW content, specific leaf weight, and leaf carbon exchange, using girdled and non-girdled limbs. Fruit DW and DW content decreased with heavier fruit loads, however, fruit on girdled limbs had higher fruit DW and DW content. Specific leaf weight did not differ in leaves on non-girdled limbs

along the crop load gradient, but increased dramatically in leaves on girdled limbs with crop load lighter than one fruit per cm² cross-sectional area. These leaves also had a low photosynthetic rate, high stomatal resistance, and high internal CO₂ concentration. The results suggest a physiological limit for photoassimilate usage by the tree. Exceeding this limit by reducing sink strength resulted in excessive carbohydrate accumulation in leaves, causing physical damage to the photosystem.

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CROP LOAD AND LIMB GIRDLING AFFECT APPLE FRUIT SIZE, COLOR, AND QUALITY

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In 1990, 15-yr-old 'Smoothie Golden Delicious' trees on M.9, M.9/MM.111, and MM.111 were used. On each of 4 trees per rootstock, 3 branches (1.0-1.7 cm dia) were selected. On 7 June (45 DAFB), crop loads were adjusted to 3, 5, or 7 fruit per cm² branch cross sectional area (BXSA), and each branch was girdled. On 6 Sept all fruit were harvested; fruit weight, ground color, percent blush, soluble solids, starch, and firmness were regressed against crop load. Each was negatively related to crop load, most strongly for soluble solids, ground color and blush. Rootstock influenced several factors and some interaction with crop load occurred.

In 1991, heavily cropping 10-yr-old trees of Empire/M.7A were used. One each of 7 trees, branches (1.2-2.0 cm dia) were thinned to 4, 8, or 12 fruit/cm² BXSA on 5 June (40 DAFB). One branch per crop load per tree was girdled on 5 June. On 29 Sept fruit were harvested for evaluation. ANOVA indicated significant interactions between crop load and girdling for fruit weight, firmness, soluble solids and starch. Each showed a significant negative linear regression with crop load on girdled branches; on ungirdled branches none of the regressions were significant.

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REGULATION OF APPLE FRUIT GROWTH RATE BY TURGOR PRESSURE?

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Maintenance of positive cell turgor is an essential factor in cell, and fruit, expansion. Since apple fruit partition carbohydrates between the starch and soluble pools to maintain turgor, variation among cultivars in this osmoregulatory aspect may play an important role in defining cultivar-specific fruit growth rates. Cultivar-specific apple fruit growth rates were determined over a 6 week period following June drop during 2 seasons. Fruit water relations parameters and carbohydrate levels were also measured. Although cultivar differences were evident, generally, fruit absolute growth rate increased, relative growth rate (RGR) declined, water potential and osmotic potential declined, and turgor potential increased as the season progressed. Soluble carbohydrate levels increased over 6 weeks, while starch levels fluctuated. Soluble carbohydrates contributed 50 to 90% of the osmotic potential. RGR was not correlated to either turgor potential or the relative allocation of carbohydrates between the soluble and starch pools. Thus, although positive turgor was maintained, factors other than turgor *per se* determine fruit growth rate.

380

DETERMINING TEMPERATURE OPTIMA OF APPLE CULTIVARS AND ROOTSTOCKS BY THE TEMPERATURE-DEPENDENT REAPPEARANCE OF VARIABLE FLUORESCENCE FOLLOWING ILLUMINATION

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Development of valid temperature-based models of physiological processes such as seed germination, bud development, vegetative growth, fruit development, or fruit maturation, requires a parameter to link temperature with plant metabolism. The Thermal Kinetic Window (TKW) concept uses the temperature characteristics of an enzyme kinetic parameter, the Michaelis constant (K_m) as indicators of metabolic efficiency. Recently, Burke³ has shown that the temperature dependence of the rate and magnitude of the reappearance of photosystem II (PSII) variable fluorescence following illumination corresponded with the optimal temperature described by the TKW for several plant species. The present study investigated the use of the temperature sensitivity of PSII fluorescence in the identification of temperature optima of apple cultivars and rootstocks. ³Burke, J.J. 1990. Plant Physiol. 93:652-656.

CHANGES IN RIPENING ENZYMES DURING SWEET CHERRY FRUIT DEVELOPMENT

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The activities of the fruit ripening enzymes cellulase, polygalacturonase (PG) and pectin methylesterase (PME) were detected during the development of sweet cherry (*Prunus avium* L.) fruit. Cellulase and PG activities of pericarp tissue increased 4-10 times between hypanthium abscission and harvest. PME activity remained high throughout this period of fruit development. There was a positive correlation between the anthocyanin content of the pericarp and both cellulase and PG activities. Concomitant with the increases in the activities of these ripening enzymes was a decrease in fruit firmness. The increases in cellulase and PG activities were checked following two-weeks storage at 10 C after harvest. The purification and characterization of the putative cellulase and PG enzymes will be discussed, together with attempts to chemically inhibit their activities and modify fruit softening.

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ROOTSTOCK EFFECTS ON THE EARLY GROWTH AND PRODUCTIVITY OF 'MONTMORENCY' SOUR CHERRY.

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A 'Montmorency' sour cherry planting was established on 20 clonal rootstocks in April, 1987, as part of the NC-140 cherry rootstock trial. After 5 seasons scion/rootstock combinations showed a 2.5-fold range in trunk circumference. During the fifth season there was a 6-day range in bloom date, a 4-fold range in growth rate, a 7.5-fold range in yield and a 3-fold range in yield efficiency as influenced by rootstock. Trees on GM 9 were the smallest, had the lowest yields, smallest fruit and were among the lowest in yield efficiency. Mahaleb has been the standard cherry rootstock in Utah. Rootstocks whose trees were comparable or exceeded those on mahaleb in both yield and yield efficiency during the fifth season included 148-1, 196-13 and MxM 2. Differences were also observed in root sucker tendency.

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CYTOHISTOLOGY OF A 2-2-4 TYPE SPORT IN BARTLETT PEAR (*Pyrus Communis*)

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In the 1980's, a Bartlett pear giant fruit sport was found in Pingdu, Shandong. The characteristics of mutation are larger fruit, thicker branch, shorter internode and much more spur. By grafting propagation, the clones began to bear fruit in 1990, and maintain the characteristics of variable mother plant.

From microspore formation to blossom and spreading pollen, the cytological observation of sport flowering organs indicates: in every phase of pollen development, the size of florets, anthers and pollen grains are similar to CK; their pollen types both belong to tricolporate, pollen grains are nearly equal in size. This indicates that sport sporogenous tissue do not mutate. The observation of shoot apex sections shows: for CK, the cells of three histogenic layers range regularly; the size of cells, nuclei, and nucleoli among L_1 , L_2 , L_3 are similar. For sport, the cells of L_1 , L_2 are no difference from CK, but in L_3 and inner tissue, cells, nuclei, nucleoli all become larger clearly. This indicates L_3 had mutated. So this sport is a 2-2-4 type chimera.

178 ORAL SESSION 54 (Abstr. 384-391)

Cross-commodity: Stress Physiology

384

STRESS TOLERANCE INDEX- A NEW INDICATOR OF TOLERANCE

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Selection criteria for identifying genotypes with high stress tolerance and high yielding potentials were compared using a moderately stressed, (Stress intensity, $[1 - (\text{mean stress yield } (Y_p) / \text{mean potential yield } (Y_T))] / 0.73$) and a severely stressed (Stress intensity, 0.24) mungbean yield data sets. Selection based on tolerance (T), difference between potential yield (Y_p) and the yield in

stress environment (Y_s) favored genotypes with tolerance and low yield potentials. Selection based on the mean productivity (MP), $[MP = (Y_p + Y_s) / 2]$ favored the genotypes with high yielding potential. The Stress Susceptibility Index (S), $[S = (Y_p - Y_s) / Y_p] / [(Y_T - Y_s) / Y_T]$, also favored the low yielding and stress tolerant genotypes. These selection criteria failed to identify genotypes with high yielding and stress tolerance potentials. Thus, a selection criterion, Stress Tolerance Index (STI) is proposed here which identifies genotypes with high yield and stress tolerance potentials. The STI takes into account both stress tolerance and yield potentials. The STI is estimated as: $[Y_p / Y_T] [1 - (T / Y_T)]$. The higher the value of STI for a genotype in a given stressed environment, the higher was its stress tolerance and yield potential. The inter-relationships between these stress tolerance criteria are discussed by a biplot display.

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A MECHANISM FOR TRANSPORT OF SUBSTANCES BY TEMPERATURE-INDUCED PRESSURE GRADIENTS

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Diurnal changes in air and soil temperatures lead to temperature gradients between air and soil, between roots and shoots, and within plant organs. In response to these gradients, fluctuations in gas pressures may develop in organs that are resistant to exchange of gases. These fluctuations may regulate mass flow of gases or solutions within plants. Patterns of diurnal temperature changes were generated to illustrate temperature gradients between roots and shoots. Experimental confirmation of pressure changes induced by temperature differences between roots and shoots were measured with water manometers attached to stumps of detopped tomato plants. When roots were maintained 8 C lower than shoots, internal pressure decreased by 22 cm H₂O. Reversing the direction of the temperature gradient led to an approximately equal and opposite pressure change and to sap movement. These results support a hypothesis that internal pressure gradients resulting from temperature gradients contribute to transport of substances in plants.

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INFLUENCE OF APOPLASTIC SOLUTES ON THE TURGOR OF TOMATO PERICARP CELLS

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The pressure microprobe was used to measure cell turgor (Ψ_c) in tomato pericarp tissue, and also to sample vacuolar fluid for the measurement of cell osmotic potential (Ψ_s) in a nanoleiter freezing point osmometer. In fresh tissue, cell Ψ_c agreed well with the Ψ_s of frozen-thawed whole tissue measured with a vapor pressure osmometer. Under a wide range of ripeness conditions however, and for both intact fruit and discs of fruit tissue, fruit cell turgor was consistently lower than expected, based on the values of cell Ψ_s . When tissue discs were hydrated in aerated distilled water, disc fresh weight increased substantially (20 - 50%), and both cell turgor and tissue Ψ_s increased. Cell Ψ_s however, remained relatively constant. These and other observations suggest that the turgor increase during hydration was largely due to losses of solute from the apoplastic space, partly by direct losses from the tissue, and partly by cell solute accumulation.

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IMPROVING THE SURVIVAL OF NURSERY PLANTS DURING POSTHARVEST HANDLING.

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Desiccation stress during the postharvest handling of bare-root nursery plants is often responsible for poor performance after transplanting. Alternate methods of handling deciduous sensitive trees, such as Washington hawthorn (*Crataegus phaenopyrum* Med.), and herbaceous perennials species, including *Iris*, *Hosta*, and *Hemerocallis*, are needed for improving survival after transplanting.

A new antidesiccant compound called Moisturin has been useful in reducing water loss from Washington hawthorn trees during storage and shipping, and in improving survival and plant performance during establishment. Hawthorn seedlings or multi-stemmed trees treated with Moisturin before a period of water stress had up to 75% less dieback than control or other antidesiccant treatments.

The use of Moisturin treatment and / or protection with plastic bags of topped bare-rooted herbaceous perennials before five weeks of cold storage (2C) was effective in improving the survival of *Iris ensata*, *Iris*

sibirica, and *Hosta* plants. *Hemerocallis* plants survived equally well with all treatments. The greatest effect on reduction of water loss and improvement of survival was when plants were sealed in plastic bags.

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IRRIGATION MANAGEMENT AND FRUIT QUALITY IN ASIAN PEAR

Kathleen M. Griffiths, Mohammad H. Behboudian*, and Melanie Dingle, Department of Plant Science, Massey University, Palmerston North, New Zealand.

Asian pear (*Pyrus serotina* Rehder) is endemic to southern China, Korea and Japan where it is an important fruit. Recent introduction into New Zealand has necessitated research to achieve high fruit quality. In this experiment three irrigation treatments were imposed on the cultivar Nijisseiki and the effect on fruit quality and storage life assessed. They were: a control for which soil water was maintained at 85% of field capacity (FC), "field" receiving only rainfall, and regulated deficit irrigation (RDI) in which soil water was depleted to 50% FC until rapid fruit growth started and then treated as in the control. Fruit weight and firmness were higher in the control and soluble solids were higher in the field treatment whose fruit matured earlier. Irrigation treatment showed no effect on the ripening pattern of the fruit in coolstorage or the incidence of the postharvest disorder flesh spot decay. Nitrogen and potassium levels were highest in the control fruit. However, levels of Mg, Ca, and P were not affected by irrigation.

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NITROGEN STATUS INFLUENCES BARK STORAGE PROTEIN GENE EXPRESSION IN POPLAR

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In poplar (*Populus deltoides*) a 32kDa bark storage protein (BSP) accumulates during the fall, and is a major form of stored nitrogen during overwintering. This protein is induced by short-day (SD) photoperiod and may play an important role in nitrogen cycling in the plant. To determine the effect of plant nitrogen status upon BSP gene expression, poplar plants were grown in controlled environmental chambers under either SD or long-day (LD) photoperiods and watered with either 5, 10, 50, and 100 mM NH_4NO_3 for four weeks. [^{15}N]- NH_4NO_3 was applied during the first and third weeks. SDS-PAGE and western blot analysis were used to detect the relative amounts of BSP. RNA gel blot analysis was used to determine the changes in BSP gene expression. BSP accumulation was enhanced by increasing levels of nitrogen under both photoperiods, however, SD photoperiod appears to moderate the response. These results indicate that BSP gene expression is dependant upon the nutritional status of the plant. [^{15}N] analysis will also be presented.

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DORMANT BUDS OF *Amelanchier alnifolia* Nutt. 'SMOKY', SURVIVE EXTREME COLD IN THE GLASSY STATE

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Aqueous fractions in dormant buds of *Amelanchier alnifolia* Nutt. 'Smoky', may exist either as liquid, ice or glass phases depending on the temperature history and the water content of the tissue. Phase diagrams for these states were constructed from differential scanning calorimetry (DSC) freezing and warming scans. The diagrams show that glass transition temperatures shift to warmer temperatures as cold hardening increases and as the water content is lowered by controlled desiccation. Glass transitions were detected from -60 to -20° C, during slow freezing scans in the DSC, suggesting that survival of this extremely cold hardy tissue is based upon a potential to undergo glass transitions in the dormant state. Endogenous raffinose family oligosaccharides (RFO) increase during cold hardening, and decrease as hardness diminishes with the onset of growth.

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COMPARATIVE HEAT TOLERANCE AMONG FIVE SPECIES OF BIRCH

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Leaf gas exchange and chlorophyll fluorescence measurements were used as indices for evaluating heat tolerance among five species of birch: paper (*Betula papyrifera*), European (*B. pendula*), Japanese (*B. platyphylla* var. *japonica* 'Whitespire'), Himalayan (*B. jacquemontii*), and river (*B. nigra*). Measurements

were conducted on individual leaves at temperatures ranging from 25C to 40C. Carbon exchange rates (CER) were depressed for all species at 40C. However, there was considerable variation in both absolute and relative (percent of maximum) CER among species at 40C; river birch maintained the highest absolute and relative CER while CER of paper birch was reduced the most. Although stomatal conductance of paper birch decreased at higher temperatures, internal leaf CO_2 increased indicating that reduced stomatal conductance was not responsible for decreased CER. Stomatal conductance of river birch increased at higher temperatures which provided for enhanced uptake of CO_2 and greater evaporative cooling. Variable chlorophyll fluorescence decreased similarly for both species with increasing temperatures. Measurements of dark respiration rates over the range of 25C to 40C suggested that the primary factor influencing variation in CER at higher temperatures was due to variation in respiration rates at higher temperatures.

POSTER SESSIONS 1-18 (Abstr. 400-916)

400 (PS 8)

FLOWER ORIENTATION INFLUENCES OVARY TEMPERATURE DURING FROST IN PEACH

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Ovary temperatures of upward and downward facing flowers of 'Jungold' Peach (*Prunus persica* (L.) Batsch) were measured on 5 nights in March 1991 to determine whether differential survival of ovaries following frost was related to flower orientation. Flowering twigs were removed from mature trees and positioned horizontally ≈ 1.5 m above ground level prior to occurrence of low temperatures (0-5C). Thermocouples were inserted through the hypanthium to contact ovaries of 10 upward and 10 downward facing flowers, and temperature and meteorological data were logged every five minutes. Under clear, calm conditions, temperature of upward facing flowers averaged 0.33C lower than that of downward facing flowers during the coldest period of the night, with maximal differences of 0.77C. Under cloudy, calm conditions, temperature differences between upward and downward facing flowers were less frequently observed and lower in magnitude (0.08 - 0.15C). Under windy conditions (>2.5 m/s), no temperature difference between upward and downward facing flowers occurred, despite strongly negative net radiation. Based on known values of ovary cold tolerance, it is concluded that differences in survival of up to 38% could occur due to flower orientation when air temperature reaches critical values.

401 (PS 1)

APPRESSORIUM FORMATION IN THE PECAN SCAB FUNGUS

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Pecan scab, caused by the fungus *Cladosporium caryigenum* (Ell. et Lant) Gottwald, produces more damage to pecan than all other diseases and insects combined. Early events during infection are critical to disease establishment and to expression of host resistance, but have not been examined previously. Objectives of this research were to determine if there is regulation of appressorial formation and if it is related to resistance. Pre-infectional host-pathogen interactions were studied *in vivo* (on leaves) and *in vitro* (on callus, dialysis membrane, and agar) with light and electron microscopy. Leaves, callus tissue, dialysis membranes, and agar were inoculated with scab conidia and were incubated under conditions optimum for germination. Conidia germinate and produce a germ tube on agar and dialysis membrane, but appressoria are not formed. Appressoria form on pecan callus, but germ tubes are long. Long germ tubes are often associated with resistant disease reactions. *In vivo*, appressoria form readily, but germ tube length varies depending on the location of the spore on the leaf surface. Preliminary evidence indicates that surface topography affects induction of appressorium formation in the scab fungus.

402 (PS 1)

FALL, SPLIT, AND TANK-MIX APPLICATION METHODS AS ALTERNATIVES TO SPRING PREEMERGENT HERBICIDE APPLICATION

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Preemergent herbicides were applied to vineyards in the southcentral Missouri Ozark region. These were applied at full label rate in

the fall or in the spring, at half rate in the fall and again in the spring, and as tank-mixes in the spring. Days of acceptable annual weed control (30% or less cover) beyond the untreated control were determined for these application methods over three years. The fall applications were effective at controlling winter annual weeds and early summer annual weed growth the following season. By mid summer the fall applied preemergents lost residual activity. Splitting the label rate between fall and spring was no better than a full rate spring application at increasing the days of acceptable summer annual weed control. Single preemergent spring application performed as well as tank-mixes.

403 (PS 1)

VEGETATION MANIPULATION WITH SELECTIVE HERBICIDES IN VINEYARDS
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Cover crops are planted between vineyard rows to control erosion, maintain organic material and influence pest management. Planted cover crops are preferable to resident vegetation (weeds) because they can be selected for beneficial characteristic. Sethoxydim and fluzifop-butyl alone and in combination with 2,4-D were applied in December 1988 and 1989 to release *Festuca megallura* (Zorro fescue). Untreated plots were mowed to maintain vegetation. Frequency, percent cover and biomass of the vegetation was evaluated to determine species shift. The vegetation was composed mainly of: 1. *Festuca megallura*, *Poa annua* with other grasses in minor amounts; and 2. *Stellaria media*, *Centaurea solstitialis*, *Erodium botrys* and *Erodium cicutarium*.

Following sethoxydim or fluzifop-butyl treatments, annual grasses other than *Festuca megallura* and *Poa annua* were reduced but *Centaurea* sp. increased over the length of the experiment. Treatments containing 2,4-D *Centaurea* and *Erodium* spp. declined in both frequency and percent cover. The desirable cover crop species (*Festuca megallura*) increased in all treated plots. No species shift was observed in the mowed treatments. Two applications of selective post-emergence herbicides maintained shift of species over the 5 years of the study.

404 (PS 1)

ISOLATION OF *LISTERIA MONOCYTOGENES* FROM FRESH FRUITS AND VEGETABLES

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Listeriosis, a fatal food and environment borne disease of public health and veterinary importance, caused by *Listeria* spp. has not been explored in Pakistan. One hundred and fifty samples of fresh fruits and vegetables collected over a period of 12 months from various localities of Karachi city were screened according to the standard protocols. Suspected isolates were subjected to conventional methods for identification which included morphological, cultural, biochemical and serological tests. Out of 30 samples each of papaya, water melon and cantaloupe, and 15 each of cucumber, tomato, radish and carrot, *Listeria monocytogenes* was isolated from two samples of papaya and tomato each and one sample of water melon and cucumber each. It is inferred that fruits and vegetables, if not handled hygienically and served fresh, may be responsible for the transmission of listeriosis.

405 (PS 1)

ZONATE LEAF SPOT: A NEW DISEASE OF TOMATO IN ARKANSAS. J. C. Correll*, J. K. Mitchell, R. T. Holland, and P. E. Cooper Dept. of Plant Pathology and Dept. of Horticulture and Forestry, University of Arkansas, Fayetteville, AR 72701.

Zonate leaf spot (ZLS) caused by *Cristulariella moricola*, apparently a rare disease of tomato, was identified in a commercial tomato field in southeastern Arkansas in June, 1991. Although lesions of ZLS were similar to early blight (*Alternaria solani*) lesions, which were also present, there were several distinctions between the lesions: the concentric rings in lesions of ZLS were more symmetrical than early blight lesions, no distinct chlorosis was associated with the lesions, and ZLS lesions were not localized near the bottom of the tomato canopy. Koch's postulates were completed on several greenhouse grown tomato cultivars. Inoculum was produced on autoclaved tomato leaves incubated at 20 C and consisted of large (300-400 um long) "Christmas tree" shaped propagules. When free moisture was maintained at 20 C, large (> 1 cm), rapidly expanding, water-soaked lesions were observed on

leaves of inoculated plants 1-3 days after inoculation. Lower humidities caused lesions to rapidly dry out. Epidemiological factors, such as temperature, leaf wetness, and cultivar susceptibility also have been examined.

406 (PS 1)

INFLUENCE OF INTEGRATED PEST MANAGEMENT ON PESTICIDE RESIDUES IN TOMATO PACKINGHOUSE WASTEWATER

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Water analyses from all commercial tomato packinghouse dump tanks in South Carolina in 1989 revealed that heavy metals and pesticides accumulate in the dump tank water throughout the course of daily operation. The amount that accumulated varied widely as follows: esfenvalerate, 0.6 to 13.8 ppb; chlorothalonil, 0.1 to 2.85 ppm; copper, 2.0 to 7.3 ppm; manganese, 0.3 to 2.4 ppm. Contamination was lowest when growers were implementing integrated pest management (IPM) practices during production.

In 1990, tomatoes were grown under the following pest management practices: IPM protocol; modified IPM with more frequent spray; or weekly pesticide application regardless of pest pressure. In a small scale dump tank study the water used for tomatoes on the weekly spray schedule had from 2 to 10 times the amount of pesticide and metal residues found in water used for tomatoes grown under IPM. These results confirm that IPM programs can be effective in reducing residues in tomato packinghouse wastewater.

407 (PS 1)

COLORADO POTATO BEETLE CONTROL WITH CYROMAZINE

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Cyromazine is a triazine molecule with insect growth regulator properties being developed for control of Colorado potato beetle (*Leptinotarsa decemlineata* Say) (CPB) in vegetables. Research presented focuses primarily on results with potato (*Solanum tuberosum* L.), however, crop safety has been observed in other crops within the Solanaceae. Several trials were conducted in PA and NY during 1991 to examine the rates and timing necessary to control CPB in potatoes. Data from replicated small plot trials and non-replicated large block trials are included. Rates examined ranged 70 to 560 g ai na⁻¹ applied alone or in combination with a pyrethroid or Bt. Comparisons were made with insecticides presently registered for CPB control in potatoes and cyromazine compared quite favorably. Two applications per CPB generation were made, the first at the beginning of CPB egg hatch and a second 7-16 days later for each generation. This application schedule provided excellent (90%) control of CPB larvae. The reduction in larvae also resulted in a reduction in adult CPB and potato leaf area damaged through insect feeding. In the test conducted in PA, an increase in size and number of tubers was observed when plants were treated with cyromazine. These increases resulted in a 23-28% increase in total yield compared to that obtained from the untreated check plots.

408 (PS 1)

THE WHITEFLY UPSURGE: IMPACT ON CALIFORNIA VEGETABLE PRODUCTION

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In the fall of 1990, a new form of whitefly, tentatively identified as the poinsettia strain of *Bemisia tabaci* (Gennadius), was introduced into the agricultural regions of the desert southwest. Large densities of whitefly nymphs developed on cruciferous crops and substantial increases in pesticides for whitefly control were used. After overwintering in active stages on these crops, whiteflies moved into spring cantaloupes and developed moderate populations levels in some fields. In March, whiteflies migrated to newly-planted cotton and developed huge densities by August. At this time emerging fall cantaloupe was attacked and over 95% of this crop was destroyed by whitefly feeding. Whiteflies also developed to damaging numbers on alfalfa, grapes, citrus, crops not known to host the cotton strain of *B. tabaci*. Population densities remained high through the fall crucifer and lettuce seasons causing crop losses and delayed maturity. Damage estimates presently rest at roughly \$122 million.

409 (PS 1)

EFFECTS OF THE CONTENT OF DRY MATTER, VITAMIN C, AND CAPSAICIN ON THE RESISTANCE TO TMV, CMV, AND ANTHRACNOSE IN *CAPSIDUM ANNUUM*

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990 *Capsicum annuum* varieties were assessed at the seedling stage in greenhouse for their resistance

to TMV(T), CMV(C) and anthracnose(A), and their mature (purple-red) fruits were analyzed for the content of dry matter(DM), vitamin C(VC) and capsaicin(CA). The data were eventually analyzed by means of correlation and path coefficient analysis. The result was as follows: the content of DM had little positive effect but significantly ($P=0.01$) negative effect on the resistance to TMV, CMV and anthracnose, i.e. $P_{dt}=0.0066$, $P_{dc}=(-0.1364^{**})$, $P_{da}=(-0.1881^{**})$; whereas the content of VC or CA respectively exerted positive effect, even significantly ($P=0.01$) positive effect, on the resistance to TMV, CMV and anthracnose, i.e. $P_{vt}=0.0756^{**}$, $P_{vc}=0.0093$, $P_{va}=0.2069^{**}$ and $P_{ct}=0.2003^{**}$, $P_{cc}=0.2300^{**}$, $P_{ca}=0.0091$.

Sonoran Desert. Control measures include wide use of fungicide applications to prevent economic damage. Recent removal of EBDC type fungicides from the market and restrictions imposed on other registered materials has increased interest by growers and broccoli breeders in developing varieties tolerant to downy mildew. From 1984 to 1989 varieties were evaluated for tolerance to downy mildew in unreplicated trials conducted in commercial fields. In 1990, named varieties of current interest in desert production which showed tolerance to the disease in the previous trials were compared to standard varieties used by the industry. Varieties were replicated four times using a randomized complete block design. A rating scale from 1 to 5 was used to describe the severity of foliar lesions. The varieties Everest, Zeus, Legend, Pirate and Sultan showed significant tolerance when compared to the more susceptible varieties Arcadia, Emerald City, Emperor, Greenbelt, Packman, Commander, and NS 649.

410 (PS 1)

ENDOPHYTIC AND EPIPHYTIC GROWTH OF BIOLUMINESCENT *XANTHOMONAS CAMPESTRIS* PV. *CAMPESTRIS* IN AND ON RESISTANT AND SUSCEPTIBLE HOST PLANTS AND THEIR ENVIRONMENT.

Fenny Dane* and Joe Shaw, Department of Horticulture and Department of Botany and Microbiology, Auburn University, Auburn, AL 36889

The movement of genetically engineered, bioluminescent, *Xanthomonas campestris* pv *campestris*, causal agent of black rot in crucifers, was followed after wound or mist inoculation of susceptible and resistant host plants. Wound inoculation resulted in higher bacterial population levels in susceptible (Perfect Ball) as compared to resistant (Hancock) cabbage plants. More leaves became infected in the susceptible host and peak levels were reached after 4-8 days, but after 10-12 days in the resistant plants. Mist inoculation resulted in high levels of bioluminescent Xcc after 11-15 days in susceptible tissues only, unless entry was gained through damaged tissue of the resistant plant. In the field environment, Xcc was found endophytically after mist inoculation in susceptible cabbage only, but found to grow epiphytically for as long as 2 1/2 months to the same degree on resistant and susceptible host plants. Dispersal of the bacterium was limited and survival in the soil environment found to last for four months.

414 (PS 1)

EVALUATION OF TWO DISEASE FORECASTING SYSTEMS FOR CONTROLLING EARLY BLIGHT ON TOMATO IN NEW JERSEY.

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Two disease forecasting systems - FAST, Pennsylvania State University and CUFAST, Cornell University - were used to generate spray schedules for controlling *Alternaria solani* Ell. and *Mart.* on 'Celebrity' tomato (*Lycopersicon esculentum* Mill.) at The Rutgers Snyder Research and Extension Farm in Northwest New Jersey. Disease control was compared to that obtained following standard weekly spray schedules. Chlorothalonil, 1.5 lb/A, was used for disease control for all treatments. Disease ratings of the FAST and CUFAST plots were significantly lower than that of the unsprayed control and were not significantly different from the plots sprayed according to standard spray schedules. A total of 10 fungicide applications were made following FAST recommendations; 7 applications were made following CUFAST recommendations; 13-15 applications were made following standard recommended schedules. Using CUFAST resulted in an estimated \$200 per acre savings in spray costs. Chemical name used: tetrachloroisophthalonitrile (chlorothalonil).

411 (PS 1)

CARBOHYDRATE CONTENT OF SNAP BEAN LEAVES INFLUENCES CHINESE ROSE BEETLE FEEDING.

S. C. Furutani* and L. H. Arita, College of Agriculture, University of Hawaii at Hilo, Hilo, HI 96720

Shading studies were conducted on snap bean, *Phaseolus vulgaris* L. cv. Hawaiian Wonder, plants to observe the influence of endogenous carbohydrate content of leaves on the feeding activity of the Chinese rose beetle (CRB) *Adoretus sinicus* Burmeister. Increasing the shade level from 0 to 40 or 80 % shade significantly decreased carbohydrate content of leaves and reduced CRB feeding.

The normal distribution of carbohydrates within snap bean plants was altered by foiling the 2 terminal ranks of leaves and exposing the 2 subtending ranks to full sun. The feeding pattern of the CRB was observed to change in accordance to the carbohydrate concentration at each leaf rank. We speculate that carbohydrate concentration within leaves stimulates CRB feeding.

415 (PS 1)

EFFECTS OF CARBOFURAN ON MELON GROWTH AND YIELD.

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Field and laboratory experiments were conducted to study the effect of soil applied (Carbofuran) Furadan on watermelon and cantaloupe yields. Yields were significantly ($p \leq 0.05$) greater when Furadan was used than when it was not. The observed yield increases may have been due to factors other than just the insecticidal properties. Other systemic insecticides demonstrated no similar increase in yield. Yield increases were also evident even when plants were grown in sterile soil. Yield increase was due to a significant increase in the first harvest of watermelon and the first three harvests of cantaloupe. Numbers of fruit and average wt/fruit were increased for watermelon at the first harvest. Midwest growers usually receive the highest price per pound of watermelon at the first harvest. This significant increase in early harvest more than pays for the application of the chemical.

412 (PS 1)

EVALUATION OF ALTERNATIVE NEMATOCIDES FOR THE CONTROL OF ROOTKNOT NEMATODES IN EDIBLE GINGER.

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Fourteen different nematocides were tested for efficacy against the rootknot nematode in edible ginger during the 1990 and 1991 seasons. The test site was located in Papaikou, Hawaii and on land previously cropped to ginger. Soil treated with methyl bromide formulations resulted in comparatively good yield and rootknot nematode control. Metam sodium at 100 gallons per acre appeared to be a good alternative nematocide for edible ginger.

416 (PS 1)

ANTHURIUM YIELD AND WEED CONTROL IN RESPONSE TO HERBICIDES AND WOVEN POLYPROPYLENE MULCH UNDER SHADEHOUSE CONDITIONS IN HAWAII.

Joseph DeFrank*, Tadashi Higaki and Joanne Imamura

Horticulture University of Hawaii at Manoa, 3190 Maile Way, Honolulu, HI 96822. Yield components of 4 anthurium cultivars over a 2 year harvest period were determined. The varieties are 'Ozaki' (red color-OZ), 'Nitta' (orange-NT), 'Kozohara' (dark red-KZ) and 'Marian Seefurth' (pink-MS). The herbicide treatments are: diuron (1.1 kg ai/ha) every 3 months (DN); granular formulation of oxyfluorfen (2%) and oryzalin (1%) (3.4 kg ai/ha) in an alternating 3 month cycle with diuron (1.1 kg ai/ha) (OO). Black polypropylene mulch (PM) is the non-chemical control treatment. Yield components include: total cut flower yield, mean stem length and mean flower size (spathe width x length). Total flower yield was not significantly affected by weed control treatments. Yield ranking was: MS>KZ>NT>OZ. A significant interaction was recorded for stem length and flower size. OZ stem length was unaffected by weed control treatments

413 (PS 1)

BROCCOLI VARIETAL TOLERANCE TO DOWNY MILDEW

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Downy mildew is a major concern to broccoli growers in the

while the others showed variations dependent on treatments. KZ and OZ flower size was not affected by weed control treatments, however, herbicide treatments did reduce flower size of MS and NT. Weed control ranking was: PM=OO.>DI.

417 (PS 1)

MOVEMENT OF OXYFLUORFEN IN CONTAINER NURSERIES

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Little information is available on herbicide movement in soilless container media and subsequent movement in container leachate and container bed runoff. The objective of this study was to evaluate oxyfluorfen movement in irrigation water following application to container grown nursery crops in a commercial nursery. Oxyfluorfen levels in the container bed runoff were 9 to 27 times higher than those in container leachate during the 3 irrigations following herbicide application. Maximum oxyfluorfen level in the container leachate was 8.3 ppb following the first irrigation but declined to 2.0 ppb by the 12th irrigation. The oxyfluorfen level was still about 2.0 ppb following the 75th irrigation. Oxyfluorfen in the container bed runoff peaked at 99 ppb following the 3rd irrigation before declining to 67 ppb following the 6th irrigation.

419 (PS 1)

POSTHARVEST TREATMENTS FOR PESTS OF TROPICAL CUT FLOWERS AND FOLIAGE

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Postharvest treatments significantly reduced or eradicated pests on various tropical cut flowers and foliage. Immersion in water at 49° C for 10 minutes killed armored scales on bird of paradise leaves, *Strelitzia reginae* Banks, as well as aphids and mealybugs on red ginger, *Alpinia purpurata* (Vieill.) K. Schum. Vapor heat treatment for 2 hours at 45.2° C provided quarantine security against armored scales on bird of paradise leaves. A 5 minute dip in fluralinate combined with insecticidal soap eliminated aphids and significantly reduced mealybugs on red ginger. A 3 minute dip in fluralinate, a 3 minute dip in chlorpyrifos, or a 3 hour fog with avermectin-B significantly reduced thrips on orchids, *Dendrobium* spp., without injury to the flowers. No postharvest treatment was both effective and nonphytotoxic on all commodities.

420 (PS 1)

TREATMENT OF ADVANCED ROOT ROT IN DRACAENA FIELD STOCK.

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Two fungicides and lime were evaluated for their effect on *Dracaena fragrans* Ker. cv. Massangeana plants which were severely affected by root rot. A completely randomized design with 5 treatments and 4 replicates was utilized. These treatments were: control, lime at 3362 kg/ha, 4 applications of metalaxyl at 10.4 kg/ha, 6 applications of benomyl at 12.92 kg/ha and a metalaxyl/benomyl combination treatment. Field plots were 13 m², and plants were spaced 0.5 m from center. Data was taken from 15 plants per plot at 0, 10 and 20 weeks.

There were significant differences in plant height and the quality of new growth between the treatments containing metalaxyl and those without metalaxyl. There was no significant difference between the metalaxyl and the metalaxyl/benomyl treatments.

421 (PS 1)

PHYTOTOXICITY OF PENDIMETHALIN TO ANNUALS UNDER LANDSCAPE CONDITIONS

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The granular formulation of pendimethalin (Southern Weedgrass Control) safely provides preemergent control of grasses and broadleaf weeds in a variety of landscape ornamentals but few annuals. The purpose of this experiment was to evaluate phytotoxicity of pendimethalin to several annual species under

landscape conditions. Pendimethalin at 1.7, 2.2, 2.8, or 3.4 kg ai/ha was applied over-the-top to cool and warm season annuals in a simulated landscape at 4-month intervals starting 15 October 1990. The simulated landscape was divided into 4 blocks (reps) with pendimethalin levels as the main plot factor and annual species as the subplot factor. Unweeded and hand-weeded plots served as controls. Irrigation (over-the-top) and insecticides were applied on an as-needed basis. All annuals except 'Sonnet Burgundy' snapdragon exhibited some degree of stunting. 'Vodka' wax begonia was the most sensitive to pendimethalin as it was moderately stunted at all rates. Weed control generally was good to excellent.

422 (PS 1)

USE OF TRICHODERMA FOR BIOLOGICAL CONTROL IN EBB AND FLOW PRODUCTION SYSTEMS.

Marsha Ann Bower*, David H. Trinklein and John M. Brown, Department of Horticulture, 1-40 Agriculture, University of Missouri, Columbia, MO 65211.

Recent trends in greenhouse container production suggest using ebb and flow irrigation for water conservation and pollution control. A major problem in this system is management of soil borne pathogens. Some species of *Trichoderma*, a beneficial fungi, are known to control *Pythium* and *Phytophthora* in container production. This study investigates the potential of applying a *Trichoderma* conidial spore suspension in an ebb and flow irrigation system. *Trichoderma* conidia were collected from culture and placed in 101 l stock solution tanks at 10⁻² and 10⁻⁴ colony forming units (CFU) per ml. Six inch container grown *Dendranthema grandiflora* 'Delano', were irrigated as needed. To determine *Trichoderma* density in the root environment, soil samples were acquired from the container at 7 day intervals. Results showed that initial population densities of 10⁻⁴ CFU/ml were required to achieve adequate container populations to control disease after one irrigation. This study successfully demonstrated that *Trichoderma* could be dispersed through irrigation water into container plants in an ebb and flow system.

423 (PS 1)

A NEW SAMPLING TECHNIQUE FOR MANAGEMENT OF SPIDER MITES IN FIELD ROSES

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Spider mites are the most commonly treated arthropod pest of roses grown for sale as plants in Kern County, California. One obstacle to possible reduction of acaricide use has been lack of a quantitative method for field evaluation of mite populations. A presence/absence (P/A) technique for mite sampling was evaluated in 1987-1991. Background data was collected in six fields of first-year and second-year rose plants in 1987 and 1989. A strong correlation existed between numbers of infested leaflets and leaves. P/A counts were similar among strata within first-year and second-year fields. A strong correlation existed between numbers of infested leaflets and leaves. In 1990 and 1991 P/A data was compared to mite counts obtained by brushing in replicated plots using leaves as sampling units. Acaricide applications have been made in the field on the basis of P/A count. Further work is underway to estimate the effects of treatment at several threshold levels of mite infestation as evaluated by P/A.

424 (PS 1)

SORBITOL METABOLISM IN BACTERIA PATHOGENIC TO THE ROSACEAE FAMILY

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Many tree crops belonging to the *Rosaceae* family translocate and metabolize sorbitol. We have determined that some species of bacteria belonging to the genus *Agrobacterium*, *Pseudomonas*, and *Erwinia* pathogenic to the *Rosaceae* demonstrate the ability to metabolize sorbitol while those that were isolated from other hosts could not utilize sorbitol. Employing cellulose acetate electrophoresis (CAE) we have been able to demonstrate the presence of isoenzymes of sorbitol dehydrogenase (SDH) that correlate with the ability to metabolize sorbitol in these organisms. In order to study the properties of SDH in these organisms we carried out a detailed enzymatic analysis of the enzyme from *A. tumefaciens*. We found that the enzyme displayed activity when mannitol or xylitol were used as substrates, in addition to sorbitol. Michaelis constants (Km) were 32.8 mM, 0.19 mM, and 38.2 mM for sorbitol, mannitol, and xylitol respectively. To further distinguish the reactions with the different substrates the enzymatic extracts were further characterized on CAE using different substrates to visualize patterns of isoenzymes for a particular sugar alcohol. These analyses revealed the presence of unique isoenzymes for SDH. In addition we observed the presence of mannitol dehydrogenase (MDH) representing in most species a non-specific polyol dehydrogenase.

425 (PS 1)

EFFECTS OF A HYDROGEL, WETTING AGENT, AND METALAXYL ON PHYTOPHTHORA WILT IN CONTAINER-GROWN RHODODENDRON

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Phytophthora wilt, caused by the root-infecting fungus *Phytophthora cinnamomi*, is a serious disease of rhododendron. The symptoms of this disease include wilt, dieback, and death of nursery cuttings as well as large plants. The effects of two soil additives, Supersorb (a hygrogel) and Aquagro (a wetting agent), with and without Metalaxyl (Subdue 2E), were assessed on decreasing the incidence of Phytophthora wilt in container grown 'Nova Zembla' rhododendron. Rooted cuttings grown in amended or non-amended mix were inoculated with *P. cinnamomi*. Metalaxyl treatments were applied once at the full label rate of 4 fl oz/100 gal at planting, or twice (at planting and 8 wks later) at 1 or 2 fl oz/100 gal. Trials were conducted from June to September in the greenhouse (1990) and outdoors (1991). Plant growth and disease incidence were evaluated weekly. In both trials, the Supersorb and Aquagro treatments did not affect disease incidence, although they did significantly affect plant growth. All metalaxyl treatments reduced disease incidence significantly when compared to controls.

426 (PS 1)

CROP TOLERANCE TO WEEDS

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Plant breeders have successfully increased crop tolerance to many pests and physiological stresses. However, very little work has examined the potential for increasing levels of tolerance to weeds, despite weed control costs of several billion dollars annually. Evidence will be summarized from the literature supporting the contention that genotypic differences in tolerance to neighboring plants exist. Approaches to screening for tolerance, choice of selection environment, and genotype identification will be discussed.

427 (PS 1)

PATH ANALYSIS OF NIGHTSHADE (*SOLANUM NIGRUM* L. AND *S. PTYCANTHUM* DUN.) COMPETITION WITH TOMATO *Milton E. McGiffen, Jr.** and Dan J. Pantone, USDA, Agricultural Research Service, North Iowa Avenue, Morris, MN 56267.

Path analysis is a statistical method for determining the magnitude and direction of multiple effects on a complex process. We used path analysis to determine the direct effects of nightshade density on yield components (number of green fruit per plant, rotted fruit per plant, total fruit per plant, and weight per fruit) of the processing tomato cv. Heinz 6004. In addition, the analysis indicated the direct and indirect effects of yield components on total yield per ha and marketable yield per ha. The greatest direct effects of eastern black nightshade and black nightshade were on green fruit per plant and total fruit per plant. Effects other than density (density-independent factors) were more important in determining the number of rotted fruit per plant and weight per fruit. Path analysis showed that the total number of fruit per plant was the most important yield component determining total yield and marketable yield per ha.

428 (PS 1)

CYPERUS KYLLINGIA AND CYPERUS BREVIFOLIUS: A POTENTIAL MODEL FOR THE STUDY OF ALLELOPATHY *C. Scott*, R.K. Nishimoto, and C.S. Tang*, Depts of Horticulture and Environmental Biochemistry, University of Hawaii, Honolulu, Hawaii USA 96822

Cyperus kyllingia and *Cyperus brevifolius* are problematic turfgrass weeds in Hawaii. Both are closely related weed species with similar morphology and growth characteristics. *C. kyllingia* appears to be a more successful weed with regards to interference than *C. brevifolius*. Greenhouse experiments were conducted to compare the levels of interference exerted by *C. kyllingia* and *C. brevifolius* upon *Cynodon dactylon* turfgrass. *C. kyllingia* reduced the growth of *C. dactylon* by about 50 %, while *C. brevifolius* did not significantly reduce *C. dactylon* growth. These results correspond with the chemical profiles of *C. kyllingia* and *C. brevifolius*. Analysis has shown that *C. kyllingia* contains two sesquiterpenes which have been identified as potentially allelopathic components of *Cyperus rotundus*. *C. brevifolius* contains waxes and the two sesquiterpenes found in *C. kyllingia* are absent. This suggests that allelopathy may be the mechanism responsible for the different levels of interference exhibited by *C. kyllingia* and *C. brevifolius*, and these species may provide an important model for the study of allelopathy.

429 (PS 1)

THE EFFECTS OF VARIOUS HOST PLANTS ON GROWTH, WATER RELATIONS, AND CARBON BALANCE OF THE HEMIPARASITE *CASTILLEJA INDIVISA*

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Castilleja indivisa grows hemiparasitically attached to the roots of various nearby plants. Studies were done using several host plants to determine the effects of the parasitic relationship on the growth of *C. indivisa* and the host plants. Transpiration rates, and leaf water potentials of *C. indivisa*, and various hosts, were also measured at various soil moisture levels. Carbon transfer between *C. indivisa* and each host was examined using a ¹⁴CO₂ tracing technique.

The various hosts used in this experiment enhanced the growth of *C. indivisa* by 200-700% compared to non-parasitic controls. Transpiration rates of non-parasitic controls remained relatively low at all soil moisture levels while transpiration rates of parasitic *C. indivisa* increased rapidly as soil moisture increased, and generally exceeded that of its host at low to medium soil moisture levels. Leaf water potentials of non-parasitic controls were generally more negative than other treatments. Carbon exchange between *C. indivisa* and its hosts was insignificant and appears not to be a major nutritional factor.

430 (PS 1)

EFFECT OF ETHEPHON ON MISTLETOE REMOVAL

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The parasitic eastern mistletoe, *Phoradendron serotinum* is a perennial evergreen that infests trees including the deciduous pecan [*Carya illinoensis* (Wangenh.) C.Koch]. Various chemical and/or mechanical methods of mistletoe eradication have been studied. An efficient method of mistletoe removal in deciduous trees involves the use of ethephon, an ethylene-releasing compound. Mistletoe in dormant 'Stuart' trees and 'Desirable' trees at bud break were treated on 15 Mar. with 0, 2500, 5000, 7500, or 10,000 ppm ethephon [pH of treatment solution adjusted with 1.2 ml/L of a buffering agent (pH +, Stoller Chemical Co.)]. 'Desirable' trees at the prepollination stage of development were treated with 0, 312, 625, 1250, or 2500 ppm + 1.2 ml/L of the buffering agent on 27 Mar. 1991. All ethephon treatments except 312 and 625 ppm resulted in >95% defoliation on 18 Apr. All chemical treatments resulted in abscission of some mistletoe branchlets. There was a negative correlation between ethephon concentration and mistletoe regrowth on 2 Dec. for both cultivars. The most effective treatment was 2500 ppm applied at prepollination on 'Desirable'. This treatment resulted in no mistletoe regrowth on 80% of the trees. No phytotoxicity to the pecans was observed.

431 (PS 1)

DISPERSAL OF *TRICHODERMA* VIA IRRIGATION WATER

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Trichoderma has been known to control soil-borne pathogens and to enhance plant growth and development. The objective of the study was to evaluate dispersal of *Trichoderma* via irrigation water in container production. 3.81 x 30 cm PVC pipes were filled with Sunshine Mix #5 up to 25 cm. Ten tomato seeds, boiled and coated with *T. harzianum*, were placed at 0.5 cm depth in each pipe. All treatments were irrigated carefully with 100 ml of DD water from top every 2 days. Before and one hour after irrigation the potting mix was sampled from 5 depths at 5.5 cm intervals every 2 days for 8 days to determine *Trichoderma* density. *Trichoderma* density was significantly higher in after irrigation. *Trichoderma* dispersed up to 25 cm deep in container potting mix after 4 days via irrigation water. This study successfully demonstrates that *Trichoderma* can be rapidly dispersed via irrigation water.

432 (PS 2)

RESPONSES OF GROUNDCOVERS TO RENOVATION BY MOWING

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The objectives of this study were to investigate the responses of several groundcovers to periodic mowing and determine which ones benefit from mowing in terms of aesthetic quality, density, height and

thatch development.

Eight species were transplanted on 30 cm centers in September. Five species had become fully grown in 10 months and were mowed to either a 5 cm or 10 cm height. Four species received a second mowing at 10 cm 8 or 11 months later. The remaining three species became fully grown in 18 or 21 months and were mowed at 10 cm at that time. Visual quality scores were recorded monthly, as were average overall plant and thatch heights. *Lantana*, *Osteospermum* and *Verbena* expressed little or no long-term loss in visual quality, while their height and thatch growth were controlled well when mowed in the spring-summer period. Height and thatch growth were controlled well in *Drosera* and *Aptenia*, but visual quality was unacceptable. Spring mowing appears to produce reductions in height and thatch with no significant loss in quality of *Myoporum* and *Baccharis* but with significant loss in quality of *Rosemarinus*.

433 (PS 2)

THE EFFECT OF SHADE ON *KALMIA LATIFOLIA* GROWTH AND FOLIAGE COLOR

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Container production of recently-developed and popular *Kalmia latifolia* cultivars has not been fully optimized. A study was conducted using six cultivars grown in full sun, 40% shade or 60% shade. Under 60% shade, plant height was reduced slightly, but shading, at either 40% or 60%, had no significant effect on all other measured growth parameters. Plants were too young to set significant numbers of flower buds, so the study will be continued a second year to quantify the effects of shade on flower bud set. Foliage color was measured using a Minolta CR-200 Chroma Meter. As shading increased, hue angle increased and the chroma and value of the color decreased, indicating that shading produced greener (less yellow), darker and duller foliage colors. Foliar chlorophyll content increased with increasing shading. Higher foliar chlorophyll content correlates with greener leaves in shaded treatments and is likely contributing to the green color. Using moderate levels of shade over container-grown *Kalmia* could allow growers to produce greener, more marketable plants without sacrificing plant growth.

434 (PS 2)

RHODODENDRON AND AZALEA CULTIVAR PERFORMANCE IN THE GREAT PLAINS AS AFFECTED BY LANDSCAPE EXPOSURE

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Lepidote and Elepidote *Rhododendron* cultivars were established May 2, 1988 in selected landscape sites with amended soil to evaluate performance under stress by the continental climate characterized by hot summers and cold, desiccating winters. Evergreen azaleas were also screened with emphasis on flower bud hardiness. Survival and flowering were acceptable in exposures protected from winter sun especially on Lepidote 'RJM Victor' which survived 42°C although *Phytophthora* root rot occurred in hottest locations. In contrast flower buds on large leaf types 'Nova Zembla' and 'Roseum Elegans' often failed to open due to desiccating winter conditions. Cultivars which flowered best after 3 years were 'Aglo', 'Lodestar', 'Nova Zembla', 'Olga Mezitt', 'RJM', 'Waltham' and 'Windbeam'. Hardest azaleas which flowered following -28°C were 'Boudoir', 'Caroline Gable', 'Kaempferi', 'Herbert', 'poukhanense', 'Karens', 'Pride's Pink' and 'Snowball'. Additional cultivars appear promising given suitable bed preparation, proper exposure and adequate maintenance in spite of climatic extremes in the great plains.

435 (PS 2)

TREE GROWTH RESPONSES TO THE ENVIRONMENT.

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The prediction of which species will do well in various microclimates is of obvious interest to horticulturists as well as homeowners. To this end, the following 5 species of trees and shrubs were planted at 5 disparate sites across Kansas in spring 1985 and growth and environment measured for the 4 following years: *Phellodendron amurense*, *Acer rubrum*, *Acer platanoides* 'Greenlace', *Quercus acutissima*, and *Cercocarpus montanus*. Preliminary analysis of trunk diameter growth vs. environment indicates few simple relationships and several rather complex relationships. Rather simplistic linear relationships (growth vs. a single environmental parameter) are largely meaningless, and often misleading.

For instance, growth of *Q. acutissima* was negatively correlated with the highest maximum temperature prior to the growing season and positively correlated with the lowest minimum temperature prior to the growing season. More complex, and reasonable, relationships will be presented.

436 (PS 2)

RESOURCE OF WILD ORNAMENTAL PLANTS IN THREE-RIVER PLAIN

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Three-river Plain, the key agriculture and animal husbandry developing region of China is located in the northeast part of Heilongjiang province. There were rich resources of wild ornamental plants in Three-river Plain. 134 species of those were investigated belonging to 54 families. 35 were woody plants and 99 herbaceous. The domestication and cultivation of several plants with high decorative value were studied and briefed as follows: (1) *Viburnum sargentii* Koehne propagates by seeds beginning to blossom in 3 years and by rhizome. The plants grown in the plain are subject to insect pests; (2) *Sambucus buergeriana* Blume propagates by seeds after sand cultivation for 4-6 months and begins to blossom in the next year; (3) *Acanthopanax Senticoccus* (tupr. et maxim) harnes propagates by seeds, shoot layering and root cutting. The germination of seeds is lower and the shoot layering is best. It grows slowly in the white clay soil, (4) *Hemerocallis midendorffii* Trantv. et Mey, propagates by seeds and suckers and blossoms in the next year, growing well in the plain; (5) Ostrich fern (*Matteuccia struthiopteris* (L.) Todaro) propagates by spore. The spore grows to sporophyte in 70-90 days after sowing and the sporophyte grows to sporophyll in 4 years.

437 (PS 2)

IRRIGATION, WATER RELATIONS, AND CRABAPPLE GROWTH IN ROOT-CONTROL BAGS IN A FIELD NURSERY

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Limited root development of nursery stock in root-control bags facilitates harvest but without irrigation may predispose stock to water stress. The effect of bags and irrigation on growth and water relations of field-grown *Malus sieboldii* var. *zumi* were investigated following transplanting as large liners into a silty-clay soil. Predawn leaf water potential (Ψ), and midday stomatal conductance (g_s) and Ψ , were measured periodically through the season. Late-season osmotic potential (Ψ_{π}), caliper, leaf area, and root growth were also measured. Non-irrigated treatments exhibited water stress during an extended mid-summer drought, as predawn Ψ and particularly g_s were less than irrigated treatments, resulting in lower vegetative growth and Ψ_{π} . For combined bagged treatments water relations did not differ, but leaf area, root growth, and Ψ_{π} , but not caliper, were less than non-bagged trees. Growth measurements and Ψ_{π} of non-irrigated bagged trees, however, were consistently lower but non-significant than the other treatments. Bag-induced root reduction can limit some top growth even with optimum soil water. Moreover, in terms of potential Type-II errors extrapolated over a conventional production cycle, trees grown in root-control bags in normally non-irrigated soils may be more susceptible to water stress and subjected to further cumulative growth limitation.

438 (PS 2)

INCORPORATED SLOW-RELEASE FERTILIZER FOR CONTAINER-GROWN NURSERY STOCK

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Media fertility is a critical factor in the successful production of container grown plants. Fertility treatments including fertigation and slow-release fertilizers (topdressed and incorporated) were compared. Fertility treatments were studied over a two-year period on a variety of deciduous and evergreen plant materials. Plant growth was quantified based on height, volume, branching, and quality. Soil fertility levels based on leachates were followed during the study. Nutrient release for incorporated fertilizers tested was variable although less so than when the same fertilizers were topdressed. Fertility treatment effects were species-dependent. Several incorporated, slow-release fertilizers, especially those high in nitrogen (Sierra 17-6-10, Sierra High N 24-4-6, Woodace Briquettes 23-2-0, Woodace 21-4-10), show promise for use in two-year container production systems.

439 (PS 2)

AN EVALUATION OF POINSETTIA 'ECKESPOINT FREEDOM' GROWN AS A MULTIBRANCHED PLANT

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A recently introduced poinsettia cv. Freedom was evaluated during 1990 and 1991 for production of multi-branched plants in 10 and 15 cm pots and 25 cm baskets. In 1991 'Freedom' was compared to four cvs. for cutting production and rooting in a mist house. Number of usable cuttings (from 24 nodes on stock plants) was 21.1, 22.9, 25.2 and 25.8 for 'Freedom', 'Celebrate 2', 'Supjibi' and 'Glory', respectively. Root development of 'Freedom' was better than 'Celebrate 2' and equivalent to 'Supjibi' and 'Glory'. In 1990, 'Freedom' exhibited bract color 35.8 days after initiation of short days and was marketable in 51.2 days. These dates were 9.1 and 8.1 days earlier than 'Amy' and 16.4 and 14.7 days earlier than 'Glory', respectively. Similar dates were recorded in 1991. 'Freedom' plants were taller than 'Amy', of a height similar to 'Supjibi', and shorter than 'Glory' following treatment with growth regulators. Post production studies indicated that leaf retention of 'Freedom' was similar to 'Glory' but less than 'Supjibi' and 'Lilo'. 'Freedom' exhibited some bract necrosis, especially at high nutrition levels, but showed good potential as an early cultivar for Florida.

440 (PS 2)

EASTER LILY RESPONSE TO PREPLANT - INCORPORATED ANCYMIDOL IN A BARK-BASED MEDIUM.

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Easter lilies, *Lilium longiflorum* Thumb. cv Nellie White, were grown in a commercial pine bark-based medium (25% by vol.), amended with 0.5 g Acrylamide Acrylate Gel (AAG) per 1.6 liter pot. Lilies were grown in media drenched with ancymidol, at 0, 0.25, 0.375 or 0.5mg a.i.pot⁻¹ following shoot emergence, or grown in media containing ancymidol impregnated AAG at 0, 0.25, 0.375 or 0.5mg a.i.pot⁻¹. AAG applied ancymidol treatments resulted in a significant linear decrease in both lily stem and internode length as the rate of ancymidol increased. Drench applied ancymidol had no effect on stem or internode length. Stem and internode lengths of drench treated lilies were not significantly shorter than lilies not exposed to ancymidol. Bud length, leaf and bud number, and days to anthesis were not affected ($P \leq 0.05$) by any treatment. Ancymidol activity in the top, middle and bottom strata of medium filled containers, and in the leachate from these containers, was measured using a lettuce hypocotyl length bioassay. Ancymidol activity was uniformly distributed throughout the bark medium when applied in AAG. With this treatment, 10-15% of the ancymidol activity was detected in the leachate. When ancymidol was applied as a drench, over 95% of the activity was detected in the top two strata, with 70% in the upper most stratum and the rest in the leachate.

441 (PS 2)

COMPARISON OF APPLICATION METHODS OF PACLOBUTRAZOL FOR HEIGHT SUPPRESSION OF POTTED TULIPS

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'Kees Nelis' tulips were potted five bulbs per 0.8-l container using a commercial peat moss and perlite growing medium. Bulbs were exposed to 9C for 4 weeks, followed by 5C until the emerging shoots were 4 to 5 cm long. One day after plants were moved from the cooler to a greenhouse (14C minimum), the following treatments were applied: drench or spike (International Spike, Inc.) of 0.062, 0.25, or 1.00 mg paclobutrazol per pot; or drench of 0.25 mg ancymidol per pot. Flowering height was reduced linearly as concentration of paclobutrazol increased for both application methods; flowering height was 24.0 cm with the highest rate of paclobutrazol, 23.8 cm with ancymidol, and 27.7 cm with untreated plants. Treatments had no effect on flower diameter or time to flowering.

442 (PS 2)

PINE BARK AND PEAT-BASED MEDIA INFLUENCE THE EFFECTS OF UNICONAZOLE DRENCH ON 'GUTHIER V-14 GLORY' POINSETTIAS.

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The objective of this study was to determine the influences of 8 commercial media, 4 peat-based and 4 pine bark-based, on the effects of uniconazole applied as a media drench to 'Guthier V-14 Glory' poinsettias. The peat-based media were Baccto

Grower's Mix, Baccto High Porosity Professional, Baccto High Porosity Professional with Bacctite, and Baccto Rockwool Mix. The pine bark-based media were Metro 300, 360, 500, and 700. Uniconazole was applied to plants grown in each media at 5 rates (0, 2, 4, 6, and 8 mg • 15 cm pot⁻¹).

Uniconazole effectively reduced plant height and width, bract dry weight, and bract number in all media. Plants grown in the Metro products, however, tended to be larger than those grown in the Baccto products. Bract size and number, plant weight, width and height were greatest in Metro 360. The rockwool mix produced the smallest plants. Plants grown in the peat-based media were more sensitive to uniconazole drenches. Plants grown in Metro 360 were the least sensitive to uniconazole drenches.

443 (PS 2)

MOVEMENT OF SELECTED GROWTH-REGULATING CHEMICALS IN ARTIFICIAL GROWING MEDIA

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The presence of the growth regulators paclobutrazol and uniconazole in leachate or distribution through media consisting of various proportions of Douglas fir bark, sphagnum peat and perlite was evaluated. Distribution through a column 25 cm deep occurred rapidly and growth regulators were found in the leachate the first day after drench application when perlite was in the mix. Movement was limited to a maximum of the top 60% of the column in bark and peat mixes without perlite. Leachate was collected daily over a 12 day period after drenches were applied. Paclobutrazol and uniconazole showed similar distribution patterns in the media.

444 (PS 2)

COMPARISON OF GROWTH REGULATOR PERSISTENCE IN VEGETATIVE CHRYSANTHEMUM

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The persistence of five growth regulators applied as spray or soil drenches was studied in vegetative *Dendranthema X grandiflorum* (Ramat) Kitamura 'Bright Golden Anne' (BGA) and 'Deep Luv' (DL). Spray treatments applied as 3 ml per plant consisted of 0.038 mg uniconazole (UC), 15 mg daminozide (DM), or 0.075 mg of either paclobutrazol (PB), flurprimidol (FP), or ancymidol (AC). Drenches of 0.025 mg UC, or 0.05 mg of either PB, FP or AC were applied at 60 ml per 500 cm³ pot. Growth (cm per week) in BGA was suppressed 60-73% compared to controls the week after application in all treatments except DM, which suppressed growth only 43%. By week 8, growth was similar to controls in all treatments except FP. With DL, all treatments suppressed growth 34-75% compared to controls the second week following application, except for no response to DM and PB sprays. Only plants treated with FP or UC drenches had not returned to similar growth as the control plants by week 10.

(abstract withdrawn)

446 (PS 2)
PROMOTION OF BRANCHING IN WOODY LANDSCAPE PLANTS BY
ASC-66952

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Eight species of container-grown woody landscape plants received a single foliar spray of 0, 25, 50, 100, or 200 mg a.i. ASC-66952 $\cdot$ liter⁻¹ on 13 June 1990. (ASC-66952 is a proprietary chemical being developed by ISK-Biotech.) Axillary, rhizomatous, and total shoot numbers of 'Harbour Dwarf' nandina were increased with increasing concentrations of ASC-66952. Relative to those of the control plants, axillary shoot numbers were increased from 350% with 25 mg $\cdot$ liter⁻¹ to 950% with 200 mg $\cdot$ liter⁻¹, while rhizomatous shoot numbers were increased 144% with the lowest concentration and 477% with the highest concentration. Growth indices were decreased from 2.1% with 25 mg $\cdot$ liter⁻¹ to 9.7% with 200 mg $\cdot$ liter⁻¹. Branching and growth indices of other species tested were minimally affected by ASC-66952 application.

447 (PS 2)

INFLUENCE OF BA, PROMALIN, AND DIKEGULAC-SODIUM ON FROND INITIATION AND VEGETATIVE GROWTH OF BOSTON FERN

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Effects of BA, Promalin and Dikegulac-sodium on frond number and overall growth in Boston Fern (*Nephrolepis exaltata* L.) were studied. Four weeks after transplanting, fern liners were sprayed with aqueous solutions of BA, Promalin and dikegulac-sodium. Chemical concentrations of BA and promalin ranged from 0 to 150 mg $\cdot$ liter⁻¹ at 50 mg $\cdot$ liter⁻¹ increments. Chemical concentrations of dikegulac-sodium ranged from 0 to 750 mg $\cdot$ liter⁻¹ at 250 mg $\cdot$ liter⁻¹ increments. Chemical treatments were arranged in a randomized complete block design with 6 replications. BA and Promalin significantly increased the number of fronds, average frond length, leaf area and dry weight as the concentration of the chemicals increased. In contrast, dikegulac-sodium significantly suppressed the average frond length, leaf area and dry weight when compared to the control. Similarly to BA and Promalin, dikegulac-sodium increased the number of fronds as the concentration of the chemical increased.

448 (PS 2)

VARIETAL RESPONSE OF LANDSCAPE ANNUALS TO GREENHOUSE-APPLIED TRIAZOLE GROWTH REGULATORS
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Seven to 9 cvs each of *Begonia semperflorens*, *Tagetes erecta*, *T. patula*, and *Petunia hybrida* (grandiflora and multiflora types) were sown into seedling trays. One to 3 weeks after transplanting to flats (75 cm²/cell), paclobutrazol (PB) was sprayed at concentrations of 10 (begonia), 60 (marigold) or 100 (petunia) mg liter⁻¹ at a 200 ml m⁻² rate. Uniconazole (UC) was applied at one-half the PB concentrations. Plant height was measured before planting in the field May 17 and monthly through July. Species were analyzed separately and generally, there were no cultivar by triazole interactions. During the greenhouse phase, the triazoles controlled height of both marigold species compared to control, but in July the PB and UC treated plants were 100 and 91%, respectively, of control plant height. Flowering was delayed up to 4 days for UC treated *T. patula* plants. Height of triazole-treated petunias was 60-67% of control height during the greenhouse phase and 84-95% after 2 months in the field. Begonia height was reduced by triazoles during both phases. After 2 months in the field, PB and UC treated begonias were 72 and 44%, respectively, of control plant height.

449 (PS 2)

HORMONE CONCENTRATION AND CUTTING MATURITY INFLUENCES ON ROOTING OF REDBUD

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Rooting experiments have been conducted with a pink flowered redbud (*Cercis canadensis*) in anticipation of its release to the nursery trade. Cuttings taken in May, June and August were treated with NAA or IBA at 0, 1,000, 10,000 and 20,000 ppm and rooted under mist. Rooting percentages as high as 94% have been

obtained by using IBA at 20,000 ppm on cuttings taken 3 weeks after growth began. Fifty percent of cuttings taken in June rooted when treated with the highest IBA rates. Cuttings taken later than June did not root. In a separate test, terminal (semi-hardwood) cuttings making active growth were compared to sub-terminal (hardwood) cuttings. IBA and NAA application at 20,000 ppm resulted in 57% rooting for terminal cuttings while producing only 14% rooting for sub-terminal cuttings. Data will be presented on the comparison of the rooting ability of this clone as compared to seedling trees.

450 (PS 2)

FLOWERING AND GROWTH REGULATOR RESPONSE IN 'FREEDOM' COMPARED TO OTHER POINSETTIA CULTIVARS

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Euphorbia pulcherrima cvs. Freedom, SUPJIBI, and Celebrate 2 were sprayed with paclobutrazol or a tank mix of daminozide and chlormequat at week 40, 41, 42, 43, or 44. Application time had little effect on plant size. The tank mix had greater efficacy on 'Freedom' but not on the other cultivars. Interactions for bract size indicated: 1) time of application had less effect on 'Freedom', 2) there was little difference between the chemicals on 'SUPJIBI', but the tank mix had greater efficacy on the other cultivars, and 3) the tank mix had greater efficacy than paclobutrazol during weeks 41, 42, and 43.

'Freedom', 'Celebrate 2', 'SUPJIBI', and 'V-14 Glory' were planted on 8 or 15 Aug. and placed under short days on 12, 19, or 26 Sept. 'Freedom' reached anthesis between 30 Oct. and 6 Nov., about 5 days before 'SUPJIBI' and 'Celebrate 2' and 7-10 days ahead of 'V-14 Glory'. 'Freedom' planted in Aug. and given short days 14 days apart flowered only 7 days apart (40 to 47 days from start of short days), but when planted in Sept. flowering was in 54 days and each long day resulted in 1 day delay in flowering.

451 (PS 2)

EFFECT OF DIKEGULAC ON BOUGAINVILLEA FLOWERING UNDER INCREASING AND DECREASING DAYLENGTH

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Profitability and production of hanging baskets of bougainvillea, a short day species, could increase if vegetative growth and flowering were more easily controlled. Three-month-old rooted liners of *Bougainvillea* 'Barbara Karst' and 'Rainbow Gold' were transplanted into 4.5-liter hanging baskets (3 liners/basket) in late April (Expt. 1) or late July 1991 (Expt. 2) and pruned 2 or 3 days later. Selected combinations of 0, 600, 800, 1200, or 1600 ppm dikegulac were applied at 0, 2, and 4 weeks after initial pruning. Control plants were also pruned at 4 weeks. Plants were grown under full sun. Peak flowering occurred 9 to 10 weeks after initial pruning in both experiments. Dikegulac enhanced flowering of both cultivars under increasing and decreasing daylengths but was greatest under increasing daylengths, especially for 'Rainbow Gold'. There was little to no effect on branching.

452 (PS 2)

ROLES AND INTERACTIONS OF ETHYLENE AND POLYAMINES DURING THE SENESCENCE OF HIBISCUS (*HIBISCUS SYRIACUS* CV. YEONGGWANG) FLOWER. Ki-Cheol Son*, Y. Chae, Dept. of Horticulture, Kon-Kuk University, Seoul, 133-701 and Y. Lee, Agric. Sci. Institute, RDA, Suwon KOREA 441-744.

During the aging of *H. syriacus* flower, biosynthetic pathways of ethylene and polyamines, their interactions, and their effects on senescence were investigated. The evolution of ethylene in ephemeral flower was rapidly increased immediately after initiation of in-rolling of corolla at which EFE activity became maximum peak. After that, EFE activity was gradually decreased even though the aging was continued. Ethylene production was, however, slightly inhibited by the treatments of AOA and putrescine. The activity of ACC synthase and SAM decarboxylase were most rapidly increased at the time of 36th hrs. The contents of ACC and MACC were gradually increased from the early stage. However, ACC contents was decreased at the final stage but MACC was continuously increased. In normal condition, endogenous level of polyamines exists in the order of putrescine>spermidine>spermine. Putrescine was reduced from the initial point of aging, but spermidine and spermine were reduced from the middle and final stage of aging, respectively.

454 (PS 2)

RESPONSE OF CONTAINER-GROWN *ACER SACCHARUM* TO DROUGHT STRESS

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Two year old sugar maples grown in 25 gallon containers were subjected to different levels of stress by withholding water. Drought levels were measured using irrometers. Irrometer readings of 40, 60, and 80 centibars were used to determine when to add water. The media used were a primary nursery mix of 50:50 sand and pine bark by volume. The maples were evaluated for differences in stomatal responsiveness with the porometer and growth parameters of number of nodes, internode length, and leaf number were taken. Some of the trees were treated with ROOTS as a drench to determine if it would enhance resistance to water stress of containerized nursery plants. Despite the use of ROOTS there was no significant difference between the stressed and the non-stressed plants of stomatal responsiveness or the growth parameters.

(abstract withdrawn)

456 (PS 2)

RESISTANCE TO ROOT-ZONE HEAT STRESS DIFFERS AMONG CULTIVARS OF RED MAPLE

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Alden M. Townsend, USDA-ARS, National Arboretum, Washington, DC 20002

Use of cultivars resistant to high soil temperature could improve the performance of urban trees. The objective of this project was to examine selections of red maple (*Acer rubrum* L. and *A. x freemanii* E. Murray) for genotypic differences in resistance to root-zone heat stress. Development of roots and shoots from rooted single-node cuttings of seven genotypes grown in solution culture was optimal at about 28C. Shoot extension stopped within 3 weeks and terminal buds formed on plants of all genotypes at 36C. In a second experiment, the influence of 34C root-zone temperature on development varied significantly among six genotypes. Formation of terminal buds at 34C was observed only on plants of cv. Morgan and cv. Red Sunset. The reduction in new dry matter at 34C compared to plants at 28C ranged from 21% for cv. Schiesinger to 69% for cv. Morgan. We conclude that genotypes of red maple differ in resistance to high root-zone temperature.

457 (PS 2)

SUPRAOPTIMAL ROOT-ZONE TEMPERATURE EFFECTS ON WATER USE OF THREE *CERCIS* SPP.

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Sap flow rates of three *Cercis* spp. exposed to supraoptimal root-zone temperatures were characterized in a controlled environment chamber using a water bath to control temperatures. Flow rates of sap in the xylem were measured every 15 sec. and averaged over 15 min. intervals. Sap flow measurements were

correlated to root-zone temperatures recorded during the same time intervals. Whole plant transpiration was measured gravimetrically. Root-zone temperatures were maintained at 22C for three consecutive 24-hr cycles and then increased to 45C for an additional three 24-hr periods. All plants, regardless of species, had reduced sap flow patterns when exposed to high root-zone temperatures. Plants maintained at a constant temperature of 22C showed no extreme fluctuations in sap flow rate. Stomatal conductance rates and leaf water potentials showed similar trends to whole plant transpiration.

458 (PS 2)

ATTAINMENT OF VEGETATIVE MATURITY (VM), CHILLING REQUIREMENT, AND ABA LEVELS IN DOGWOOD (*CORNUS SERICEA* L.) CLONAL ECOTYPES.

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Dogwood (*Cornus sericea* L.) clonal ecotypes from northern latitudes (Northwest Territories "NWT") and more southern latitudes (Massachusetts, Utah, and Chalk River, Ont.) were allowed to acclimate naturally in a shade house (52°07') beginning in early July and continuing through the middle of October. The NWT ecotype began to attain vegetative maturity by the second week of September, whereas the southern ecotypes did not attain any significant degree of VM before the first lethal frost.

Defoliation tests in controlled environment chambers paralleled shade house results. Under VM-inducing conditions (20/15°C, 8h), NWT ecotype attained VM after 40-50 days. Conversely, after 80 days Utah ecotype had not attained full VM.

Chilling requirement will be compared among ecotypes and ABA levels will be quantified using HPLC and ELISA systems. The results will be compared with date of VM attainment, subsequent freezing tolerance and satisfaction of the chilling requirement.

459 (PS 2)

FIELD SCREENING OF ROSA ROOTSTOCKS FOR TOLERANCE TO ALKALINE SOIL

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Roses are adapted for growth and production on acid to slightly acid soil. When grown on alkaline soil sites, without extensive soil modification and acid forming and/or iron chelate fertilization, growth is reduced and severe iron chlorosis is prevalent. This study screened 24 *Rosa* rootstock species and selections on one acid and two alkaline soil sites for 2 consecutive years. Plants were observed for chlorosis, chlorophyll content, fresh and dry weight production and overall quality. A final reciprocal grafting study using susceptible and tolerant selections was conducted to assure the scion could realize the adaptability of the rootstock. Overall, the following five selections consistently exhibited greater growth and decreased chlorosis on the alkaline sites: *R. odorata*, *R. canina*, *R. manetti*, *R. sp. "Mexican"*, *R. fortuniana*, and *R. multiflora* selection K-1. All other *R. multiflora* selections performed poorly. On the acid soil site, all rootstocks grew well. When susceptible selections were budded onto tolerant rootstocks, the scions exhibited a higher degree of tolerance. Tolerant selections budded onto susceptible rootstocks exhibited increased chlorosis and decreased growth.

460 (PS 2)

DEEP SUPERCOOLING OF FLOWER BUDS WITHIN THE GENUS *FORSYTHIA*

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Thermal analysis of *Forsythia x intermedia* 'Spectabilis' flower buds had previously detected the occurrence of low temperature exotherms (LTE) during freezing. The LTE apparently resulted from the freezing of supercooled water and corresponded to the death of the florets. The genus *Forsythia* encompasses a wide array of species and interspecific crosses ranging in flower bud hardiness and floret size. The ability of buds to supercool, the relationship between the LTE and flower bud hardiness, and the extent to which floret size affects both were studied in flower buds of the following *Forsythia* species: *F. x intermedia* 'Spectabilis', *F. x intermedia* 'Lynwood', *F. 'Meadowlark'*, *F. suspensa* var. *fortunei*, *F. 'Arnold Dwarf'*, *F. europaea*, *F. giraldiana*, *F. x intermedia* 'Arnold Giant', *F. japonica* var. *saxatilis*, *F. mandshurica*, *F. ovata*, and *F. viridissima*. Flower buds used for thermal analysis were also used in subsequent size determinations. Hardiness evaluations were conducted using controlled freezing tests, and the sampling interval defined using the temperature range of the LTEs. Initial evaluation indicated a high degree of correlation ($\alpha > .50$) between mean LTEs and mean killing temperatures. The *Forsythia* genus, with its broad range of bud hardiness and size provides an excellent system in which to study the mechanisms of supercooling. Thermal analysis of cultivars which exhibit LTEs can accurately assess bud hardiness with minimal plant material.

461 (PS 2)

OPERATIONAL COLD HARDINESS TESTING AND DATA ANALYSIS METHODS
Karen E. Burr* and Rudy M. King, U.S. Forest Service, Rocky Mtn. For. and Range Exp. Stn., Flagstaff, AZ 86001, and Fort Collins, CO 80526, respectively.

Cold hardiness testing is an important tool used at US Forest Service nurseries for evaluating the physiological quality of conifer stock. Three tests were compared. A whole-plant freeze test without root system insulation permitted evaluation of cold injury without complication by drought symptoms if plants were misted. A cutting freeze test underestimated expected field foliar injury due to high humidity used to maintain the cuttings. An electrolyte leakage test failed to detect economically important bud mortality when buds were less hardy than other tissues.

Data from all three testing methods were analyzed with an original software package consisting of standardized input files and a step-by-step series of fortran programs and command files for use with commercially available non-linear modelling programs. Injury (y) versus temperature (x) data were modelled with the versatile, 4-parameter Weibull sigmoid model. Injury estimates at specific temperatures (I_t) or temperature estimates causing specific injury levels (LT_t) were calculated with confidence and calibration intervals, respectively. The statistical significance of differences between I_t or LT_t estimates was then determined.

462 (PS 2)

INFLUENCE OF IRRIGATION WATER SALINITY ON OPTIMAL NITROGEN, PHOSPHORUS, AND POTASSIUM FERTILIZER RATES ON *SPATHIPHYLLUM* 'PETITE'.

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Salinity is a limiting factor in plant growth. The combination of water high in soluble salts and water-soluble fertilizers can induce salt damage in plants. The objective of this work was to investigate the effects of salinity in irrigation water on optimal fertilization rates in *Spathiphyllum* 'Petite'. The combination of 5 levels of fertilizers and 5 salinity levels were tested. Maximum growth was observed at 250 mg l⁻¹ N and no salts, and with 2000 mg l⁻¹ salts at 125 mg l⁻¹ N. As salt levels increased, height and leaf area decreased. Tissue calcium, sodium, and chloride increased with increasing levels of salinity. Tissue nitrogen, phosphorus, and potassium generally increased with increasing levels of fertilizers, and were not affected by salinity level. It is possible that high sodium and chloride concentrations in leaves, petioles, and roots produced an ion toxicity.

463 (PS 2)

WATER STRESS DETECTION WITH FOLIAGE TEMPERATURE FOR IRRIGATION SCHEDULING IN NURSERY PRODUCTION
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Changes in foliage temperature with environmental conditions were investigated for use in detecting water stress and scheduling irrigations of woody nursery plants. Midday leaf-minus-air temperature (Tl-Ta) and vapor pressure deficit (VPD) were monitored seasonally for container-grown shrubs—prostrate juniper, upright juniper and dwarf red-stem dogwood—at open and closed spacings. There was an inverse relationship between Tl-Ta and VPD for all species and spacings but with substantial scatter. Slopes for open- and closed-spaced shrubs were not significantly different for any species. As container moisture and predawn leaf water potential declined during a dry-down cycle Tl-Ta increased significantly over well-watered levels for open-spaced plants and closed-spaced dogwood. In a field experiment Tl-Ta and VPD were monitored in young London plane, flowering pear, and redbud with-and-without irrigation. Only irrigated London plane Tl-Ta was inversely related to VPD. Leaves coated with petroleum jelly, however, had Tl-Ta levels consistently greater than uncoated leaves in all species, and non-irrigated Tl-Ta rose to those levels during a mid-summer drought. These results suggest that irrigation of container shrubs can be timed to increases in Tl-Ta with VPD, while comparing coated and non-coated Tl-Ta may be more successful for irrigated field production.

464 (PS 3)

INFLUENCE OF BUNCH COUNT PER VINE ON YIELD AND EARLY MATURITY OF FLAME SEEDLESS GRAPES

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Early maturity is of major importance to table grape producers in the Sonoran Desert. Prices are historically high at the beginning of the

season, declining substantially over the first few days or weeks of harvest. Research was conducted in 1990 and 1991 at a commercial vineyard in southwest Arizona to determine the effect of bunch count per vine on yield and early maturity of fifth and sixth year flame seedless grapes. Vines were thinned to 15, 25 and 35 bunches in 1990, and 20, 30, 40, and 40 short bunches in 1991. The two-row, 0.2 acre plots were replicated four times using a randomized complete block design. Despite the large variation in crop load, there were no significant differences in total yield. There was an increase in percent soluble solids as bunch counts decreased. Berry weight followed the same trend. Small to moderate bunch counts produced a larger number of boxes and a greater percentage of the crop early in the season. By maintaining small to moderate bunch counts, early maturity is attainable without significantly reducing total yield.

465 (PS 3)

VEGETATIVE GROWTH AND REPRODUCTIVE POTENTIAL OF THREE TYPES OF MICROPROPAGATED RED RASPBERRY NURSERY STOCKS.

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The growth and fruiting of 3 types of micropropagated red raspberry plants were compared. The 3 types of nursery material included: 1) Stage 4 (S-4) - 10-15 cm tall, actively growing plants; 2) dormant Stage 4 (DS-4); and 3) nursery matured (NM) - S-4 plants that are grown for 8-12 weeks in the field. On 1 Apr. 1991, 'Redwing' plants of each type were planted 0.6 m apart in ridged, drip-irrigated, and straw-mulched rows spaced 3 m apart. Fruit harvest began on 16 Aug. and continued until 28 Oct. On 12 Nov., the above ground portion of each plant was harvested for measurements of plant growth. The S-4 and NM plants had the highest fruit yields (number and weight), and the S-4 plants had the largest fruit size. NM plants had the first ripe fruit followed 4 days later by S-4 plants and 10 days later by DS-4 plants. The NM and S-4 plants had the greatest cane lengths and diameters. The S-4 and DS-4 plants had the largest above ground dry weights. The DS-4 plants produced the largest number of canes.

466 (PS 3)

ESTABLISHMENT OF 'GULFCOAST' SOUTHERN Highbush BLUEBERRY
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In a 1989 field study, 'Gulfcoast' southern highbush blueberry plants were subjected to irrigation [8 liters per week (low) and 30 liters per week (high)], mulching (none and 15 cm height), row height (level and raised 10-15 cm), and soil incorporated peat (none and 15 liters in each planting hole) treatments at establishment. Plants were grown on a well-drained fine sandy loam soil that contained < 1.0% organic matter. Plant volume was increased by either mulching, high irrigation, incorporated peat moss or level beds. Fruit yields were not significantly affected by irrigation levels but were highest with either mulching, level beds or incorporated peat moss. The bed height X mulching interaction indicated that mulching increased yield more with level beds than with raised beds. Plants grown with the combination of mulching, level beds, incorporated peat moss, and high irrigation levels yielded 1.1 kg per plant or approximately 10 times more than plants grown without mulch, with raised beds, without peat moss, and with the low rates of irrigation. Of the 4 establishment practices evaluated, mulching had the greatest influence on plant growth and fruiting.

467 (PS 3)

EFFECT OF PLANT SPACING AND PLANTING DATE ON YIELD OF ANNUAL STRAWBERRY SYSTEM IN NEW JERSEY

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High density strawberry planting systems have increased yield and fruit quality, and allow greater production on small acreage. To adapt the system to New Jersey conditions, replicated plantings of 'Chandler', 'Tribute', and 'Tristar' were established at 3 spacings and two planting dates (9/9, 9/15) in 1989, and two plant spacings and two planting dates (8/14, 9/7) in 1990. Plants were propagated as plugs from runner tips. The plantings were covered with floating row covers (polypropylene) in December; covers were removed in early April at 5% bloom. In 1990, 'Chandler' yield increased as density increased, and decreased with later planting date. Fruit quality was very good; saleable % was over 90%. Size ranged from 8 to 21 g., and averaged from 12 to 17 g. for the various treatments. 'Tribute' responded similar to 'Chandler' but 'Tristar'

yield at 12" was not significantly different than 6", but greater than 9". Size ranged from 9 to 19 g., and averaged from 10 to 14 g.; saleable % was over 85%. In 1991, 2 spacings (6", 12") and 2 planting dates (8/24, 9/7) were tested. The earlier planting date was superior to later; yields were not different between the 6" and 12" treatments (yield range: 3.8-5.4 T/A). Size was superior at wider spacing; day-neutral fruit size was small (avg fruit size range: 7.7-11.2g; high range: 10.1-17.4g).

468 (PS 3)

RESPONSE OF REPEATED 2,4-D SPRAYS ON THE NODE DIAMETER, INTERNODE LENGTH AND CARBOHYDRATES IN THE CANES AND COLD HARDINESS OF CONCORD GRAPE BUDS

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Field grown high and low vigor *Vitis labruscana* cv, Concord grapevines were sprayed with 2,4-D amine in concentrations of 0, 2.5, 10 and 25 ppmw at 1st leaf; 1st and 3rd leaf; 1st, 3rd and 5th leaf and 1st, 3rd, 5th and 7th leaf stages of vine growth for two consecutive years. Cane and bud samples were collected for determining node diameter, internode length, carbohydrates in the canes, and T_{50} of buds. Data on yield and vegetable growth were also collected.

There were significant differences among treatments in the node diameter and cold hardness of buds (T_{50}) both in high and low vigor vines. Repeated applications of 2,4-D reduced the cane diameter significantly but the carbohydrates in the canes were not affected. When 2,4-D symptoms were severe in July, yields were reduced by as much as 85%, but there was slight or no reduction in yield when symptoms were not severe.

469 (PS 3)

EFFECT OF TRAINING SYSTEM AND PLANTING DENSITY ON GROWTH, YIELD, AND FRUIT QUALITY OF YOUNG GRAPEVINES

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Two training systems (open lyre and Kniffin) with two planting densities (3.3 m x 1.5-1.1 m and 1.8 m x 1.5-1.1 m, R x V, respectively) were evaluated for their effects on growth, yield, and fruit quality of fourteen grapes grafted to SO4. Cane pruning weights of vines grafted to SO4 rootstocks averaged 268.1 kg/10a. Chenin Blanc, Cabernet Sauvignon, and Clairette grapes had greater cane pruning weights. Pruning weights of vines trained to the Kniffin system with 1.8 m x 1.1 m spacing were greater. Fruit yields of young vines averaged 438.6 kg/10a, and SV 5276, Carignane, and Ugni Blanc grapes were more productive while Riesling, Grenache, Chenin Blanc, Muscat de Frontignan grapes were less productive. Yields of grapevines trained to the Kniffin system with 1.8 m x 1.1 m spacing were more productive. Fruit quality was less affected by training system and planting density, but significant varietal differences were recognized.

470 (PS 3)

EFFECT OF DORMANT PRUNING REGIMES ON CANOPY LIGHT DISTRIBUTION, FRUIT AND SPUR QUALITY, AND FRUIT PACKOUT OF 'MCINTOSH' APPLES.

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A randomized complete block study was initiated in 1991 in a fifteen year old 'Rogers Red McIntosh' 9-106 interstem orchard to investigate the effect of three dormant pruning regimes- an unpruned control, selectively thinned, and heavily structured or "tiered", on tree canopy light distribution and fruit and spur quality. Fruit quality parameters being measured for the 1991 and 1992 harvests include skin color (% red blush), weight (g.), flesh firmness (kg.), soluble solids concentration (% Brix), and packout (% fancy grade). Pruning treatment effect on fruit spur quality, in terms of spur bud diameter (mm.) and spur efficiency (leaf dry weight/spur), is also being evaluated at time of harvest. Light distribution is being measured (% PAR, $\mu\text{mol/s/m}^2$) within the tree canopy from petal fall through harvest. Preliminary findings indicate there is a difference in tree canopy light distribution and some fruit quality measurements, including red skin color, between pruning regimes. Complete analysis of results from 1991 will be presented.

471 (PS 3)

STUDYING THE CAUSE AND CURE OF 'ROME BEAUTY' APPLE RUSSETTING

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Effects of several growth regulators and mineral nutrient sprays on 'Rome Beauty' apple (*Malus domestica* Borkh.) russetting under

climatic conditions of southwest Idaho were studied in the 1990 and 1991 growing seasons. Zinc (Zn-50), Calcium as a 12% liquid nutrient (Stopit-6), and fungicide (Polyram) sprays slightly increased, while GA (Provide) decreased fruit russetting.

In 1991, GA and repeated Semperfresh (sucrose ester, carboxymethyl cellulose and mono and diglycerides) applications reduced russetting while Bayleton application increased russetting. Russetting varied from year to year. In 1991, a season of severe fruit russetting, trees which received a fungicide treatment for powdery mildew had generally higher incidence of fruit russetting regardless of treatments. It is believed that interaction between relative humidity, temperature, and systemic sprays used for powdery mildew control contribute to 'Rome Beauty' russetting.

472 (PS 3)

UNDERTREE SPRINKLING FOR FREEZE PROTECTION

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A Latin Square design was used to determine effects of undertree irrigation on orchard temperatures during freezes. Plots (40 x 40 m) in a tart cherry orchard included 72 trees. Water was applied at 0, 125, 250 and 380 ($\pm 5\%$) liters/min. Four meter towers held shielded thermocouples at 1, 2, 2.5, 3 and 4 meters. Thermocouples were monitored at 10-second increments using a Campbell Scientific CR10 micrologger. AM32 multiplexers switched between the 96 thermocouples involved. An IBM AT compatible computer retrieved and stored data from the micrologger at 10-minute intervals. The data acquisition system was activated shortly after midnight and operated continuously until after sunrise on three near-freeze nights. No significant heating effect was present at any water level. On one of the nights, a refrigeration effect was documented.

473 (PS 3)

GROWTH AND FRUIT PRODUCTION OF YOUNG MICRO-PROPAGATED APPLE (*MALUS DOMESTICA* BORKH.) TREES

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Tree size, cumulative yield, yield efficiency and anchorage of 6 micropropagated (MP) apple (*Malus domestica* Borkh.) cultivars were determined in 1991 after 5 years of production, as compared with trees on seedling (sdlg) or M 7a roots. Trees were planted in 1984, with crops harvested from 1987 through 1991. Trees were generally smallest (trunk cross-sectional area) on M 7a and were largest with 4 cultivars ('Delicious', 'Jonathan', 'Rome', 'Spartan') when micropropagated. 'Golden Delicious' (GD) was largest on sdlg. Cumulative yield was affected by a scion x rootstock interaction, with few trends in scion or rootstock effects. Mean cumulative yield was 84 kg tree⁻¹, 71 and 58 for M 7a, MP and sdlg, respectively. Yield efficiency was also affected by a scion x rootstock interaction. In 1991, mean yield efficiency was 0.5 kg cm⁻² for sdlg and MP trees, but was 1.05 for M 7a. Efficiency on M 7a was superior to other rootstocks with all scions except 'GD', while sdlg and MP trees were statistically similar with all scions. All trees leaned in response to prevailing westerly winds, with trees on sdlg tending to be more upright than MP or M 7a trees.

474 (PS 3)

FRENCH PRUNE TREE GROWTH AND YIELD COMPARISONS ON MARIANNA 2624, MYROBALAN SEEDLING AND 29C ROOTSTOCKS

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French prunes growing on marianna 2624 (*P. cerasifera* x *P. munsoniana*; M 2624), myrobalan seedling and 29C (*P. cerasifera*; MS and M 29C, respectively) were planted in 1981 on a clay type soil, and evaluated for growth and yield components over a 10 year period. Thirty replicate trees per treatment were pruned and grown under uniform irrigation and fertility regimes. There were no tree size differences among rootstocks after 10 years growth even though initial and seasonal trunk cross sectional area differences were observed. Trees on MS rootstock were highest yielding in the initial 2 years of fruiting, but cumulative yields were not different as a function of rootstock. More rootstock suckers were counted on M 2624 than myrobalan rootstocks. Excavations revealed that trees on MS had a deeper root distribution. No statistical differences were observed with regard to fruit size and fresh to dry fruit weight ratios.

CELLULOSE FIBERS SHOW PROMISE IN REDUCING SUNBURN INJURY OF 'PAULARED' APPLES.

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A set of 3 experiments was conducted to determine if cellulose fibers (CF) could reduce the incidence of sunburn injury in 'Paulared' apples. Sunburn injury was artificially increased in these experiments by fruit manipulation and removal of shading vegetative growth to expose apples to at least 4 hours of direct sunlight. The 4 treatments applied included an unsprayed control, a commercial binding agent (CBA), a 1% corn starch (CS) colloidal suspension, and a 3% CF suspension that contains CBA and CS. No differences between treatments were found in the first experiment. The CF suspension concentration was increased to 9% for the second experiment. This resulted in uneven CF distribution on the fruit surface and no significant differences between treatments. The third experiment was designed to more precisely determine sunburn symptom expression by delineating the manipulated fruit surface area directly exposed to sunlight prior to treatment. The resulting percent of area that showed a white (bleached) sunburn symptom was significantly less for the apple fruit treated with CF than CBA alone.

DORMANT PRUNING INFLUENCE ON PEACH PISTIL HARDINESS

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Ethephon (100 mg-liter⁻¹) was applied to mature peach trees (*Prunus persica* (L.) Batsch. cv Redhaven) on 13 Oct. 1989. Ethephon-treated and non-treated trees were pruned on 12 Dec. 1989, or left not pruned. Flower bud hardiness was assessed via exotherm analysis from Dec. through Mar. on buds taken directly from the orchard and on buds deacclimated / reaclimated under controlled conditions. Buds from ethephon-treated trees were consistently harder than buds from non-treated trees. After a warm spell in Jan., buds from pruned trees not previously treated with ethephon were less hardy than those from non-pruned trees. Hardiness of buds from ethephon-treated trees after the warm spell was not affected by pruning. All buds rehardened with the return of low temperatures. Under controlled conditions, buds from pruned trees were less hardy than those from non-pruned trees. Pruning resulted in a rapid loss of hardiness at warm temperatures (21°C). If trees had been treated with ethephon the previous fall, significant rehardening of dehardened buds from pruned trees occurred at 5 or -1°C. Buds from pruned, non-treated trees did not rearden.

EVALUATION OF LOW-INPUT PECAN ORCHARD FLOOR MANAGEMENT SYSTEMS

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Legume ground covers in pecan orchards can reduce nitrogen inputs and increase beneficial insects. Preliminary data indicate that certain legumes can supply over 100 kg/ha⁻¹ N. Additionally, certain legumes have high aphid populations which attract beneficial insects. When aphid populations on the legumes crash, beneficial insects seek alternative food sources in the pecan trees, thus reducing the necessity for pesticide applications. Preliminary studies suggest that a mixture of 'Dixie' crimson clover and hairy vetch produces high populations of beneficial insects and over 100 kg/ha⁻¹ N. Treatments were established at four pecan orchard sites in Oklahoma, each with 5 ha of a crimson clover/vetch mixture and 5 ha of native grass sod. Additions of 0-200 kg/ha⁻¹ N were added to the sod plots but no supplemental N was added to the legume plots. Nitrogen and biomass production by the legumes, and leaf N concentration of pecans were determined. In addition, both aphid and beneficial insect populations were monitored in the legume and grass treatments, and in the pecan trees. Results will be discussed in the presentation.

COMPARISONS OF PLANT DENSITIES AND TRAINING SYSTEMS OF PEACH TREES

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'Redhaven' peach tree plantings were established in 1985 to compare tree densities (299 trees/ha to 1794 trees/ha) and training systems (Open Vase, Central Leader, Y-shaped, Palmette Trellis, Tatura Trellis, and MIA Trellis). Tree trunk growth (diameter) was significantly less as the population of trees increased. Trunks of trees trained to the

Open Vase were larger than Central Leader or Y-shaped trees. In 1988, yields per ha increased as tree density increased. Trees trained to the Tatura Trellis (897 trees/ha) had the highest yields (27.7 t/ha). Trees trained to the Central Leader and planted at 1794, 897, and 598 trees/ha had next highest yields of 24.5, 21.4, and 24.3 t/ha, respectively. By the 6th year, yield differences were not generally related to tree density. The top yielding systems were Open Vase (598 trees/ha) and Tatura Trellis (897 trees/ha) with yields of 32.1 and 29.0 t/ha, respectively. Trees trained to Open Vase had higher yield efficiencies (kg/cm² limb CSA) in 1991 than trees in other systems-spacings and had yields of 23.6, 27.4, and 32.1 t/ha for plant densities of 299, 448 and 598 trees/ha, respectively.

EFFECTS OF APPLE TREE DENSITY AND ROOTSTOCK ON YIELD AND FRUIT CHARACTERISTICS OVER 13 YEARS

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A three density-three rootstock test was conducted on three spur-type apple cultivars grown in sandy loam soil. Trees of the three cultivars: 'Redspuree' (RS), 'Goldspuree' (GS), and 'Spuree Rome' (SR) were trained to a central leader system in a 100% grass cover. All cultivars produced best in the high density planting (1344 trees/ha.). Most consistently and significantly affected were the SR. The least productive density, the low density, had 336 trees per ha. while the medium density had 672 trees/ha. Density had a more significant effect on SR culls and a slightly more significant effect on SR fruit soluble solids than it did on these variables of the other cultivars. Density had little effect on fruit firmness of all cultivars. Of these rootstocks: m7a, m26, and mml06, the mml06 rootstock usually produced the greatest yields, especially in the RS and SR cultivars. Results for the GS were more variable than they were for RS and SR with its production on the m7a rootstock occasionally exceeding that of the mml06 rootstock. The m26 rootstock produced the lowest yields. Rootstock had no significant effect on fruit firmness of all cultivars.

CONTAINER CULTURE OF HIGH-CHILLING PEAR AT TAIWAN'S LOWLAND

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High-chilling pear cv. Shinseiki (*Pyrus serotina* Rehd.) were used to evaluate the cultivation potentiality at warm area via the decrement of supraoptimum temperature damage and the escape from dormancy. Several experimental results were obtained as follows: the media prepared by combination of peat and bark compost (1:1 in volume) inside nonwoven bag was lower in temperature than other media; both of the temperature of leaf surface and media decreased more than 2°C at noon by 25% shading favoring the CO₂ exchange in the daytime; the foliage application of Aminofol increased leaf thickness and chlorophyll content; and BA or PP-333 treatment enhanced lateral buds development during the supraoptimum temperature period of summer, etc. An integrated management based on these results helped the 1-year old container-grown Shinseiki pear trees over-summer. The experimental trees were then forced to budbreak and flower by application of cyanamide in October. Eventually, the fruits were harvested in March. These results suggested that the production of high-chilling pears in warm area was technically feasible.

SHORT-LIFE AND NON-SHORT-LIFE SOIL RATIO AND ROOT TYPE AFFECT PEACH TREE SURVIVAL IN FIELD MICROPLOT

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A planting of 90 Redhaven peach (*Prunus persica* (L.) Batsch) trees either budded to Lovell and Nemaguard rootstocks or on their own roots, was established in spring 1984 using in-ground 55-gallon microplots. Planting soils (top soil, not B and C layers) prepared in five ratios by mixing soils from peach tree short life (PTSL) and non-PTSL (NPSL) sites (100% PTSL, 75% PTSL + 25% NPSL, 50% of each, 25% PTSL + 75% NPSL, and 100% NPSL) as main plots, were replicated 3 times. Two trees per rootstock were randomized within main plots. The planting was maintained using conventional cultural practices. Observations for tree survival were recorded in December each year. During this investigation, both soil mix and root types significantly affected tree survival, which was consistently the highest in 100% NPSL and the lowest in 100% PTSL soil. Effects of other soil combinations were intermediate; however, greater tree mortality was associated with increased ratio of PTSL soil. Trees on Lovell roots invariably survived the best followed by those on Nemaguard roots and the lowest when on their own roots. As early as in fourth leaf, >55% of the own-rooted trees died compared to < 10% on either rootstock.

482 (PS 3)

NUTRITIONAL REQUIREMENTS OF CITRUS CONVERTED FROM FLOOD TO A PRESSURIZED IRRIGATION SYSTEM

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A study was conducted during four seasons to evaluate the nutrient requirements of 'Valencia' oranges converted from flood to a pressurized spray irrigation system. The experiment was a 3x2x2 factorial with 3 N rates (0.34, 0.68, and 1.36 kg/tree/year), 2 P rates (0 and 0.11 kg/tree/year) and with and without added micronutrients (Fe, Zn, Mn, and Cu). There were no growth or yield responses to micronutrients. Phosphorus fertilization increased fruit yield, improved juice quality, and reduced peel thickness. There were trends for N to reduce juice quality and increase peel thickness when P fertilizer was not added. Tree growth increased by N fertilization only the first season after conversion. Fruit yield also increased by N but only when P was added. Leaf tissue N concentrations increased with time during the first two years within N treatments. These data suggest that the higher rates of N may only be needed initially after conversion as the tree roots adapt to the new irrigation system.

483 (PS 3)

GROWTH AND YIELD OF MATURE CITRUS CONVERTED TO PRESSURIZED IRRIGATION SYSTEMS

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A study was conducted during four seasons to evaluate the performance of mature 'Valencia' oranges converted to pressurized irrigation systems. Trickle, bubbler, spray, and sprinkler systems were all compared to the traditional flood-border irrigation. During the second year after conversion, trees irrigated by flood grew significantly more than trees irrigated by any of the pressurized systems. However, there were no differences in tree growth during the third and fourth year, suggesting that the trees adapted to the new irrigation systems. Effects of irrigation treatments on leaf concentrations of N, P, Fe, Zn, Mn, and Cu were minimal. There were significant differences in orange yields among the irrigation treatments within years. However, average or total yields over the four year period did not vary by irrigation treatments. Similarly, there were no consistent differences in fruit or juice quality. Overall, results from this study indicate the mature citrus can be converted to pressurized irrigation systems with minimal effects on fruit yield and quality.

484 (PS 3)

ASSESSMENT OF KNO₃ PRECONDITIONING TREATMENT ON PAPAYA SEEDS AFTER EXTENDED STORAGE.

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Extended storage studies were conducted on papaya, *Carica papaya* L. 'Kapoho Solo', seeds to observe the effect of KNO₃ preconditioning treatment when seeds were stored under ambient (25 C) and refrigerated (10 C) temperatures for 0, 2, 6, and 12 months. KNO₃ treated seeds maintained a constant germination percentage of 46.7 ± 2.7% throughout the 12 month period at both storage temperatures. Nontreated seeds stored at 25 C, however, had increased germination percentages (from 11 to 40% germination) after 2 months storage. Nontreated seeds stored at 10 C displayed a slower increase in germination percentages. The beneficial effects of KNO₃ preconditioning treatments over nontreated seeds is observed only when seeds are sown immediately or within 2 months of storage at 25 C.

485 (PS 3)

GIRDLING OF THE FUERTE AVOCADO, *Persea americana* Mill., TO INCREASE FRUIT SET AND YIELD IN A COOL CALIFORNIA COASTAL AREA

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The Fuerte avocado cultivar is known to be an alternate and inconsistent producer of avocados in cool coastal areas and hot interior areas of California because of its sensitivity to such extremes of climate during its bloom and fruit setting periods. This study attempted to increase fruit set and yield of this cultivar in a cool central coast area by applying a three-eighths inch wide girdle to one large limb, equivalent to one-third of the tree, on each of five 43-year-old trees. A double bladed girdling knife was used to remove the bark

all around each limb. Another equal sized limb on each tree was used as the control. Girdling was completed on December 15. Girdled limbs had means of 42.6 more pounds which was 186.8% more fruit yield as compared to control limbs. Girdled limbs also had means of 89 more fruit which was 222.5% more fruit by count than control limbs. Fruit on girdled limbs was smaller in size (8.1 oz. average) than that on control limbs (9.1 oz. average) but was still of an acceptable size to bring good prices.

486 (PS 3)

PRELIMINAR STUDIES ON 'CIMARRON' WILD PLUM AS A NEW FRUIT CROP FOR ARID LANDS

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The high cost of inputs and water deficit in arid lands demand the use of more drought tolerant species into the agriculture. The flora of the deserts offer a variety of fruits and vegetables that may diversify horticulture. 'Cimarrón' wild plum tree or "ciruelo cimarrón" (*Cyrtocarpa edulis* Brand.)Anacardiaceae) is one of the species with potential importance in arid lands. *C. edulis* is an endemic tree of the meridional portion of the Baja California peninsula, occurring along arroyos and on gentle slopes in sandy soils. The flesh of the fruits is edible, with a slight acid tang, and is used locally. Actual exploitation is based on the fruit harvest in natural dry forest and xerophilous shrubs, where average density is near 100 trees/ha. There is a growing interest in marketing the dried fruits, especially for the snack industry, hence, the need to develop a breeding program in order to establish it as a reliable fruit crop.

487 (PS 3)

MICROPROPAGATION OF TEXAS MADRONE, *ARBUTUS TEXANA*, AND MEXICAN REDBUD, *CERCIS CANADENSIS* VAR. *MEXICANA*

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Micropropagation studies of several desirable species native to west Texas were initiated to develop clonal propagation systems for ornamental production. Actively growing shoots were collected from mature Texas Madrone and Mexican Redbud trees and successfully cultured on basal medium consisting of WPM salts, MS vitamins, 30g·l⁻¹ sucrose, 0.8% Phytagar supplemented with 2.5 mg·l⁻¹ BA. Shoots were subcultured every 4 weeks on the same medium to obtain sufficient culture material for experiments. Experiments were performed examining inorganic salt formulations, growth regulator materials, and gelling agents to optimize shoot proliferation and rooting.

488 (PS 3)

MEDIA COMPOSITION, IBA, AND NODE POSITION AFFECT ROOTING OF CLEMATIS CUTTINGS.

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Five cuttings from different node positions on stock plants were taken from each of 3 *Clematis* cultivars (Jackmani, Contesse de Bouchard, and Gypsy Queen) and *Clematis purpurea plena elegans*. Actively growing plants with 5 nodes were acquired. Node number increased from 1 at the base of the plant to 5 at the tip of the plant. Cuttings were treated with or without 0.1% IBA (indole-3-butyric acid) and placed in 1 of 5 different media: 100% washed sand (WS), 50% washed sand and 50% sphagnum peat (WP), 50% sphagnum peat and 50% perlite (SP), 100% perlite (PT), or 50% sphagnum peat plus 25% perlite plus 25% vermiculite (PV). Rooting date, primary and secondary root number, and root dry weight were collected after 8 weeks. 'Gypsy Queen' showed the earliest rooting with the greatest root development. Jackmani showed the worst rooting. Media WS and PT showed the best rooting whereas WP and SP showed the worst. Cuttings taken from the first 3 nodes rooted the best. As node position increased root number and dry weight decreased and time to root increased. Application of IBA had no significant effect on time to root or degree of rooting.

489 (PS 3)

PROPAGATION OF FIREBUSH BY STEM CUTTINGS

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Factors affecting the greenhouse propagation of firebush (*Hamelia patens*) by leafy stem cuttings during winter were studied. Without bottom heat (BH), mid-day rooting medium temperature was 22 ± 3 C. About half of the auxin-treated cuttings without BH rooted. Maintaining the rooting medium at 29-39 C increased rooting for auxin-treated cuttings to 96-100% and increased root length and visual rating scores several-fold. Rooting percentage, root length, and visual ratings were consistently high in perlite and low in peat. Stem-tip cuttings and sub-terminal stem segment cuttings with basal stem diameters of 3-5 mm rooted slightly better than stem segment cuttings with basal diameters of 6-8 mm. Stem-tip cuttings not treated with auxin but with BH had rooting percentages of 81-86%. Treatment of stem-tip cuttings with auxin generally yielded 90% rooting or above. Despite this, plants grown from auxin-treated cuttings were indistinguishable from plants grown from non-treated cuttings 2 months after the rooting period. Of the variables studied, BH had the most dramatic effect on rooting of firebush cuttings during winter months.

490 (PS 3)

EFFECTS OF STRATIFICATION ON FIVE NATIVE CUT FLOWERS

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The effect of cold on germination rate, percentage and range of five cut flowers was investigated: *Baptisia australis* (Wild Blue Indigo), *Echinacea purpurea* (Purple Coneflower), *Helianthus maximiliani* (Maximilian Sunflower), *Solidago petiolaris* (Spike Goldenrod), and *Vernonia missurica* (Ironweed). Viability was determined for the species using TTC staining and germination based on percent viable seed. Seeds were given 0, 2, 4, 6, 8, or 10 weeks of cold at 5°C. Increasing weeks of cold decreased days to germination in all five species, with *Baptisia* demonstrating the greatest effect. The germination percent increased as weeks of cold increased in all five species, but was most significant in *Helianthus* and *Vernonia*. Days from first to last germinating seed was significantly decreased in all five species as weeks of cold increased. Four weeks of cold was optimum for *Echinacea* and *Vernonia*, while optimum weeks of cold for *Helianthus* and *Solidago* was six weeks and *Baptisia* ten weeks.

491 (PS 3)

WILDFLOWER SPECIES ADAPTABILITY IN GEORGIA AND SOUTHEASTERN UNITED STATES

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Eighty horticultural wildflower taxa were evaluated for performance at three locations over three years in Georgia (USDA climatic zones 7-9). Plant performance and persistence were rated as superior perennial/reseeding annual, secondary perennial, annual, and unadapted. Length of bloom season for each species was determined at each location. Forty-eight species were rated as superior, 11 as secondary, 14 annual, and seven were not adapted. From these data, specialty mixes for meadow gardens, roadside beautification, landscape color, and native plant restoration areas have been formulated for use in cost-efficient landscape plantings. The mixes contain 10-15 species with overlapping bloom seasons to provide color during most of the growing season of eight months.

492 (PS 3)

IS ETHYLENE ASSOCIATED WITH THE RELEASE FROM DORMANCY DURING CHILLING STRATIFICATION IN EASTERN REDBUD SEED (*CERCIS CANADENSIS*)?

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Ethephon and ethylene gas applied to intact Eastern redbud seed induced germination in 44 or 53% of dormant seed. However, endogenous ethylene production was not found to be correlated with the release from dormancy during chilling stratification (5°C). Seeds stratified in the presence of 6000 ppm 2,5-norbornadiene germinated at the same percentage as control seeds. Isolated embryos treated with 100 to 500 µM AOA or 1000 µM silver thiosulfate germinated at a slower rate than control seeds, but the release from dormancy during stratification was unaffected by either ethylene inhibitor. Ethylene evolution, ACC and MACC content remained at a low level throughout stratification. EFE activity was not detectable in hydrated dormant or non-

dormant seed. All ethylene parameters measured increased sharply during germination with peak activity correlated with radicle emergence. These data indicated that ethylene production was linked to germination, but unrelated to dormancy release in Eastern redbud seed.

494 (PS 6)

EVALUATION OF RESIDENTIAL WATER UTILIZATION UNDER AN EDUCATION AND CONSERVATION PROGRAM

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Depletion and contamination of traditional water supplies and population pressures are straining the water resources of the United States. This has placed increased emphasis on the need for water conservation through all phases of the use cycle. Objectives of this research were to: 1) Determine water use in residential, commercial, and institutional landscapes; 2) Evaluate landscape irrigation system performance; and 3) Evaluate feasibility of landscape irrigation scheduling. Beginning in 1991, water meters on 18 test sites in Lincoln, NE were read on a weekly basis. Water meter readings during the winter were used to develop a baseline on non-landscape water use. The "can test" method was used to evaluate landscape irrigation system precipitation rate and distribution efficiency. Four recording weather stations were used to estimate daily potential evapotranspiration (ETp). Lysimeters (20 cm dia. x 31 cm deep) were installed in two Kentucky bluegrass and one tall fescue landscape to estimate water use coefficients for calculating landscape evapotranspiration. Irrigation system Christiansen coefficients of uniformity ranged from .43 to .87 with scheduling coefficients ranging from 1.31 to over 15.14. Poor irrigation system performance characteristics made it difficult to schedule irrigation on estimated water use.

495 (PS 3)

WATER RELATIONS OF SHRUB AND GROUND COVER LANDSCAPE COMMUNITIES

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Landscape plantings have been designed traditionally using aesthetic criteria with minimal consideration given to water requirements. The primary objective of this research was to develop quantitative information on water use of plant communities conventionally used in urban landscapes. Pots of *Photinia x Fraseri* (photinia Fraseri), *Lagerstroemia indica* 'Carolina Beauty' (crape myrtle), or *Ligustrum japonicum* (wax leaf ligustrum) were transplanted from 3.8 l into 75.7 l pots with either *Stenotaphrum secundatum* 'Texas Common' (St. Augustinegrass), *Cynodon dactylon* x *C. transvalensis* 'Tiffway' (bermudagrass), *Trachelospermum asiaticum* (Asiatic jasmine), or left with bare soil. Whole community water use was measured gravimetrically. In addition, sap flow rates were recorded for shrub species with stem flow gauges. Sap flow measurements were correlated to whole community water use recorded during the same time intervals. Whole community water use differed due to the groundcover component; bermudagrass, Asiatic jasmine, and bare soil communities used less water than St. Augustinegrass communities. Differences were also noted in stomatal conductance and leaf water potential among the species.

496 (PS 16)

THE USE OF CALCIUM FORMATE FOR THE QUANTITATIVE EXTRACTION OF NITRATE, PHOSPHATE, CHLORIDE, AND SULFATE IN BOTANICAL TISSUES.

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Ornamentals, fruit and vegetable crops are commonly tested for inorganic anions, NO₃-N, PO₄-P, Cl and SO₄-S, to identify the nutritional status of the plant. Two percent (0.20 M) acetic acid has primarily been used as the extractant for these inorganic anions. The use of acetic acid does not quantitatively extract SO₄-S and PO₄-P. Research using calcium formate was initiated to assess its effectiveness as an universal extractant for inorganic anions. Results of a series of experiments will be presented identifying the optimum calcium formate concentration, extraction time, and extractant sample ratio for quantitative removal and measurement of NO₃-N, PO₄-P, Cl and SO₄-S. Results of spiking experiments will be presented using a range of horticultural crops important to California agriculture. Additional data will be presented on the use of calcium formate for the determination of K and NH₄-N in botanical tissues.

497 (PS 3)

EFFECT OF AN IRRIGATION SYSTEM CONTROLLED BY SOIL MOISTURE TENSION IN REDUCING WATER USAGE AND RUN-OFF IN POINSETTIA PRODUCTION

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An irrigation system for monitoring and controlling soil moisture

tension in the root zones of potted plants using computer and solid-state tensiometer technologies was evaluated in a commercial greenhouse on 'V-14 Glory' poinsettias over a 10 week period. Replicated benches with separate drip circuits controlled by the computer maintained the soil moisture tension of the potted poinsettia plants between 1 kPa and 5 kPa. The amount of water used by each bench and the amount leached was compared to benches with separate drip circuits that were manually operated by the grower according to standard commercial practice. There was a 65% savings in the total amount of water used for the computer-controlled system and an average weekly reduction of 98.6% in leachate. The differences were significant and there was no measurable reduction in plant quality, even though soil analyses showed slightly elevated EC levels.

498 (PS 4)

THE INFLUENCE OF CONTINUOUS AND INTERMITTENT CO₂ ENRICHMENT ON THE GROWTH, PRODUCTIVITY, AND PHYSIOLOGY OF GREENHOUSE TOMATO

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The objective of this experiment was to examine the influence of continuous and intermittent carbon dioxide enrichment on the growth of greenhouse tomato plants. Tomato plants were grown under four CO₂ regimes: Control at 330 ppm, continuous supply at 1000 ppm, and intermittent supply (1h supply/2 hours) at 1000 ppm and 2000 ppm. Carbon enrichment produced an increase in photosynthetic rate and plant dry weight, a decrease in leaf nitrate level, and leaf accumulation of reducing sugars and starch. A loss in efficiency was observed over time in plants grown under high atmospheric CO₂ concentration. However, intermittent carbon enrichment reduced the plant acclimation. Even with 32% less CO₂, intermittent enrichment at 1000 ppm produced yields 6% greater than continuous enrichment. The superior yield may be explained by preferential allocation of photosynthates to the fruit under intermittent supply.

499 (PS 4)

THE INFLUENCE OF FLOWERING PATTERNS ON FRUIT-SET IN TWO CULTIVARS OF MUSKMELON

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Two muskmelon (*Cucumis melo* L.) cultivars, Mission and Laguna, were direct-seeded in spring plantings separated by 30 days at the TAES farm in Weslaco. Females were tagged each morning for 8 consecutive days beginning on the first day of flowering and evaluated for fruit set 15 to 20 days later. Mean numbers of flowers and fruits produced on individual plants were compared across cultivars and planting dates. The flowering patterns appear to be bimodal with the majority of blooms occurring during the first 5 days followed by a sharp decline on day 6 and gradual increase, thereafter. The majority of the fruit is set during the first 5 days of flowering and failed to increase with the subsequent rise in flowering. Mission produced approximately 30% more female flowers per plant than Laguna; however, fruit numbers were the same for both cultivars. The environmental conditions associated with earlier plantings suppressed flowering in Laguna but had no effect on the daily rate of fruit-set. Fertilization and fruit set appear to be relatively unaffected by the population dynamics of female flowering.

500 (PS 4)

EFFECTS OF HIGH-PRESSURE SODIUM AND METAL HALIDE SUPPLEMENTAL LIGHTING ON GROWTH, YIELD AND GAS EXCHANGES OF VEGETABLE CROPS

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The objective of the experiments was to compare the performance of metal halide (MH) and high-pressure sodium (HPS) lamps on growth and yield of vegetables. Four experiments with lettuce were carried out. The lettuce grown under HPS lamps had a head firmness higher than under MH lamps. The difference between the type of lamps on fresh weight was not very constant with the period of production. There was no interaction between lamp and cultivar. Two experiments were carried out with tomato in Spring and Fall 1991. For a tomato crop, the yield and quality of the fruit were not affected by the type of lamps. Photosynthesis and transpiration of tomato and pepper plants were measured under MH and HPS lamps. No significant differences were found between both lamps under two humidity conditions and four PPFs. Under high humidity conditions, transpiration under MH was higher than under HPS.

501 (PS 4)

GROWTH OF PICKLING CUCUMBER FRUIT

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Pickling cucumber production has steadily shifted to machine harvest as availability and cost of labor have become limiting factors. In a once over harvest, one needs to schedule harvest for optimum yield and economic return. This becomes a critical factor when one is scheduling both equipment and planting schedules. To predict the time for mechanical harvest of pickling cucumbers, one needs to know the relative fruit growth rates. Previously two cultivars were grown in the greenhouse and they were Calypso and H-19, a little leaf cultivar. Growth rates of individual fruit and combinations of two fruit at adjacent nodes were measured. The cultivar H-19 had overall slower growth rates than Calypso but the competition from adjacent fruit was less in H-19 than Calypso. The experiment was repeated with plants in the field and similar results were obtained. Data will be presented showing the growth rates of field grown fruit for individual and combinations of adjacent fruit. Growth rates were recorded for a population of fruit within a square meter. This data will be compared to the growth rates for individual fruit.

502 (PS 4)

PHOTOMORPHOGENIC DEVELOPMENT AND CARBOHYDRATE COMPOSITION OF YOUNG WATERMELON PLANTS AS AFFECTED BY INDIVIDUAL OR MULTIPLE FR SIGNALS DURING THE DARK PHASE OF THE PHOTOPERIOD

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Treatment of young watermelon (*Citrullus lanatus* cv. Sugar Baby) plants with individual and multiple FR light (15 min) treatments during the dark phase of the photoperiod influenced plant growth and development (i.e., petiole elongation, internode elongation, and reduced petiole angles) as compared to plants not treated with FR signals. The timing for the most effective light signal for inducing a growth response was when the signal was delivered immediately after the plant entered into the dark phase of the photoperiod. Decreasing growth responses to FR signals were observed as the signals were delayed after the plant entered into the dark phase. Multiple FR signals during the dark phase slightly increased growth responses as compared to plants that received the signal immediately after the light period. Young watermelon plant growth responses to FR light signals do not appear to be photoperiodic as plants similarly treated with a white light signal did not generate growth responses. Tissue analysis of petioles, leaves, stems, and cotyledons from plants treated with individual and multiple FR signals suggested that carbohydrate composition, distribution, and diurnal fluctuation were affected by the light quality treatments.

503 (PS 4)

INFLUENCE OF COLD TREATMENT, CO₂ LEVEL, AND TEMPERATURE ON VEGETABLE TRANSPLANT QUALITY

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Tomato and pepper seedlings were grown in six controlled environmental chambers with three different temperature levels (high: 24/16°C, medium: 20/12°C, and low: 16/8°C) and two CO₂ levels (1500 ppm and ambient) after cotyledons had unfolded. After 4 weeks, seedlings were planted into 15 cm pots. After 4 weeks, another set were transplanted to the field on 5/13 and arranged with 4 replications in a randomized complete block design. Only temperature treatment had a significant influence on the number of flowers developed in greenhouse experiments. However, for field transplanted seedlings, CO₂ enrichment had a significant effect on flower formation and increased total flower numbers and fruit numbers in the early growth stages in field. Temperature also influenced seedling height. In other experiments, cold treatments were given to tomato and pepper seedlings. Seedlings were treated with 13°C temperatures for 0, 1 or 2 weeks after cotyledons unfolded. Results indicate that tomato seedlings with either 1 or 2 weeks of cold treatment had greater dry weight and leaf numbers and larger and more mature flower buds than those given no cold treatment. Pepper seedlings receiving 2 weeks of cold treatment showed similar increases compared to those receiving 0 or 1 weeks of cold treatment. The earliest flower initials were observed microscopically when tomato had only one visible leaf and pepper had 8 or 9 visible leaves. These results indicate that cold treatments should be started as soon as the cotyledons have unfolded to hasten flower formation.

504 (PS 4)

RESPONSE OF GREENHOUSE CUCUMBER PLANTS TO VA MYCORRHIZAL INFECTION

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The growth response of cucumber to vesicular-arbuscular mycorrhizal fungi (VAM) infection was determined from plant establishment to full maturity. Percent infection of plants by VAM species (*Glomus mosseae*, *G. dimorphicum*, and *G. intraradices*) decreased with increasing

phosphorus (P) fertilization level. P deficiency was not visually observed during plant establishment (to 38 days after planting (DAP)). Leaf area, leaf and stem dry wt. and total plant dry wt. were greatly increased by VAM infection and P. The VAM-improved plant growth did not decrease as P level increased, and the pattern of dry matter partitioning was affected by VAM species. Plant P concentration (conc.) increased with P fertilization level and decreased with DAP. Stem P conc. was greatest in control plants, whereas leaves and roots of VAM-infected plants had the highest P conc. throughout the study. The conc. of soluble nitrogen (N) in leaves and roots decreased with increasing P level and time. Leaf and root tissues of control plants had higher soluble N conc. than that from VAM plants. Leaf total soluble carbohydrates (TSC) increased faster in control plants, but root TSC increased faster in VAM plants over time. VAM infection did not significantly affect total fruit yield per plant, although some vegetative growth parameters of mature plants were affected. Stimulated early growth by VAM results in fruit-bearing at an earlier date, and thus decreased time to yield and economic return.

505 (PS 4)

ENDOMEMBRANES AND POLLEN WALL PATTERN FORMATION IN *VIGNA VEXILLATA* L.

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During the initiation of pollen exine wall formation in *Vigna*, localized accumulations of membranes in the microspore cortex coincide with sites which during further development reflect the lumina of the reticulate exine, and with apertural sites. Multi-membrane bodies are prominent in the cytoplasm, especially subtending aperture sites. Multi-membrane structures continue to be present as pollen wall development proceeds, notably during the early patterning stages. Labelling with the endomembrane-specific fluorochrome DiOC₆ does not conclusively lead to membrane identification. However, electron micrographs illustrate elaborate membrane systems during stages when the most obvious developmental activity is initiation of the microspore wall. This suggests that there may be a causal relationship between endomembranes and exine pattern formation.

506 (PS 4)

INFLUENCE OF GROWTH REGULATORS ON SHOOT EMERGENCE AND GROWTH OF ASPARAGUS UNDER GREENHOUSE CONDITIONS

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Mary Washington, UC157F₁ and UC157F₂ asparagus cultivars were grown from 1-year-old crown under greenhouse conditions in 30-liter pots containing Pro-Mix medium. The roots were cut to 10 cm prior to planting on 12 Feb. 1991. On July 12, 1991 the plants were transferred outdoors and sprayed with BA, GA₄₇ and Promalin at 400 mg. liter⁻¹ using tap water as control. On July 16, 1991 the treated ferns were cut at ground level and the plants were returned to the greenhouse, and arranged in a RCB design. Seven reps with one pot/rep were used. Data on time of emergence of first shoots were recorded daily until all pots had produced at least 1 shoot. When all plants had sprouted, cumulative number of all shoots/pots was recorded weekly thereafter over 5 weeks. BA and Promalin reduced time of emergence of shoots and increased the number of shoots/plant. GA₄₇ had no effect on shoot emergence or shoot number.

507 (PS 4)

OXALATE CONCENTRATION IN SPINACH LEAVES DURING ONTOGENESIS

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Changes in oxalate concentrations in individual leaves during ontogenesis were examined by a sequential sampling of spinach plants grown in solution culture. The period between initiation of two successive leaves was 1.58 days. Fresh weight of each leaf increased at a constant rate with time after the leaf became 1 cm in length. Oxalate concentrations in plant tops decreased gradually with plant age. Oxalate concentrations in each leaf remained constant during ontogenesis, and they were negatively correlated with the leaf position numbered from the base. Leaf growth rates and the relationship between oxalate concentrations and leaf position were combined to

make a model that describes the changes in oxalate concentrations in plant tops as the age of the plant advanced. The resulting model indicated that oxalate concentrations in plant tops decreased more rapidly as plastochron became shorter.

508 (PS 4)

SQUASH ROOT DISTRIBUTION AND GROWTH AS AFFECTED BY IRRIGATION LEVEL

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Roots of acorn squash were washed from soil cores, dried and weighed. The cores were taken in a pattern about individual plants to reflect the roots present in each selected zone at different periods during the season. A different plant was sampled at each period so that there would be no effect from previous sampling. The root weights were multiplied by factors commensurate with the volume of soil represented by each core sample. Two years data have indicated that irrigation level effects the size of the root system but not its distribution. Density of roots was always greatest in the top 15 cm of soil and this zone of the greatest density progressively moved out from the center of the plant with time. Pattern of root distribution was not effected by plastic mulch, bare ground, trickle or furrow irrigation treatments. Root distribution was the same on all sides of the plant.

509 (PS 4)

THE DEVELOPMENT OF "FISHMOUTH" SEEDS DURING MUSKMELON FRUIT MATURATION AND DECAY

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Muskmelon (*Cucumis melo* L.) seed crops sometimes contain seeds with split coats that expand to twice their normal water content. These expanded seeds are often referred to as "fishmouth" seeds, because the split seed coat resembles an open fish's mouth when viewed longitudinally. "Fishmouth" seeds are dead seeds. However, little is known about why death occurs inside the fruit before harvest. Hermaphroditic flowers were tagged at anthesis and fruits were harvested at various intervals during the later stages of development and decay. Seeds were removed from the fruits and incubated in water on germination blotter paper for 14 days. The percentage of germinable, dead and "fishmouth" seeds were averaged for each harvest date. Fruit pericarp samples were analyzed for pH, ethanol, and acetic acid content. At 50 days after anthesis (DAA), just past edible maturity, 100% of the seeds germinated. However, at 60 and 78 DAA germination dropped to 60 and 17%, respectively, while the occurrence of "fishmouth" seeds increased from 2 to 54% over the same period. The ethanol content of the tissue increased from 0.11 to 0.28%, the pH dropped from 6.2 to 5.1, and acetic acid concentration increased from 3.0 to 3.7 mM from 50 to 60 DAA, respectively. However, when dried seeds were incubated in the laboratory under conditions similar to those within the fruit, the formation of "fishmouth" seeds was related to the ageing effects of long term hydration and was not correlated with any chemical product within the fruit.

510 (PS 4)

PHYSIOLOGICAL CHANGES OF DISORDERED ORIENTAL MELON FRUITS DURING MATURATION IN KOREA.

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Physiological disorder occurred in a recently developed oriental melon cultivar, 'Gunsaragi-Bunchun' (*Cucumis melo* var. *makuwa*), is involved with the appearance of water soaking area in placenta and can be extended to the pulp when severely affected. Physiological changes between normal and disordered fruits were compared. Ethanol soluble sugars were significantly decreased in both pulp and placenta tissue of disordered fruits whereas acidity was increased. Ethanol and acetaldehyde accumulation were confirmed in juice from disordered fruits, which were not detectable in normal ones. The contents of boron and calcium, especially water and HCl soluble calcium, were fairly low in disordered pulp. Also, there was a great difference in pectin content between both fruit tissue and severe hydrolysis of water soluble pectins isolated from disordered placenta was found by gel chromatography. However, the hydrolysis of pectins seemed not to be associated with the increase of wall hydrolase activities such as polygalacturonase and β -galactosidase.

511 (PS 4)

UTILIZATION OF SOIL-APPLIED AUXINS FOR SYNCHRONIZATION OF FRUIT SET AND YIELD INCREASE IN *CITRULLUS LANATUS*.

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Exogenous application of auxins to plants has been reported to increase flowering, fruit set and decrease fruit abscission. This laboratory and field study

determined that two auxins, identified by HPLC analysis with a long soil residence time and a high conversion to indole-3-acetic acid, synchronized and increased harvest of melons. The two watermelon varieties, 'Tiffany' (seedless) and 'Picnic' (seed) were treated with auxin and tryptophan (TRP) concentrations ranging from 10^{-4} to 10^{-10} M applied to the root ball one week before transplanting to a Buren soil. Optimum application levels (10^{-6} to 10^{-9} M) resulted in 86, 92 and 86% of the total harvested Tiffany melons mature at one date for the auxins and TRP, respectively, compared to <70% for the control plants. Optimum application rates significantly increased harvested weight 4.0 and 5.3 kg (Tiffany) and 10.0 to 10.5 kg (Picnic) plant⁻¹. Soil-application of auxins and TRP significantly increased the number of harvested Tiffany melons, increased both weight and harvested number of Picnic melons and increased the uniformity of the harvested melons in both varieties when compared with control plants. Measurements of early growth, branching and early fruit set were not significantly correlated with harvest weight or number of harvested melons but auxin and TRP application stimulated flowering in both melons by 7-10 days.

512 (PS 4)

EFFECTS OF CHLOROCHOLINE AND RELATED COMPOUNDS ON THE GROWTH AND OTHER CHARACTERISTICS IN SEVERAL VEGETABLE CROPS

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A series of experiments were conducted to investigate the effects of chlorocholine and similar compounds such as choline, chlorocholine chloride (CCC or chlormequat) and other compounds on the rooting and seedling quality for transplanting. The growth of shoot and root and the ratio of shoot/root were influenced and consequently the seedling quality was improved by chlorocholine treatment. Mungbean bioassays for plant hormone revealed that rooting was promoted and shoot growth or stem elongation was inhibited by the treatment. Addition of other PGRs such as atonik, vitamins and surfactants to chlorocholine solution significantly promoted the rooting of mungbean cuttings as well as the rooting of cutting of sweet potato, cucumber, and watermelon.

513 (PS 4)

GROWTH REGULATOR EFFECTS ON EARLINESS AND YIELD IN ARTICHOKE GROWN AS ANNUALS FROM SEED

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Growth regulator application effects on earliness and yield were evaluated on drip irrigated artichokes grown as annuals from seed for winter (November through February) production in 1989, 1990, and 1991. Foliar treatments were applied three times at two week intervals. Gibberellic acid treatments which began four, six, and eight weeks after transplanting gave six to eight weeks earlier first harvest and significantly greater yields. Treatment with gibberellic acid beginning four weeks after transplanting gave the earliest first harvest.

514 (PS 4)

ENHANCEMENT OF VEGETABLE SEED GERMINATION AND EMERGENCE USING ABA AND ABA ANALOGS.

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Seeds of celery, spinach, onion, cress, water cress, iceberg lettuce, Great Lakes lettuce, cabbage, tomato, sweet corn and celery were pre-treated with 0.1 μ M/g seed of both ABA and analogs of ABA. The chemicals were dissolved in a mixture of methanol:hexane (9:1 v/v) and applied to the seeds for approximately 3 minutes. The solvent was removed from the seeds within 5 minutes by rotary evaporation under reduced pressure. Effects on petri plate germination and soil emergence were monitored daily at 5, 10 and 15°C. The methanol/hexane solvent alone improved spinach seed emergence at 10°C from 10% to 100% and from 50% to 90% at 15°C in celery. Certain ABA analogs reduced time to 50% emergence in celery by at least 7 days at 15°C. Two ABA analogs synchronized emergence in celery and effect was temperature-dependent. One analog improved seed germination in tomato from 15% to 90% at 10°C. In most cases treatment effects on radicle germination on petri plates was not a good indicator of treatment effects on emergence from a soil based system.

515 (PS 4)

EFFECTS OF HYPOCOTYL MORPHOLOGY ON SURVIVAL RATIO AND GROWTH OF CUCUMBERS GRAFTED ON *Cucurbita* spp. AT HYPOCOTYL

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Horizontal grafting, in which scion and rootstock are cut and grafted horizontally at the hypocotyls, is essential for

mechanization of grafting. The present studies have been conducted to improve the survival ratio and the growth of cucumbers grafted on *Cucurbita* spp. through horizontal grafting at the hypocotyls. The survival ratio of 'Nankyoku 2' (*Cucumis sativus*) which had six vascular bundles at the hypocotyl was different when it was grafted on 'Unryuh' or 'Kongoh' (*C. moschata*), six vascular bundles. The survival ratio of the scion grafted on 'Dairoku' (*C. maxima*) which had twelve vascular bundles was the lowest. It was found that the survival ratio inversely correlated with the difference in the diameters of the hypocotyls of the scion and the rootstock. Fresh and dry weights of survival scions on 'Unryuh' and 'Kongoh' were almost same and heavier than that on 'Dairoku'. It is suggested that minimizing the differences in the diameters and the numbers of the vascular bundles of the hypocotyls between the scion and the rootstock promotes the survival ratio and the growth of cucumbers which are horizontally grafted on *Cucurbita* spp..

516 (PS 4)

DRIP IRRIGATION SCHEDULING FOR FRESH MARKET TOMATO PRODUCTION

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Drip irrigation scheduling techniques for fresh market tomato production were compared in three consecutive seasons (1989-1991) in the southern coastal environment of Irvine, California. Three techniques were compared: 1) reference evapotranspiration (ET_o, corrected Penman) x programmed crop coefficients (K_c), ranging from 0.2 (crop establishment) to 1.1 (full canopy development); 2) ET_o x K_c, based on % canopy cover as estimated by average canopy width per row; and 3) irrigation at 20% available soil moisture depletion (SMD) at 30 cm, with recharge limited to a maximum of 0.8 x cumulative ET_o since the previous irrigation. The use of programmed crop coefficients and K_c values based on % canopy cover gave equivalent yields and fruit size distribution in all years; there was no difference in crop response between daily irrigation and irrigation three times a week. Both scheduling techniques maintained soil water content in the top 45 cm near field capacity throughout the growing season. The use of K_c based on % cover required less total irrigation in all seasons, averaging 78% of seasonal ET_o vs. 88% with programmed coefficients. Irrigation at 20% SMD required an average of only 66% of seasonal ET_o; marketable yield was equivalent with the other scheduling techniques in 1989 and 1991 but showed a modest yield reduction in 1990.

517 (PS 4)

AUTOMATED CONTROL OF WATER TABLE LEVELS FOR SUBIRRIGATED TOMATO PRODUCTION USING THE FULLY ENCLOSED SEEPAGE SYSTEM

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The use of the recently developed fully-enclosed seepage subirrigation system for fresh market tomato production has demonstrated an improved ability to maintain a water table at a desired level (when compared to conventional ditch-conveyed seepage subirrigation) by means of more precisely controlled application and a greater uniformity throughout the field. This is achieved through use of microirrigation tubing rather than open ditches to convey water to raise the water table to desired levels. When manually controlled, the system has shown to save 30-40% in irrigation amounts primarily due to almost total elimination of surface runoff. An automated control system was designed and evaluated with respect to practicality, durability, and performance of various designs of level-sensing switches. The advantages and limitations of the designs in relation to water table control for tomato production will be presented.

518 (PS 5)

'EARLY ACRE': A NEW SOUTHERN PEA FOR ARKANSAS

T.E. Morelock*, J.L. Bowers, D.R. Davis and D.R. Motes

Southernpeas are an important crop to Arkansas processors, market gardeners and home gardeners. While the bulk of the acreage produced in the state is pinkeye purple hull types, there is a demand for other horticultural types. At present some processors consider 'White Acre' to be the standard of cream pea quality, but under Arkansas conditions, 'White Acre' produces excessive vine growth, is very late to mature and is susceptible to bacterial blight. For these reasons, the Arkansas Agricultural Experiment Station announces the release of 'Early Acre'. 'Early Acre' has been widely tested under the designation Arkansas 84-154 and produces a very compact bush plant that has seed similar in size and shape to 'White Acre', but matures 8-10 days earlier under Arkansas conditions. Although the plant type is

well suited to narrow row spacing, 'Early Acre' has produced yields similar to 'White Acre' when both are planted at conventional row spacings. Samples have been canned by the Dept. of Food Science at the University of Arkansas and the samples have been rated equal to 'White Acre' in processed quality. 'Early Acre' has exhibited high levels of resistance to bacterial blight in replicated yield trials under field epidemics in both Arkansas and Texas.

519 (PS 5)

DIFFERENTIAL FEEDING PREFERENCE OF LEAFMINER ON FOUR COS LETTUCE CULTIVARS

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Damage due to leaf mining by Liriomyza trifolii (Burgess) is a major problem in many leafy vegetables, especially lettuce. A hierarchy of feeding preference of leafminer on lettuce, Lactuca sativa L. cultivars 'Valmaine', 'Parris Island Cos', 'Floricos 83', and 'Tall Guzmaine' was determined. Leafminers were given a choice of two plants. Observations on the number of times that leafminers probed the leaf surface to feed or oviposit in each plant was counted. 'Tall Guzmaine' was significantly preferred in all combinations. Probe ratio of 'Tall Guzmaine' verses the other cos lines ranged from 4:1 to 90:1. There were no significant difference between the other three lines, although 'Valmaine' had the lowest count in most cases. Based on the pedigrees of the cultivars tested, the observed preferences appears to be under genetic control.

520 (PS 5)

STUDIES ON FLOWER PRIMORDIUM DIFFERENTIATION OF BELL PEPPER (*CAPSIUM ANNUUM* L.)

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Based on anatomical investigations, temperature effect on the rate of plant and flower primordium differentiation were determined. Flower primordium differentiation of bell pepper was divided into 10 stages from a vegetative shoot apex to a fully developed flower bud according to ontogenic changes of the shoot apex. Both the physiological age as determined by leaf number and the flower primordium differentiation were significantly hastened by the high temperature of 30°C day and 15°C night. The flower primordium differentiation was highly correlated with the physiological age and the relationship was independent of temperature. The result showed that carpels were initiated between the sixth and seventh leaf stage and were fused with each other and with developing placentae after the eighth leaf reaching 1 cm long.

521 (PS 5)

BREEDING BROWN ANTHOR TYPE MALE STERILITY OF CARROT

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This experiment was carried out to breed promising brown anther type male sterile lines of carrots having the desirable characteristics of higher seed yield and stable phenotypic expression of male sterility. Brown anther type male sterile lines used for this experiment had been derived from the male sterile sources selected from the seed multiplication plots of Shin Kurota cultivar in 1972. Brown anther type male sterile lines are, in general, good seed yielders but frequently show unstable phenotypic expression of male sterility as compared to petaloid type male sterile lines. Through several years of selection for male sterile lines and plants, brown anther type male sterile lines with good seed-yielding potentials and stable phenotypic expression similar to petaloid type were developed. Outline of the breeding scheme, potential benefits of these newly bred MS lines, etc. will be discussed.

522 (PS 5)

INHERITANCE OF PGM-1, ADH-1, AND 6-PGDH-1 in *ALLIUM FISTULOSUM* L.

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The inheritance and linkage relationships among PGM-1, ADH-1, and 6-PGDH-1 were determined for *Allium fistulosum* (Japanese bunching

onion) individuals. Individuals expressing *Pgm-1*/*Pgm-1*², *Adh-1*/*Adh-1*⁴, *Adh-1*/*Adh-1*⁵, or 6-*Pgdh-1*/*6-Pgdh-1*² were selfed separately. These backcrosses and their reciprocals were made: *Pgm-1*/*Pgm-1*² to *Pgm-1*/*Pgm-1*¹ or *Pgm-1*²/*Pgm-1*²; *Adh-1*/*Adh-1*⁴ to *Adh-1*/*Adh-1*³ or *Adh-1*⁴/*Adh-1*⁴, 6-*Pgdh-1*/*6-Pgdh-1*² to 6-*Pgdh-1*/*6-Pgdh-1*¹ or 6-*Pgdh-1*²/*6-Pgdh-1*². Progeny segregations were tested for Mendelian inheritance using a chi-square goodness of fit test. Expression of 6-*Pgdh* has not been previously reported in onion. Two zones of activity were detected and were designated as 6-PGDH-1 and 6-PGDH-2. 6-PGDH-2 was monomorphic for all individuals tested. Progeny segregation of 6-PGDH-1 fit a model for a dimeric enzyme encoded by one disomic locus with two alleles, expressed as fast (1) and slow (2), in a dimeric enzyme pattern in heterozygous individuals.

523 (PS 5)

SCREENING FRESH-MARKET TOMATO CULTIVARS FOR CATFACING SUSCEPTIBILITY WITH GA₃ SPRAYS. H.C. Wien* and A.D. Turner, Dept. of Fruit and Vegetable Science, Cornell University, Ithaca, NY 14853

When GA₃ foliar sprays are applied to tomatoes at transplanting (7.5 ppm, twice, one week apart) the lowest main stem clusters bear fruits which have large blossom-end scars (catfacing). Later flowering clusters are less affected as long as the plants are being grown under normal temperature conditions. Preliminary trials (Wien and Zhang, Hort Sci. 26:583-585, 1991) indicated that cultivar differences in catfacing susceptibility were reflected in GA₃-induced catfacing differences. In 1990 and 1991, field trials were conducted in Freeville, N.Y. to compare the catfacing susceptibility of 14 and 18 fresh tomato cultivars, respectively, using GA₃ treatment. Catfacing was measured by counting the percentage of fruit on the third main stem, primary branch and two basal clusters that had blossom scars longer than 1 cm. Of the 14 cultivars common to both seasons, Valerie, Sunrise and Rocketree were least affected by catfacing in both control and GA₃-treated plots, and Starfire, New Yorker and Olympic were most catfaced. GA₃ spray shows promise for selecting catfacing-susceptible tomato cultivars.

524 (PS 5)

LINKAGE CHARACTERIZATION OF RESISTANCE TO ZYMV AND WMV-2 IN THE INBRED CHINESE CUCUMBER LINE TMG-1

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TMG-1 is resistant to ZYMV and WMV-2, two closely related potyviruses. Resistance to ZYMV is due to a single recessive gene (Provvidenti, 1987); however, two recessive genes appear to confer resistance to WMV-2. We sought to further characterize the resistances by studying possible linkage relationships with physiological, morphological, electromorphic, and phytopathological markers. TMG-1, WI-2757 (an inbred line susceptible to both viruses), and their F₂ progeny were screened for various single gene characters that differ between the two parents. Linkages reported in the literature were also observed in this study: (1) between bitterfree (*bi*) and female (*F*), and (2) between numerous spine (*ns*), small spine (*ss*), and tuberculate (*Tu*). New linkages detected were between: (1) resistance to WMV-2 and *F*, (2) resistance to WMV-2 and ZYMV, and (3) possibly resistance to ZYMV with fusarium and *ns*.

525 (PS 5)

A CYTOGENETIC STUDY IN *ALLIUM FISTULOSUM*, A. CEPA, THEIR F₁ HYBRID, AND BACKCROSS PROGENY

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Cytogenetic studies were performed on *Allium fistulosum*, A. cepa, their F₁ hybrid, and ten backcross (BC₁) progenies [(A. fistulosum × A. cepa) × (A. cepa)]. In meiosis the F₁ hybrid showed 41 percent heteromorphic bivalent pairing with 10.6 ± 1.8 chiasmata per cell. Meocytes were observed with one, two and three bridges and fragments, indicating at least three paracentric inversions. Multivalent associations indicate at least two translocations, one involving the satellite chromosome. The percentage of bivalent pairing, bridges and fragments, and multivalent associations varied in BC₁ progenies. The F₁ hybrid and all of the BC₁ plants were either

sterile or had very little seed set. The satellite chromosomes used as cytological markers showed variation in nucleolus position, degree of attachment and number.

526 (PS 5)

SELECTION OF POTATO SOMACLONAL VARIANTS WITH BLACKSPOT BRUISE RESISTANCE AND FRYING POTENTIAL AFTER COLD STORAGE.

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Eight hundred and fifty-three clones of Russet Burbank and 1012 clones of Lemhi Russet were obtained from Native Plants, Inc. in 1988. The clones were produced via a tissue culture system designed to produce somoclonal variants. Four cycles of selection were completed from 1988-1991. Selection was based on resistance to blackspot bruise, a tuber flesh discoloration caused by condensation of free tyrosine; or the ability to produce light french fry color following cold storage. At the end of the four selection cycles all but six Russet Burbank clones and seven Lemhi Russet clones were eliminated. ANOVA across years was completed for the eleven somaclonal variants and Russet Burbank and Lemhi Russet checks.

Of the Russet Burbank clones, three were significantly ($p=.05$) more resistant to blackspot bruise and one had significantly better fry color after cold storage. All four clones had significantly reduced yield in comparison to the check clones. Of the Lemhi Russet clones, three were significantly more resistant to blackspot bruise, and four had significantly better fry color than the check clone. Only one of the seven clones (one with superior fry color designated L1908) did not show a significantly lower yield potential.

527 (PS 5)

COMPARATIVE KARYOTYPE ANALYSIS OF *ALLIUM GRAYI* REGEL COLLECTED IN KOREA AND *ALLIUM NUTANS* L. COLLECTED FROM USSR. Sang-Jung Hahn*, Dept. of Horticulture, Hyosung Women's University, Kyungsan, Kyungpook, 713-702, KOREA

Four local cultivars of *Allium grayi* Regel collected from different habitats in Korea and *Allium nutans* L. originated from USSR were studied for their karyotypes to obtain basic data for breeding. In *Allium grayi* Regel, somatic chromosome number was 32 in Ulleung, Milyang, and Daegu local cultivars and 40 in Jeju local cultivar. They were tetra- and pentaploids whose basic number was $n=8$. Karyotypes of *Allium grayi* were $K(2n)=32=26V+V^1+3V^4+2J$, $K(2n)=32=24V+2V^1+2V^4+4J$, $K(2n)=32=24V+2V^1+5J+J^1$ and $K(2n)=40=34V+2J+j+J^1+2J^2$ in Ulleung, Milyang, Daegu and Jeju, respectively. *Allium nutans* L., native to USSR, was identified as an autotetraploid having chromosome number of $2n=32$. It also has 4 subterminal chromosomes, i.e., metacentric or submetacentric chromosomes and satellite. Karyotype of *Allium nutans* was $K(2n)=32=28V+4J^1$ with chromosome length of 11.1-5.9 μ m and short arm/long arm ratio of 1.00 to 0.31.

528 (PS 5)

VARIATION OF LEAF AND TUBER SHAPE IN HYBRID YAM (*DIOSCOREA OPPOSITA* T. CV. YAMATOIMO X CV. NAGAIMO)

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Dioscorea is one of the important tuber crops in Asia and dioecious. *D. opposita* cv. Yamatoimo (female, round tuber shape, high eating quality, low yield) and cv. Nagaimo (male, high yield, low eating quality) are typical cultivars in Japan. Much labor is necessary for harvesting tuber of cv. Nagaimo because this tuber is slender and brittle, and elongates to 60-70 cm underground. Some hybrid plants between the mentioned 2 cultivars were successfully grown and obtained through artificial pollination under high temperature conditions and embryo culture. The variations of leaf and tuber shape in hybrid yam were estimated by image processing and principal component analysis. A large range of variation in leaf shape was recognized, and a more round-shape(cordate) leaves and longer and narrower leaves in comparison with the parent cultivars were observed. In tuber shape, the variations with regard to fullness and elongation were recognized. The fullness ranged from the level of cv. Nagaimo (thin) to that of cv. Yamatoimo (thick), and slender, ellipsoid and clump shape tubers were observed. A correlation between leaf shape and tuber shape was not recognized. A relationship existed between the shape of tuber harvested in the 1st year (1990) and 2nd year(1991) after transferring *in vitro* plantlets to soil.

529 (PS 5)

CHARACTERIZATION OF NEW SPECIALTY SOYBEAN GERMPLASM FROM CHINA. Rangappa, M.*, McArthur Floyd, Val Sapra, Jagmohan Joshi, Thomas Carter and M. R. Reddy, Virginia State University, Petersburg, VA 23806.

A USDA/OICD sponsored agricultural research team visited the Republic of China (Taiwan) and the People's Republic of China (PRC) in 1990 to gather information regarding soybean

utilization and to increase genetic diversity of the soybean crop through new germplasm collections. A total of 25 new soybean accessions were collected and brought to the Virginia State University, Petersburg, VA, one of the OICD sponsored team participants. In accordance with the U.S. policy on the New Germplasm Collection, part of the seed of each accession was sent in original packs to USDA Soybean Germplasm Collections, University of Illinois, Urbana, Ill. Limited seed increase was done in the greenhouse and one 10m long observational row of each accession was grown at VSU Research Station in 1991. Seed traits, plant agronomic characteristics, insect pest, and disease pathogen reactions were observed and documented. Chemical analysis for nutritional quality, antinutritional factors, and biochemical components of green seeds and pods at R-7 stage and mature seeds of each accession are underway and those values will be compared with existing commercial cultivars, advanced breeding lines, and plant introductions.

530 (PS 5)

BREEDING TROPICAL SUPERSWEET CORN

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"Waimanalo Supersweet" will be released at the time of the 1992 ASHS meeting in Hawaii. A singlecross supersweet corn based on the brittle gene, "Waimanalo Supersweet" represents over 50 generations of inbreeding and backcrossing in Hawaii. Successive projects involved the development of sugary inbreds and their conversion to Mv. Ht. Rp-d and brittle genes. The inbred parents have very limited temperate germplasm and are relatively daylength sensitive. This single cross hybrid and its related 3X ("Hawaiian Supesweet #10") and OP variety ("Hawaiian Supersweet #9") show tolerance to Puccinia sorghi rust and Fusarium Moniliforme kernel rot greatly in excess of commercial sweet corns to which they have been compared, and they have performed capably throughout the tropics. Available data on pest tolerance, growth and quality will be summarized.

531 (PS 5)

SWEET CORN EAR RESISTANCE TO THE EUROPEAN CORN BORER (*Ostrinia nubilalis*, Hubner) AND ITS RESPONSE IN SINGLE CROSSES.

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Development of sweet corn hybrids having resistance to ear feeding by the European corn borer (ECB) (*Ostrinia nubilalis*, Hübner) would save growers millions of dollars annually. Sweet corn breeding lines have been developed which show resistance to ear feeding. To determine whether resistance in these lines was heritable, testcrosses were made between 6 resistant lines and 2 susceptible inbreds. The testcrosses, resistant lines, susceptible inbreds, and Jubilee, a standard susceptible hybrid, were planted in randomized complete blocks replicated 8 times at each of 2 locations. Primary ears were infested, on the ear tip, at mid-silk (R3) with approximately 50 neonate larvae and were evaluated for damage 25 - 30 days later using a 9 point scale. The resistant parents and their testcrosses had 15% to 64% more resistant ears (less than 1% kernel damage at the tip only) than Jubilee. The inbreds and their commercial hybrid did not differ in resistance from Jubilee. Resistance to ECB appears to be polygenic and it has been suggested that some level of non-additive gene action is important. While the specific traits responsible for ear resistance are not known, the resistance of the breeding lines was transmitted to the testcrosses.

532 (PS 5)

DEVELOPING ENHANCED PEPPER GERMPLASM RESISTANT TO VERTICILLIUM WILT

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A Verticillium wilt-resistant population of pepper (*Capsicum*) is being developed from the USDA P.I. 215699 accession. Three selfing cycles with disease screening and selection have been done. The disease screen was conducted at a soil temperature of $25\pm 1^{\circ}\text{C}$ and at an inoculum level of 2000 microsclerotia per gram of soil. Sixty days after inoculation, individual plants were scored using an interaction phenotype scale (IP), ranging from 1 to 9, where 1= no aerial symptoms, and 9= death. Plant shoot height was also measured. Even after three selfing cycles, P.I. 215699 segregates for Verticillium wilt resistance. The percentage of resistant plants at S_3 is 75%. Another cycle of selection (S_4) was done and the progeny are being tested. The S_4 progeny data, interaction phenotype, shoot height, and percentage of resistant plants, will be analyzed by using standard analysis of variance followed by appropriate means separation. An analysis of correlation for shoot height by interaction phenotype variables will also be conducted.

533 (PS 5)

MITE DETERRENCE OF TOMATO GENOTYPES IS CLOSELY RELATED TO LEAF SURFACE CHEMISTRY

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Choice and non-choice bioassays were used to examine deterrence *in vitro* and *in vivo* of *Tetranychus urticae* Koch. *In vivo* deterrence of leaflets from 11 *Lycopersicon hirsutum* accessions as well as the tomato cultivar 'Ace 55' was measured as was *in vitro* deterrence of their leaf hexane extracts. Leaf surface chemistry was examined by gas chromatography. All 6 accessions of *L. hirsutum* f. *hirsutum* contained sesquiterpene hydrocarbons. Each of these extracts also contained one or a few late eluting components. All were deterrent *in vitro* and 5 out of the 6 were deterrent *in vivo*. The one lacking *in vivo* deterrence had low density of type IV trichomes. All 5 accessions of *L. hirsutum* f. *glabratum* contained methyl ketones. These accessions were less deterrent *in vitro* and 4 out of the 5, less deterrent *in vivo*. The one accession having high *in vivo* deterrence also had high density of type IV trichomes. 'Ace 55', having few hexane extractable compounds was neither deterrent *in vitro* nor *in vivo*. Within an accession, secretions from different types of trichomes shared similar chemical profiles and were similar to leaf profiles.

534 (PS 5)

DETECTION OF ISOZYME VARIATIONS IN AMERICAN ELM AND SIBERIAN ELM

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Isozymes have been widely used as markers in cultivar identification, gene mapping and evolutionary studies. However, isozyme data have not been reported in elm species. This work was to develop an optimal system to analyze isozyme variations in American elm and Siberian elm. Two isolation methods were used to extract proteins from young leaf tissues and protein samples were separated by starch gel electrophoresis with three buffer systems. Eight isozymes have been detected in American elm (*Ulmus americana*) and Siberian elm (*Ulmus pumila*). Six out of these isozymes (DIA, GOT, MED, ALP, MNR, ACP) showed difference between the two elm species. These results suggest that isozymes can be used as markers in genetic studies in elms.

535 (PS 5)

ISOZYME POLYMORPHISM IN *LEUCAENA* SPECIES

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The Leguminous *Leucaena* including 15 species, of which several have become pantropical as fodder, fuelwood, shade and ornamental trees. 160 collections of 12 *Leucaena* species, including 3 tetraploids and 9 diploids, were analyzed for six isozyme systems. Extensive inter and intra-specific variability was detected using cotyledon tissues. The uniformity of isozymic expression in 80 collections of the "common *Leucaena*" from all over the world supported the hypothesis that it is a single self-pollinated variety. It was first distributed to the Philippines from Mexico in late 1500s, then spread worldwide. ACO polymorphism appeared to be controlled by three loci ACO1, ACO2, ACO3 and IDH by two loci IDH1, IDH2 in *L. lanceolata*. Peroxidase polymorphism was early shown to involve 4 loci, PX1-PX4. Polymorphism in these loci was applied to clarify phylogeny of the *Leucaena* spp. and hybrids (>60 made in Hawaii), that are growing in the Waimanalo Sta. of UH.

536 (PS 5)

MEIOTIC CHARACTERIZATION AND POLLEN TUBE GROWTH OF *VERNONIA GALAMENSIS* SUBSPECIES

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Vernonia galamensis (Cass.) Less. (Asteraceae) constitutes a species complex of six subspecies, one of which contains four varieties. Crossing barriers between the subspecies and

varieties are being examined. In the analysis of microspore mother cells, no differences in chromosome number ($n=9$) were found, and meiosis appeared to be normal within and between subspecies. However, an extended delay in time was observed in all subspecies in which chromosomes remained condensed during the post-meiotic tetrad stage. No apparent effect on pollen formation or pollen tube growth was observed from this unusual phenomenon. Self and reciprocal intraspecific crosses are being made, and pollen tube growth into the ovules assessed by fluorescent microscopy. These techniques are being used to characterize self-incompatibility within subspecies and varieties, and to determine the possible barriers to pollen tube growth and autofertility.

537 (PS 5)

AN IMPROVED FIXING AND STAINING PROCEDURE FOR PLOIDY DETERMINATIONS FROM ROOT TIP SQUASHES

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A comparison of pretreatment, fixing, and staining methods for root tips of *Fragaria x ananassa* ($2n=8x=56$), a polyploid species with small chromosomes, was made to facilitate chromosome counting. Three pretreatments (8-hydroxyquinoline, α -bromonaphthalene, and *p*-dichlorobenzene), three fixatives (Farmer's, Carnoy's, and Newcomer's), and five stains (acetocarmine, lactic-propionic orcein, leucobasic fuchsin, altered carbol fuchsin, and alcoholic hydrochloric-acid carmine) were examined in a factorial design to determine which treatment combination produced the best chromosome preparation. Field propagated runners were grown in sand under greenhouse conditions with supplemental lighting to produce root tips for late morning collection. The treatment combinations of α -bromonaphthalene or 8-hydroxyquinoline, Farmer's fixative, and altered carbol fuchsin, or the combination of α -bromonaphthalene, Farmer's fixative, and alcoholic hydrochloric-acid carmine produced the most intensely-stained and well-defined preparations.

538 (PS 5)

ESTIMATES OF OUTCROSSING AND MALE STERILITY FREQUENCY IN *LESQUERELLA FENDLERI*

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Genetic markers have not yet been described for *Lesquerella fendleri* (Gray) Wats. a potential new industrial oilseed crop. Seeds of this species are also utilized as a primary component in some desert wildflower seed mixes. Allozyme variation was analyzed for aconitase (ACO), phosphoglucosmutase (PGM), and phosphoglucose isomerase (PGI). Four codominant loci, useful as markers, were clearly resolved. In an open-pollinated population, an outcrossing rate and pollen gene frequency was obtained from 20 random families, using these loci. This initial estimate indicated that seed production primarily resulted from outcrossing. Male sterility was discovered in six bulk populations derived from single plant selections. The frequency of this trait, which could affect the outcrossing rate, was found to occur in 15 percent of the plants. Additional populations will be analyzed for validation.

539 (PS 5)

TAXONOMIC STUDIES ON CULTIVATED AND KOREAN NATIVE GENUS *PYRUS* PLANTS BY MULTIVARIATE AND ISOZYME ANALYSIS
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Fifty nine morphological characters and isozyme band patterns of glutamate oxaloacetate transaminase, peroxidase, glucose phosphate isomerase from fully expanded leaves were used for taxonomic study on 51 taxa consisted of Korean native and principal cultivars of the genus *Pyrus*. Taxonomic relationships were analyzed by complete cluster analysis method based on Euclidean taxonomic distance of IBM PC SPSS/PC(ver. 3.0). Among the 39 qualitative morphological characters, a great deal of variations among 51 taxa were observed in immature fruit shape, skin luster, hair density on pedicel, anther color, shape of leaf apex and base, hair density on leaf surface, and leaf margin. Considerable variations were found in most tested quantitative characters except in the number of petals and styles.

More reliable taxonomic results could be obtained by comparing morphological characters rather than examining isozyme band patterns. Even though there were considerable differences depending upon the methods of investigation, classification of the genus *Pyrus* by using isozyme band patterns was proved to be a good tool for rapid taxonomic studies.

540 (PS 5)

CROP ADVISORY COMMITTEES: AN ADVISORY COMPONENT OF THE NATIONAL PLANT GERMPLASM SYSTEM

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The United States' National Plant Germplasm System (NPGS) is responsible for the acquisition, preservation, evaluation and distribution of plant genetic resources in the form of seed and clonal germplasm. In order to operate more effectively, the NPGS established a network of 40 Crop Advisory Committees (CACs) to provide analysis, data, and advice about germplasm within a crop or group of related crops of current or future economic importance. CACs are composed of Federal, State and industry scientists representing a variety of agricultural disciplines and geographic areas of importance to the crop. The committees are involved in a variety of activities including: 1) Developing crop descriptors for the collection of standardized characteristic and evaluation data, 2) Determining priorities for germplasm acquisition, evaluation and enhancement, 3) Advising curators on maintenance techniques, and 4) Developing special reports on the status of genetic resources for their crop(s). Twenty-four of the CACs are concerned with horticultural crops.

541 (PS 6)

EFFECTS OF WATER STRESS ON PHYTOPHTHORA-INFECTED RHODODENDRONS

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Phytophthora cinnamomi infected *Rhododendrons* subjected to moderate moisture levels had greater survival rates than at the wet or dry levels. We potted rooted cuttings of *Rhododendron* L. hybrid, "Lee's Dark Purple" in 3 liter containers using a mixture of 3 pine bark: 2 coarse builder's sand: 1 canadian peat moss (by vol.) and infected them with *P. cinnamomi*. Tensiometers maintained the moisture levels of the treatments at 0, -5, -10, -15, and -20 kPa. After 90 days, measurements of the plants revealed virtually curvilinear results, with the highest survival rate, plant and root weights at -5 and -10 kPa. Investigation continues on susceptibility of *Rhododendrons* to *P. cactorum*, *P. cryptogea*, *P. cinnamomi*, and *P. citrophthora* under wet and dry conditions.

542 (PS 6)

THE DIFFERENT EFFECTS OF OXYGEN RELEASE COMPOUND (ORC) IN COMBINATION WITH COMMERCIAL PLANT FERTILIZERS ON BEDDING PLANTS

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The effects of ORC and different commercial plant fertilizers on Marigolds, Salvias, and Begonias were determined by height, flower number, fresh weight, dry weight, root length and tissue analysis. The treatments included controls, regular fertigations, and an over fertigation schedule. The experiment was set in a randomized block design with 5 reps per treatment which included 9 ORC and commercial plant fertilizer combinations, 4 commercial plant fertilizers, and controls. The plants with the ORC were more vigorous, had more flowers, and better overall color than the controls.

543 (PS 6)

EFFECT OF PACLOBUTRAZOL, UNICONIZOLE, DAMINOZIDE AND FERTILIZER ON POTTED CHRYSANTHEMUMS.

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Red Delano chrysanthemum cuttings were transplanted into 15 cm pots. Fertilizer treatments were started immediately. Initial fertilizer rates were 14.8 cc of the designated formulation per pot. Two formulations of fertilizer, 20-20-20 and 5-50-17 NPK, were used in excessive rates to determine if it would override the effects of the growth inhibitors. Paclobutrazol, uniconazole, and daminozide were used to retard growth. Three rates-30, 60, and 120 ppm of

paclobutrazol, and 10, 20, and 40 ppm of uniconazole and one rate of 25 % daminozide were foliar applied (two applications) on the plants. After two weeks the plants were treated with the growth retardants and an additional treatment of fertilizer were added at the rate of 29.6 cc per pot. Measurements taken were plant height, top fresh weight, root fresh weight, and root development. ANOVA was used to determine differences and interactions. Significant differences were noted in plant height and root development.

544 (PS 6)

SOIL pH AND MOISTURE EFFECTS ON VEGETABLE AMARANTH PRODUCTION

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The effect of soil moisture and pH levels on the vegetative growth of amaranth were studied in the greenhouse during 1990-91. Three soil pH levels: 4.5, 5.3, and 6.4 and four soil water levels: 3, 6, 12 and 18% (w/w) comprised the treatments of the two studies. The plants grown in pH 6.4 were significantly taller and had greater leaf area than plants grown in pH 5.3 or 4.7 soil. There was a significant decrease in all above ground plant parts with each increase in soil acidity. The top fresh weight of plants grown in 5.6 and 4.7 pH soil were 27% and 73% lower, respectively, than plant grown in 6.4 pH soil. Plant grown in 3% soil water had significantly lower leaf, stem and root fresh weights than other soil water levels. There was no significant difference in the performance of plants grown in 6, 12 or 18% soil water, suggesting that amaranth plant is adapted to a wide range of soil moisture conditions.

545 (PS 6)

REDUCE LEACHATE WITH MODIFIED CONTAINER DESIGN

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Potential exists for reduced water use and improved water quality in container nurseries through redesign of the container to minimize leaching. 'Celebrate' poinsettias were grown in trade gallon containers with modified drainage hole number and size. Irrigation was applied when an individual container's medium decreased to 80% of container capacity; a gravimetric method was used to determine daily water requirements. Containers with one drainage hole in the center bottom reduced applied water (13%) and leachate volume (90%) compared to standard nursery containers (4 drainage holes in the side and one in the center bottom). Plant quality was similar with these treatments.

546 (PS 6)

KENAF PITH AS A VERMICULITE SUBSTITUTE IN PEAT-BASED MEDIA.

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Kenaf is an alternative fiber crop being evaluated in Mississippi. Kenaf, primarily grown in Asia, can be used in the manufacture of paper, fiber board, acoustical tiles and compost. The bark is the source of the fiber used, leaving the fiber core or pith for use as a paper additive, poultry litter, or is discarded. The objective of this study was to evaluate the potential use of kenaf fiber core as a vermiculite substitute in a sphagnum peat moss-based medium.

Plugs of *Celosia argentea*, *Viola x wittrockiana*, and *Impatiens wallerana* were transplanted into 10 cm pots containing 5 different sphagnum peat moss-based media modified with the milled fiber core (pith) of kenaf (*Hibiscus cannabinus*) and/or vermiculite. The media were as follows: 5 peat : 0 kenaf : 5 vermiculite (v/v/v); 5 peat : 1 kenaf : 4 vermiculite (v/v/v); 5 peat : 2 kenaf : 3 vermiculite (v/v/v); 5 peat : 3 kenaf : 2 vermiculite (v/v/v); 5 peat : 4 kenaf : 1 vermiculite (v/v/v); and 5 peat : 5 kenaf : 0 vermiculite (v/v/v). Water holding capacity, pore space, pH and media shrinkage were monitored throughout the study along with plant growth and plant quality.

547 (PS 6)

EVALUATION OF THREE TREATMENTS TO CONTROL THE COMMON CITRUS PEST, ARGENTINE ANT *Iridomyrmex humilis* (Mayr)

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Three different treatments were evaluated for preventing the common citrus pest, Argentine ant *Iridomyrmex humilis* (Mayr), from foraging in skirt pruned citrus trees. The treatments were: 1) 1% (AI) chlorpyrifos 4 EC applied to the basal 15 cm portion of the trunk, 2) 32 g (AI) diazinon 14G broadcast in a 60 cm radius around the trunk, and 3) a trunk barrier of petroleum wax applied in a 10 cm wide strip around the trunk. The treatments were evaluated in two-week increments from August 1, 1991, to October 20, 1991, by counting the number of ants to cross an arbitrary line 10 cm above the soil surface

on the trunk of each tree. Each of the three treatments resulted in a highly significant reduction in the number of ants entering trees compared to untreated control trees. There were no significant differences among the three treatments.

548 (PS 6)

AN ELECTROPHORETIC COMPARISON OF CULTIVATED MEMBERS OF THE CUCURBITACEAE

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Thirty-eight cultivated accessions of the diverse Cucurbitaceae were electrophoretically surveyed using 13 enzyme systems. Included were representatives from 6 of the 6 Cucurbitaceae tribes, 9 genera, and 17 species. Additionally, several cultivars or groups were included for those species possessing marked morphological diversity such as the 7 groups of *Cucumis melo* var. *melo* and 7 of the numerous cultivars representing *Cucurbita pepo*. Zymograms were scored for the presence or absence of bands measured in mm from the origin. Cluster analysis (complete linkage method) was used to detect affinities among the accession surveyed. Data suggest that: 1) *Cucumis melo* (x=12) possessed greater biochemical affinity with *C. sativus* (x=7) than with either *C. anguria* or *C. metuliferus* (both x=12); 2) *Sechium edule* and *Cyclanthera pedata*, both members of the tribe Sicyeae, were more closely associated with members of other tribes than with each other; 3) Some cultivars of *Cucurbita pepo* shared greater affinity with *Cucurbita moschata* than with other cultivars of *C. pepo*. Additional observations as well as their possible implications will be presented.

549 (PS 6)

EFFICACY OF AMMONIUM NITRATE FOR WEED CONTROL IN CRUCIFER CROPS

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A field experiment was conducted on broccoli (Taki Marathon variety) at California Polytechnic State University, San Luis Obispo to evaluate three rates of AN-20 for weed control and crop phytotoxicity. The rates were: low-40 gal./A, standard-60 gal./A, high-80 gal./A, and untreated control. Each treatment was applied to the base of the broccoli plant to avoid crop injury. Each treatment had four replications. Data collected included hoe time/plot and percent visual control. Broccoli was not injured at any rate of AN-20. It was noticed that the older weeds, greater than five-leaf stage, managed to pull through, so size of weed is crucial. On a cost-per-acre basis, the money saved on the high rate is half that of the low rate and one third that of the control. Weed control was not adequately controlled at the standard and low rates. An economic analysis was conducted, and it was found there was a savings as less labor was required to hoe the field when AN-20 had been applied.

550 (PS 6)

CERTIFIED PROFESSIONALS IN HORTICULTURE

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Evidence of professional competence is needed for those whose activities affect the well-being of the general public. Graduates of BS and MS programs in horticulture are not distinguishable from self styled individuals who assume the title of "Horticulturist" without earning it. Certification of horticultural graduates is the first step in gaining a recognition for the Horticultural Profession. ASHS has established a Certified Professional Horticultural Sub-Board of the American Registry of Certified Professionals in Agronomy, Crops and Soils (ARCPACS). Professional core requirements include courses horticultural crop management, pest management, soil science, plant physiology, botany, chemistry, and genetics. Supporting core courses include math, communication skills, and horticultural specialization courses. Applications from individual horticultural graduates will soon be accepted. Details of the curriculum, continuing education, ethics, and other eligibility requirements will be detailed.

551 (PS 6A)

ACCUMULATION AND METABOLISM OF CARBOHYDRATES IN MARIGOLD SEEDLINGS

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Marigold seedlings, 3 weeks old, were grown in natural light growth chambers at 3 day/night temperature regimes, 8°N/16°D, 13°N/20°D and 18°N/24°D, in a factorial combination with ambient and 1000-1500 ppm CO₂.

Seedlings were harvested at regular intervals during a 24 hr period and were analyzed for soluble sugars (reducing sugars and sucrose) and starch. Neither temperature nor CO₂ concentration affected the accumulation of soluble sugars or starch during the day or night. The soluble sugar concentration ranged from 3% of dry weight at sunrise to 6% at mid-day; the concentration changed little during the night. Light intensity was different during replications of the experiment. Increased light intensity appeared to cause a slight increase in the soluble sugars maintained by the seedling during the day. Accumulated starch increased 6% to 8% from sunrise to late afternoon. Preliminary results indicate that light intensity greatly affected the concentration of starch. On the higher light intensity day, starch accumulated to a maximum of 18% of dry weight; whereas on the lower light intensity day the maximum concentration was 10%. During the night following the lower light intensity day, the starch concentration decreased to approximately 3% by the end of the night; following a brighter day the starch content was 13% at the end of the night.

553 (PS 6A)

GROWTH RESPONSE UNDER THE FLUCTUATING LIGHT OF ROTATING SHELVES IN THE GREENHOUSE

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Growth and flowering of chrysanthemum, poinsettia, fuchsia, hydrangea, and geranium grown on rotating shelves were compared with that of plants grown in full ambient sunlight on a stationary greenhouse bench. Ambient insolation reaching plants on the rotating shelves was ca. 55% of that on the stationary greenhouse bench on a sunny day and ca. 60% of full insolation on a cloudy day. Plants grown on the rotating shelves required two to six days longer to flower and were smaller in height, weight, and number of flowers compared to plants under full light. The lasting of chrysanthemum leaves and petals was lessened by growth on rotating shelves compared to plants grown in full light while there was no effect on the lasting of poinsettia bracts or of hydrangea leaves and sepals under simulated home conditions.

554 (PS 6A)

RED TO FAR-RED RATIO IN HIGH-PRESSURE SODIUM LIGHTS AFFECTS YIELD IN ROSES

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An experiment was conducted to determine whether the high R:FR ratio in high pressure sodium (HPS) lamps contributes to lateral bud breaking in roses. *Rosa hybrida* cv. 'Samantha' plants were grown under HPS lamps, HPS lamps fitted with blue gel filters to reduce the R:FR ratio or metal halide lamps. Spectral graphs showed R:FR ratios of 1.05, 0.5 and 3.8 for HPS, filtered HPS and metal halide respectively. Although the R:FR ratio in metal halide was notably higher than in HPS the total energy in this range was much lower. At a 24hr supplemental PPF level of 70-75µEm⁻²s⁻¹ more flowering shoots were produced under HPS and metal halide lighting than under filtered HPS. There were more dormant shoots under the filtered HPS. No differences in quality were found among flowers from any treatment.

555 (PS 6A)

INFLUENCE OF SPECTRAL FILTERS ON LEAF PIGMENTS AND ANATOMY OF 'SPEARS' CHRYSANTHEMUM

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'Spears' chrysanthemums were grown in chambers fitted with double-walled exolite filled with spectral filtering solutions: a blue textile dye that absorbed red light, CuSO₄·5H₂O that absorbed far-red light, and H₂O that was spectrally non-selective (control).

Leaves of 'Spears' grown under CuSO₄-filters had increased chlorophyll a (23%), chlorophyll b (26%), xanthophyll (22%), and β-carotene (24%) compared to plants grown under H₂O or blue-dye filters. Ratios of total carotenoid : chlorophyll and chlorophyll a : chlorophyll b were not affected by filter.

Individual leaf area was reduced 25% under CuSO₄ filters compared to other filters. Stomates per unit area were not affected by filters, however stomates per leaf were reduced 25% under CuSO₄ filters because of leaf size reduction. Stomate length and width were not affected by filter. Leaves from plants grown under CuSO₄-filters had an internal structure resembling that of sun-type leaves. Other filters induced a shade-type leaf.

556 (PS 6A)

INFLUENCE OF END OF DAY FAR-RED LIGHT ON HEIGHT OF CHRYSANTHEMUM PLANTS UNDER CuSO₄ SPECTRAL FILTERS

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The response of 'Bright Golden Anne' and 'Spears' chrysanthemum plants to EOD-R or FR light was evaluated to determine the involvement of phytochrome in regulation of plant morphology under CuSO₄ filters. Light transmitted through the CuSO₄ filter significantly reduced height, internode length and stem dry weight of 'BGA' and 'Spears' chrysanthemum plants. However, the degree of response varied with the cultivar. Exposure to EOD-FR reversed the reduction of plant height, internode length and the stem dry weight caused by the light transmitted through CuSO₄ filters to a level comparable with control plants. Exposure to EOD-FR did not significantly alter height and stem dry weight under control filter. Exposure to EOD-R light reduced the height and stem dry weight of 'BGA' plants grown under control filter but EOD-R had no effect under CuSO₄ filters. In 'Spears' plants, EOD-R caused stem dry weight reduction under control filters, but did not reduce stem or internode elongation. The results suggest phytochrome may be involved in controlling plant response under CuSO₄ filters. However, there are evidence to indicate that an additional mechanism may be acting on stem/internode elongation.

557 (PS 6A)

INFLUENCE OF LONG DAYS AFTER COOLING AND DATE OF EMERGENCE ON EASTER LILIES

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Easter lily bulbs (*Lilium longiflorum* 'Nellie White') were given 6 weeks of cold, placed in the greenhouse and subsequently divided into groups based on emergence date after placement in the greenhouse: 0-6, 7-13, 14-20 and 21-27 days. At emergence bulbs received 0, 1, 2 or 3 weeks of long days (LD). Late-emerging plants had fewer days to visible bud and anthesis from emergence than early-emerging plants; consequently, late-emerging plants flowered within 3-10 days of early emerging plants despite 14-21 days difference in emergence time. Late emerging plants were tallest and middle emerging plants had the highest leaf number. Increasing LD tended to decrease numbers of days from emergence to visible bud and anthesis and increase plant height. LD did not effect leaf or flower number. Interactions between LD and emergence date will be discussed. Experiment was repeated for three consecutive years.

558 (PS 6A)

TIME VARIATION IN FLOWER QUALITY AND YIELD OF ZINNIA

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The introduction of an alternative crop invokes a myriad of unknowns. Cyclic production patterns need to be described so that staggered plantings can be programmed to provide continual product supply to the marketplace. The impact of time on flower quality as well as yield is critical. *Zinnia elegans* 'State Fair Mix' (tall and large flowered) and 'Pumila Mix' (smaller flowered) were field-produced for study. Flower diameters of *Z. elegans* 'State Fair' and *Pumila* displayed similar patterns; increasing from first harvest to week 5, decreasing until weeks 8/9 and then beginning to increase in week 10. Flower diameters were smaller at weeks 8/9 than at initial harvest. The number of stems harvested (per sq. meter) of *Pumila* decreased from initial harvest (13.5) until weeks 5-7 (7.5) and then increased dramatically to week 10 (38). Stem numbers of *State Fair* decreased from initial harvest (4.9) until weeks 4/5 (1.6) and then increased through week 9 (6.8).

559 (PS 6A)

EFFECT OF PLANTING DATE, PINCHING, AND PLANT DENSITY ON QUALITY AND YIELD OF FIELD-GROWN GODETIA

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Different planting dates, plant densities and pinching practices were used to determine the production practices that produced the best quality cut stems from field grown *Godezia* under Kentucky conditions. *Godezia* 'Grace Salmon' transplants were planted at a plant density of 40 plants m⁻² on Mar 23, Apr 8 and Apr 23, 1991 in ground beds with black plastic mulch. All plants

flowered in early to mid June, but plants from the Mar 23 planting date had the highest yields of commercial quality stems (387 stems m⁻²) and over 80% of the stems were longer than 55 cm. In a separate experiment, transplants of 'Grace Red' and 'Grace Rose Pink' were planted on April 5 at plant densities of 4.5 m⁻² (unpinched), 10 m⁻² (soft pinch on May 1) and 23 m⁻² (hard pinch on May 1). Pinching treatments were used to increase the number of secondary and tertiary branches on each plant. Although the pinching treatments produced more branches, a low percentage of the branches were commercial quality cut stems.

561 (PS 6A)

THE EFFECT OF TEMPERATURE ON CARBON GAIN IN ALSTROEMERIA

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Leaf and whole plant gas exchange (net photosynthesis Pn, dark respiration Dr, transpiration Tr, and resistance R) of 'Jacqueline' *Alstroemeria*, grown in pots inside a greenhouse, were measured under lab conditions using an open-flow and a semi-closed system respectively.

Temperature responses of apical fully expanded leaves, on flowering and non-flowering shoots, showed an optimum range for net photosynthesis (Pn) from 15 to 20 °C. Above 25 °C Pn dropped considerably as temperature increased. Leaf transpiration rates over the same range of temperature showed a similar decrease, indicating that low leaf Pn rates at higher temperatures were due in part to increased stomatal resistance.

Whole plant photosynthetic response to temperature was similar to that of leaf gas exchange. The optimum temperature range for whole plant Pn was from 12 to 17 °C. These results show that moderately low temperatures are essential for carbon assimilation and efficient water use in *Alstroemeria*. Temperature interactions with other environmental factors will also be presented in models describing Pn rates as a function of irradiance, CO₂ concentration, and temperature.

562 (PS 6A)

INFLUENCE OF LOW TEMPERATURE ON FLORAL DEVELOPMENT IN CHRYSANTHEMUM

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The progression of flower initiation was documented in *Dendranthema X grandiflorum* (Ramat) Kitamura 'Bright Golden Anne'. Rooted cuttings were planted and grown under 16 hours photoperiod (360 μmol·s⁻¹·m⁻²) and a constant 20C. After 7 days, the plants were pinched, the temperature reduced to 5, 10 or 15C and the day length shortened to 10 hours (13 mol·day⁻¹·m⁻²). Scanning electron microscopy was used to determine the transition from vegetative to reproductive meristem and to document the flower formation process. Shoot apices from three randomly selected plants were dissected weekly from each temperature until plants had developed floret primordia to completely cover the apical dome. Delayed floral development in the low temperature grown plants was a combination of a later flower initiation event and a slower progression of flower development. Required time for formation of 3-4 rows with floret primordia was about 21 days at 15C, 32 days at 10C and 70 days at 5C.

563 (PS 6A)

TEMPERATURE IS A KEY REGULATOR OF GROWTH AND FLOWERING IN PROTEA NERIIFOLIA AND PROTEA CYNAROIDES

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The strategy of this study was to determine the period of floral initiation for both species and then to determine the critical regulator(s) of flower initiation and floral development. Plants grown under different temperature regimes gave best shoot extension and flower initiation at temperatures with 10°C night and 15 to 25°C day. Field data from four locations showed a correlation of time of flower initiation and temperatures over the same range.

Temperature is an important determinant of the vegetative flush period of both species. The stem diameter of all shoots is a consequence of the vegetative flush growth and in turn is well correlated with flower initiation. Plants given day temperatures of 20°C or above remain in the vegetative phase. Flower abortions in *Protea neriifolia* and reversions from floral to vegetative shoots in *Protea cynaroides* result from high day temperatures.

Daylength was not found to be critical for flower initiation. A cool temperature period acts as a control to change shoots from the vegetative to reproductive phase.

564 (PS 6A)

THE MICROCLIMATE IN A HAWAIIAN ANTHURIUM SHADE HOUSE

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The microclimate in anthurium shade houses, which has not been previously studied, has been hypothesized to contribute to the development of anthurium blight and is important for flower production. The magnitude and spatial and temporal distribution of temperature and other conditions were measured at eight locations inside and upwind of a 3.5 ha, uniform, level, commercial shade house near Pahoa, Hawaii for two months. The energy balance was measured occasionally during this time by eddy correlation to allow explanation of the prevailing conditions. Daytime temperatures in the shade house are elevated over outside temperatures with the greatest magnitudes of about 2 to 4°C being associated with high solar radiation and low winds; nighttime temperatures are lower in the house. Conditions at the upwind edge of the house resemble outside conditions less than 40 m into the house. A temperature inversion inhibits convective exchange in the house.

565 (PS 7)

EFFECT OF DRYING METHODS ON THE RECOVERY AND YIELD OF ARTEMISININ FROM *ARTEMISIA ANNUA* L

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Postharvest methods of handling *Artemisia annua* L. were evaluated to determine the recovery of artemisinin, a sesquiterpene used in the treatment of malaria, because low yields have been a limitation to commercialization. Immediately following field harvest in October, plants were subjected to: freeze drying, oven drying (40°C), and open air drying. Leaf samples (50 gfw) were dried for 7 days in each treatment, and stable weights were achieved after day 2 for oven or open air drying and day 1 for freeze drying. One gram of dry weight was sampled from each treatment for artemisinin analysis using reverse phase chromatography by HPLC with EC detection. Open air drying of samples gave significantly higher artemisinin yield (0.13g/100g) than oven drying (0.10g/100g) and freeze drying (0.02g/100g). In a second experiment, open air drying for 2, 4, 6, and 8 days was compared to microwave drying for 2 minutes, of foliage samples with 10 gfw, of a plant low in artemisinin. Time of drying did not affect artemisinin content but microwave drying greatly reduced artemisinin (0.02g/100g air drying vs 0.002g/100g microwave drying). In our protocol artemisinin was detected in a greenhouse plant (0.3g/100g artemisinin) in samples as low as 50 mgdw.

566 (PS 7)

POSTHARVEST QUALITY AND PH OF *FUSARIUM*-INOCULATED TOMATO FRUIT UNDER CONTROLLED ATMOSPHERES

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Tomato (*Lycopersicon esculentum* Mill., cv. BHN 91) fruit were hand harvested at the pink stage of maturity and stored at 12.5, 20, and 30°C in air, 3% O₂ + 5% CO₂, or 0.5% O₂ + 20% CO₂ for up to six days. Half of the fruit were inoculated with *Fusarium*. Control fruit retained the best appearance in 3% O₂ + 5% CO₂ at both 20 and 30°C. Inoculated fruit at 12.5, 20 and 30°C in air or 3% O₂ + 5% CO₂ were acceptable for 12, 3 and 2 days, respectively, but they deteriorated more rapidly compared to fruit held in 0.5% O₂ + 20% CO₂ as temperature and time increased. Off-odors were present in all 0.5% O₂ + 5% CO₂ treatments by days 12, 9 and 5 at 12.5, 20 and 30°C, respectively. A significant time- and temperature-dependent increase in pH of locular and pericarp tissue, and of supernatant pH occurred in inoculated regions of fruit held in air by days 12, 6 and 3 at 12.5, 20 and 30°C, respectively. In contrast, reduced acidity occurred at 9 and 5 days in 3% O₂ + 5% CO₂ at 20 and 30°C, respectively. Generally, increased pH followed a trend with air > 3% O₂ + 5% CO₂ > 0.5% O₂ + 20% CO₂.

567 (PS 7)

Studies on Essential Oil and Antioxidants of Rosemary (*Rosmarinus officinalis* L.) Growing in China

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The essential oil constituent of Rosemary harvested in different times and grown in different introduction regions were analyzed with GC method and compared in this study. The composition of the

essential oil in different harvest times were almost similar, the content of main constituents fluctuated regularly. Compared with main production countries of Rosemary, the composition of the essential oil in different introduction regions of our country have characteristics of their own, with high content of α -Pirene in Beijing, rich in Comphor and relatively high in Bonneol and Bonaryl acetate in Nanjing and with equally abundant α -Pirene and 1,8-cineole in Kunming.

Roemarol, Cornosal and Rosmadial are separated from Residues of disilted shoot and leaves of Rosemary, and are identified with MS and ¹H-NMR.

568 (PS 7)

ENZYMES IN WATER CHESTNUTS

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Chinese water chestnuts retain crispness during heating much better than most vegetables. To help explain this unusual property of water chestnuts, a study was conducted to determine their cell wall composition and to assay some of the enzymes that may be involved in hydrolysis of cell walls and starch. Water chestnuts were found to contain high levels of β -1,3-glucanase and β -glucosidase but low cellulase. A number of other enzymes were detected including invertase, α - and β -galactosidases and α -mannosidase. A rather high level of amylase is present in water chestnuts and most of the activity appears to be due to β -amylase. Water chestnuts contain low pectinesterase but a moderate amount of polygalacturonase which was purified and characterized. It is an exoenzyme that does not require Ca²⁺ for activity in contrast to most other exopolygalacturonases. An unusual property of the water chestnut polygalacturonase is its stability to heat, with retention of most of its activity after heating at 80°C for 5 min. The cell walls of water chestnuts contain low pectin which is solubilized slowly by pectic enzymes.

569 (PS 7)

EFFECTS OF CONCENTRATIONS OF CULTURE SOLUTION IN HYDROPONICS ON YIELD, QUALITY, AND STORABILITY OF HERBS

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Concentrations of culture solution in hydroponics were changed for the purpose of improving the quality of herbs. Culture solution containing Ca(NO₃)₂·4H₂O:45g, KNO₃:36g, MgSO₄·7H₂O:22.5g, NH₄H₂PO₄:6.75g, and Fe-EDTA:6.67g in 45l water was defined as 1 unit solution. Japanese honewort (*Cryptotaenia japonica* Hassk.), soup celery (*Apium graveolens* L. var. dulce DC.), and parsley grown with 2 unit solution showed higher contents of ascorbic acid(ASA), phenols, free amino acid, and chlorophyll than those grown with 1 unit, but they showed lower yields and shorter shelf lives. Lowering the concentration of solution to 2/3 unit resulted in the increase of yield of peppermint, sage, basil, and perilla (*Perilla frutescens* Britton) and the decrease of ASA and chlorophyll contents. Shelf lives of herbs with 2/3 unit were longer than those with 1 unit. The smell of herbs tested in this experiment was not affected significantly in sensory test by the change of concentration of solution.

570 (PS 7)

WALLA WALLA SWEET ONION STORAGE AND SHELF LIFE

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Walla Walla Sweet onions (*Allium cepa* L.) have a short storage and marketing season. Studies to determine viable shelf life and to extend post-harvest life with controlled atmosphere (CA) storage were conducted. Onions were exposed to various CA gas mixtures in combination with heat curing (35°C) and/or chlorine dioxide (ClO₂) fumigation, to control disease. Preliminary results indicated *Borritys* was the primary cause of post-harvest losses. A 1% O₂, 5% CO₂ atmosphere appeared to maintain onion quality better than other gas mixtures tested during 15 weeks of CA storage (0°C). Carbon dioxide series above 5% show promise in reducing the 35% storage loss that occurred with the 5% CO₂ treatment. Curing for at least 72 hours followed by a 1-hour ClO₂ fumigation resulted in the least bulb decay and after 15 weeks of storage (1% O₂, 5% CO₂), 75% of the bulbs were in marketable condition. Onions stored 15 weeks in air (0°C, 70% RH) were unmarketable. Shelf life of freshly harvested onions was 18 days, after which the onions rapidly decayed. After CA storage, shelf life was reduced to 10-14 days due to rapid sprouting. To enjoy a 30-day market window, disease control is necessary for freshly harvested onions and sprouting must be controlled in post-storage onions.

571 (PS 7)

LIMITATION TO THE USE OF ELECTRICAL CONDUCTIVITY FOR THE MEASUREMENT OF CHILLING INJURY IN TOMATO FRUIT
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Five tomato cultivars were tested for tolerance to chilling. After exposure of varying times to chilling at 3 °C, the fruits were returned to ambient temperature for development of chilling injury (CI) symptoms (uneven ripening and pitting). Ripening was assessed by measuring carotenoids. Electrical conductivity (EC) of leachate from pericarp discs, an indirect measure of membrane damage, was used to determine CI. During chilling EC greatly increased in the three sensitive cultivars, but hardly in the tolerant ones, in good correlation with the development of CI symptoms after rewarming. However, this correlation broke down after returning the fruit to 20 °C. While slightly injured fruit showed a large increase in EC, surprisingly EC was drastically reduced in the extensively injured fruit. Calcium pectate production due to cell wall degradation may explain the lack of correlation between EC and CI after rewarming. We conclude that EC is not always a reliable measure of membrane damage.

572 (PS 7)

CLASSIFICATION OF TOMATO RIPENESS AND MATURITY BY FOOD COLORIMETRY

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Tomato ripeness is currently assessed by a subjective visual classification scheme based on external color while maturity of green fruit is based on a destructive evaluation of internal locule development. In an effort to develop an objective method of tomato maturity and ripeness classification, external color measurements were performed on fresh, sized (6x7) 'mature-green' tomatoes (cv 'Sunny') initially and through ripening using a Gardner XL-845 colorimeter. Hue angle ($\tan^{-1} b/a$, designated θ) provided the best objective means of ripeness classification with proposed ranges for mature-green ($\theta > 114^\circ$), breaker ($101^\circ < \theta < 114^\circ$), turning ($85^\circ < \theta < 101^\circ$), pink ($64^\circ < \theta < 85^\circ$), light red ($36^\circ < \theta < 64^\circ$) and red ($\theta < 36^\circ$) classes using average hue at the circumference. Hue angle at the blossom end was 2-12° lower than at the circumference due to initiation of color development at the blossom end. Colorimetry was not able to distinguish differences in physiological maturity of mature-green tomatoes as determined by the length of time required to develop from mature-green to breaker which varied from 1 to 22 days in the test.

573 (PS 7)

CELL WALL COMPOSITION AND SYNTHETIC CAPACITY OF THE PERICARP OF RIPENING 'JACKPOT' TOMATO

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Discs from outer pericarp of mature green (MG) and light red (LR) tomatoes were incubated with ¹³C₆-glucose as precursor to cell wall constituents, to determine biosynthetic capacity of the outer 2mm (including cuticle) and adjacent inner 2mm of tissue. Cell wall material was fractionated into pectic and hemicellulosic classes by sequential extraction, and alditol acetates and partially-methylated alditol acetates were prepared. Neutral sugars (NS), glycosidic linkage compositions and incorporation of label were determined by GC-FID and GC-MS. Rhamnose, arabinose and galactose accounted for ca. 90% of both labeled and total NS in the pectic fractions (sugar ratios within ripeness stage were the same for labeled and total NS). Xylose and glucose accounted for ca. 70% of both labeled and total NS in the hemicellulosic fraction (sugar ratios within ripeness stage were different between labeled and total NS). In the crude cell wall, galactose and glucose contents were significantly higher in the inner than in outer tissues for both MG and LR tomatoes. Loss of galactose during ripening was higher from outer tissues. These results show compositional differences between inner and outer tissues, and suggest that ripening-related wall synthesis may give rise to pectic polymers similar in NS composition to existing polysaccharides, and hemicellulosic polymers which may differ in composition.

574 (PS 7)

ASPECTS OF ETHYLENE BIOSYNTHETIC PATHWAY IN TOMATO FRUITS DURING THE RIPENING PROCESS

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Green fruits of normal ripening type of tomatoes (*Lycopersicon esculentum* Mill) were picked 13-39 days after anthesis and stored at

20°C. Although more days were required for the ripening of the fruits if the stage of picking was earlier, all fruits became red and soft during storage. This result shows that considerably immature fruits have the ability of ripening. Green tomato fruits at three stages (18, 29 and 38 days after anthesis) were treated with ethylene for one day. The activity of ethylene forming enzyme (EFE) and the conversion of applied 1-aminocyclopropane-1-carboxylic acid (ACC) to N-malonyl-ACC (MACC) in the three stages of tomato fruits were accelerated by exogenous ethylene, though endogenous ethylene production was hardly observed. When the green tomato fruits (31-34 days after anthesis) were treated with ethylene for one day and then transferred to air, the activity of EFE and the conversion of applied ACC to MACC were depressed. The activity of ACC synthase was not accelerated by ethylene treatment of only one day, but was accelerated by a longer term treatment, followed by increased ethylene production and the onset of ripening.

575 (PS 7)

CHLOROPHYLL DEGRADATION IN PARSLEY LEAVES STORED UNDER DIFFERENT ATMOSPHERES.

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Pigments in stored parsley leaves (*Petroselinum crispum* Nym.) were monitored to determine if degradative products of chlorophyll (chl) differed while under different types of atmosphere. The leaves were stored in a closed container under a stream of humidified air at 20°C with or without 10 ppm ethylene and with or without 10 percent oxygen and 10 percent carbon dioxide. Analysis of pigments with HPLC showed that chl a and b decreased sharply with or without ethylene and the decrease was considerably less under CA. Chlorophyll a-1, the oxidized form of chl a, was initially low, and the level decreased slightly with all of the storage conditions. Chlorophyllide was also low, but it increased slightly during storage. Xanthophyll derivatives, which appeared to be the esterified xanthophylls, increased slightly during storage. These results indicate that chl degradation in stored parsley leaves was hastened by ethylene or suppressed by CA condition and the pathway of chl degradation did not appear to be altered by the different storage atmospheres.

576 (PS 7)

WATER JET TECHNOLOGY AND SALT TREATMENT USED FOR CARROT STICKS.

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Water jet technology to slice carrots or salt treatment prior to slicing was studied to minimize the unappealing whitish tissue noted with carrot sticks. The water jet was a fine stream with 378,950 kPa force. Salt treatment consisted of immersing carrots in NaCl solution ranging from 0.0 to 1.0 M concentration for 3 to 20 hours. Subsequently, the carrots were sliced, stored at 5 °C, and analyzed. Carrot sticks sliced with the water jet had a greater amount of white tissue than those sliced with a knife. Scanning electron microscopy showed that the water jet caused grooves on the cut surface, which exposed many layers of cells to dehydrate rapidly. The grooves probably can be minimized by increasing the speed of slicing. Salt treatments of 0.5 to 1.0 M concentration caused 3 to 10 percent weight loss when treated for 20 hours at 5 °C or 3 hours at 20 °C. Carrot sticks with increased weight loss had less whitish tissue and had an appearance of freshly cut sticks; however, the textural quality decreased.

577 (PS 7)

EFFECT OF ALLYLISOTHIOCYANATE ON ASCORBIC ACID CONTENT OF SHREDDED CABBAGE

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Allylisothiocyanate (AITC) is known as a main pungent compound in cabbage, which indicates several biological activities. Our previous studies have suggested that AITC acts as a natural regulator which inhibits browning and ethylene evolution of shredded cabbage. It was found that AITC mainly inhibits *de novo* protein synthesis and in some case, it partially inhibits enzymatic reactions directly. This time we investigated the changes in ascorbic acid (AsA) content and AsA oxidase activity of shredded cabbage, treated with various amounts of AITC.

AsA content of shredded cabbage was initially 16.9 mg/100g fresh wt. After 24 h incubation at 10°C, it was reached to 26.3 mg/100g fresh wt. This increase was suppressed by AITC and also by cycloheximide, well known inhibitor of protein synthesis. It was suggested that the increase in AsA was a result of wounding reaction that took place in shredded cabbage. AsA oxidase activity increased during incubation, which was suppressed by AITC, too.

From these results, AITC was thought to be a natural regulator of wounding reactions in cabbage.

578 (PS 7)

LIPID CHANGES IN MICROSOMES AND PLASTIDS DURING STORAGE OF TOMATO FRUIT AT CHILLING AND NONCHILLING TEMPERATURES

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MG tomato fruit were stored for four or 12 days at chilling (2°C) or nonchilling (15°C) temperature. Fruits stored 12 days at 15°C ripened to the turning stage, whereas fruits at 2°C did not ripen. Lipids of microsomes and plastids from pericarp tissue were analyzed at harvest and after four or 12 days of storage. After 12 days at either 15°C or 2°C, the ratio of phospholipid (PL) to protein in microsomes declined, with a concomitant increase in the ratio of total membrane sterols (TMS) to PL. The TMS/PL ratio also increased in crude plastids. In both microsomes and plastids, free sterols (FS) increased more at 2°C than at 15°C, and thus accounted for a larger percentage of the TMS. The ratio of stigmaterol to sitosterol in sterol lipids, particularly in FS, increased more at 15°C than at 2°C. The unsaturation index of fatty acids in PL and galactolipids generally increased slightly during storage at both 15°C and 2°C. The ratio of phosphatidylethanolamine to P-choline increased in both membrane fractions at both temperatures. In plastids, the ratio of mono- to digalactosyldiacylglycerol declined substantially at 2°C but not at 15°C.

579 (PS 7)

QUALITY EVALUATION OF CANTALOUPE FROM AHPID-INFESTED PLANTS

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¹USDA/ARS, South Central Agric. Research Lab., Lane, OK 74555; ²Dept. Horticulture, Oklahoma State University, Stillwater, OK; ³Dept. Entomology, WWAREC, Lane, OK 74555. High populations of melon aphid (*Aphis gossypii*) reduce cantaloupe plant growth and yield; effects on subsequent fruit quality are unknown. The purpose of this study was to evaluate fruit quality from plants with high and low aphid populations. Up to 50% of melons from plants having high aphid populations were unmarketable due to surface sooty mold. Melons from plants with high or low aphid populations, but not cultivars, were similar in flesh quality. The internal color of 'Perlita' and 'Sweet Surprise' was a more yellow hue while that of 'TAM Uvalde' was more orange. 'Sweet Surprise' melons were lower in percent soluble solids concentration and titratable acidity, but were higher in mg fructose/ml juice compared to the other cultivars. A trained taste panel of 30 people evaluated melons from 2 cultivars showing little damage from melon aphid infestations and from 2 cultivars exhibiting high damage. All melons had similar taste qualities with acceptable sweetness, flavor, odor and texture. These results show that high aphid populations deleteriously affect cosmetic appearance, but not flesh quality, of melons.

580 (PS 7)

EFFECT OF HOT WATER TREATMENT ON THE POSTHARVEST BEHAVIOR OF WINTER SQUASH (*Cucurbita maxima* Duch)

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Winter squash is grown in the Northwest of Mexico for export to distant markets with risk of produce loss. A study was conducted to investigate its postharvest behavior as affected by hot water (50°C) for 0, 3, 6, 9 and 12 min, and stored at 10 or 20°C with 75% RH for 4, 8, and 12 weeks. The highest weight loss (11.35%) was in fruits without hot water treatment stored at 20°C for 12 weeks; at this temperature the weight loss was 3.65, 7.18, and 10.19% in the 4, 8 and 12 week storage period, respectively. At 10°C the weight loss was 3.41, 6.83 and 7.56% for the same period. Chlorophyll content decreased as temperature and storage period increased. β -carotene content showed no change at 10°C, but slightly increased after 8 and 12 weeks at 20°C. Fruits showed decay by

Rhizopus and Aspergillus. Weight loss, chlorophyll content, and decay were not affected by length of hot water treatment. General appearance was better in fruits stored at 10°C than at 20°C.

581 (PS 7)

UNICONAZOLE AND REDUCED IRRIGATION AFFECT POSTHARVEST PERFORMANCE OF CHRYSANTHEMUM

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Eight-week-old potted chrysanthemum (*Dendranthema grandiflora* Tzvelev. c. Ovaro) plants were treated with a soil drench of 0 or 2.5 mg uniconazole per liter and irrigated daily with 350 or 250 ml of nutrient solution. Plants were frequently water-stressed during their development. At the beginning of anthesis treatments were split and transferred to chambers with 20C/24 hr photoperiod or 25C/dark conditions. Anthesis progressed at the same rate in the two postharvest storage conditions, regardless of previous treatments. Plants were not watered until wilting, which was observed first in control plants under continuous photoperiod (8 days) and last in uniconazole-treated plants in dark storage (12 days). During the first 6 days in storage, evapotranspiration (ET) was lower for plants grown with 250 ml daily irrigation. From day 8 to day 12, when most plants were irrigated after they had wilted, ET was affected by uniconazole and an interaction of uniconazole and storage conditions.

582 (PS 7)

REDUCTION OF POST-PRODUCTION QUALITY LOSS IN POTTED MINIATURE ROSES

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Potted miniature roses (*Rosa hybrida* 'Belle Sunblaze') held after production in simulated home conditions performed poorly due to premature yellowing and abscission of buds and leaves, and failure of buds to open. These symptoms were accelerated when the plants were exposed to low concentrations (1 ppm) of ethylene. Spray application of 100 ppm 6-benzylaminopurine (BA) reduced yellowing, but had little effect on bud yellowing and flower opening. Application of 1 mM STS prevented the abscission of leaves and buds, although it only partly reduced leaf yellowing. A combined BA and STS treatment greatly improved the postproduction quality of rose plants, particularly if applied 1 day before harvesting.

583 (PS 7)

EFFICACY OF COMMERCIAL STS FORMULATIONS FOR INCREASING POSTHARVEST LONGEVITY OF GYPSOPHILA

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Commercial formulations of silver thiosulfate (STS) were evaluated for their efficacy in promoting postharvest longevity of gypsophila. Argylene, Chrysal AVB, Chrysal OVB, Oasis Dry Flower Conditioner, Rogard RS, and Silflor were compared to the anionic STS complex and to Physan plus sucrose. Flowers were pulse treated, then placed overnight at 2°C in Physan plus sucrose. Flowers treated with Rogard RS, Chrysal OVB, and Physan were held continuously in the solution. Overnight treatments of STS were compared to short pulses at higher concentrations. To simulate the effect of shipment, treated flowers were packed in boxes, then held either for 48 hours at room temperature (12-18°C) or for 60 hours in a range of ethylene concentrations. Individual stems were then placed in Physan plus sucrose. The number of open flowers, buds, and dead flowers was determined on each stem at various intervals. All products effectively extended the display life of gypsophila except Rogard RS and Chrysal OVB. Although overnight treatments with STS formulations were not as effective as pulse treatments, their convenience could warrant commercial use.

584 (PS 7)

MOLECULAR INVESTIGATION OF FLOWER SENESCENCE IN DAY LILY (HEMEROCALLIS SP.)

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Rapid senescence of day lily flowers (*Hemerocallis* sp. cv. Cradle Song) has been shown to be associated with a rapid disappearance of proteins. Senescence was significantly delayed by pulsing developing flowers with cycloheximide, an inhibitor of protein synthesis. A cDNA library prepared from mRNA extracted from flowers in the very early stages of senescence was probed with mRNA from flowers at different stages of opening and senescence. Characterization of senescence-specific clones, and implications for the control of senescence in this non-climacteric flower will be discussed.

585 (PS 7)

VASELIFE OF ZINNIA UNDER LOW-TECH CONDITIONS

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When alternative crops are first introduced, prospective growers often lack the expertise and capitol to enter traditional market channels. Farmers' markets often become the initial market for the crop in its' introductory phase. Postharvest handling practices, requiring significant capitol investment and intense management typically are not economically feasible for the small producer. Little work has been done to provide information on practices to prolong vase life of specialty cut flowers under less than ideal commercial conditions. A study was conducted to determine the vase life of field grown zinnias using readily available products for preservatives, no precooling and less than optimum storage and handling practices. Flowers held in a 68 ppm bleach solution had an acceptable vase life of 6.6 days compared to water at 5.7 days and commercial preservative at 8.6 days.

586 (PS 7)

SHELF-LIFE RESPONSES OF TWO MINIATURE POT ROSE CULTIVARS TO PRODUCTION ENVIRONMENT, SHIPPING, AND AOA OR STS TREATMENT.

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Routed liners of Rosa cvs. Meijikatar and Meirutral were potted into 11 cm pots and placed into growth chambers. One chamber provided 14 hours of light with 30C/21C (day/night) air temperature (HTLD) and another chamber provided 8 hours of light with 21C/17C (day/night) air temperature (LTSD). PPF was 725 $\mu\text{moles m}^{-2} \text{s}^{-1}$ in both chambers. When plants were established, they were pinched and forced to flower. Simulated shipping for 4 days at 16C in darkness resulted in a shorter shelf-life when placed in an interior environment at 21C with a continuous PPF of 30 $\mu\text{moles m}^{-2} \text{s}^{-1}$ and compared to non-shipped plants. In addition, LTSD grown plants exhibited a shorter shelf-life than HTLD grown plants. When Meirutral plants were sprayed to runoff 24 hours prior to shipping, 2 mmolar (aminoxy)acetic acid (AOA) increased the shelf-life to the same length as the non-shipped plants and 2 mmolar silver thiosulphate (STS) increased the shelf-life to longer than the non-shipped plants. However, AOA did not increase shelf-life over that of shipped plants for Meijikatar whereas STS increased the shelf-life to that of the non-shipped plants.

587 (PS 7)

RAPID TESTING OF FILMS FOR MODIFIED ATMOSPHERE PACKAGES USING ACTIVE MODIFICATION

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It frequently takes days to weeks for testing films to determine if desired steady state concn of gases are reached when atmospheres are passively modified through commodity respiration. Our objective was to develop a rapid method to test the appropriateness of packaging films and designs using active modification of the atmosphere. Repeated exposures of commodities to partial vacuum were followed by infusion of N_2 to 1 atm. Three to five minutes were allowed following each N_2 infusion. Initial O_2 concn achieved in packages (polyethyl vinyl acetate) depended upon the extent of the vacuum and the number of exposures. Within packages of tomatoes, O_2 concn of $8.3 \pm 0.5\%$ and $5.0 \pm 1.0\%$ were measured following exposure to 460 and 360 mm Hg vacuum, respectively. Three exposures of cabbage and muskmelon packages to 460 mm Hg resulted in O_2 concn of $5.1 \pm 1.4\%$ and $5.0 \pm 1.4\%$, respectively. Maintenance or deviation from actively established atmospheres was determined within hours.

588 (PS 7)

STUDIES ON RHAMNOGALACTURONASE IN FRUIT

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Rhamnogalacturonase (RGase) is a new fungal enzyme which degrades the highly branched regions of apple fruit cell wall pectin by cleaving the glycosyl linkage between rhamnosyl and galacturonosyl residues

(Schols et al., 1990. *Carbohydr. Res.* 206:105.). This enzyme, if present in fruit, could play a significant role in fruit softening. Partial purification of RGase was accomplished from a fungal enzyme preparation (Pectinex Ultra SP-L, NOVO Ferment) produced from *Aspergillus niger*. The crude enzyme hydrolyzed chelator-soluble pectin from red ripe tomato fruit. Methylation linkage analysis of the product suggested that an increase in terminal-rhamnosyl residues accompanied pectin hydrolysis, indicative of RGase activity. Cross-linked alginate, hydroxyapatite, and DEAE-Sephadex chromatography were used to partially purify RGase. Polygalacturonase was efficiently removed using the alginate column. Crude pectin obtained from mature-green tomato fruit cell wall by extracting with 0.5 M imidazole buffer (pH 7) and 50 mM Na-carbonate was incubated with pure polygalacturonase and the residue hydrolyzed with 0.1 N trifluoroacetic acid. This modified pectin was used as a substrate to investigate the presence of RGase in tomato and other fruit.

589 (PS 7)

PURIFICATION AND CHARACTERIZATION OF POLYGALACTURONASE OF 'FUJI' APPLES.

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Polygalacturonase (PG) was purified from apple, *Malus domestica* Borkh, cv. Fuji by gel filtration, CM cellulose ion exchange column chromatography and characterized by means of several biochemical methods. Two forms of isozymes, PG-I and PG-II, were detected and the activities of PG-I were found to be higher than PG-II. The K_m and V_{max} values were calculated to be 1.54 mg/ml and 0.25 μM with reducing sugar 1 ml/30min., respectively. The PG was active between pH 3 and 8 with the optimum pH of about 4-5. The stable temperature for the PG was below 55°C with 30°C optimum. The PG activities were increased by Na^+ and Cu^{++} , but were inhibited by Ag^+ , EDTA and SDS.

590 (PS 7)

PURIFICATION AND CHARACTERIZATION OF β -GALACTOSIDASE OF 'FUJI' APPLES

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β -Galactosidase was purified from apple, *Malus domestica* Borkh, cv. Fuji by gel filtration, CM cellulose ion exchange chromatography, and characterized by means of several biochemical methods. One form of β -Galactosidase was detected and the K_m and V_{max} values were calculated to be 0.035 and 0.036 mM with para-nitrophenyl- β -D-galactoside 1mM/15min., respectively. The β -galactosidase was active between pH 3 and 7 with the optimum pH of about 4-5. The stable temperature for β -galactosidase was lower than 45°C with 30°C optimum. The β -galactosidase activities were inhibited by Ag^+ , EDTA and SDS.

591 (PS 7)

PECTIN OLIGOMERS - POTENTIAL ENDOGENOUS REGULATORS OF RIPENING?

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Acid hydrolysis-generated pectic oligomers have been shown to affect ripening of tomato fruit by inducing both acceleration of reddening and increased ethylene biosynthesis (Campbell & Labavitch, 1991 Plant Physiol 97:706-713). In the present work, homogeneous size classes of these oligomers were demonstrated to have different impacts on ethylene production of tomato fruit pericarp discs. Endogenous oligomeric material of the same size classes was isolated from ripening tomato tissues and also tested for biological activity. They promoted some aspects of ripening as shown by increased ACC and ethylene production, which suggests that pectic oligomers are potential regulators of the ripening process in tomatoes. A metabolic origin for these oligomers is suggested by the fact that they are produced by *in vitro* polygalacturonase I treatment of polygalacturonic acid or tomato pectin.

592 (PS 7)

PLASMA MEMBRANE PHYSICAL-CHEMICAL CHANGES OF MUSKMELON FRUIT DURING MATURATION AND POSTHARVEST STORAGE
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Plasma membrane (PM) from hypodermal-mesocarp tissues of muskmelon fruits (*Cucumis melo* L. var. *reticulatus* Naud.) were compared to the electrolyte leakage changes of the same tissue during maturation and storage at 4 or 24°C. During fruit maturity and storage, leakage of the hypodermal-mesocarp tissue increased, which is coincident with increased total sterol: total phospholipid ratios and increased phospholipid fatty acid saturation index of the PM. ATPase activity, a marker for the PM, indicated that the PM increased in buoyant density from 1.13 g.cm⁻³ to 1.14 g.cm⁻³ during maturity and ATPase activity peaked with fruit maturation. ATPase activity decreased with 10 days postharvest storage and was less at 24°C vs. 4°C, which was coincident with increased hypodermal-mesocarp electrolyte leakage. Biochemical changes within the sterol and phospholipid matrix of the PM are suggested to contain the processes capable of altering fruit membrane permeability and subsequent muskmelon fruit storage life.

593 (PS 8)

DIURNAL PHOTOSYNTHESIS AND STARCH DEPOSITION IN LEAVES OF FRUITING AND DEFLOWERED RED RASPBERRY CANES

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On four dates during the 1991 growing season, gas exchange rates were measured on the same middle leaflets every 3 h from 7am-10pm from deflowered (DF) and fruiting (F) red raspberry (*Rubus idaeus* L. cv. "Meeker") canes. Concurrently, the adjacent side leaflets were sampled for anatomical starch determination. The dates corresponded to the late anthesis/early green fruit, early red fruit, late red fruit, and post fruit maturity stages of the growing season. For all dates, CO₂ assimilation (A) was highest from 7-10am, lowest at 4pm, and increased at 7pm. Overall A peaked during fruit development. Leaves of F canes had greater A than leaves of DF canes during fruit development, but rates were similar after fruit maturity.

Starch accumulation in leaf cross-sections generally followed the diurnal pattern observed for A. Starch appeared heaviest from 7am-1pm and often showed an increase from 7-10pm. Leaves from DF canes generally had a greater accumulation of starch. Seasonally, leaf starch from F canes appeared greatest at late anthesis, decreased during fruit development and was very low post fruit maturity. Leaf starch in DF canes appeared greatest at the late anthesis and late red fruit stages.

DF leaves had greater dry weight accumulation than F leaves during the red fruit stages. A Western blot showed that Rubisco levels as a percentage of total soluble protein were higher during fruit development and decreased after fruit maturity.

594 (PS 8)

NAD-DEPENDENT AND NADP-DEPENDENT ALCOHOL DEHYDROGENASE ENZYMES: ANALYSIS OF THEIR FUNCTIONAL SIGNIFICANCE IN STRAWBERRY FRUITS
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Assays of enzyme activity, *in vivo* inhibition studies and the developmental analysis of strawberry (*Fragaria x ananassa* Duch.) fruit alcohol dehydrogenases (ADH) suggest that both the NAD- (E.C. 1.1.1.1) and the NADP-dependent (E.C. 1.1.1.2) forms of ADH enzymes play integral roles in the development and ripening of fruits. One role of ADH enzymes appears to be the evocation of changes in sugar, soluble solids, acidity and volatile compounds necessary for the normal organoleptic character of strawberry fruits. The data presented includes: 1.) The wide substrate specificity of both ADH enzymes for the "fragrance and flavor alcohols and aldehydes" synthesized by ripe strawberry fruits, 2.) the effect of inhibitors of ADH activity upon strawberry fruit ripening, and 3.) the comparative regulation of NAD- and NADP-ADH enzymes including 4.) the developmental control of ADH enzymes in strawberry fruits.

595 (PS 8)

PHOTOSYNTHESIS AND CARBOHYDRATE PARTITIONING IN CRANBERRY.

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Fruit set has been shown to be a major limiting factor in cranberry (*Vaccinium macrocarpon* Ait.) productivity. Total nonstructural carbohydrate (TNC) content is lowest during the flowering and fruit set period. This research was undertaken to determine the potential sources of carbohydrates which are important to support fruit set and fruit growth in cranberry. Fruiting uprights had lower TNC content than vegetative

uprights beginning at early bloom and continuing through harvest, largely due to lower starch content. Starch from fruiting uprights is apparently remobilized to support flowering and fruit set. This also suggests that uprights on which the fruit are borne are the primary source for carbohydrates for fruit set and fruit growth throughout the season. Net CO₂ assimilation rates (NAR) were measured in the field on current season and one year old leaves on cranberry uprights. New leaves had higher NAR than one year old leaves throughout the season. Thus, newly formed leaves on uprights, appear to be an important source for carbohydrates for fruit set and fruit growth. On a diurnal basis NAR peaked at approximately 9:00 a.m. and gradually declined through the day.

596 (PS 8)

WATER CONTENT IN PRIMARY GRAPE BUDS

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Changes in water content of 'Pinot Noir' endo- and ecodormant primary buds were gravimetrically partitioned into extracellular (ECW) and intracellular water (ICW). During endodormancy, water status remained unchanged with values of 0.6 and 0.1 mg/mg dw for ICW and ECW, respectively. Ecodormant buds, prior to budbreak, increased in ICW from 0.5 to 4.4 mg/mg dry weight for Jan. and Apr., respectively. Liquid water in the buds was determined by H-NMR. The spin-spin relaxation time (T₂) at -30°C represented the bound fraction, which peaked in Jan. at 0.3 mg/mg dw followed by a decrease to 0.2 mg/mg dw in March. During the dormant season the free fraction was always larger than the bound fraction. No vascular connection between bud and stem was observed by mid Jan. Changes in bound water indicated that there is a transient fraction changing to the free form. These changes were not strictly related to the bud's dormancy status.

597 (PS 8)

STRAWBERRY GROWTH FOLLOWING A SUB-LETHAL FREEZE

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'Earliglow' strawberry (*Fragaria x ananassa* Duch.) plants were frozen to -5°C to examine the distribution of ice in the crowns. Anatomical studies were also performed to characterize tissue growth in a greenhouse at 4, 8, and 16 weeks after freezing to -5°C. Ice masses observed in fresh crown tissue corresponded to the presence of extracellular tissue voids in specimens fixed for scanning electron microscopy (SEM). Voids were present near the peduncle and adjacent to the vascular system in crown tissue. After plants were grown in the greenhouse, cell division and enlargement were observed near the voids in crowns subjected to -5°C. By 15 weeks after freezing, a few small extracellular voids remained in the crowns.

598 (PS 8)

STAINING TECHNIQUE TO ASSESS FREEZE INJURY IN OVERWINTERING BUDS OF 'DANKA' BLACK CURRANT

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'Danka' black currant floral buds produce multiple low temperature exotherms (LTEs). However, the absence of visual injury symptoms in the buds after exposure to subfreezing temperatures make it difficult to assess injury in these buds. A 2,3,5-triphenyltetrazolium chloride (TTC) reduction assay was used to determine whether LTEs corresponded to freezing injury of individual floral primordia or to the entire floral axis. Intact buds were cooled at 3°C/n, removed at 30 intervals from -12 to -33°C, and thawed on ice for 24 h. Duplicate samples were subjected to differential thermal analysis. Freeze injury could not be measured with TTC in thawed, intact buds. However, incubation of excised floral primordia in TTC resulted in an all or nothing response. The number of LTEs did not correspond to the number of floral primordia killed within a floral bud, but the median LTE did correspond with the temperature at which lethal injury of the whole inflorescence occurred. Therefore, preliminary results indicate that TTC reduction assay of individual floral buds is a fast, reliable technique to assess bud injury.

599 (PS 8)

SEASONAL CHANGE IN COLD HARDINESS AND DAYS TO
BUDBREAK OF *RUBUS IDAEUS* L. 'CHILCOTIN', 'CHILLIWACK',
'MEEKER', AND 'WILLAMETTE'

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Days to bud break and freezing tolerance of 'Chilcotin',
'Chilliwack', 'Meeker' and 'Willamette' red raspberry were measured
during the 1990-1991 winter and at monthly intervals from mid-September
1991 through mid-March 1992. Canes were harvested from the field
and cut into two-bud samples which were either frozen in laboratory
tests or held with cut stem ends in water in a controlled environment
chamber and monitored daily until bud growth was observed. Viability
was estimated by visual browning after exposure to controlled laboratory
freezing treatments. In general, freeze test results indicated 'Meeker'
and 'Willamette' were not as hardy as 'Chilliwack' and 'Chilcotin' in late
fall and midwinter but retained their hardiness longer in spring. Results
for 1990-1991 indicated the greatest delay in days to bud break occurred
in midwinter.

600 (PS 8)

RAPID LAB SCREENING METHODS FOR WINTER
PROTECTION METHODS OF STRAWBERRY.

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On average, one year in ten is a true test winter for
screening winter hardy plants. Thus, screening of cultural
practices under field conditions is often difficult, requiring many
years data. In Saskatchewan, the two major winter stresses are
low temperature and desiccation. Under controlled lab conditions,
a rapid screening method for cultural practices on strawberry
(*Fragaria x ananassa* Duch.) plants was developed. Temperature
profiles and survival under various row covers and mulches in this
controlled system corresponded well to previous field results.
Straw over plastic and snow over plastic row covers conferred the
best low temperature protection on these plants.

601 (PS 8)

THE EFFECT OF LEAF WATER STRESS AND AGE ON PHOTOSYNTHESIS IN
STRAWBERRY PLANTS

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The effect of water stress on photosynthesis was
investigated in strawberry plants to see responses of
different aged-leaves within the same plant. Preliminary
results indicated that, under severe stress (SS) conditions,
young leaves had lower water potentials and higher
photosynthetic CO₂ assimilation rates than old leaves had, due
to higher stomatal conductance in young leaves. This
situation was not found in moderately stressed or well-watered
plants, probably because of the higher non-stomatal limitation
in old leaves under SS condition. Under SS condition, old
leaves had a higher intracellular CO₂ concentration. Osmotic
adjustment or acclimation might occur during slow drying
process, so that the young leaves could adjust their stomata
and still remain open under low water potentials.

603 (PS 8)

RELATIVE HARDINESS OF BLOSSOMS AND SMALL NUTS OF
NINE ALMOND CULTIVARS

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Almond (*Prunus dulcis* Mill.) cultivars vary in
tolerance to cold with flowers at pink bud more
tolerant than at full bloom or than small nuts.
Branch samples 60 cm long with 30-100 blossoms or
nuts were cut, sprayed with water, and artificially
frozen. Subsamples were removed after exposure to 4
to 6 successively lower temperatures for 30 minutes.
After 48 hours of ambient temperatures, flowers or
small nuts were sectioned and examined for visual
evidence of injury. Of the early cultivars,
'Peerless', is most sensitive at full bloom and
'Sonora' is most hardy. 'Sonora' is especially hardy
at pink bud. 'NePlus Ultra' is intermediate. Of the
mid-blooming cultivars, 'Carmel' is most sensitive
to cold while 'Nonpareil' is most tolerant. 'Price'
is intermediate. The late blooming cultivar,

'Mission' is most sensitive while 'Padre' and
'Butte' appear similar. This study compared several
popular new cultivars to older industry standards.

605 (PS 8)

DROUGHT STRESS ALTERS BIOGENESIS OF APPLE LEAF VOLATILES

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Potted apple trees were severely (S) or moderately
(M) droughted and compared to a well-watered control (C)
to determine changes in biogenesis of leaf volatile compounds.
Total available water (TAW) of the soil was allowed to
decline to near 0% TAW, 20% TAW, and 100% TAW, for S, M and
C, respectively, by the end of a two-week drying period.
Twenty-nine volatile compounds were identified by GC-MS
using headspace sampling of detached leaves. Concentrations
of (E)-2-hexenal, (E)-2-hexenyl acetate, 1-hexanol, (E)-2-
hexen-1-ol and hexyl acetate were 5 to 310 times higher for
S than C. It is suggested that the large drought induced
increase in C-6 compounds was related to enhanced
lipoxygenase activity.

606 (PS 8)

COLD HARDINESS OF PASSION FRUIT AND MAYPOP

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Differential thermal analysis, electrolyte leakage,
tetrazolium stain test, and the "feeder plate" tissue
culture regeneration technique were used to determine cold
hardiness of passion fruit and maypop. The "feeder plate"
technique showed that yellow passion fruit did not
regenerate at 0C, -3C, and -6C while purple passion fruit
showed callus formation at all temperatures. The
remaining tests gave similar lethal temperatures for the
two species. Lethal temperatures were -9C to -10C, -10C
to -12C, and -11C to -13C for yellow and purple passion
fruit and maypop, respectively.

607 (PS 8)

SEEDLING EMERGENCE AND GROWTH OF THREE CITRUS ROOTSTOCKS UNDER
SALT STRESS

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Salt tolerance of Carrizo citrange (CC), sour orange
(SO), and Cleopatra mandarin (CM) rootstocks during seedling
emergence (SE) and early seedling growth (SG) was studied
under greenhouse conditions. Increasing salt (NaCl + CaSO₄)
concentration delayed and depressed SE, increased time to 50%
emergence, reduced SG, but did not affect emergence spread.
At the first salinity level (5 mmol), emergence of the first
seedling (EFS) was delayed by 2 to 3 days in CC and one day in
SO but was not affected in CM. At the highest salt level (80
mmol), EFS was delayed by up to 6, 7, and 5 days for CC, SO,
and CM, respectively. At the two lowest salinity levels (5
and 10 mmol), final percent emergence (FPE) was not affected
in CC but was reduced in SO and CM while shoot biomass was
reduced in CC but was not affected in SO and CM. At the 80
mmol salt level, FPE was reduced by 23% in CC and by 33% in SO
and CM while SG was reduced by 70% in CC and by 60% in SO and
CM. Among the rootstocks studied, the delay in emergence was
not necessarily more salt sensitive than FPE. However, SG was
generally more affected by salinity than SE, particularly at
high salinity levels (20, 40, and 80 mmol).

608 (PS 8)

GROWTH OF LETTUCE IN ANIONIC SURFACTANTS

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Anionic surfactants are the major class of surfactants used in
detergent, laundry and related industries. Hence, they are a
major contaminate of both domestic and industrial waste
streams. Lettuce (*Lactuca sativa* cv Waldemann's Green) was
grown in nutrient solutions with the addition of the anionic
surfactant, Igepon TC-42. The toxic response of lettuce to Igepon
was that the roots turned brown and became necrotic within 24 h

following exposure. Growth was suppressed for approximately 4 days following exposure to concentration greater than 0.35 mM; new roots formed rapidly and growth resumed. When fresh plants were transferred to the solutions containing Igepon 48 h following introduction of the surfactant no signs of toxicity were observed. This would indicate that either the first series of plants absorbed the toxic material or the Igepon was decayed or degraded in the nutrient solution. The rapid recovery of plants from this stress suggests the potential of a wide range of strategies that could be developed for utilizing waste streams containing anionic surfactants.

609 (PS 8)

LETTUCE SEEDLING RESPONSE TO DETERGENTS RECOMMENDED FOR SPACE TRAVEL

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Water contributes approximately 90% of the life support consumables in a closed space environment, therefore, regeneration of pure water from waste streams is important for long term space travel. Controlled Ecological Life Support Systems (CELSS) will rely on plants to produce food, oxygen, consume CO₂ and purify water. Igepon TC42, Amide coco N-methyl N-2-sulphoethyl sodium salt, is the main ingredient of the soap recommended for showering and hand washing aboard Space Station Freedom. To determine the soap concentration which causes plant toxicity, lettuce seeds were germinated in 0.1 strength modified Hoagland's nutrient solution and a series of increasing concentrations of Igepon. After 5 days, the seedlings were examined and primary root length measured. The dose response curve indicates an Igepon acute toxicity threshold of 0.2 g l⁻¹. Below the threshold concentration the curve is similar to that of the control, but drops linearly upon reaching the toxic threshold. Seedlings exposed to concentrations of soap greater than the toxic threshold exhibited root damage characterized by the browning of cells in bands above the root cap resulting in reduced growth rates. The damaged cells enlarged becoming round in appearance prior to departing from adjacent cells. The underlying cells appeared clear and uniform making up a thinner, more fragile root mass when compared to undamaged root regions.

610 (PS 8)

CAN PLANTS DETECT SMALL DIFFERENCES IN IRRADIANCE OBTAINED BY VARYING THE REFLECTANCE PROPERTIES OF THE GROWTH CHAMBER WALLS?

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A controlled-environment study was conducted in separate growth chambers with the wall surface covered either with white enamel paint (WEP) or polished aluminum (PA). 'Williams' soybean were grown under 1500 mA cool white fluorescent lamps and internodes measured at 7, 14, and 21 days. Photosynthetic photon flux (PPF) levels in the center of each chamber were set at 320 $\mu\text{mol m}^{-2} \text{s}^{-1}$ with a quantum sensor. Means $\pm$ SD for PPF levels in the WEP and PA chambers were 286 $\pm$ 28 and 307 $\pm$ 11 $\mu\text{mol m}^{-2} \text{s}^{-1}$, respectively. This increase in mean PPF and decrease in variance of PPF in the PA chamber was reflected in: a) a decrease in hypocotyl, first internode, and total shoot elongation; and b) an increase in enlargement of the primary and the first trifoliate leaves. These findings demonstrate that plants can detect small differences in irradiance within a growth chamber and suggest the advantages of using a highly polished wall surface to improve uniformity of irradiance and reduce variability in growth.

611 (PS 8)

SENSITIVITY OF FRENCH PRUNE PRODUCTION TO WATER DEPRIVATION AT DIFFERENT STAGES OF FRUIT GROWTH

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During this three year study, irrigation water was withheld from trees in a commercial drip irrigated french prune orchard (Butte County, CA), during different periods within the double sigmoid fruit growth pattern (stage I - III), and postharvest. Tree water stress associated with early season water deprivation was minimal, due to the presence of stored soil moisture and low evaporative demands. For mid and late season water deprivation there was no fruit growth stage that was particularly sensitive to water stress, although severe and prolonged stress caused smaller fruit with lower quality. For the three year average, irrigation treatments caused no statistically significant effects on fruit set or drop relative to the control, however most of the stress treatments

increased return bloom relative to the control, resulting in higher fruit loads and higher yields. These results suggest that moderate water stress may enhance economic prune productivity.

612 (PS 8)

PHENOLOGICAL RESPONSES OF PLANTS TO THERMAL GRADIENTS

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Controversy over regional climatic change (RCC) and the direction of RCC continues. Models that predict how local plants would respond to defined regional climatic warming (RCW) would be useful.

The urban heat island intensity (UHII) has been documented in a number of cities including Houston, Texas, Phoenix, Arizona, St. Louis, Missouri, and Gainesville, Florida. We studies the phenological response of selected horticultural plants growing along urban/rural thermal gradients in several cities where the UHII had previously been defined. Deciduous plants flowered earlier in the spring and retained their leaves longer in the fall in warmer urban areas than they did in adjacent rural areas.

The phenological response of local plants to known thermal gradients appears to be a useful model of the phenological effects of potential RCW.

613 (PS 8)

PROLINE AND ABA INDUCING CHILLING TOLERANCE VIA DIFFERENT MECHANISMS

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Exogenous proline and ABA can induce chilling tolerance. Whether there is any relationship between the proline and ABA in inducing chilling tolerance is not known. We attempted to elucidate their interrelationship by comparing the time course of proline and ABA induced chilling tolerance and of the uptake of proline and ABA in the cultured cells of maize (*Zea mays* L. Black Mexican Sweet). The uptake of proline was increasing continually during a 24 h culture at 28°C. However, the proline induced chilling tolerance became significant after 6 h treatment and reached maximum after 12 h. When cells were transferred to a ABA-containing medium the uptake of ABA in the cells reached almost plateau in 2 h period. The ABA-induced chilling tolerance was insignificant at 6 h, became significant at 12 h, and reached maximum at 24 h. Although the rate of ABA induced chilling tolerance was slower than the rate of proline induced chilling tolerance, there was no any increase in endogenous free proline in the ABA treated cells. Statistical analysis indicates that there is no interrelationship between proline and ABA in the induction of chilling tolerance in maize. ABA induces specific proteins which may play essential role(s) in the development of chilling tolerance. None of these proteins was observed in proline treated cells. We concluded that the induction mechanisms of chilling tolerance between proline and ABA are independent in maize.

614 (PS 8)

USING WILD MUSTARD AND TALL FESCUE TO LOWER BORON AND SELENIUM CONCENTRATION IN THE SOIL

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High concentration of boron (B) and selenium (Se) found in the environment may be detrimental to the sustainability of agriculture in regions of the western USA. Boron and Se uptake by wild mustard (*Brassica juncea* (L Czern & Coss.)) and tall fescue (*Festuca arundinacea* Schreb. L.) was investigated under greenhouse conditions in thermic typic torriorthent soils containing naturally high levels of B and Se. The design structure was a randomized complete block with six 18-L plots per treatment, three blocks, and two treatments. After plants were harvested and separated into shoots and roots, tissues were analyzed for total tissue B and Se, and soils from each pot were analyzed for residual B and Se. The highest concentrations of B were recovered in shoots from wild mustard and roots from tall fescue. Tissue Se concentrations were generally similar in both plant species. Post-harvest soil B and Se concentrations were significantly lowered irrespective of the plant species and of the harvest. The effectiveness of using wild mustard and tall fescue for B and Se soil reclamation will be discussed.

615 (PS 8)

LOCALIZATION OF PECTINS IN XYLEM RAY CELLS OF WOODY PLANTS.

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Our previous research has indicated that the pit membrane regulates deep supercooling of xylem parenchyma in woody plants. This area of the cell wall is composed of three layers that may be rich in pectins. Since pectins may define the porosity of the cell wall they may also regulate deep supercooling. The present study examined pectin

distribution in ray cells using monoclonal antibodies, that recognize un-esterified (JIM5) and methyl-esterified (JIM7) epitopes of pectin, in conjunction with immunogold electron microscopy. Antibodies were obtained courtesy of J. Paul Knox, John Innes Inst., U.K. Dormant and non-dormant tissues of *Prunus persica*, *Cornus florida* and *Salix babylonica* were utilized. Labelling with JIM7 revealed that methyl-esterified pectins were abundant and evenly distributed within the primary cell wall and amorphous layer. Labelling with JIM5 revealed that un-esterified pectins were located specifically within the pit membrane, in the outer region of the primary cell wall. No differences were observed between species, however, preliminary data indicated that JIM5 labelling was greater in dormant than in non-dormant tissues.

616 (PS 8)

EFFECTS OF SULFATE SALINITY AND SELENIUM TOLERANCE OF PLANTS ON SELENIUM ASSIMILATION IN WHITE CLOVER AND TALL FESCUE. Lin Wu* and Zhang Z. Huang Department of Environmental Horticulture, University of California, Davis CA 95616.

Substantial difference of selenium tolerance was found between the tall fescue (*Festuca arundinacea* Schreb.) and white clover (*Trifolium repens* L.). An inverse relationship between Se accumulation and Se tolerance suggests an exclusion mechanism that restricts Se uptake by the plant with greater Se tolerance. A positive relationship between the increase of protein Se concentration and growth inhibition in the plants suggests that assimilation of Se into protein is responsible for the reducing Se toxicity at the protein level. No evidence of a Se exclusion mechanism which exclude Se from incorporating into protein plays any major role of Se tolerance in this two species.

617 (PS 8)

AMELIORATION OF CHILLING INJURY IN *PHASEOLUS VULGARIS* BY GLK-8903.

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Protection mechanism of a new compound, coded as GLK-8903, from chilling injury in bean plants was assessed by measuring several physiological parameters. The decline in leaf water potential caused by the chilling exposure to 4°C (day/night) was minimized when GLK-8903 was applied to the plants as compared to the non-treated control. Chilling causes an increase in electrolyte leakage, an indication of chilling injury that occurs at the site of plasma membrane. An increased electrolyte leakage was reduced in the GLK-8903-treated plants during chilling. Data from plasmolysis and deplasmolysis studies of epidermal cells suggest that GLK-8903 is able to stabilize the plasma membrane under stress condition by determining the permeability coefficients plasmometrically (1.96 cm s⁻¹ x 10⁻⁴ for GLK-8903-treated plants vs. 4.00 for the controls 3 d at 4°C) with less decreased activity of the plasma membrane ATPase (9.36 μmol ATP.mg chl⁻¹.h⁻¹ for GLK-8903-treated plants vs. 5.04 for the controls 3 d at 4°C). GLK-8903 appears to have high application potential in protecting bean plants from chilling injury with improved yield.

618 (PS 8)

INTERACTION BETWEEN DIURNAL TEMPERATURE FLUCTUATIONS AND GIBBERELLINS ON *LYCOPERSICON* STEM ELONGATION AND CHLOROPHYLL CONTENT.

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Lycopersicon esculentum cv 'Money Maker' seeds were germinated at constant 20°C. Three days after germination seedlings were randomly divided into 3 groups and placed into 3 growth chambers maintained at 23/17, 20/20, or 17/23°C (day/night temperature) (DT/NT). Irradiance and photoperiod were maintained at 250 μmol s⁻¹ m⁻² and 12 hrs, respectively. At the 2 leaf stage, plants in each chamber were divided into 3 groups of 3 plants each to receive a growth regulator treatment. Growth regulator treatments consisted of spray applications of either ancymidol (52ppm), GA₃ (12ppm), or water applied every 3 days for 21 days. Measurements were taken on internode length and chlorophyll content after 21 days. Internode length increased as the difference (DIF) between DT and NT increased (DT-NT). Exogenous applications of GA₃ overcame inhibition of stem elongation resulting from a -DIF environment. Application of ancymidol did not significantly decrease stem elongation in a -DIF environment. Temperature regime had a significant impact on chlorophyll content per mg dry weight. In contrast, growth regulator applications had a significant impact on chlorophyll content cm⁻². There was no significant impact of either temperature regime or growth regulator treatment on the chlorophyll a/b ratio.

619 (PS 9)

RUNNERING RESPONSE OF DIVERSE STRAWBERRY GENOTYPES Carolyn L. Paynter* and Barbara M. Reed, USDA-ARS National Plant Germplasm Repository, Corvallis, Oregon 97333-2521

The National Plant Germplasm Repository, Corvallis, houses over 700 different *Fragaria* genotypes. Many of these produce few or no runners, making propagation difficult by in vitro or conventional methods. Experiments were run to determine the response of non-runnering genotypes to environmental conditions and GA₃ treatments. Two groups of plants of 12 genotypes were grown in a 25°C growth chamber (GC) with 24 h light. One group was sprayed twice with 500 ppm GA₃, 24 h apart, while a second group was not sprayed. Control plants of each genotype were grown at ambient temperature and long days and were not sprayed with GA₃. Both *F. vesca* L. cultivars and day-neutral genotypes produced significantly more runners with the GA₃ GC treatment than the unsprayed GC or the control. Most June-bearing cultivars had improved runnering with both GC treatments. A separate experiment using 30 genotypes with two GA₃ sprays (500 ppm, 24 h apart) at ambient temperature and long daylength showed that plants with the GA₃ sprays produced significantly more runners than unsprayed controls. In both experiments, GA₃ sprays improved runner production by most of the unresponsive *Fragaria* genotypes.

620 (PS 9)

TETRASOMIC INHERITANCE OF ISOZYME AND PHENOTYPIC MARKERS IN ALLOTETRAPLOID BLUEBERRIES

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A study was done to test whether inheritance is tetrasomic or disomic in tetraploid F1 hybrids between 2x *Vaccinium elliotii* Chapm. and 4x *V. corymbosum* L. Seventeen F1 hybrids derived from *V. elliotii* homozygous for recessive anthocyanin deficiency (AD) were confirmed by isozyme analysis and, where *V. elliotii* was the seed parent, by the presence of anthocyanin. Fertile hybrids with high pollen stainability were assumed to be 4x and duplex for the AD allele, having arisen from 2n gametes in *V. elliotii*. In nine F1 X F1 crosses, all progeny populations segregated for AD phenotype at or above the expected tetrasomic ratio of 1 AD:35 normal; no AD would be expected with disomic inheritance. Tetraploid AD progeny were used in testcrosses on sixteen F1 hybrids in 1991. Progeny segregated tetrasomically, 1 AD:5 normal. Isozyme loci PGD-2 and PGI-2 also segregated tetrasomically.

621 (PS 9)

GENOTYPE X LOCATION INTERACTIONS IN BLUEBERRY

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Rabbiteye (*Vaccinium ashei* Reade) and southern highbush (mostly *V. corymbosum* L.) type blueberry selections were evaluated in regional trials at five locations. Entry X location interactions (E X L) were significant for all traits in the rabbiteye type and all except plant productivity, plant volume, Julian date of 50% ripe fruit, and berry weight at harvest 3 in the southern highbush type. Despite the significant interactions, selection FL80-11 and 'Gulfcoast' were the earliest flowering rabbiteye and southern highbush entry, respectively, at each location. Significant E X L for plant volume and yield suggests that adaptation to the local environment is important in the selection of potential cultivars. Fruit quality traits appear less affected by environment than fruit production traits for the entries tested.

622 (PS 9)

USE OF CLONALLY REPLICATED SEEDLINGS IN FIELD SCREENING FOR RESISTANCE TO PEACH TREE SHORT LIFE

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Lovell rootstock is recommended for Peach Tree Short Life (PTSL) sites in the Southeast because it outlives Nemaguard. No genetic studies of PTSL tolerance have been done. Clonally replicated peach seedlings [*Prunus persica* (L.) Batsch] of Lovell, Nemaguard and four F₁ selections of Lovell x

Nemared were tested for field survival in a high density planting on a PTSL site. Rootstock families (12 seedlings x 8 ramets each) differed in growth, survival and longevity. Genetic variation was comparable to environmental variation for most families. Based on seedling within rootstock family, estimated broad-sense heritabilities for survival and longevity were high. The use of clonally replicated seedlings allowed the selection of apparently superior individuals from both Lovell and the other more short-lived rootstock families in a single screening after 6 years. Survival of Lovell at that time was 50% compared to 16-29% for other families. Across all families, all 8 ramets were dead for 21 seedlings, whereas all 8 were alive for only 3 seedlings.

623 (PS 17)

EVALUATION OF ELECTROLYTE LEAKAGE FROM CRYOPRESERVED APPLE BUDS

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Three years ago we established a long-term cryogenic storage project for apple germplasm and utilized grafting of buds obtained from stored dormant shoot sections as the major viability assay. Grafting, however, is time consuming and requires considerable skill. Electrolyte leakage and oxidative browning tests were used as alternative viability assays. Using leakage from individual buds in a multiwell analyzer, we examined modifications of the electrolyte leakage test and analyzed the kinetics of leakage in an attempt to determine whether the test can predict grafting success. The results suggest that more buds were viable than were estimated by the grafting test. In vitro culture is being examined to test this and to determine if practical recovery is feasible for diversity within the germplasm collection.

624 (PS 9)

THE EFFECT OF ENFORCED SELFING ON RESULTANT SEED AND SEEDLING QUALITY IN THE SELF-INCOMPATIBLE ALMOND VARIETY *NONPAREIL*

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All of the major California almond varieties are self-incompatible necessitating the interplanting of pollinizer varieties. The incorporation of self-compatibility into the dominant variety *Nonpareil* through mutation or genetic engineering would greatly improve cropping efficiency. Negative effects of inbreeding on resultant seed and seedling quality could negate production advantages. Inbred seed of *Nonpareil* were obtained by:

a) enclosing mature trees in pollination cages containing bees at flowering, and, b) controlled crosses to a *Nonpareil* mutation (*Jeffries*) which is unilaterally compatible when used as the seed parent. Selfed seed set from caged trees was less than 0.001% of available flowers. Seed set from crosses to the *Jeffries* mutation averaged 34.4% which was not significantly different than outcrossed controls. No significant loss in kernel weight and dimensions were observed in any of the inbred material when compared with outcrossed controls though a higher proportion of the inbred seed and seedlings failed to develop fully. Both average tree height and trunk diameter after 1 year of growth was significantly lower in inbred vs. outcrossed material. Results suggest no major penalty to kernel quality following self-pollination, though losses in progeny vigor should be a concern when utilizing selfed seed in variety development programs.

625 (PS 9)

VERIFICATION OF AN EPIDEMIOLOGY MODEL OF NONINFECTIOUS BUD-FAILURE IN 'CARMEL' ALMOND

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A model for the epidemiology of noninfectious bud-failure (Fenton, et al., 1988) predicts that BF-potential is universally present within specific almond cultivars with variation existing in the rate and pattern of development of BF phenotypes. Orchard surveys of Carmel in 1990 and 1991 involving four nursery sources showed a trend of 2 per cent of affected trees after one year in the orchard, increasing to 4 per cent in the second, with prospects for gradual increase with time. All four sources produced some BF trees with significant differences among sources. A study has been started to identify the source and pattern of BF-potential within the entire Carmel cultivar. It has two parts. A pedigree analysis of propagation sources from eleven commercial nurseries traces their genealogy from the original seedling plant first discovered in 1947. A propagation test of approximately 3000 individual trees representative of the propagation sources of all eleven commercial nurseries has been established. The origin of each progeny tree has been maintained in respect to source, tree, budstick and individual bud location on the stick. Expression of bud-failure symptoms in individual trees will identify the source and pattern of BF-potential within the cultivar.

626 (PS 9)

GENETIC STUDIES ON WILD *PRUNUS YEDOENSIS* VAR. *NUDIFLORA* AND ITS PUTATIVE PARENTS GROWING IN HAENAM DISTRICTS IN KOREA.

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This study was carried out to investigate the distribution, morphological and ecological characteristics, cross fertility and peroxidase banding pattern in floral buds of wild *Prunus yedoensis* var. *nudiflora* and its putative parents, *P. subhirtella* and *P. donarium* growing at Haenam districts in Korea. *P. yedoensis* was distributed 200-250 m elevation and showed extensive variations in sterility and morphological variations. The morphological characteristics of *P. yedoensis* are judged to be intermediate between *P. subhirtella* and *P. donarium*. *P. subhirtella* and *P. donarium* were naturally found 150-350 m and 150-900 m elevation. Flowering date of *P. subhirtella*, *P. donarium* and *P. yedoensis* were early April, mid-to-late April and around April 8, respectively. The floral morphology of *P. yedoensis* showed greater variations than that of *P. subhirtella*. It is proved that *P. yedoensis* is an interspecific hybrid between *P. subhirtella* and *P. donarium* considering the intermediate characteristics of flower, leaf and peroxidase banding pattern of the floral buds by isoelectric focusing electrophoresis.

627 (PS 9)

INHERITANCE OF LOW CHILLING CHARACTER ON THREE ALMOND PROGENIES.

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Almond production is restricted to areas with at least 300 chill units. Selection of plants with lower chilling requirements is a priority in our area. The progenies of two low chilling cvs. 'Rané' and 'Constantini' and one of medium chilling cv. 'Cavaliera' were chosen for this study. The selected trees were open pollinated and 100 seeds of each variety were planted on individual pots after three week stratification. Three groups were formed according to the speed of germination and transplanted to the nursery. The date of blooming of each individual was recorded. A positive correlation was found between time of blooming of the progenitor and that of the progeny regardless of the origin. On the descendance of 'Cavaliera', a positive correlation between speed of germination and bloom date was observed. However on 'Constantini' and 'Rané' progenies, the same correlation had no significance. 'Cavaliera' produced a 45% of low chilling requirement descendants, 'Rané' had 67% and 'Constantini' had the higher ability to transmit the low chilling character with a 78% of the progeny with that trait.

628 (PS 9)

PAPAYA RINGSPOT VIRUS TOLERANCE AMONG DIVERSE PAPAYA GENOTYPES

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Open-pollinated progeny from 20 papaya (*Carica papaya*) cultivars, 2 *Carica pubescens* and 1 *C. goudotiana* were evaluated for vegetative growth and for tolerance to papaya ringspot virus under greenhouse and field condition. The artificial inoculation with the viral strain of severe mottle and necrosis symptom type was followed two months after germination. The survival rate and symptom development were significant difference among genotypes. Plant height was negatively correlated with viral survival rate; $r = 0.58^{***}$ at greenhouse, and $r = 0.56^{***}$ in the field, respectively. The direct ELISA (the conjugate of purified McAb-14 with alkaline phosphatase) was applied to guarantee successful inoculation and to detect plant responding to viral infection one month after artificial inoculation. Then, selection for resistance to papaya ringspot virus is done on a single plant basis. The progeny of positive index of direct ELISA with no symptom development had often from the parent with higher survival rate.

629 (PS 9)

PROCUMBENT GROWTH HABIT CHARACTERIZED IN SEEDLINGS OF 'CIPÓ' ORANGE

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'Cipo' sweet orange [*Citrus sinensis* (L.) Osbeck] is distinctive among citrus selections because of reduced tree height and procumbent growth habit. Open-pollinated seeds were collected from

'Cipo' orange and 'Pineapple' sweet orange (*C. sinensis*) at Riverside, California, and grown under cool greenhouse conditions. Seedlings of 'Cipo' were relatively uniform in morphology (including drooping shoot habit) and were presumed to be apomicts derived from nucellar embryos. 'Cipo' seedlings were distinctly different from 'Pineapple' in several characteristics, including smaller shoot altitude/extension ratios (a measure of uprightness) and broader stem-petiole angles ('Cipo' 1.33 radians; 'Pineapple' 0.84 radians). The procumbent habit of 'Cipo' appeared to be related to a preference for horizontal shoot orientation rather than a weakness of stem structure. Some increased sensitivity to ethylene was observed in the 'Cipo' seedlings. 'Cipo' is proposed as a resource for hormone research and a potential parent in breeding for unique tree morphology and reduced tree size.

630 (PS 9)

A COMPARISON OF ATTITUDES AND PRACTICES AMONG SECTORS OF THE FLORICULTURAL INDUSTRY

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Floricultural producers, cut flower wholesalers, mass market retailers and general retailers were surveyed to compare and contrast the industry in terms of attitudes and problems. Questions involved general business information, as well as specific crops. Overall, all four segments of the industry were neutral to negative on potted flowering plants, but were positive to neutral on bedding and foliage plants. However, producers were slightly negative concerning the postharvest life of bedding plants. While cut flower wholesalers had a positive attitude concerning cut flowers, retailers and mass marketers tended to be neutral to negative. In particular, retailers and mass marketers felt cut flowers were too expensive and too short lived. Floral preservatives were used by 81.6% of general retailers, while only 18.8% of mass market retailers used preservatives. All cut flower wholesalers used preservatives. Capital availability and market demand were the factors most limiting to expansion for producers and general retailers; mass market firms listed competition as their most limiting factor. Results from other questions will also be provided.

631 (PS 9)

REQUIREMENTS AND COSTS OF ESTABLISHING AND OPERATING A GARDEN CENTER

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The objective of this project is to estimate establishment and operating costs for garden centers at two levels of sales and to specify the general set of financial, marketing and business principles that should be available to the owner/manager of a garden center.

After surveying 25 garden centers across the United States, two models were derived. A large garden center with annual sales of \$1,000,000 is described. A smaller garden center with annual sales of \$350,000 is described. Capital budgets, including investment and operations costs for each firm have been developed.

Each firm is evaluated based on standard business indicators. A merchandising program composed of layout, pricing, advertising, cost structure and diversification is outlined.

632 (PS 9)

COMPARISON OF MARKETING SURVEY RESPONSES BETWEEN GARDEN SHOW AND GARDEN CENTER SAMPLES

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Correctly anticipating consumer preferences for goods and services can have a large impact on profitability. Surveying patrons at individual retail outlets does insure the sampling is taken from a customer base, but such surveys are time and labor intensive. A survey sample, taken from attendees at Flower, Lawn and Garden Shows, offers the possibility of large sample sizes, of potential purchasers of horticultural goods and services, with reduced time and labor requirements. A survey to measure the influence of plant size, packaging and price on consumer purchasing habits was conducted at garden shows and garden centers. On the criteria of price and quality of nursery plant materials responses from the two samples were similar. Plant size and packaging appeared to be more influential criteria to the garden show sample.

633 (PS 9)

FIELD-GROWN CUT FLOWERS: AN ECONOMICAL ANALYSIS FOR PRODUCTION IN THE OZARKS

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Several cut flower species were studied to determine their feasibility for cut flower production. Three fertilizer treatments (0.5, .1, and .15kg/m² respectively) were used and their effect on number of stems, stem length and fresh weight were determined. *Celosia cristata* and *Ageratum houstonianum* 'Blue Horizon' proved to respond best to fertilizer treatments. *Celosia* fertilized at a rate of .15kg/m² will produce approximately 200 stems/m². *Ageratum* will produce approximately 400 stems/m² when fertilized at a rate of .10kg/m². Fertilizer rates of .10 and .15 kg/m² for *Eustoma* culture yielded 86 stems/m², which was lower than other species used in this test. Extended vase life and consumer response could possibly justify using this species in cut flower production. An economic break-even analysis will be presented to show what price will have to be received per stem to cover costs.

634 (PS 10)

GENETIC TRANSFORMATION OF ROSE (*ROSA* SPP) USING THE BIOLISTIC PROCESS.

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Genetic transformation of cut roses may greatly facilitate cultivar improvement programs by shortening the time required to introduce new genes into elite germplasm. The biolistic process offers a very promising method for the genetic transformation of roses.

The biolistic process uses high velocity microprojectiles (gold or tungsten) to carry foreign DNA into cells. This process has been shown to be useful for genetic transformation of many organisms. The first step in taking advantage of this process is to optimize the factors which affect transformation efficiency.

Several factors that have a significant affect on transformation efficiency were examined in an effort to optimize the biolistic process for gene transfer in roses. The factors examined were type of tissue (leaf segments, petioles, callus, etc), bombardment distance, the number of bombardments, DNA construct and microcarrier velocity.

The reporter gene, GUS, was used for determining transformation efficiency in this study. GUS was carried on several plasmid constructs which also contained antibiotic resistance (kanamycin or streptomycin). Efficiency of gene transfer was determined by calculating the number of transiently expressing GUS cells for each combination of factors.

Results of this study will be discussed and summarized.

635 (PS 10)

AGROBACTERIUM-MEDIATED INTRODUCTION OF CHALCONE SYNTHASE GENE INTO CHRYSANTHEMUM AND PERFORMANCE OF COLOR-MODIFIED TRANSGENIC PLANTS.

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We developed an *Agrobacterium*-mediated leaf disk transformation method for chrysanthemum. We introduced a chimeric chalcone synthase (CHS) gene isolated from chrysanthemum into cv. Moneymaker (pink type) to produce white-flowered plants. The CHS coding sequence was in antisense or sense orientation relative to the CaMV 35S promoter. 3.6% (3/83) antisense-transformed plants and 1.5% (2/133) sense-transformed plants produced completely white flowers. Pigment analysis revealed that this was due to a block at CHS. To study stability of color change of the white Moneymaker plants. Moneymaker, a Moneymaker regenerant, an antisense white (2706), and a sense white (31435) were compared. There was no difference between Moneymaker and the regenerant. Both 2706 and 31435 were vegetatively propagated with good stability; all plants produced white or very pale pink flowers. 2706 flowered 7 days late and 31435 10-12 days late. Flower number was similar for all four lines tested.

636 (PS 10)

AN APPROACH FOR GENETICALLY DWARFING *DENDRANTHEMA GRANDIFLORA* USING GENETIC ENGINEERING.

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Although the size of pot mums can be controlled with retardants, the use of such chemicals may become limited. Genetically dwarfing current cultivars may be an alternative. Using a construct including a chimeric oat phytochrome structural gene, tobacco phenotypes have been produced that

strongly resemble retardant-treated plants. We wished to insert this construct in mum by using particle bombardment and determine the effects on plant size and flowering dynamics. A target system was developed using 'Iridon' mum leaf sections regenerated on an IAA/BA medium. Shoots developed from surface cells principally at the cut edges. Regenerates were grown-on through flowering and no visual aberrations were apparent. Levels of 50 to 100 mg/l kanamycin were inhibitory to bud development. Sections were exposed to gene transfer and shoots recovered that appear resistant to kanamycin. Some appear chimeric while others appear to be escapes stimulated by a 'feeder' effect from nearby transformed cells. Further analyses will determine whether some plants are stably transformed. (Supported by a Duffett Research Grant from Yoder Brothers, Inc.)

637 (PS 10)

CHARACTERIZATION OF PAPAYAS WITH GENETICALLY ENGINEERED VIRUS RESISTANCE

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Nine transgenic papaya clones, produced previously by microprojectile bombardment, are being characterized for frequency of somaclonal variation. Five clones have proven to be hermaphrodite. Four of these appear to have normal fertility, while the fifth has drastically reduced pollen fertility, averaging about 15% stainability with acetocarmine. Four other clones are pistillate and appear to have normal fertility, with one exception which has been demonstrated to be tetraploid (2n=36 chromosomes). One of twelve plants in a pistillate clone was a somaclonal mutant showing altered leaf and flower morphology. The transgenic clones and their sexual progenies are also being evaluated at the molecular level for expression and segregation of npt, gus, and the coat protein (CP) of papaya ringspot virus (PRV), as well as for PRV resistance.

638 (PS 10)

RANDOM AMPLIFIED POLYMORPHIC DNA (RAPDs) DETECTS PATTERNS OF GENETIC DIVERSITY IN DIPLOID MUSA ACUMINATA COLLA.

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Patterns of diversity among thirty diploid clones of banana (Musa acuminata Colla.), collected in Papua New Guinea and the surrounding islands between 1987 and 1989, were examined genetically using the polymerase chain reaction (PCR) and random primers, to detect random amplified polymorphic DNA (RAPDs). PCR products were visualized on ethidium bromide stained agarose gels. Twenty of 60 random primers examined detected RAPDs in CTAB-extracted genomic DNA. Banding patterns ranged from very simple (1 or 2 bands/gel) to very complex (more than 20 bands/gel). All 30 Musa clones were distinguishable from each other based on their unique RAPD banding pattern. Principal component analysis (PCA) revealed several clusters of closely related clones within the materials examined. However, these clusterings were not correlated with either the geographic origin or the morphological characteristics of the clones. A role of the use of RAPDs in germplasm characterization is discussed.

640 (PS 10)

MOLECULAR CLONING OF cDNA-ENCODING SORBITOL-6-PHOSPHATE DEHYDROGENASE FROM APPLE

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¹National Institute for Basic Biology, Japan

Sorbitol plays a important role in the translocation of photosynthate in apple. Sorbitol-6-phosphate dehydrogenase (S6PDH) is the key enzyme regulating sorbitol biosynthesis. The cloning of functional gene like S6PDH provides the potential to elucidate the mechanism of production and translocation of sugar in the Rosaceae family and to manipulate endogenous sorbitol production in horticultural crops.

Poly(A)⁺RNA was prepared from apple seedlings and cDNA library constructed in an expression vector was screened by the loquat-S6PDH antibody prepared by Hirai (Nat'l. Res. Inst. Veg. Orn. Plants & Tea, Japan). The cloned cDNA contained an open reading frame of 930 base pairs encoding a sequence of 310 amino acids. Identification of the cDNA was accomplished by expression of active enzyme in Escherichia coli harboring the cDNA and by the presence of a partial amino acid sequence identical to that found in the purified enzyme. Northern blot analysis showed the expression of S6PDH gene in apple seedlings.

641 (PS 10)

EFFECT OF VIR GENE INDUCERS ON GENETIC TRANSFORMATION FREQUENCIES OF SWEET POTATO AND GARDEN EGG PLANT

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Explants of sweet potato (Ipomoea batatas) and garden egg plant (Solanum integrifolium) were cocultivated with disarmed strains of Agrobacterium tumefaciens containing binary vectors with gusA, gusA-nptII fusion or gusA-intron genes. We examined whether the addition of vir gene inducers during cocultivation would improve the transformation in both crops. Acetosyringone and galacturonic acid were tested individually and in combination. A very high GUS expression was detected histochemically in both plant species. The frequency and extent of transformation varied with the type of explant, petioles being the most responsive. The presence of the vir inducing substances in the medium influenced the percent explant area transformed but did not appreciably affect the frequency of transformation. The selective proliferation of the transformed tissue and organogenesis was achieved by the culture of explants on MS medium supplemented with antibiotics.

642 (PS 10)

POLYMORPHISMS OF RAPD MARKERS IN CELERY CULTIVARS

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Celery cultivars (Apium graveolens var. dulce) in North America have a narrow genetic base. Twenty-two celery, one celeriac and one annual cultivar were screened for polymorphic RAPD (Random Amplified Polymorphic DNA) markers with 28 arbitrary 10-mer primers. Among the total 231 bands obtained, 28 (12%) of the bands were polymorphic among the 24 accessions screened, but only 18 (7.8%) were polymorphic within the 22 celery cultivars. These markers are sufficient to distinguish each of the cultivars used. The average number of marker differences is 6.2 between two celery cultivars, 13.5 between the celeriac and the remaining cultivars, and 16.5 between the annual and the other cultivars. The relationship among the celery cultivars disclosed from this study is basically consistent with that observed using total protein and isozyme markers. RAPD technology provides a new alternative for cultivar identification in celery.

643 (PS 10)

MOLECULAR MARKERS FOR CHARACTERIZATION OF GRAPE CULTIVARS II. Y. Gogorcena, S. Arulsekar, and D.E. Parfitt*, Dept. of Pomology, University of California, Davis, CA 95616-8683

The work reported here is an extension of studies reported in 1990. The general objective was to develop molecular markers for genotype 'fingerprinting', with specific reference to possible clonal differences among 'Pinot noir' clones. Leaf DNA from 8 cultivars and 9 'Pinot noir' clones were isolated. RFLP and RAPD markers were identified and used to characterize the genotypes. 65 32-P labelled cloned probes were constructed with the pUC18 plasmid and Hind-III digested 'Pinot noir' DNA. The probes were tested for their ability to discriminate among the 8 cultivars. 3 probes pGAD10, pGAD15, and pGAD44 showed polymorphisms among the cultivars. pGAD15 was most useful, with 5 polymorphisms for the 8 cultivars. RAPD makers were also tested for 'fingerprinting'. Several primers were tested and polymorphisms were identified among cultivars. However, significant problems with repeatability for some bands were observed. Therefore, a series of experiments were conducted to test the effect of season and extraction method. These factors did not account for the inconsistency which seemed to be more a function of the primer used. None of these studies showed clear evidence that the 'Pinot noir' clones tested were genetically different.

645 (PS 10)

ESTIMATION OF GENETIC SIMILARITY AMONG CULTIVARS OF THEOBROMA CACAO USING MOLECULAR MARKERS

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RAPD markers were used to examine genetic similarity in cacao. DNA from 30 cacao cultivars amplified using 15 arbitrary oligonucleotide primers, produced a total of 112 fragments, of which 88% were polymorphic. A phenogram was developed which illustrates the genetic relationships among the cacao cultivars representing the four major geographic groups of cacao (Criollo, Trinitario, Forastero Lower Amazonian, and Forastero Upper Amazonian). The phenogram indicated a general separation of the four groups into three clusters. Criollos and Trinitarios (supposedly hybrids between Forastero and Criollos types) appeared in

a single cluster. Lower Amazonian cultivars (mainly selections made in Bahia, Brazil) appeared in a separate cluster. The third cluster consisted of the Upper Amazonian cultivars, which were originally collected from the region believed to be the center of origin of this crop. This cluster displayed the furthest genetic distance from the others. Crosses between Upper Amazon germplasm and local selections have shown heterosis in clonal crosses, which has been exploited in all genetic improvement programs for cacao. We propose that genetic distances based on RAPD markers can be potentially used as a criterion to select parents capable of producing superior hybrids and populations. Genetic relationships can also be useful to define germplasm collections and conservation strategies. Studies are underway to compare phenograms derived from RAPD markers and ribosomal RNA gene polymorphisms.

646 (PS 10)

INCREASED SHOOT PROLIFERATION OF APPLES CO-CULTIVATED WITH *AGROBACTERIUM TUMEFACIENS*
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'McIntosh' apple shoots were inoculated in vitro with *Agrobacterium tumefaciens* strain tms328::Tn5 (tms) carrying a functional cytokinin gene. Callus tissue, removed from the infected stems, produced shoots on shoot proliferation medium. After three subcultures, axillary shoot production from a tms-infected putative transformant was eight times that of controls. Subsequent shoot production on three different levels of BA (3, 6 and 10 μ M) was significantly greater than from controls on all levels of BA. PCR analysis of putative transformants revealed an expected 503 bp DNA fragment corresponding to the amplified portion of the cytokinin gene. After 6 months of in vitro propagation, proliferation rates of shoots obtained from the original transformants were similar to the controls and the expected PCR fragment of 503 bp could only be detected by Southern analysis. Even though the T-DNA appears to be lost from the apple genome, the data suggest that the tms strain may be useful in co-infection experiments to induce shoot formation, thus avoiding difficult regeneration procedures.

647 (PS 10)

TRANSFORMATION OF CITRUS SUSPENSION CULTURES BY MICROPROJECTILE BOMBARDMENT
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Citrus is one of the major horticultural cash crops in the Southern United States. Several attempts have been made to genetically improve present citrus cultivars using biotechnology. We report transformation of citrus (*Citrus sinensis* (L.) Osbeck 'Hamlin') suspension cultures using microprojectile bombardment.

A thin layer of seven day-old suspension cultures, grown in HH medium, were transferred to Whatman #1 filter paper at a cell density of 0.15 mg/ml fresh weight. The cells were bombarded with 1.112 μ M diameter, DNA-coated, tungsten particles using the Dupont PDS 1000 biolistic system. Plasmid PRT 99 GUS containing the marker genes β -Glucuronidase (GUS) and NPT II, with a 35S promoter, and NPT II terminators was used in transformation.

GUS activity was monitored on a time scale. Expression of GUS was observed after 48 hours of bombardment. Further studies are being done to enhance the transformation efficiency.

648 (PS 10)

CYTOKININ EFFECTS ON TOMATO SEED QUALITY, FRUIT YIELD, AND RIPENING IN TRANSGENIC PLANTS CARRYING THE *ipt* GENE
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Lycopersicon esculentum cv. UC82b cotyledons were co-cultivated with *A. tumefaciens* carrying vectors with modified isopentenyl transferase (*ipt*) genes. The *ipt* gene was placed under the control of the RUBISCO promoter in both the sense and antisense orientation. Over 50 transformants were recovered on kanamycin-containing media. Seeds from RO plants were germinated on selective media and R1 plants transformed with the *ipt* gene identified by PCR and Southern blot hybridization. Phenotypes of the R1 plants, whether transformed with the *ipt* gene in the sense or antisense orientation, were comparable to the control plants transformed with an inactive cytokinin gene. Fruit weights from both were similar to those from control plants, however, yields were reduced and ripening delayed. Most fruit had no seeds or very few small seeds. Cytokinin levels are being determined in order to correlate them to the observed phenotypes.

649 (PS 10)

DEVELOPMENT OF TRANSFORMATION SYSTEM FOR *COFFEA ARABICA* USING PARTICLE GUN METHOD
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Somatic embryogenesis of coffee has been studied for the purpose of obtaining target tissues for stable genetic transformation through use of a particle gun. Eight cultivars of *C. arabica* were selected for callus induction from leaves. Primary calli were induced within two weeks in over 98% of the leaf disks explanted on MS medium with 2,4-D and kinetin prior to treatment on a secondary culture medium. Somatic embryos were obtained from 'Catuai' and 'Blue Mountain' after six months from explanting. Somatic embryos were germinated in MS media and developed into plants. Somatic embryos and embryogenic calli are being used for gene transformation experiments with the helium-driven particle gun.

650 (PS 10)

AGROBACTERIUM-MEDIATED TRANSFORMATION OF APPLE
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Two strains of *Agrobacterium tumefaciens* carrying a disarmed Ti-binary vector, pZA-7, were used as vectors for transformation of apple leaf segments. EHA101:pZA-7 carries a helper plasmid derived from pTiB0542, and C58Z707:pZA-7 carries a helper plasmid derived from pTiC58. The binary vector provides two selection markers, neomycin phosphotransferase (*nptII*) and hygromycin resistance genes, and a screening marker, β -glucuronidase (*GUS*) gene. Preliminary experiments were conducted to determine the effect of different concentrations of kanamycin, carbenicillin, and cefotaxime on regeneration of apple leaf sections and inhibition of *A. tumefaciens* strains. In vitro-derived leaf sections of 'Royal Gala' apple were grown on a regeneration medium containing thidiazuron and NAA; these were then dipped into a suspension culture of *A. tumefaciens* and transferred to a fresh regeneration medium. Callus lines exhibiting kanamycin and hygromycin resistance were obtained mostly with *agrobacterium* strain EHA101:pZA-7. Expression of *GUS* activity was also determined in putative transformed calli. Southern blot analysis was used for confirming integrative transformation in transgenic lines.

651 (PS 10)

CHARACTERIZATION OF GRAPEFRUIT FLAVEDO PEROXIDASES

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Grapefruit (*Citrus paradisi*) flavedo is a rich source of peroxidase (POD) (EC 1.11.1.7). Changes in POD have been related to senescence and environmental stress in a variety of plant tissues. However, due to the large number of POD isoenzymes as well as the broad substrate specificity, measurement of POD activity in crude extracts is of limited value for gaining an understanding of the role of POD *in vivo*. We have begun to purify and characterize POD isoenzymes from grapefruit flavedo. HPLC gel permeation chromatography reveals 2 peaks of POD activity with apparent MW of 66 kD and 30 kD. Native PAGE (8% bis-acrylamide, pH 8.8) followed by activity staining indicates that the PODs differ in *Pi*; the 30 kD POD migrates anodally, whereas the 66 kD POD does not migrate. Isoelectric focusing has been used to separate flavedo PODs into acid (*Pi* ca 4.0) and basic (*Pi* > 8.5) forms. Treatment of grapefruit with ethylene (2 ppm 72 hours) induces a basic POD not present in freshly-harvested fruit or in nonethylene-treated controls.

653 (PS 11)

HIGH TUNNELS EXTEND THE SEASON FOR TOMATOES

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High tunnels (unheated walk-in structures) are widely utilized in Europe, Asia, and the Middle East for early vegetable production. There are relatively few high tunnels used for vegetable production in the U.S. In a 2-year study, determinate tomatoes matured up to 32 days earlier than the same cultivars under standard field culture. Earliness was gained through 16 days earlier planting and 16 days earlier maturity than in the field. In tunnels, when ground grown, yield was 7.4 kg m⁻¹; and when grown with a basketweave trellis, yield was 6.8 kg m⁻¹. Even though these yields (for

a 30-day period) were less than the yields from the field, the earlier harvest provides an extra marketing opportunity at premium prices. Under current production and marketing conditions in New Hampshire, at a conservative average selling price of \$1.60/lb, the net return is \$0.71/lb. By using relatively low cost tunnels, growers are able to economically extend their growing and marketing season without a high capital outlay.

654 (PS 11)

ROLE OF SEED STORAGE RESERVES IN OSMOCONDITIONING OF SWEET CORN

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Interconversions of seed storage reserves during osmoconditioning (controlled imbibition of water) may influence seed performance under sub-optimal conditions. Sweet corn (*Zea mays* L. cv. Florida Staysweet) storage reserve changes were examined during osmoconditioning in relation to seed germination performance. Seeds were osmoconditioned in two experiments using distilled water (duration 3, 6, 9, 12, and 24 h) and polyethylene glycol 8000 solutions (0, .5, and 1.0 MPa for 12, 24, 48, 72 and 96 h). Germination performance was evaluated at 10 and 25°C, and seed moisture, carbohydrate, and protein concentrations were quantified at each water potential x duration combination. Germination performance was not significantly improved by any treatment at 25°C. Germination percentage at 10°C was increased 10% for seeds osmoconditioned for 24 h in distilled water, and time to germination was decreased 50%. For seeds osmoconditioned 12 and 48 h at .5 and 1.0 MPa, respectively, germination percentage at 10°C was increased 15%. Time to germination was reduced 50% for seeds osmoconditioned at .5 and 1.0 MPa after 48 and 96 h, respectively. Starch levels increased for seeds osmoconditioned at higher water potentials, but remained the same or decreased at lower water potentials.

655 (PS 11)

GROWTH OF GREEN PEPPER AND LETTUCE TRANSPLANTS AS EFFECTED BY MYCORRHIZAE, MEDIA, AND CONTAINER TYPE

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The effects of two mycorrhizal species (*Glomus versiforme* and *Glomus intraradix*) and a control on the growth of green pepper, *Capsicum annuum*, and lettuce, *Lactuca sativa*, seedlings have been evaluated using three types of growing media (Fafard bulk mix, Cornell mix and a compost based mix) and two types of containers, Cell Packs (125 cubic cm volume) and Pro-Trays (65 cubic cm volume) for green pepper and Cell Packs (125 cubic cm volume) and Plug Flats (33 cubic cm volume) for lettuce. The experiments used a split plot randomized complete block design with 4 blocks, and were carried out in a double-poly greenhouse in 1991. Supplemental lighting was provided by HPS lights with a 16 hour photoperiod. Seeds were sown directly into the containers of mycorrhizal inoculated media. All treatments received the same fertilizer regime. Plants in the higher volume cells were larger than those in the smaller volume cells for both pepper and lettuce. The Fafard Bulk Mix and the Compost mix gave larger plants than did the Cornell mix for both crops. An additional experiment examining the effect of light type on mycorrhizal transplant growth and development is underway and will be presented.

656 (PS 11)

GREENHOUSE ENVIRONMENT OPTIMIZATION FOR SEEDLESS CUCUMBERS

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The greenhouse cover has previously been shown to have large effects upon the greenhouse environment, crop productivity and energy use. However, in most cases, because of inadequate treatment replication, the extent of these effects has been impossible to quantify with confidence. In the fall of 1987, a new greenhouse complex of 9 mini greenhouses (6.4m x 7.2m, each) was constructed at the Harrow Research Station on the principles of the 3x3 Latin Square experimental design and with glass, double polyethylene film and double acrylic panel greenhouse covers as the three levels of treatment in the Latin Square. During the spring seasons of 1988 and 1990 the greenhouse cucumber cultivar Corona was cropped in rockwool in all 9 mini greenhouses, under 3 day air (DAT: 18°C, 21°C and 24°C) and 3 night air temperatures (NAT: 16°C, 18°C and 20°C), superimposed across the rows and columns of greenhouses, respectively, to estimate yield and energy use response to DAT, NAT and greenhouse cover variation. Early marketable yield was highest at the 18/18 and 18/20°C DAT/NAT combinations and final marketable yield was highest at 18°C DAT regardless of NAT. Yield differences due to the greenhouse cover were insignificant. However, there were consistent differences in greenhouse air RH due to greenhouse cover (60%, 70% and 75% daily averages for glass, double polyethylene and double acrylic, respectively). Also, there were significant energy savings with the use of double polyethylene or double acrylic, as compared to glass greenhouse cover, and with low DAT and NAT (28%, 15% and 12% energy use reduction, respectively).

657 (PS 11)

THE INFLUENCE OF SHELTERBELT ON MUSKMELON PRODUCTION.

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Windbreaks can increase crop growth and improve crop quality. The effects of shelter on vegetable production varies with crop, location, and farming practices. While the advantages of minimizing wind stress on vegetable production is well-known, little research documents the specific response of vegetables to microclimate modification through the use of shelterbelts.

During the summer, 1991, a preliminary experiment was conducted on the effects of tree windbreaks (shelterbelts) on muskmelon plant growth, yield, and fruit quality. A split-plot design was used with shelter and exposed areas as main treatments with 3 replications. Subtreatments were 7 combinations of anti-transpirant and time of application. Leaf growth was measured 4 and 6 weeks after planting. Muskmelon fruit were harvested over a 6 week period at 2 day intervals. Muskmelon yield, fruit and cavity diameter, fruit color, and total sugar content were obtained.

The use of anti-transpirant did not significantly affect total yield, fruit or cavity diameter, total sugar content, or early leaf growth. The effect of shelter varied with the measured variable.

658 (PS 11)

ASSESSING THE NITROGEN FIXATION ABILITIES OF NEWLY DEVELOPED *PHASEOLUS VULGARIS* LINES

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Methods to improve the grain yield of red kidney bean without the addition of commercially fixed nitrogen will have significant benefits to farmers in Jamaica and other tropical regions. Red kidney beans provide a major portion of the dietary protein for most families in these regions. Our experimental objective was to evaluate the nitrogen fixing capabilities of several breeding lines of *Phaseolus vulgaris* when inoculated with *Rhizobium* strains isolated from Jamaican soils. Surface sterilized seeds of 11 *Phaseolus* lines were inoculated with inoculum prepared from 5 day old *Rhizobium* YEM mixture. *Rhizobium* used were T₂ and B₁₇ from Jamaica and UMR 1889. The greenhouse study was arranged as a completely randomized design. Bean lines 9056-101, 9056-98B, 8954-5 and 8954-4 showed improved nodulation and N₂ fixation when inoculated with UMR 1889. The combination of breeding line 8954-5 and *Rhizobium* strain B₁₇ produced the highest nodule number and shoot dry weight of 193 and 0.72 g, respectively. The *Rhizobium* strain B₁₇ showed some ability to compete successfully for nodule sites against known effective strains.

659 (PS 11)

INTEGRATION OF NEW CROPS INTO THE FARMING ENTERPRISE USING A SYSTEMS APPROACH

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An interdisciplinary approach had been developed to examine the production, economic, and marketing feasibility of new crops. The methodology requires the determination of yield potential and product quality, construction of production budgets, and completion of marketing window analyses. Potential for integration of new crops into the existing farm enterprise is assessed using linear programming techniques that consider labor and equipment constraints, crop rotations and best management practices. Risk analyses consider yield, production costs, and price of both new and traditional crops. By using this method, broccoli has been identified as a potential new crop for eastern Virginia, with labor requirements and slush ice availability being the major constraints to integration into vegetable production in this area.

660 (PS 11)

THREE ALTERNATIVE TOMATO PRODUCTION SYSTEMS

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Tomatoes, cultivar 'Mountain Pride', were evaluated for productivity, post-harvest qualities, and pest populations in three different production systems. These included a

conventional, high chemical input system with prophylactic applications of pesticides and fertilizers; a reduced chemical input system that used pesticides only as needed; and a transitional organic system that followed the guidelines of the Organic Farmers Association of New Jersey. No significant differences were observed in either the high input or low input system despite a reduction in synthetic pesticide and fertilizer use. Organically produced tomatoes yielded significantly less than the other production systems in terms of total yields. Average fruit size was increased, however, along with the percentage of tomatoes with diameters larger than 7.7 cm. Differences in pest populations were noted between the plots.

661 (PS 11)

TOMATO PRODUCTION IN AN ENCLOSED ENVIRONMENT

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It was proposed to study and develop a system for producing salad vegetables on a space station. To this end a 'Salad Machine' was designed to act as a controlled environment growth chamber within which various plants will be grown on a continuous and predictable basis such that crew members will periodically have available the ingredients of a "normal" salad. Within this framework we studied the enclosed environment production of tomatoes.

Forty-five tomato cultivars were screened in a greenhouse and four were selected for further evaluation. The criteria for selection were total plant yield, fruit size, fruit quality and the total weight of the fruit on the main stem as compared to the axillary branches. The four selected cultivars were grown in an environmentally controlled chamber ('Salad Machine') at 6 plants/m³ (volume rather than area is important here). The data collected included: weekly plant height, total daily yield, water use and nutrient uptake.

The continuous production of tomatoes in a small volume using a selected cultivar will be discussed.

662 (PS 11)

COMPOSTING METHODS AND AMENDMENTS AFFECT GERMINATION AND GROWTH OF VEGETABLES

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Nitrogen additions to high C:N yard wastes improve the composting process and the usefulness of the product. Nine composts were made with additions of 10 or 25% grass clippings or poultry manure (PM) and several composting methods (in bin, turned, static). Turnip, tomato, watermelon, snap bean, and lettuce seeds were germinated, and some were grown to maturity in pots. The 25% PM compost delayed germination of turnips and beans by 2 days, but final germination % was not affected. Germination of melon (27%) was significantly less with 25% PM than with other composts. Tomato germination was not affected by any treatment, but dry weight of 4 week old seedlings grown in PM treatments was 4 times greater than other treatments. Pod yield of beans grown in 10% PM compost was equal to beans grown in potting mix with soluble fertilizer.

663 (PS 11)

POTENTIALLY SUSTAINABLE DESERT LETTUCE PRODUCTION SYSTEMS

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Three main plot production systems - conventional, organic and mixed organic/conventional - were established in a fixed location at the Yuma Valley Agricultural Center in September 1989. A split plot treatment of a liquid biological soil conditioner was applied to one-half of each main plot. Chemical or organic fertilizers were applied to give 225 kg N/ha for the growing season. During a two-year transition plant mineral nutrient content did not differ greatly. However, nitrate and total nitrogen were significantly lower in the organically grown lettuce. Plant nitrate content was also enhanced by the soil conditioner as was early head weight. A greater number of heavier heads was harvested early from the chemically fertilized plots. Soil microbial populations did not reflect an effect of fertilizer treatments in the first season; there were trends for population fluctuations in response to sidedressing in the second and third seasons. No significant insect activity was observed and no pest control was necessary. Higher populations of soil pathogens were detected on mature lettuce roots in the conventionally fertilized plots.

664 (PS 11)

EFFECT OF COVER CROP AND N RATE ON SOIL N AND YIELD OF NO-TILL SWEETCORN AND STRIP-TILL TOMATO

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A no-till sweetcorn strip-till tomato rotation was established to determine whether a grass or legume winter cover crop would provide greater summer mulch and more soil inorganic nitrogen from residue decomposition. Sweetcorn yields improved as N rate increased in rye residue and bare soil, but only increased at the 50 kg N/ha rate in vetch residue. Strip-till tomato yields improved with all N rates for all covers. Total soil N and C were greater in both the vetch and rye residue treatments than the bare soil. Fertilizer N addition did not affect changes in total N or C percentages. Greater soil nitrate was measured beneath vetch residue at spring planting than in the rye residue or bare soil surface.

665 (PS 11)

INFLUENCE OF SOIL TENSION ON TOMATO FRUIT CRACKING

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Fruit cracking in tomatoes is a serious problem, particularly when trellis culture is used. Past studies indicate that fruit cracking is associated with fluctuating soil moisture levels. Soil moisture variations are influenced by irrigation practices, and an irrigation regime employing frequent applications of water will lessen variations in soil moisture. A field study was initiated to study the effect of trickle irrigation regime on fruit cracking in 'Celebrity' tomatoes (*Lycopersicon esculentum* Mill). In the three treatments used, soil was allowed to dry to 10-20, 50-60, and 100-110 centibars of tension, respectively, between watering and then was irrigated to field capacity. These tension levels corresponded with soil moisture levels of field capacity (10-20 cb), 20% of available water depleted (50-60 cb), and 40% of available water depleted (100-110 cb). Yield measurements indicated that the driest treatment (100-110 cb) significantly reduced the percent of radially cracked fruit. This treatment also significantly lowered the total yield, in terms of both fruit number and weight. There was no significant effect, however, on marketable fruit yield due to irrigation treatments. Further field studies are required to determine the optimum irrigation program to reduce fruit cracking.

666 (PS 11)

MECHANICAL HARVEST OF HOT PEPPERS AS INFLUENCED BY PLANT SPACING

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Field studies were conducted in 1991 with 'Jalapeno-M' and 'TAM' Jalapeno pepper. Plants were established by direct seeding at 10, 20, 30, and 40 cm in-row plant spacing. Lodged plants, fruit quality and yield were monitored. A commercial snap-bean harvester was evaluated for harvest. Closer plant spacings resulted in greater yields and reduced plant lodging. No interaction of variety with plant spacing was observed. There were, however, differences in several yield parameters due to variety. Fruit quality characteristics of mechanically and hand harvested pepper stored at 6 C were similar. The use of the mechanical snap-bean harvester appears to be a feasible technique to harvest Jalapeno pepper.

667 (PS 11)

EVALUATING PREPLANT MOISTURIZATION TECHNIQUES FOR IMPROVED FIELD PERFORMANCE OF SHRUNKEN-2 SWEET CORN.

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Germination and stand establishment of shrunken-2 sweet corn is a major production-related problem, particularly during early spring in the upper Midwest U.S. Several potential physical and physiological factors have been identified as contributors to poor stand establishment. Poor pericarp integrity and high sucrose levels may lead to non-uniform moisturization and imbibitional injury. Studies were conducted to determine if the use of "controlled moisturization" preplant treatments reduced imbibitional injury and improved germination and seedling vigor. Both laboratory and field results will be discussed.

668 (PS 11)

MINIMIZING CORKY ROOT DESTRUCTION OF LETTUCE ROOT SYSTEMS BY THE USE OF TRANSPLANTS

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Corky root (CR) of lettuce (*Lactuca sativa* L.) is caused by the bacterium *Rhizomonas suberifaciens*. Current management strategies involve the use of resistant cultivars and crop rotation. The use of transplants as a method to grow CR-susceptible cultivars in CR-infested fields was recently demonstrated. The objective of this study was to evaluate corky root destruction of root systems of direct-seeded and transplanted lettuce. Direct seeded, and three and five week old transplants of CR susceptible 'Shawnee' and CR resistant 'South Bay' crisphead lettuce were grown in a naturally CR-infested field. Root systems were evaluated at head harvest maturity. When direct seeded, South Bay developed 104% more total lateral root length than did Shawnee. When transplanted at three and five weeks, South Bay developed 50% and 61% more total lateral root length than Shawnee, respectively. Total lateral root length for Shawnee transplanted at five weeks was 100% greater than direct seeded Shawnee. Comparatively, total lateral root length for South Bay transplanted at five weeks was 58% greater than direct seeded South Bay. Tap root lengths and dry weights were not different among planting systems. Transplanting is a possible method for reducing the impact of CR on lettuce lateral root development.

669 (PS 11)

GROWTH OF ORNAMENTAL CABBAGE AS EFFECTED BY UNICONIZOLE, PHOSPHORUS AND WATER STRESS

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Hybrid ornamental cabbage started from seed and grown in a greenhouse was studied. The plants were transplanted into 15 cm pots, and treated with foliar sprays of 30 and 60 ppm of uniconazole, and 7.4 and 14.8 cc of triple superphosphate. Combinations of 30 ppm of uniconazole and 7.4 cc of P, 30 ppm of uniconazole and 14.8 cc of P, 60 ppm of uniconazole and 7.4 cc of P, 60 ppm of uniconazole and 14.8 cc of P, and a control was also used. Half of the plants in each treatment were water stressed. Data taken was plant's height, fresh weight, stem caliper, and porometer readings. There were significant differences in the plants height. The tallest plants were treated with 14.8 cc P, while the shortest was treated with 60 ppm uniconazole and 14.8 cc of P. The addition of phosphorus seemed to increase the activity of uniconazole as noted in the height differences. Water stress did not effect the plants except for aesthetic appearance.

670 (PS 11)

COVER CROP MIXTURES FOR VEGETABLE PRODUCTION
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Polyculture mixtures of several species of cover crops may be the best way to optimize some of the benefits associated with cover crop use. In the first year of a three year study, 16 polyculture mixtures of cover crops (4 species/mixture) were screened at seven sites throughout the state. Five of the mixtures were seeded at two planting dates. Fall evaluation of the cover crop mixtures included ease of establishment, vigor, percent groundcover, plant height, and relative biomass. The two mixtures with the highest percent groundcover were (1): sudex, rye, mammoth red clover, and subterranean clover (62% and 80% groundcover, one and two months after planting respectively), and, (2), annual alfalfa, hairy vetch, ryegrass, and rye (56% and 84% groundcover one and two months after planting respectively). The six mixtures with the highest percent groundcover did consistently well, relative to other mixtures, at all locations. Mixture (1) above also had the highest relative biomass throughout the state. Yellow and white sweet clovers, hairy vetch, winter oats, subterranean clover, red clover, rye and barley established well and maintained high vigor ratings throughout the fall. Ladino clover, timothy, and big flower vetch consistently had poor vigor ratings.

671 (PS 11)

INFLUENCE OF CULTURE ON FRESH-MARKET TOMATO PRODUCTION COSTS

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Fresh market tomato cultivar and cultural trials are conducted yearly at the Oklahoma Vegetable Research Station near Tulsa. From 14

to 18 cultivars have been evaluated each season since 1985 comparing the Florida stake-and-weave and the wire mesh cage cultural systems. Results from 7 years of trials indicate caging produced 32% greater marketable yield than the stake-and-weave system. Percentage early yield was reduced with the cage system. Percentage of cull fruit was greater with the stake-and-weave system due to a higher incidence of fruit cracking. Average fruit size was not affected by cultural system. Cost of production analysis showed a lower cost of production with the cage system. The cage system is more capital intensive and the stake-and-weave system is more labor intensive. Undesirable factors in the use of cages are greater difficulty in picking the early fruit clusters, logistics in off-season storage of cages and the larger capital investment required for the cage system.

672 (PS 11)

ECONOMIC ANALYSIS OF THREE TOMATO PRODUCTION SYSTEMS

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Fresh tomatoes grown under three production cropping systems at the Rutgers University's Snyder Research and Extension Farm were compared for differences in yields, gross revenues, production costs and net returns. Maximum marketable yields were obtained using the Integrated Pest Management (IPM) system, followed closely by the conventional system. Yields of the organic plots were only 54 percent of the conventional yield. However, the organic plots yielded only 17 percent culls whereas the IPM plots yielded 37 percent culls. Fifty-two percent of the organic tomatoes were U.S. Number Ones, while only one third of the produce from the other two systems were U.S. Number One grade. Organic plots had lower chemical costs, but substantially higher labor costs than the other two systems.

673 (PS 11)

STUDIES ON SOILLESS RAISING OF SEEDLING OF STEVIA REBAUDIANA

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Stevia rebaudiana Bertoni was hydroponically raised on the matrices of sand or slag and sprinkled periodically with three different nutrient solutions (BD, KO, Knop) respectively. The conventional raising method of Hailin state farm was used as the control. The results showed that the seedlings grown on the matrix of sand and sprinkled with Knop nutrient solution were stronger with well-developed root systems, obvious spindle-shaped root tubers, and less plant diseases, no insect pests, and weeds, which was significantly better than the control method in respect to the root length, root fresh weight, stem height, shoot fresh weight, and number of leaves, and significantly better than other treatments in respect to the root length, root fresh weight and stem height. This raising method is worth extending.

674 (PS 11)

RECONNAISSANCE SURVEY OF TRACE ELEMENT CONCENTRATIONS IN PROMINENT CROPS OF CALIFORNIA'S SAN JOAQUIN VALLEY

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Since the discovery of elevated concentrations of selenium in the water, sediments, and biota at the Kesterson Wildlife Refuge, several studies regarding trace element distribution in the San Joaquin Valley and their potential environmental impacts have been initiated. We conducted a reconnaissance investigation to assess the concentration of boron, selenium, arsenic, molybdenum, uranium and vanadium using inductively coupled mass spectroscopy in prominent vegetation in the San Joaquin Valley. Five regions representing a range of geochemical environments with known differences in trace element concentrations in their soils or shallow ground water were selected for plant and soil sampling. Concentrations of boron, selenium, arsenic, molybdenum, uranium, and vanadium in soil and tissue will be presented for these geographic areas for alfalfa, almonds, cotton, garlic, grapes, onions, tomatoes, and wheat. Interpretations of the wide range of trace element tissue concentrations that have been found will be discussed.

675 (PS 11)

POTASSIUM AND SODIUM INTERRELATIONS IN CELERY

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Recent research suggests that celery (*Apium graveolens* var. dulce) produced on Florida Histosols does not respond to rates of K fertilizer as high as previously recommended. The soil-test Na levels of Florida Histosols have been increasing as a result of canal dredging which has exposed saline water from shallow aquifers to mixing with surface water used for irrigation. Sand culture and field experiments were conducted to obtain a better understanding of the effect of Na on the K nutritional requirement of celery. The sand culture experiment included factorial combinations of 0, 2, 4, and 8 mM concentrations of K and 0 and 0.5 mM concentrations of Na. The field experiment was a 13 point fractional factorial with K and Na rates ranging from 0 to 400 kg ha⁻¹. The data indicated that Na partially substituted for the K requirement of celery when K was limiting growth and yield. Interestingly, the data also suggested that optimal celery yields were obtained when some Na was present even where K was not limiting.

676 (PS 11)

RESPONSE OF FIVE LETTUCE TYPES TO K FERTILIZERS ON HISTOSOLS

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Potassium is often considered the nutrient element most limiting to crop production on organic soils. On Histosols in southern Florida, K₂SO₄, rather than KCl, is often used for lettuce (*Lactuca sativa* L.) production to minimize the risk of salt injury. However, recent soil-test calibration research suggests that current K fertilizer recommendations for lettuce may be too high. Four field studies were conducted from 1989 to 1991 to evaluate the response of five lettuce types to K rate and source. The five lettuce types evaluated were leaf, bibb, boston, romaine (cos), and crisphead. Two sources of fertilizer K (K₂SO₄ and KCl) were evaluated at rates ranging from 0 to 600 kg K ha⁻¹. Lettuce showed a minimal or no response to K fertilization. Potassium chloride had detrimental effects on lettuce only when applied at rates in excess of those required for optimal production. These studies showed that K fertilizer recommendations for lettuce produced on Histosols in Florida can be reduced. Furthermore, KCl, a more economical source, is suitable when the K is applied at appropriate rates.

677 (PS 11)

FALL BROCCOLI PRODUCTION USING MICRONUTRIENTS IN A SUSTAINABLE SYSTEM

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Arkansas soils can range in pH from the low 4's to 7 depending on the location and liming history. Deficiency of zinc, boron and molybdenum coupled with the soil acidity complex of manganese toxicity had been previously identified as a severe limiting factor in production of quality brassica crops on our farmer cooperator's land. Building on the results reported here in 1991, the fall 1991 broccoli study focused on the effect of including/not including micronutrients in the watering solution during the greenhouse growth phase coupled with/without micronutrients in the transplant water. Additional treatments looked at the contribution of individual micronutrients to the final yield. The final yields of the boron, zinc and magnesium treatments were found to contribute approximately 75-80% of the final yield of a full range micronutrient solution. Research supported by a LISA grant.

678 (PS 11)

PRACTICAL MEANS OF ENHANCING TUBER CALCIUM CONTENT AND REDUCING INCIDENCES OF SOFT ROT AND INTERNAL BROWN SPOT BY APPLICATION OF SOLUBLE FORM OF CALCIUM DURING BULKING
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We have shown that tuber calcium can be enhanced by supplying soluble forms of calcium near the tuber stolon region during bulking. In the present study we applied calcium nitrate or N-HIB during bulking (hilling, 3 and 6 wks after hilling) by injecting these Ca sources into sprinkler irrigation line. Field plots were established with cv 'Russet Burbank' in sandy loam soil containing about 1200 Kg

Ca ha⁻¹. All plots received equal amounts of nitrogen. Plots receiving only nitrogen (as NH₄NO₃) at the same time served as split N controls and the plots receiving complete nitrogen by the time of hilling (non-split N) served as the grower control.

In 1990 compared to non-split-N control a consistently higher tuber yield was obtained with split-N, N-HIB (113 Kg Ca ha⁻¹) calcium nitrate (113 Kg Ca ha⁻¹). However, these differences were not significant. Tuber calcium contents were increased with N-HIB and calcium nitrate. After 5 months of storage the incidence of soft rot and of internal brown spot was significantly reduced. In 1991 N-HIB (113 Kg ha⁻¹) gave significantly higher tuber yield than other treatments. Tuber calcium contents were increased with both calcium nitrate and N-HIB treatments. After four months of storage incidence of internal brown spot was reduced by calcium nitrate and N-HIB although calcium nitrate was most effective. These results demonstrate that it is possible to improve tuber calcium contents by application of 113-226 Kg Ca ha⁻¹ during bulking even in a soil containing sufficient calcium for plant growth.

679 (PS 11)

MANGANESE TOXICITY OR TOLERANCE IN SWEETPOTATO

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Greenhouse studies were conducted to evaluate 5 levels of Mn (0.00025 to 0.1 g.L⁻¹) on Mn toxicity or tolerance of sweetpotato [*Ipomoea batatas* (L.) Lam] grown in a modified half Hoagland's solution. The presence of oxidized Mn on the roots and leaves was demonstrated by the blue staining test with benzidine and the solubility and bleaching of oxidized Mn in the oxalic-sulfuric acid solution. Both storage root and foliage fresh and dry weights were highest at Mn concn of 0.00025 g.L⁻¹ in the nutrient solution, while fibrous root dry weight was highest with 0.01 g.L⁻¹ Mn in the solution. More Mn accumulated in foliage than in fibrous roots for all levels of Mn evaluated. N, P, and K concn in foliage was highest at a Mn concn of 0.1 g.L⁻¹ Mn in the solution. Foliage dry weight was preserved up to a high Mn level of about 2700 ug. g⁻¹ Mn in tissues, while tuber for storage roots was preserved up to a high Mn level of about 1000 ug. g⁻¹ in the tissues. Deposition of oxidized Mn was observed on fibrous roots particularly at the highest Mn levels in the nutrient solution.

680 (PS 11)

RESPONSE OF SWEETPOTATO GROWN IN NFT TO DIFFERENT PHOTOPERIODS

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Growth chamber studies were conducted to determine growth responses of sweetpotato [*Ipomoea batatas* (L.) Lam] to differing photoperiods (PP) when grown by use of NFT. Four vine cuttings (15 cm length) of GA Jet and TI-155 were grown for 120 days at 12/12, 15/9, 18/6, and 21/3 light/dark PP. Irradiance averaged 427 umol m⁻² s⁻¹, with day/night temperatures of 28/22C and 70% RH. A modified half Hoagland's solution was used. Number of storage roots/plant, and storage root fresh and dry weights for GA Jet increased as PP increased from 12 to 21 h, while storage root fresh and dry weights for TI-155 increased up to 18 h PP but declined at 21 h PP. Storage root number/plant for TI-155 declined at 15 h PP but was higher at both 18 and 21 h PP. Highest foliage dry weight for GA Jet was obtained at 21 h PP while that for TI-155 was obtained at 18 h PP. Leaf area index (LAI) for GA Jet increased with increased PP, while LAI for TI-155 increased with increased PP up to 18 h then declined at 21 h PP.

681 (PS 11)

NH₄/NO₃ MIXTURES ENHANCE GROWTH IN POTATOES

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The effects of various NH₄-N/NO₃-N ratios on growth and mineral accumulation in potatoes (*Solanum tuberosum* cv. Norland) were investigated using a nutrient film technique. Plants were grown for 35 days after transplanting at six NH₄-N/NO₃-N mixtures of 0/100%, 20/80%, 40/60%, 60/40%, 80/20%, and 100/0% with the same total N concentration of 4 mM. All mixed N treatments significantly increased total and tuber dry weights, plant size, leaf area, and specific leaf area as compared to either NH₄ or NO₃ alone. Plant growth was better with NO₃ alone than with NH₄ alone. Compared with mixed N treatments, total N concentrations in shoots were lower with either N form alone whereas total N in roots was lower only with NO₃ alone. With increased percentages of NH₄, root nitrate N concentrations decreased, and reduced N increased. The NO₃ alone treatment increased concentrations of Ca, Mg, Fe and Mn, and reduced concentrations of P, S, Cl, B, Zn and Cu in shoots as compared with NH₄ and mixed N treatments. It is concluded that a proper maintenance of both NH₄ and NO₃ forms can potentially promote growth and yield in potatoes.

THE EFFECT OF ALTERING THE N:S RATIO ON CONSUMER ACCEPTANCE OF LEAF LETTUCE

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Previous research on leaf lettuce has shown that altering the N:S ratio has an effect on plant color and N and S content. It appears that nitrogen rates can be decreased if known rates of sulfur are applied. The next step was to determine what effect altering the N:S ratio in lettuce had on consumer acceptance of the product.

'Grand Rapids' lettuce was grown hydroponically at six rates of S (0, 7.5, 15, 30, 60, 120 ppm) and four rates of N (30, 60, 120, 240 ppm). Sensory evaluation was performed on 20 of 24 treatments. The sensory panel was composed of 12 panelists who used the nonstructured hedonic scale to evaluate each lettuce treatment on appearance, color, texture, flavor, bitter flavor, and overall acceptability.

Results from the sensory evaluation indicate that differences in color, appearance, and bitter flavor were detected between treatments by the panel. Lettuce plants that received higher amounts of N in relation to S were considered less bitter in flavor and, over all, more acceptable than plants which received higher amounts of S in relation to N. These results indicate that altering the N:S ratio will affect consumer acceptance of leaf lettuce.

683 (PS 12)

FERTILIZER RESPONSIVENESS OF 'WOODARD' IN RABBITEYE BLUEBERRY

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The fertilizer responsiveness to macronutrients of 'Woodard' was investigated to obtain the data for the recommended rate of fertilizer application in a rabbiteye blueberry.

One-year-old rooted cuttings of 'Woodard' was grown under water culture in 1991. The plot was consisted of 13, a control (application rate: N-28, P-30, K-40, Ca-40, Mg-24 ppm) and 12 high volume application plots of macronutrients (applied 5 times that of the control).

The growth (dry matter per bush) was most superior in the N+Mg plot, most inferior in the N+Ca, the other plots was medium. As compared with the control, the growth of N+Mg, P+K, P+Ca, P+Mg, K+Ca, K+Ca+Mg and Ca+Mg plots was better than the control, and the growth of N+K, N+P+K and K+Mg plots was below. The concentration of macroelements in leaves of the control plot was low among all of. In each plots of high volume application of macronutrients, the concentration of the macroelements in leaves with some exceptions, became high, and the interaction between nutrient elements was confirmed. The difference of the growth of 'Woodard' was considered to be caused not only by the excess of some macroelements but also the imbalance of certain elements in the leaf and root.

684 (PS 12)

GROWTH CHARACTERISTICS AND YIELD OF 'HERITAGE' RASPBERRY AS AFFECTED BY ADDED NITROGEN

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Tissue cultured 'Heritage' raspberry plants were planted in April 1990. Split applications of ammonium nitrate were made to 0.6 m widths on each side of the row at total rates of 0, 22, 45, 90, or 180 kg/ha. Applications were made in May and August in 1990 and in March and July in 1991. The plants were cut to ground level during the winter. In 1990, cane length and number of buds on the central cane were unaltered by N treatment, but all N treatments resulted in the development of more canes than the control and thus more total length of cane growth. Date of 50% accumulated yield was advanced and total yield increased with added N. Foliar N contents (2.35%) of the two highest rates were greater (3 weeks after the second application) than the control (2.12%). In 1991, early yield was slightly delayed by N. Total yield was reduced by the highest N rate. The 45 kg/ha N treatment had the highest yield of 2.53 t/ha. Plants receiving 180 kg/ha had greater foliar N content in June and October than control plants. Soil samples were taken to 30 cm on June 29, 1991. About 80% of the nitrate-N was found in the top 15 cm.

685 (PS 12)

FOLIAR PREHARVEST CALCIUM TREATMENT INFLUENCE ON YIELD AND QUALITY ATTRIBUTES OF STRAWBERRY

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The major limiting factors for commercial marketability of strawberries grown in the Northeast is firmness and shelf-life. The major objective of the research is to study basic and applied aspects of

exogenous calcium treatments on yield and quality of New Jersey grown berries. In 1990, 8328-1 and 8237-1 (NJUS advanced selections), and 'Earliglow' and 'Raritan' standards, were treated with 4 foliar Ca sprays (Nutrical) at 10 day intervals from bloom through harvest. In 1991, sprays (3) were applied at bloom, bloom+15 days, and pre-harvest. An 'Earliglow' plot was utilized to test timing: bloom, mid-spray, or pre-harvest. Leaf and fruit samples were taken from treated and untreated plots prior to each application. Instron texture tests were performed to quantify firmness; a taste panel evaluated quality (color, texture, flavor, and overall quality). With multiple sprays, there were no significant differences in yield, fruit size, and Brix%, between treatments; however there were significant differences between genotypes and a genotype-by-treatment interaction. The lone bloom spray treatment reduced fruit size. Ethylene was reduced with calcium treatment, respiration was unaffected. Differences in flavor attributes were genotype specific.

686 (PS 12)

SHADING INCREASES TISSUE AMMONIUM, NITRATE, AND INFLORESCENCE NECROSIS IN 'PINOT NOIR' GRAPEVINES

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One- and two-year-old 'Pinot noir' grapevines were irrigated with Hoagland's nutrient solution and shaded with 60% shade cloth to investigate the effect of shading on inflorescence necrosis (IN), tissue ammonium, and nitrate status. Shading increased IN, tissue ammonium, and nitrate concentrations of laminae, petioles, and rachis in two-year-old vines. IN was positively correlated with tissue ammonium and nitrate levels. In one-year-old vines, tissue ammonium and nitrate concentrations were increased by shading in most tissues except for nitrate in tendrils and old roots. Tissue ammonium correlated with nitrate concentration in various tissues after anthesis in one-year-old vines and in laminae, petioles, fruit, and rachis of two-year-old vines. Elevated tissue ammonium in rachis has been suggested as a possible cause of IN.

687 (PS 12)

FRUITING REDUCES FOLLOWING YEAR FRUIT SET IN CRANBERRY UPRIGHTS

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Biennial bearing of uprights has been documented for cranberry (*Vaccinium macrocarpon* Ait.). Percent return bloom (%RB) may vary from 14% to 74% depending on cultivar and growing region. Floral initiation for the following season in cranberry takes place during the same time period as flowering and fruit set for the current season. This research was undertaken to document the effect of fruiting or not fruiting in the previous year on %RB and %RF (return fruit) in two cultivars (Stevens and Ben Lear) and five growing regions (MA, NJ, WI, OR, WA). Previous year fruiting caused a reduction in %RB compared to non-fruiting in the previous year. The effect on %RF was even greater. For 'Ben Lear', uprights that fruited in 1990 had 31%RB and 22%RF while those that did not fruit in 1990 had 67%RB and 54%RF. Both %RB and %RF in 1991 were about 49% lower for 'Stevens' which fruited in 1990 than those that did not fruit in 1990. It is still not clear whether biennial bearing in cranberry uprights is a function of hormonal interaction and regulation or of resource limitation or both.

688 (PS 12)

NEW LEAVES ARE THE PRIMARY SOURCE OF RESOURCES FOR FRUIT SET IN CRANBERRY

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The sources of carbohydrate and other resources for fruit growth in cranberry (*Vaccinium macrocarpon* Ait.) can be spatially partitioned into new growth, old leaves, and woody stems or other adjoining uprights. This research was conducted to determine which spatial source of resources was most important for fruit set in cranberry. At fruit set in late June, we removed the current season growth, one year old and older leaves, or both from 50 uprights per treatment plus a control at two locations. At harvest, fruit set, fruit number and size were determined. In all cases, removing the current season's growth significantly decreased fruit set. Removing both the current season's growth and old leaves produced an additional reduction in fruit set. Removing only old leaves reduced fruit set at one location but not the other. Fruit length, diameter or mean berry weight was not reduced by any treatment. The response of cranberry

to resource limitation apparently is to reduce fruit numbers rather than fruit size. This research suggests that current season growth is the primary source of carbohydrates for fruit set in cranberry and that once the fruit are set they have sufficient sink strength to attract resources from a distance.

689 (PS 12)

ALTERNATIVE N FERTILIZATION STRATEGIES FOR PEARS

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Current N fertilization practices, where high spring applications are utilized, may lead to excessive vegetative growth. However, high rates may not be required to maximize fruit yield and quality. Therefore, alternative strategies to minimize shoot growth while still providing the N needs of the tree were investigated. Mature 'Comice' and 'Bosc' pear trees were given one of the following treatments: a spring soil (SS) application of NH_4NO_3 nitrate at 112.5 kg/ha rate, a similar application in the fall after harvest (FS), a fall foliar (FF) spray of a 7.5% urea solution after harvest (FF), or no N (Control). Trees that received a FF application had the same leaf and fruit N content as control trees, but they yielded more fruit. The SS application gave more vigorous trees than FF application. Yield, however, was not different.

A ^{15}N enriched urea solution was applied at harvest as either a foliar spray, soil application, or combination of both treatments to mature 'Comice' trees. Flower buds from trees that previously received a foliar treatment had 37% of their N derived from the foliar N application. No labeled N was detected in buds from the soil treatment. These results indicate that vegetative and reproductive N requirements of fruit trees may be managed separately.

690 (PS 12)

INFLUENCE OF NITROGEN SOURCE AND ALUMINUM ON THE NUTRIENT UPTAKE AND GROWTH OF PEACH

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'Nemaguard' peach [*Prunus persica* (L.) Batsch] seedlings were grown hydroponically in a modified Hoagland's solution containing $\text{NO}_3\text{-N}:\text{NH}_4\text{-N}$ ratios of 100:0, 75:25, 50:50, 25:75 and 0:100. The solutions contained 0 or 50 ppm aluminum supplied as $\text{Al}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$ or $\text{AlNH}_4(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$. Analysis of pooled nitrogen source data revealed Al significantly reduced plant leaf area, height, total growth, and root:shoot ratio. Ammonium concentrations > 25% of supplied nitrogen significantly reduced leaf number, leaf area, height, lateral breaks, lateral growth, total growth, and leaf, stem, and root dry weights. Only height and dry weights (stem and root) for plants receiving 100% nitrate were significantly greater than plants receiving 25% of supplied nitrogen as $\text{NH}_4\text{-N}$. Generally, phosphorus uptake significantly decreased in the presence of Al regardless of nitrogen source, but the greatest reductions occurred at high $\text{NH}_4\text{-N}$ concentrations.

(abstract withdrawn)

692 (PS 12)

ROOT DISTRIBUTION OF PECAN TREES

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This study was conducted to know the root distribution and the effect of soil properties on root number of adult pecan trees. Two pecan trees planted to 10x10 m were selected in four orchards. Different soil conditions were present among orchards. In each tree, five trenches were dug to 1, 2, 3, 4, and 5 m from the trunk. Root number were calculated at 30 cm increments down to 2.4 m soil depth, in each soil profile. A soil sample was taken to determine soil properties. Then the root number were correlated to the distance of the trunk, depth and soil properties.

Fifty percent of roots were present in the upper layer of 90 cm. Under flood irrigation system the roots were dispersed in all space between rows and trees. The correlation coefficients (r) were significant to soil texture, organic matter (OM), pH, bulk density (BD) and micronutrient content (Cu, Fe and Mn). The r values calculated were: sand, -0.311; pH, -0.334; BD, -0.174; Clay, 0.343; silt, 0.174; OM, 0.174; Cu, 0.334; Fe, 0.114; and Mn, 0.176.

693 (PS 12)

GLUTATHIONE CONTENT IN REDHAVEN PEACH BUDS IN REST. DEVELOPMENT AND RELEASE OF REST.

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Glutathione content was determined in buds of peach (*Prunus persica* L.) trees during rest development and release. Reduced (GSH) and oxidized (GSSG) glutathione content changed with the accumulation of chill units (CU). GSH content decreased in the early phases of rest, and then increased at maximum rest. GSH content continued to increase and peaked on 1 Dec at 860 CU, and then dropped during the quiescent stage. It appears that the increase of GSH during chilling was closely associated with the breaking of rest. In contrast GSSG showed a continuous increase from Oct to Dec. Five concentrations of cyanamide were applied every 2 weeks from Oct to Dec. All cyanamide treatments depleted GSH within 12 hr followed by a large increase 24 hr after treatment. The changes in GSH content induced by cyanamide were inversely related to the concentration. The extent of GSH change was dependent on both the physiological status of the bud and the cyanamide concentration. At maximum rest, the plants were more resistant to cyanamide treatment and this coincided with the highest level of cyanamide-induced GSH.

694 (PS 12)

DIFFERENCES IN FRUIT COLOR CHANGE WITH MATURITY AND GROWING LOCATION IN 'SENSATION' AND 'MAX' RED BARTLETT PEARS

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Fruit color of 'Sensation' and 'Max' Red Bartlett pears was analyzed once at mid-season and three times during later stages of fruit maturity with a Minolta CR-200b portable colorimeter. Color measurements were taken on sun-exposed and shaded fruit surfaces in three different growing locations in Oregon. Color change is nearly constant over time during fruit maturation. Both cultivars gained red and yellow on sun-exposed fruit surfaces, and lost red but gained yellow on shaded surfaces. 'Sensation' gained red on sun-exposed surfaces to a greater extent than did 'Max' at all locations. 'Max' gained more yellow and lost more red on shaded surfaces than did 'Sensation'. Differences between cultivars and locations were greater on shaded than on sun-exposed fruit surfaces. Greatest gain in both red and yellow on sun-exposed surfaces was associated with the warmest growing location. Visually perceived color change with maturity appears to be due both to loss of red on shaded surfaces and gain of yellow on all surfaces.

696 (PS 12)

CELLULAR CHARACTERISTICS OF 3 SWEET CHERRIES WITH DIFFERENT SUSCEPTIBILITIES TO RAIN CRACKING

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Electron microscopic studies were conducted on 'Sue', 'Lapins' and 'Van' sweet cherry cultivars which have a high, moderate and low resistance to rain cracking, respectively. Epidermal and hypodermal cells showed differences in size and number. Sue, the resistant cultivar, contained an additional thin elongated cell rich in protein matter, in the hypodermal layer. The three cultivars also showed differences in the cell walls and vacuoles. However, mineral content of the epidermal and hypodermal layers showed no relationship to incidence of fruit cracking.

697 (PS 12)

SHADE AFFECTS YIELD AND QUALITY OF HAZELNUTS

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Many deciduous tree fruit species have a light requirement for floral induction. Floral induction of hazelnut has been reported

to occur through the end of May into July. At the end of May, less than 5% full sun reaches the base of the canopy in a mature hazelnut orchard. Leaf area density was estimated to be 7.6. Six levels of shade (0, 30, 47, 63, 73, or 92%) were imposed on caged 7-year-old hazelnut trees (*Corylus avellana* L. cv. Ennis) to determine effects of shade on yield and nut quality. Shading reduced yield of nuts per tree from 3.43 kg in 0% shade to 0.62 kg in 92% shade and yield efficiency from 70.2 g/cm² in full sun to 18.3 g/cm² in 92% shade. Yield and yield efficiency decreased substantially in 30% shade. When shade exceeded 47%, nut and kernel size decreased sharply, but % kernel increased slightly. In comparison to trees in full sun, shaded trees had a higher incidence of moldy or shrivelled kernels and a lower incidence of blanks.

698 (PS 12)

POLLEN TUBE GROWTH AND OVULE LONGEVITY OF RED DELICIOUS APPLE IN CUAUHEMOC, CHIH. MEXICO.

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Red Delicious apple is the second most important cultivar grown in the State of Chihuahua, Mexico. Red Delicious apple is well known for pollination problems which can reduce yield. Previous research suggested female sterility might account for irregular fruit set in the apple growing region of Chihuahua. Pollen tube growth and ovule longevity were examined in 1990 under field conditions in Chihuahua. Fluorescent light with Aniline Blue dye was used to determine pollen tube growth and ovule viability. Five days after pollination, 86% of the styles sampled had pollen tubes through the entire style and only 1% of the ovules were non-viable. These results do not support female sterility as the cause of irregular fruit set. Future research might be directed to the question of pollen viability on the stigma.

699 (PS 12)

THE RELATIONSHIP BETWEEN SWEET CHERRY FLOWER BUD DEVELOPMENT AND FRUIT QUALITY

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The development of sweet cherry (*Prunus avium* L., 'Bing') flower buds from winter through anthesis was examined. Shoots were collected from the top and bottom of the canopy. The weight and size of flower buds and primordia produced on last-season's and 1-year-old wood were measured. As early as mid-December bud and primordia size and weight were greater on last-season's wood than on 1-year-old wood, with the largest and heaviest buds and primordia produced on last-season's wood in the bottom of the canopy. There was a significant negative correlation between the number of primordia per bud and primordium weight. The relationship between flower bud and primordia size during mid-December and ovary size at anthesis suggests a causal relationship, which may be a major source of variation influencing harvested fruit size and quality.

700 (PS 12)

RESPIRATION OXYGEN RESPONSE AND RESPIRATORY QUOTIENT DURING CHILLING DORMANT APPLE TREES

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During natural leaf abscission, two-year-old, potted apple trees (*Malus domestica* cv. MM.111 EMLA) were placed in a cold room at 6°C for chilling. At 0, 600, 900, and 1400 chilling hours (CH), ten trees were removed and terminal shoots cut into four 15 cm sections. These sections were randomly placed in forty 10 l test tubes at 20°C and subjected to ten oxygen levels from 0.5 to 21% O₂ with four reps each by flushing tubes with mixtures of air and nitrogen prior to sealing. Tubes remained sealed for 4 hr then refilled and resealed for another 4 hr after which 1 ml gas samples were drawn and CO₂ and O₂ levels measured on a gas chromatograph. Respiration decreased with oxygen level at all CH. CO₂ evolved did not show a pattern related to oxygen level, but O₂ consumed decreased at a decreasing rate with additional CH. Respiratory quotient was below one at 0 and 600 CH and equal to one at 900 and 1400 CH, indicating a possible shift in respiration substrate with chilling.

701 (PS 12)

EFFECT OF TEMPERATURE ON KIWIFRUIT MATURATION

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In New Zealand, harvest maturity for kiwifruit is determined by the soluble solids concentration (SSC) of juice (minimum 6.2%). Commercial maturity differs in various regions of the country within each season and between years and may be due to differences in temperatures during growth.

Mature 'Hayward' kiwifruit vines were grown in controlled environment temperature treatments of 14/8, 18/8, 22/8, 26/8, 14/12 and 22/12°C to determine whether the increase in SSC at low night temperatures recorded in a related study was a result of the mean temperature, the min. daily temperature, or the magnitude of the max./min. temperature difference. Measurement was made of fruit size, firmness, starch and total sugar concentrations in the fruit at 10 day intervals.

SSC increased fastest with the coolest mean temperature irrespective of the min. temperature or max./min. difference. In the coolest treatment the concentration of starch decreased rapidly with a rise in total sugar, in the warmest treatment the change in the carbohydrate components was slower. Data will be used to predict harvest date at commercial orchard sites based on field temperature measurements.

702 (PS 12)

ROOT STRUCTURE OF KIWIFRUIT (*Actinidia deliciosa*)

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The root structure of kiwifruit was investigated by sequential trenching and eventual removal of whole vines. The vines had a shallow (30 to 60 cm.) spreading root system with few sinker roots. Roots extended beyond the canopy. Radial distribution of major roots arising from the crown was non-uniform. In several instances, roots mimicked the top by tying themselves into knots.

703 (PS 12)

KIWIFRUIT POLLINATION: BEES AND WIND CONTRIBUTION

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The aim of the experiment was to define the wind and the bees effect on kiwifruit pollination. Experiment was carried out for two years in an adult kiwifruit orchard, with a ratio between staminate (cv Matua) and pistillate (cv Hayward) vines of 1:7. Four different pollination treatments were tested on kiwifruit. Bees effectiveness was evaluated on both open pollination (OP-Bees) or net-isolated vines conditions (IV-Bees). The results obtained were compared with those achieved on net-isolated vines without bees in (IV-Wind) and on hand-pollinated vines (HP). Four rows (80 vines) were net-isolated and 14 uniform vines per treatment were chosen to collect productive data. In the IV-Wind treatment traps were used to capture insects present inside the nets. Wind speed was detected inside and outside the nets. Data showed that the net isolation system did not consistently modify wind speed and no insects were found in the traps. As far as productive data best results were obtained on HP vines. Bee-pollinated vines always reached higher yield and average fruit weight than wind-pollinated vines. However no statistical differences were detected between fruit weight of OP-Bees and IV-Wind vines treatments. The results showed that in general bees represent a more efficient pollination agent than wind, even if the health of the bees and the position of the hives in the orchard have to be carefully considered to achieve best results.

704 (PS 12)

CORK SPOT IN PEAR FRUIT

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Cork spot is a serious physiological disorder in pear (*Pyrus communis* L. cv. d'Anjou) in the United States, but a reliable technique for diagnosing it has not been developed. A review of the scientific literature indicated the disorder was generally linked with low calcium concentration in the fruit. In the present study, mineral analyses were conducted in 1987 and 1988 on soil, leaves, and fruit peel from normal trees and trees prone to cork spot. Soil tests and leaf analysis did not provide measureable differences between the two groups of trees. Fruit analysis provided variable differences between normal and cork spotted fruit, but no single nutrient or ration of nutrients could be consistently associated with the disorder. An assay for pyruvate kinase was evaluated as a diagnostic tool for cork spot. The assay did not provide measureable differences between normal and cork spotted fruit. An important finding of this study was to learn cork spotted fruit had higher soluble protein concentration than normal fruit.

705 (PS 12)

PHENOLOGY OF LOW-CHILL 'FLORDAPRINCE' PEACH

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Low chill 'Flordaprince' peach trees were grown in subtropical Australia, either following paclobutrazol application to dwarf the trees, or extra nitrogen to invigorate them. Fruits were thinned uniformly. Paclobutrazol significantly reduced the competing spring shoot growth and gave earlier maturity of larger, better quality fruits. It reduced the spring, but increased the autumn root flush. Stage 2 of fruit growth was slightly longer in vigorous trees, resulting in delayed seed growth and greater dry mass of the embryos. Starch reserves were greatest in the roots, followed by the trunk, shoots and leaves. The reserves were lowest during the second half of fruit development, but rose again after the end of shoot extension growth. Leaf N, P, and K levels decreased through the season while Ca and Mg increased. There were significantly lower K and higher Ca and Mg levels in dwarfed trees.

706 (PS 12)

PHYSIOLOGICAL CHARACTERISTICS OF THREE GROWTH TYPES

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The objective was to study selected physiological characteristics of the canopy and examine changes in dry matter partitioning between the root and shoot in two genetically reduced size growth types (dwarf and pillar) relative to the standard growth type. The dwarf phenotype had reduced leaf/root ratio, less allocation of dry matter to woody tissue and more to leaf tissue, high net photosynthesis, and lower leaf respiration compared to the standard and pillar phenotypes. The dwarf and pillar types had greater resistance to water flow than the standard type. Genetic changes in growth habit significantly alter many physiological parameters of peach tree growth and structure.

707 (PS 12)

CORRELATIONS OF CITRUS LEAF CHLOROPHYLL WITH LEAF MINERAL CONTENT

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The Minolta chlorophyll meter SPAD-502 (Minolta Camera Company, 101 Williams Drive, NJ 07446, USA) has been found to be a quick, accurate, simple, and nondestructive way to determine chlorophyll content in citrus leaves and a standard curve had been developed. The SPAD-502 chlorophyll meter was used to measure chlorophyll content in citrus leaves of ten varieties on three rootstocks. Leaf mineral analysis was then determined on these leaves for N, P, K, Mg, Mn, Zn, Fe, Cu and Ca. Correlation *r* values were generally low and not significant for most nutrient elements but were highest for Fe and Ca. The relationship of leaf nutrient levels and chlorophyll meter readings are not understood. The usefulness of the SPAD chlorophyll meter for determining mineral content in citrus leaves is not yet known.

708 (PS 12)

A NUTRITIONAL MANAGEMENT SYSTEM FOR TROPICAL FRUIT AND NUT ORCHARDS.

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Monitoring the nutrient status of a crop by soil and tissue analysis is an important tool in maximizing yields and avoiding nutrient deficiencies or toxicities. A nutritional management system is presented that uses a computer database to compile periodic soil and leaf tissue analyses to assist in the development of rational fertilizer recommendations for banana and macadamia nut orchards. Database management allows the Extension Agent to organize parameters (soil type, rainfall, elevation, tree age, tree spacing, and previous fertilizer practices) used in nutritional recommendations for individual farms. Graphs depicting nutrient trends over time

and comparison of nutrient levels to nutritional standards, present visual illustrations of problems and encourage grower acceptance of fertilizer recommendations. Growers are also able to see graphic responses to application of corrective fertilizers and soil amendments.

709 (PS 12)

PAPAYA FRUIT DEFORMATION AS RELATED TO BORON DEFICIENCY.

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Nutrient field studies were conducted on papaya, *Carica papaya* 'Kapoho Solo' under rocky soil conditions in Puna, Hawaii. The objective of the study was to establish the relationship between boron (B) petiole tissue levels of trees with deformed and normal fruits. Field surveys indicated that trees with deformed fruits had 25% less B than normal trees. A 4.05 hectare field was treated with rates of 0, 1.12, 3.92 and 5.04 kilograms of B per hectare. By-weekly tissue results showed that B levels increased from 4 to 10 weeks after application with the 16 week levels substantially higher than the control trees. The results showed that maintaining the tissue B levels over 25 ppm B corrected the deformed fruit condition of papaya. Commercial fertilizer blends have been formulated with 0.3% B which is now used semi-annually on all commercial plantings.

710 (PS 12)

PHOSPHORUS EFFECTS ON OLIVE LEAF ABSCISSION

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Ethephon reduces olive fruit removal force but also results in leaf loss when used as a harvest fruit loosening agent and in reduction of flower production in the subsequent year. Phosphorus (P) has been implicated in the fruit loosening process. Nuclear magnetic resonance analyses indicate that P accumulates rapidly in olive leaf explant abscission zones. P also causes ethylene evolution prior to abscission; this effect appears to be direct. In combination with AOA an ethylene synthesis inhibitor, P accelerates 'Manzanillo' leaf explants abscission, inducing significant abscission 3 days after treatment. These results will assist in development of a P use strategy that leads to fruit but not leaf abscission.

711 (PS 12)

RELATIONSHIP BETWEEN VEGETATIVE FLUSHING AND FLOWERING OF MACADAMIA

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To study the vegetative flushing pattern of *M. integrifolia* (cvs. Keaau, Kau and Kakea) trees in Hawaii and determine when these vegetative flushes flower, trees were monitored for an entire year (1988), and shoots from these flushes were monitored for flowering during the 1988-89, 1989-90 and 1990-91 flowering seasons. Flushing occurred year-round but was most frequent during the spring-summer and fall months which coincided with the end of the flowering season and the period of fruit maturation. For all cultivars, sporadic flowering occurred in 1988-89 on shoots that were less than one year-old but was not always associated with the oldest shoots. Flowering in 1989-90 and 1990-91 was observed on a larger proportion of the shoots and occurred on shoots that had emerged throughout 1988. Flowering was most abundant on two year-old shoots (1990-91) and could occur on shoots that had flowered in the previous season (1989-90).

712 (PS 12)

FRUIT GROWTH AND DESWEETING AMONG LONGAN (*Euphoria longana* Lam.) VARIETIES

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Fruit growth curves of three longan varieties showed single sigmoid. Seed was the major sink in longan at early fruit development. Aril grew only after seed had approached full development. Early

'Yangtaoyeh' grew more rapidly than two later varieties. Desweeting, levels of aril total soluble solids (TSS) increased to maximum and then declined gradually at later fruit development, occurs often in longan. Variation of desweeting rate among varieties was significant. Increases of fruit weight during desweeting (from dates of maximum TSS to end of experiment) were 55.4%, 50.9%, and 7.3% for 'Yangtaoyeh', 'Fenko', and 'Shihyueh', respectively. Periods of water contents increase in aril coincided with the changes of fruit weight of three varieties. Dilution of TSS by water inflow was one of major factor of desweeting in longan fruit. Girdling did not slow down decline of aril total soluble solids.

(abstract withdrawn)

714 (PS 12)

EVALUATION OF HORIBA CARDY COMPACT METERS FOR MONITORING GROWING MEDIA EXTRACT AND CELL SAP pH, E.C., NO₃, NA AND K CONCENTRATION

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Horiba Cardy compact pH, Electrical Conductivity (E.C.), Nitrate (NO₃), Sodium (Na), and Potassium (K) meters were used to monitor the nutrient content of solutions extracted from five organic potting media. Solution extracts were collected using the Saturated Extract Method (SEM). Duplicate samples were sent to three analytical labs for comparative purposes. The meters proved to be quick and easy to use and there was good to excellent agreement with lab value for pH, E.C., Na and K. The NO₃ meter did not provide good values below 80 ppm. For higher values there was a good relationship to lab values. The standard deviation for meter values was low, as were lab values for all parameter. Results of cell sap measurements as a method for evaluating the nutritional status of plants will be presented.

715 (PS 12)

DIFFERENTIAL HYDRATION AND ELEMENTAL ABSORPTION OF TWO POLYACRYLAMIDE GELS

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Hydration and elemental absorption of two commercially-available polyacrylamide gels (A and B) were studied in response to a 24-hr soak time in Hoagland's solution concentrations of either 2X, 1X, 0.5X, 0.25X, 0.125X or 0X (deionized water). Elemental absorption of gel specimens was observed and analyzed within the gel matrix on a Philips CM12S STEM equipped with an EDAX 9800 plus EDS unit for micro x-ray analysis. Thick sections were cut on dry glass knives using an RMC MT6000 ultramicrotome. Surface analysis of bulk specimens was made with an AMR 1000A SEM plus PGT1000 EDS unit. Overall, gel hydration decreased quadratically as solution concentration increased linearly; however, hydration for gel A was generally greater than for gel B. Surface analysis of gel samples revealed the presence Ca, K, P, S, Fe, and Zn for both gels. An analysis within the matrix of gel B revealed the presence of Ca, K, P, S, Fe, and Zn; however, an analysis within the matrix of gel A revealed the presence of Zn, and Fe only. The increased absorptive capacity of gel A appeared to be coupled to reduced migration of salts into the gel matrix.

716 (PS 12)

MYCORRHIZAL GROWTH ENHANCEMENT OF NEEM (AZADIRACTHA INDICA) SEEDLINGS

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The Neem tree is of ornamental, revegetation, biomass and medicinal value. The compound azadirachtin, which is derived from Neem seeds, is commercially used for insecticidal properties. In a 2x2 factorial experiment, Neem seedlings were either colonized with the mycorrhizal fungi *Glomus intraradices* or noninoculated and fertilized with full strength Long Ashton Mineral Solution at 11 or 22 ppm P. Mycorrhizal and P main effects were highly significant (p-value<0.001) with all growth parameters except R:S ratio. Mycorrhizal plants had greater leaf number, leaf area, leaf dry weight, shoot and root dry weight than noncolonized seedlings. The higher P (22 ppm) level plants had superior growth compared with low P plants. Leaf area and leaf dry weight were similar in mycorrhizal/low P plants and nonmycorrhizal/high P plants. These results suggest that mycorrhizal growth enhancement has important implications for Neem trees which are found in agriculturally poor soils in hot and arid regions.

717 (PS 12)

A PRACTICAL HYDROPONIC SYSTEM FOR USE IN PLANT NUTRITION STUDIES

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A common problem of researchers concerned with micronutrient plant nutrition is the development of a reliable and affordable experimental system. If nutrient distribution is uneven or subject to outside contamination, then the time and resources dedicated to a project will have been wasted. We have devised a dependable and cost effective nutrient distribution system which has many practical applications. This design is relatively maintenance free, easily adaptable to existing greenhouse conditions and limits the possibility of outside contamination. Using perlite as the rooting medium, our system is constructed of easily obtainable hardware and mechanical components. The total material cost of our system, which included three nutrient treatments, was approximately \$800. This resulted in a conservative estimate of \$12.50 per plant in our particular study. However, the cost of a larger experiment would be reduced considerably since additional replications could be added at approximately \$2.00 each. The experimental set-up is described along with the initial cost analysis.

718 (PS 12)

MACROMIXER: A SPREADSHEET PROGRAM TO AID MIXING MACRO-NUTRIENTS FOR SOLUTION CULTURE

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In solution culture experiments, determining the quantity of nutrient sources to dispense in a solution mix is time consuming. When a source contains more than one controlled element (e.g., calcium nitrate [Ca(NO₃)₂]), a change made to control one element (Ca) requires an adjustment to the other element (N). To ease the computational chore, MacroMixer, an application program for mixing macro-nutrients, was developed using a spreadsheet for microcomputers.

MacroMixer consists of two parts. The first part computes the weight (volume for a liquid) of source necessary to give the target element concentration from each source. The second part computes the total concentration for each macro-element from a set of sources in the final mix. The total volume of the mix is specified at the beginning of program, but it can be changed later. Users can obtain a required weight for each source using the first part to use as a starting value in the second part. Adjustments are made among sources to achieve target element concentrations in the final mix.

The spreadsheet format hides computational formulae and constants for a clear view of solution composition; thus users are encouraged to exercise trial and error to achieve the most balanced mix. Using this program, we quickly formulated 13 mixes used in a 5 K-levels x 5 Ca-levels partial factorial experiment.

719 (PS 12)

ETHIDIUM BROMIDE INHIBITION OF NAA-INDUCED ROOTING IN MUNG BEAN CUTTINGS

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Ethidium bromide (EB), at 10⁻⁵ to 10⁻⁴ M, progressively inhibits NAA-induced rooting of mung bean cuttings. Cycloheximide (CH), 6-methylpurine (6-MP) and kinetin (KIN) also inhibited rooting at the same concentrations, although CH and 6-MP were more effective.

At 70 and up to 130 hours of incubation, after cuttings received a 1-ml pulse of NAA (10^{-4} M), they exhibited a progressive increase in the number of observed adventitious roots. The addition of one of the inhibitors, 6-MP, EB or KIN to cuttings, pulsed 48 hours earlier with NAA, showed an initial slight inhibition with increased inhibition over time. CH, however, inhibited rooting immediately after addition. From these and other similar kinetic studies, it appears that 6-MP, EB and KIN operate at the transcriptional level and that CH inhibits translation.

Lineweaver-Burk plot analysis of NAA-induced rooting inhibition showed that EB may act as a competitive inhibitor of NAA. Since EB is a known intercalating agent and competitively inhibits NAA-induced rooting, NAA may influence gene expression by ultimately binding to DNA. Studies with space-filling and computer-generated models show that both NAA and EB can bind to certain dinucleotides by an intercalation mechanism.

720 (PS 12)

EFFECT OF CONTAINER SIZE ON THE GROWTH AND TRANSPLANT SURVIVAL OF GUAYALE SEEDLINGS

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Studies were conducted to evaluate container size and pretreatment on transplant survival and growth of guayule (*Parthenium argentatum* Gray). Seeds of cv. 11605 were planted in a greenhouse in two different container sizes. After 60 days half of the seedlings in both treatments were clipped, and then hand transplanted into the field. The height and width of 10 plants in each treatment were measured biweekly. The percent survival, date of flowering, seed germination and weight of 1000 seeds were determined. Plants produced in large containers had a higher survival rate, plant size and flowering rate. In addition non-clipped seedling had significantly higher survival rates. There were no significant differences in seed germination or in seed weights among treatments.

721 (PS 12)

WATER IMBIBITION AND RADICLE GROWTH OF GERMINATING PEA, CORN, AND SOYBEAN SEEDS ORIENTED TO THE EAST, SOUTH, WEST, AND NORTH IN SIX DIFFERENT MAGNETIC FIELDS

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Magnetic Resonance Imaging (MRI) is currently considered as a nondestructive and noninvasive method for observing the distribution, concentration, and status of water in biological materials. However, effects of static magnetic fields of MRI systems on plant growth and development remain controversial. This study was conducted to investigate the water imbibition and radicle growth of *Pisum sativum* (cv. Little Marvel), *Zea mays* (cv. Pioneer 3379), and *Glycine max* (cv. Forrest) seeds oriented to four directions and exposed to six different magnetic field strengths commonly used in MRI systems.

Seeds were embedded in a water saturated synthetic foam medium, and were oriented, with respect to their hilum or embryo, to the east, south, west, or north. Seeds were then exposed to either 2, 4, 6, 8, 10, or 15 kilogauss static magnetic fields for 48 hours (water imbibition) or 54 hours (radicle growth).

The orientation of seeds and the magnetic field strengths had no effect on water imbibition or radicle growth of seeds tested. However, long term exposure retarded pea radicle growth in 2 KG treatment, enhanced soybean radicle growth in 10 KG treatment, but had no effect on corn radicle growth.

722 (PS 12)

OBSERVATION OF A SELECTIVE HYDRATION AND CYCLIC WATER MOVEMENT IN *LYCOPERSICON LYCOPERSICUM* ROOTS USING MAGNETIC RESONANCE IMAGING

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A top-and-bottom split root system of *Lycopersicon lycopersicum* 'Burpee's Pixie' was developed using a nonferromagnetic phenolic foam growing medium. The objective of the study was to observe hydrodynamic activity in the roots and substrate when one side of the split root system was dehydrated. After withholding water for 22 days from the top block, the plant and substrate were scanned for 46.5 hours every 30 min using a Siemens 1.5 tesla magnetron whole body imaging system operating at 63 MHz. Resulting images were compiled into a time lapse movie and clearly showed selective root hydration and dehydration on the dry side of the split root system. Those changes in the root MRI signal intensity suggest a cyclic hydration of the roots and a partitioning of water among roots in dry environment.

723 (PS 13)

REVISION OF A CERTIFIED NURSERYMAN'S MANUAL

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A nursery certification manual was originally designed to provide initial and/or continuing education to nursery employees. Industry leaders wrote a manual and corresponding examination to initiate a pilot program. This manual has been revised by Oklahoma State University faculty in cooperation with the Oklahoma State Nurserymen's Association. The revised manual covers basic plant science, ornamental and related garden center plant materials, growth and cultural management concepts, basic business guidelines and current laws and regulations governing the nursery industry. After studying the 20 chapter manual, a rigorous examination is administered. Over 100 nursery workers have been certified to date. Employers have reported increased efficiency from these certified workers. Enhanced public confidence is another advantage to the Oklahoma Certified Nurseryman's Program. This program is likely to be adopted by most retail nurseries in the state.

724 (PS 13)

COMPUTER SIMULATION PROGRAMS FOR TEACHING CROP MODELING

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The simulation programs *Stella*® (High Performance Systems) and *Extend*™ (Imagine That!) were used on Apple® Macintosh® computers in a graduate course on crop modeling to develop crop simulation models. Students developed models as part of their homework and laboratory assignments and their semester project. *Stella* offered the advantage of building models using a relational diagram displaying state, rate, driving, and auxiliary variables. Arrows connecting the variables showed the relationships among the variables as information or material flows. *Stella* automatically kept track of differential equations and integration. No complicated programming was required of the students. *Extend* used the idea of blocks representing the different parts of a system. Lines connected the inputs and outputs to and from the different blocks. *Extend* was more flexible than *Stella* by giving the students the opportunity to do their own programming in a language similar to C. Also, with its dialog boxes, *Extend* more easily allowed the students to run multiple simulations answering "What if" questions. Both programs quickly enabled students to develop crop simulation models without the hindrance of extensive learning of a programming language or delving deeply into the mathematics of modeling.

725 (PS 13)

CONSTRUCTING A DEMONSTRATION VEGETABLE GARDEN

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A demonstration vegetable garden was constructed for students in elementary, middle and high schools to expose them to agricultural science. On Charter Day, a University-wide celebration, students were invited to the garden on the University campus. The purpose of this project was twofold: (1) for participants to learn how to make a garden and (2) for visitors to see a variety of available crops and cultural techniques. Approximately 30 vegetable crops were grown. The garden also presented some cultural practices to improve plant development, which included weed control by solarization, mulching, a drip irrigation system, staking, shading and crop cover. Different types of compost bins were shown and various nitrogen-fixing legumes were displayed as useful hedge plants for the garden.

726 (PS 13)

USING INTERACTIVE C.A.D., VIDEO DISC, AND COMPUTER-ASSISTED PLANT SELECTOR TO TEACH LANDSCAPE DESIGN.

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Computer assisted plant selection coupled with video disc technology allows students with limited experience in plant identification and selection to successfully complete landscape design plans.

The plant selector and video disc components have been integrated into a C.A.D. program producing a complete work station. Students preparing computer generated designs can refer to both the selector and video disc without leaving the C.A.D. environment. This integration has proven to be an effective teaching tool in landscape design instruction.

727 (PS 5)

CMV-RESISTANT CULTIVAR SELECTION BY ENZYME-LIKED IMMUNO-SORBENT ASSAY AND PROTOPLAST ISOLATION METHOD IN CUCUMBER. Kuen-Woo Park* and Min-Jea Kim, Dept. of Horticultural Sci., Korea University, Seoul, 136-701, KOREA

This experiment was carried out to select resistant cultivar to CMV in cucumber using Elisa-test and protoplast isolation method. Twenty domestic cultivars or lines and 8 European cultivars were tested for resistance by Elisa test. Among the domestic cultivars, DADAKI group was found to be susceptible and CHEONGJANG group resistant. Among all the cultivars and lines tested, a European cultivar, DALIBOR and Janghyunghueukjinju Korean line were found to be highly resistant. When comparing for the protoplast yield depending upon the positions of seedlings (cotyledon, young leaf and hypocotyl), the highest protoplast yield could be obtained from cotyledons in macerozyme 0.5% + cellulose 2.0%. Protoplast yields in susceptible cultivars were higher than those from resistant cultivars. Differences in cell wall thickness between susceptible and resistant cultivars were observed.

728 (PS 13)

ADMINISTRATION AS A SABBATICAL EXPERIENCE FOR FACULTY Stephen D. Verkade* and Robert H. Miller, University of Florida, 3205 College Avenue, Fort Lauderdale, FL 33314 and University of Rhode Island, Woodward Hall, Kingston, RI 02881

There is a need for Universities to encourage the continuing development of administrative skills among faculty in order to meet the challenges of the future. National and university initiatives have been developed to recognize this need. This sabbatical leave was developed to provide a significant, active, and meaningful administrative experience in the Office of the Dean at the University of Rhode Island.

This paper presents information on the structure, activities and involvement; and benefits to the participating faculty member, administrator, and institutions. The case study presented was both worthwhile and enriching for the participants, and strengthening for the sponsoring institutions.

729 (PS 13)

MEASURING MOTIVATION AND WORK CHARACTER PROFILE OF INMATE/PROBATIONERS IN A HORTICULTURAL COMMUNITY SERVICE WORK DETAIL PROGRAM

Candice A. Shoemaker* and John Paul Breault, Department of Horticulture, Berry College, Rome, GA 30149, Northwest Georgia Regional Hospital, Rome, GA 30161

A community service work detail program has been established at a state regional hospital to assist the Horticultural Therapy Program. The program provides a stimulating environment, job training, and a work setting for the inmate/probationer. The primary goal of the program is to reduce the number of repeat offenders reentering the criminal justice system.

Evaluation at entry into the program and after every 200 hours was conducted to define a work character profile and prioritize motivational drives. Interest and motivation in the program increased the first 600 to 800 hours and then decreased. To be effective, community service hours in a horticultural work detail program should be no more than 800 hours. The inmate/probationers were prepared and ready to reenter the community work force at this time.

730 (PS 13)

PROFILE OF TOMORROW'S STUDENTS: A MARKET STUDY

Leonard P. Perry* and Lois Berg Stack, Dept. of Plant and Soil Science, Univ. of Vermont, Burlington VT 05405 and Dept. of Plant, Soil and Envir. Sciences, Univ. of Maine, Orono ME 04469.

Our future horticulture students are growing up in an electronic world, and are gaining knowledge increasingly from computers, videotapes and television, and decreasingly from books and other written media. We need to understand their interests and motivations in order to determine how to market our educational programs to them. This study profiles our future students on several career-oriented factors, including their plans after high school, their academic interests, their impressions of and experiences in agriculture and horticulture, and the sources of

information they look to when seeking assistance in choosing a career track. Results compare male vs. female students, urban vs. rural students, regional differences, and differences between fifth and tenth graders (critical ages in career decision-making).

731 (PS 13)

URBAN FORESTRY PROGRAM AT SOUTHERN UNIVERSITY AND A&M COLLEGE.

Kit L. Chin*, Bobby R. Phills, Catalino A. Blanche, V. R. Bachiredy, Yadong Qi and Kamran K. Abdollahi, Department of Plant and Soil Sciences, Southern University and A&M College, Baton Rouge, LA 70813

Nationally, the urban and community forests are in a state of rapid decline. About 52% of street trees are dead or dying. The average tree life of the urban areas is about five times less than in rural areas. The growing national awareness of the importance and benefits of trees and their role in maintaining a healthy environment magnifies the need for urban forestry training programs. The Southern University Urban Forestry Program (funded by USDA Forest Service, Southern Region) is set up to address the critical need for high quality, user-oriented urban forestry training for minority students, and to bridge the gap between minority participation and national forestry resources, education and management programs. This unique program places major emphasis on experiential learning activities in addition to sound academic education. The four-year curriculum will be centered around forestry, horticulture, urban and community planning and landscape architecture.

732 (PS 13)

ELEMENTARY SCHOOL SCIENCE AND MATHEMATICS ENRICHMENT USING HORTICULTURE

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According to the Missouri Mastery Achievement Tests, elementary students in Missouri have a need for strengthening basic sciences and mathematics in their curriculum. Areas in the plant sciences such as seed germination and plant growth are among subjects needing particular emphasis. A pilot enrichment program was developed to address this need. Lesson plans were developed which paralleled topics in the *Core Competencies and Key Skills for Missouri Schools* and targeted for third grade students. The lesson plans were field tested in public and private schools for three years to evaluate lesson plans, equipment, handouts, and other instructional materials. The materials currently include three units: soil, water and plants. The materials are adaptable to all types of organized youth activities and are the primary materials used in Missouri for 4-H plant and soil science programs. Instructional materials have also been developed on how to implement the use of these tools by youth leaders and Extension personnel.

733 (PS 13)

INDUSTRY'S PERCEPTION OF UNIVERSITY HORTICULTURAL CURRICULUM.

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The Industry Liaison Committee of the American Society for Horticultural Science conducted a survey of the horticulture industry to systematically determine: 1) industry's perception of university training of recent graduates and 2) industry's perception of educational needs for future graduates. A Delphi survey was sent to experts in the fruit, ornamental, greenhouse, turf, and vegetable industry. The respondents expressed dissatisfaction with the level of competence of recent university graduates in personnel management and marketing. The lack of hands-on training in university courses was viewed as a major problem, but the respondents agreed that internships should provide university students with the necessary practical experience and universities should concentrate on the science of horticulture. The respondents indicated that business management and marketing expertise will be more important in the future than knowledge of production techniques; however, they would not be more likely to hire a business major instead of a horticulture major. The following areas of study were ranked for relative importance to be included in the university curriculum (from most important to least): communication skills, horticultural technology, business management, personnel management, plant nutrition and soil fertility, pest control, plant physiology, environmental awareness, plant physiology, plant pathology, accounting, and equipment use and maintenance. A second round of questioning for this Delphi survey is being conducted and results will be presented to verify preliminary results.

734 (PS 13)

SUCCESSFUL ESTABLISHMENT OF A FOUR-YEAR CURRICULUM IN LANDSCAPE CONTRACTING

Dan T. Stearns*, Perry M. Morgan, and Stephen J. Wallner, Department of Horticulture, Pennsylvania State University, University Park, PA 16802

As the landscape design/build industry continues to develop, opportunities for providing baccalaureate degree programs in landscape contracting increase. Employers seek individuals with competencies that are not adequately addressed by traditional horticulture or landscape architecture curricula. The Department of Horticulture at Penn State has developed a Bachelor of Science in Landscape Contracting degree. The program, now entering its fourth year of resident instruction, has experienced rapid growth and a high degree of success. Annual increases in student interest and demand have necessitated caps on the number of students entering the major. An emphasis on design process and on construction technology, and a requirement for successful completion of courses in Horticulture and allied departments contribute to an education which instructs students in the art, science, and management of a professional design/build business. Integration of computer-aided design into Landscape Contracting courses positions graduates to carry current technology to the industry. Students obtain skills on the use of AutoCAD, LandCADD, and New Image software.

735 (PS 13)

THE EFFECTIVENESS OF COMPUTER - ASSISTED INSTRUCTION IN A HORTICULTURE PLANT IDENTIFICATION CLASS

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Plant identification is a prerequisite to many, if not all, horticulturally related classes. It typically has been taught through the use of live specimens, slides, and text books. Recently, computers have entered the picture as a possible tool to teach plant identification. Increased availability and sophistication of computer systems in the college setting have led to the increased use of computers in instruction.

The objective of this study was to determine if there was a relationship between a student's learning style and academic achievement following computer assisted instruction. Undergraduate students enrolled in a plant identification class were involved in the study. Students learned plant identification either by: 1) viewing live specimens, 2) utilizing a computer instruction database system, or 3) combining live specimens with computer instruction. The students' cognitive knowledge was evaluated with pre and post tests. Learning style and attitude toward computer assisted instruction were also obtained.

736 (PS 13)

CONSUMER HORTICULTURE EXTENSION PUBLICATIONS IN THE U.S. - 1992

G. Douglas Crater*, Michael Colt, B. Rosie Lerner, Wayne McLaurin and Denise Sharp, Department of Ornamental Horticulture and Landscape Design, University of Tennessee, Knoxville, TN 37901-1071

A list of the consumer horticulture publications available from the cooperative extension service of each state was compiled. This list was prepared under the auspices of the ASHS Extension Consumer Horticulture Working Group and will be available for distribution. This list includes extension publications, leaflets and other extension materials appropriate for continuing education programs in consumer horticulture.

737 (PS 13)

TECHNOLOGY TRANSFER USING VIDEO: DEMONSTRATING STRATEGIES FOR ANTHURIUM BACTERIAL BLIGHT CONTROL

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Anthurium bacterial blight is a disease that has devastated much of the Hawaii anthurium industry in recent years. In response to the crisis, the Cooperative Extension Service produced a video entitled "Strategies for Anthurium Blight Control - A Growers' Discussion." The video format was selected to allow the extension service to utilize experience of four successful large scale commercial growers and deliver blight control information to other growers with a graphic demonstration on control procedures for disease management. Production of the video eliminated the need for farm tours, eliminated the risk of disease spread, condensed information, and allowed growers to borrow copies. This video proved effective in prompting growers to adopt and implement recommended blight control procedures.

738 (PS 13)

TELEPHONE "LOOPS", A TEACHING TECHNIQUE FOR LARGE AUDIENCES USING LIMITED MANPOWER
Denise D. Sharp*, David L. Clement, Raymond V. Bosmans, John Westrope and Mary Kay Malinoski, Home and Garden Information Center, 12005 Homewood Road, Ellicott City, MD 21042

In 1990, the Maryland CES Home and Garden Information Center initiated an 800 horticulture line manned 25 hours per week, offering taped messages 7 days a week, 24 hours per day. Of a total of 45,682 calls, 23,902 calls were answered by operators. To reduce operator hours, tapes on seasonal topics were grouped at the entrance level of the phone system. In 1991, gypsy moth and turf renovation were key topics demanding repetitive operator time. In 1991, 2,090 gypsy moth callers were assisted tapes, while 289 were assisted by operators. In 1991, 2178 turf renovation callers were assisted by tapes, while 256 were assisted by operators. Tape length and programming are critical to the success of this technique.

739 (PS 13)

DEVELOPMENT OF A REGIONAL EXTENSION NURSERY PUBLICATION

Mark H. Brand*, Dept. of Plant Science, Leslie Woodward, Dept. of Agricultural Publications, The University of Connecticut, Storrs, CT 06269 and Susan M. Mulgrew, Dept. of Plant & Soil Science, University of Massachusetts, Amherst, MA 01003

Funding reductions have left many Extension field and specialist positions unfilled when they are vacated. In New England, severe economic downturns have made this situation acute and have forced Extension programs to find innovative and more efficient ways of delivering information to clientele groups. The nursery and landscape industries comprise a major agricultural sector in New England whose needs must be met to maintain agriculture in the region. *Yankee Nursery Quarterly* was developed as a regional effort to draw upon nursery and related expertise from the six New England states. *Yankee Nursery Quarterly* provides information in the areas of nursery and Christmas tree production, landscaping, arboriculture, garden center operation and turfgrass four times annually. The publication format deviates from the standard 8 1/2" by 11" size and uses 2 color printing, a four-column layout and black and white photography to provide a recognizable, informative and visually appealing product.

740 (PS 13)

INTERDISCIPLINARY COOPERATIVE EXTENSION SERVICE EFFORTS FOR VALUE-ADDED INDUSTRIES IN KANSAS

Karen Gast*, Rolando Flores, Fadi Aramouni, Lisa Abeles-Allison and Elizabeth Boyle, Extension Horticulture, Extension Agricultural Engineering, Extension Foods and Nutrition, Extension Agricultural Economics, and Extension Animal Sciences and Industry, Kansas State University, Manhattan, KS 66506.

Value-added is the transformation of a raw product, usually an agricultural product, into a product that serves consumer demand better. The value-added product usually has an increased value and a higher return than the raw product. Kansas is one of the lowest ranking midwestern states for the number of value-added industries, although it is one of the greatest producers of raw agricultural products. An interdisciplinary team of Extension Specialists was created to promote and to serve small and medium size value-added businesses in the state. This poster will describe Kansas State University Cooperative Extension's approach to serving this clientele.

741 (PS 13)

SUSTAINABLE PRACTICES FOR VEGETABLE PRODUCTION: A LISA PROJECT TO DEVELOP A SOURCE OF INFORMATION FOR GROWERS IN THE SOUTHEASTERN U.S.

Mary M. Peet, Department of Horticultural Science, North Carolina State University, Raleigh, NC 27695-7609.

It is often difficult to obtain information on producing vegetables using 'sustainable' practices such as reduced inputs of pesticide and commercial fertilizers. Lack of such information is often cited by conventional farmers and extension agents as a reason for not adopting or assisting others in adopting sustainable techniques. As part of a Southern

Region Low Input Sustainable Agricultural (LISA) Program, we are compiling a database which will include techniques for vegetable production acceptable to 'organic' farmers as well as those acceptable to conventional farmers. This information source will include information on 17 specific vegetables and well as chapters on general topics such as cover crops and weed control. We hope to make this information available both as a production manual and by way of an electronic information retrieval system. Steps in the development of this project include initially soliciting input from farmers and extension workers on the preferred content and format and conducting an on-going evaluation by these groups as segments are developed. The database should be available within 2 years in both electronic and hardcopy versions.

742 (PS 13)

IMPLEMENTATION OF A GREENHOUSE INTEGRATED PEST MANAGEMENT (IPM) PROGRAM

Michael A. Schnelle* and Sharon L. von Broembsen, Departments of Horticulture and Landscape Architecture, and Plant Pathology, respectively, Oklahoma State University, Stillwater, OK 74078

A pilot IPM program has been implemented for the commercial greenhouse industry in Oklahoma. Key growers and cooperative extension agents have formed working IPM teams across the state. After administering a pretest to establish an educational baseline, IPM workshops have been presented to growers and agents. By use of these specialist-mediated workshops key growers have received sufficient training to implement a multi-phase IPM program. Establishment of proper cultural and management practices has occurred within the first six months of training. As a result, advanced growers are now implementing basic IPM practices and are anticipating the use of biological controls within this year. Due to the success of the pilot program, workshops will be offered statewide next year. Extension IPM bulletins are being written to facilitate the comprehensive effort. This pilot program should serve as a model and impetus for extension specialists and greenhouse grower organizations in other states to incorporate IPM strategies in their production and management practices.

743 (PS 13)

SURVEY OF THE IMPACT OF THE FLORICULTURE INDUSTRY IN MINNESOTA.

Debra Schwarze and John E. Erwin*, Department of Horticultural Sciences, University of Minnesota, St. Paul, Minnesota, 55108.

A phone survey was conducted to assess the total impact of the floriculture industry on the Minnesota economy. Data were collected from wholesale growers, garden center retailers, chain stores, and florists. Information was gathered on 'hard good' sales associated with greenhouse produced plants as well as plant sales. In addition, data on labor and salaries associated with the production, distribution, and retailing of plants and goods associated with the floriculture industry was collected. This data will be provided to local flower growers organizations to enable these groups to actively lobby for their concerns within the state.

744 (PS 13)

COMPUTER-BASED INFORMATION TRANSFER FOR AGRICULTURE IN HAWAII

Ruth Y. Iwata*¹, Kent Fleming² and Scott Campbell³, Department of Horticulture¹, Department of Agricultural & Resource Economics², Department of Agronomy & Soil Science³, University of Hawaii, Honolulu, HI 96822.

AgNet-Hawaii is a computer-based information transfer system (CBIS) established at the Beaumont Agricultural Research Center in Hilo, Hawaii to improve communication among research, extension and farmers on the island of Hawaii and with the island of Oahu. AgNet-Hawaii is one node of a Pacific-wide network of CBIS nodes, whose hub is the Coconut Telegraph CBIS on the Manoa Campus of the University of Hawaii on Oahu.

AgNet-Hawaii has file and conference areas, the capability of uploading and downloading files, issuing bulletins, and sending files attached to messages. Access is by computer and modem with the following modem protocols: Telephone (808) 969-3025 (AgNet-Hawaii), (808) 956-2626 (Coconut Telegraph), Data Bits: 8, Parity: N, Stop Bits: 1, Speed: 300/1200/2400/9600/14.4K bps.

745 (PS 13)

PRIVATE PESTICIDE APPLICATOR TRAIN-THE-TRAINER PROGRAM IN ILLINOIS

Rhonda J. Ferree* and David J. Williams, University of Illinois, 1201 S. Dornier Dr., Urbana, IL 61801

Under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), private applicators who purchase and use restricted use pesticides (RUP's) are required to obtain certification. The Cooperative Extension Service has been assigned the responsibility of informing and educating those applicators about the safe and precise use of pesticides. In Illinois, area Agriculture advisors are responsible for the training. They are supported by State staff. Support is provided to area advisors through development of several teaching medias. A Private Applicator Training manual is the main educational media. That is supported by a slide set and script, videos, demonstration kits, handouts, and overheads. Trainers are encouraged to have students use workbooks, which were developed to follow the slide set, during training sessions. Additional support is provided through a newsletter, equipment and video loans, advertising, meeting site rental, and yearly program updates. Train-the-Trainer classes are provided as needed. Trainers have been surveyed as to the quality of exiting and the need for new educational materials. Examples of publications and teaching materials will be on display.

746 (PS 13)

EDUCATIONAL PROGRAMS FOR HANDLING LANDSCAPE WASTES: A PARTNERSHIP BETWEEN THE ILLINOIS DEPARTMENT OF ENERGY AND NATURAL RESOURCES AND THE UNIVERSITY OF ILLINOIS

David J. Williams* and Rhonda Ferree, University of Illinois, 1201 S. Dornier Drive, Urbana, Illinois 61801.

The State Of Illinois passed legislation banning landscape wastes deposition in land fills. Approximately 18% of all solid wastes going into Illinois landfills were landscape wastes including grass clippings, branch prunings, leaves and wood. A cooperative program between the Horticulture Department, the Cooperative Extension Service and the Illinois Department of Energy and Natural Resources was initiated to train county extension advisers, municipalities, and the consuming public on methods for landscape waste reduction and recycling.

Workshops, video tapes, Master Composters, mobile displays, fact sheets and a model municipal composting facility were developed. Publications and other educational materials will be displayed.

747 (PS 13)

NITROGEN NUTRITION FOR HOME GARDEN VEGETABLES

Neal Leimbach, Cooperative Extension Service, The Ohio State University, Oak Harbor, Ohio 43449

Studies conducted on selected vegetable crops in replicated trials using nitrogen fertilizer at the specified rates equivalent to 56 kg, 112 kg, 224 kg, and 448 kg per hectare, produced yield variations. The purpose of this research was to compare the effects of nitrogen (ammonium nitrate) on vegetable production for the home gardener. The yield in numbers of U.S. No. 1 grade bell peppers treated at the rate of 224 kg was higher for the third harvest when compared to the individual yields of the 1st, 2nd, and 4th harvests. The accumulative weight and number of fruit were higher on pepper plants receiving 56 kg than those receiving greater amounts of nitrogen. Tomato yields were higher for the 3rd harvest of plants treated at the 56 kg rate when compared to the yield at greater rates. Maturity of tomatoes was delayed at the nitrogen rate of 448 kg per hectare. At the nitrogen rate of 56 kg, the 2nd harvest of snap beans recorded a higher yield than the individual yields of the other three harvests. Individual head weight of cabbage was the greatest when plants received 448 kg nitrogen as compared to plants treated with less nitrogen.

748 (PS 13)

PEOPLE-PLANT COUNCIL RESEARCH BIBLIOGRAPHIES AVAILABLE

Diane Relf* and Pete Madsen, Department of Horticulture, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061

Through funding from various horticultural associations (including ASHS, ALCA, SAF, WFFSA, and HRI), the People-Plant Council has been able to develop a computerized bibliography that will be of great value to researchers in the area of People-Plant Interaction and a second bibliography specifically for the area of Horticultural Therapy. The combined PPI and HT bibliographies contain approximately 1600 citations, 25 percent of which include an abstract. Due to the size and length of each bibliography (over 200 pages of hard copy), they are available on diskette. This will facilitate users searching for keywords or specific articles and allow them to rearrange the material as needed.

EFFECT OF IRAQI INVASION AND OCCUPATION ON VEGETABLE PRODUCTION IN KUWAIT

Dr. Mahdi Abdal* and Mr. Mohamed Al-Bahouh, Aridland Agriculture Department, Kuwait Institute for Scientific Research, P.O. Box 24885, Safat 13109, Kuwait.

A preliminary technical study has been carried out on vegetable production in Kuwait after liberation from Iraqi occupation. These assessment observations and data have been compared with pre-invasion published and unpublished data. The extent of damage and devastation to the status and needs, as well as the opportunities existing in this sub-sector, have been preliminarily described and documented. While the harshness of the environment, the scarcity of the water, the level of the temperatures, and the mobility of the sand have always been formidable obstacles here to vegetable production activities, quantities produced, and qualities yielded, they now serve to exaggerate the adverse impact of this crisis on this sub-sector. Open fields, and their support systems, have been severely disrupted, protected environmental units have been dismantled, and irrigation systems have been destroyed, labor dissipated, and essential supplies pillaged. Opportunities now appear to abound for greenhouse and hydroponic advanced technologies in reconstructing and expanding Kuwait's vegetable production. Costs need to be balanced against value of products produced.

750 (PS 13)

EFFECT OF THE GULF CRISIS ON THE GREENERY OF KUWAIT AND PLANS FOR ITS FURTHER ENHANCEMENT

Dr. Mahdi Abdal* and Mr. Dave Kater, Aridland Agriculture Department, Kuwait Institute for Scientific Research, P.O. Box 24885, Safat 13109, Kuwait.

The August 1990 invasion and subsequent occupation of Kuwait brought about approximately nine (9) months of "forced neglect", resulting in losses of entire areas of greenery. In this study, random sites representative of 350 hectares of existing greenery were monitored to gather information on species susceptibility to "forced neglect" under harsh conditions. While the environment, water availability and sand movement have always been formidable obstacles to ornamental plant production here, they have greatly exaggerated the broad adverse impacts under these conditions of "forced neglect". Nevertheless, certain genotypes from many of the ornamental species were found to exhibit substantial tolerance to drought and fluctuating temperatures.

At the time of the invasion, efforts had been underway to develop an over-all Master Plan for beautifying the entire country. The impact of the crisis on the greening strategy, the plant palette and the unique cultivars that will be needed will be discussed.

751 (PS 13)

MONSOON PLANTING OF POTATOES: A NEW CROPPING PATTERN FOR THE ARID HIGH HILLS OF WESTERN NEPAL

Bhim B. Khatri, Janak D. Shakya, Nat. Potato Res. Progr., Khumaltar, NEPAL; James H. Lorenzen*, North Dakota State University

Potato (*Solanum tuberosum* L.) is a major food crop for farmers of higher elevations (> 2000 m) in Nepal. Farmers plant potatoes in early spring after snow melt, utilizing residual winter moisture and occasional pre-monsoon rains for crop growth. The growing season is usually ended by late blight (LB, *Phytophthora infestans*) after the onset of the monsoon. However, drier areas of the interior of W. Nepal regularly experience drought and impaired plant growth before the monsoon, and the lesser duration and intensity of the monsoon there should result in lower LB pressure with a June/July planting.

Planting just prior to the monsoon in highland areas with annual rainfall < 1000 mm has given outstanding yields with cvs Achirrana Inta and I-1124. On-station and farmers' field trials have produced over 40 and 30 T ha⁻¹, respectively, more than 4x the national average yield and nearly 2x the equivalent yield for a normal season planting in the same site. The LB resistant cultivars and the new cropping pattern may be extended to similar sites. (Supported by Swiss Devel. Assistance & Humanitarian Aid, Bern, Switzerland)

752 (PS 13)

DID WE FULFILL OUR NUTRITIONAL RESPONSIBILITY?

Y. H. Yang*, Seeds for Peace Project, 500 University Avenue, #918, Honolulu, Hawaii 96826, U.S.A.

Vegetable crops supply essential vitamins and minerals for human nutrition and survival. However, most scientists concentrated their effort on crops

low in nutrition value, causing much health problem in the developing world. In Asia alone, 300,000 children blind each year due to vitamin A deficiency and 40% population suffered from iron-deficient anemia. Their health and social consequence was unmeasurable. A practical remedy was to increase consumption of DGLVs through home garden program.

Field experiment conducted in East-West Center in Hawaii documented that a 200 sq. ft. small garden could yield vegetable fulfilling RDA of 5 people 200% of vitamin A value and ascorbic acid, 27% iron and 9% protein. Promotion of home garden program requires research, training and education, coordination, and policy support. Horticulturists should play important role on all these aspects.

Seeds for Peace Project and proposal for establishing home garden training centers at different levels will be reported.

753 (PS 13)

DEVELOPMENT OF A FARMER-BASED BEAN SEED MULTIPLICATION AND DISTRIBUTION SYSTEM FOR RWANDAN FARMERS

K.B. Paul, Cooperative Research and Extension, Lincoln University, Jefferson City, MO 65101-3594

Most farmers in Sub-Saharan Africa plant local cultivars introduced generations ago. Various national and international organizations and development projects introduce annually hundreds of improved germplasms to a country, and test these under farmer conditions for adaptability and acceptability. Although some local varieties perform well under traditional farming practices, many disease and insect pest resistant improved varieties out-yield local cultivars even under low-input production conditions of Africa. Regrettably, the seed production and distribution system in most of these countries are poorly developed; thus the promising varieties remain unavailable to the majority of farmers. To overcome this problem, the University of Arkansas-led Rwanda Farming Systems Research Project (FSRP) personnel trained farmer-cooperators in the production of good quality bean (*Phaseolus* sp.) seeds. This, and the development of a farmer to farmer seed distribution system that led to quick diffusion of improved bean varieties in the project area will be discussed.

754 (PS 13)

ROOTING CHARACTERISTICS OF 25 ZOYSIAGRASSES GROWN IN FLEXIBLE PLASTIC TUBES

K. B. Marcum* and M. C. Engelke, Texas A&M Research and Extension Center, 11760 Coit Rd., Dallas, TX 75252

Root extension to lower soil depths and root branching are important drought avoidance mechanisms, allowing efficient use of available soil water during periods of prolonged drought. Rooting characteristics of 25 zoysiagrasses included in the 1991 National Turfgrass Evaluation Program were determined. Grasses were grown in clear polyethylene tubes filled with sand, and inserted into opaque PVC sleeves, tilted 30° from vertical. Root extension was monitored weekly, and root mass and number per 10 cm depth determined. Root extension was correlated with total root weight and number of roots per 10 cm vertical section. Shoot weight was not correlated with root extension or total root weight. Grasses having exceptional root extension, root number and weight per 10 cm root section, include DALZ8516, TC5018, and GT29047, while those with poorest overall performance include DALZ9006, DALZ8508, DALZ8501, DALZ8502, and CD2013. Of five commercial cultivars tested, Emerald, Meyer, and El Toro had the greatest root extension.

755 (PS 13)

1993 INTERNATIONAL TURFGRASS RESEARCH CONFERENCE

John L. Cisar*, George H. Snyder, and Karen E. Williams, Ft. Lauderdale REC, University of Florida, 3205 S.W. College Ave., Ft. Lauderdale, FL 33314

For only the second time, the United States will host The International Turfgrass Society's (ITS) International Turfgrass Research Conference (ITRC). The VII ITRC will be held July 18-24, 1993 at The Breakers in Palm Beach, FL. Since its inception, the ITS has been devoted to addressing problems that effect turfgrass and improving the standards of turfgrass science through international communication. The Conference will offer two symposia entitled "Pesticide and Nutrient Fate in Turfgrass Systems" and "Quantification of Surface Characteristics of Sports Fields". Additionally plenary and volunteered oral and poster presentations on all topics of turfgrass science and related horticultural landscape management tours of the local horticultural industries will be offered. Volunteered papers will be published in a proceedings as either original research

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762 (PS 14)

FRUIT ODOR COMPOUNDS INHIBIT POSTHARVEST FUNGAL DECAY OF STRAWBERRIES AND RASPBERRIES

Steven F. Vaughn* and Gayland F. Spencer, USDA, ARS, National Center for Agricultural Utilization Research, Peoria, IL 61604

The shelf-life of strawberries and raspberries is limited primarily due to losses from fungal decay. During ripening, these fruits release numerous volatile compounds, some of which have been shown to have antifungal activities. We examined fifteen volatiles released by both fruits for the prevention of postharvest fungal decay. Benzaldehyde, 1-hexanol and 2-nonanone completely inhibited all fungal growth on fruit at gas headspace concentrations of 0.1 µl/ml, while causing little damage to the fruit. However, greater levels of these compounds, although completely inhibiting fungi, generally caused some fruit damage. Headspace concentrations of these compounds at 0.04 µl/ml or greater completely inhibited the growth of *Botrytis cinerea* and *Alternaria alternata* in culture but higher levels were required to inhibit *Colletotrichum gloeosporoides* and *Rhizopus stolonifer*. These results suggest that these compounds could be used to effectively prevent fungal decay if constant, low levels could be maintained in the headspace surrounding the fruit.

763 (PS 14)

MODIFIED ATMOSPHERE PACKAGING OF GRAPES

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Grapes (*Vitis vinifera* L. cv. Thompson Seedless) were packed in low density (LDPE) and high density (HDPE) polyethylene bags (Bag size: 25x25 cm containing 300 g of fruit). LDPE and HDPE films had a thickness of 38.7 and 28.2 µm, water permeability of 960 and 720 g/m².hr.atm., and O₂ permeability of 7030 and 3700 cc/m².day.atm., respectively. Carbon dioxide gas (400 cc) was introduced to the bag immediately after sealing, after 2 weeks. and/or after 4 weeks. Fruits were evaluated after 3 months at 0°C. CO₂ was about 30% immediately after introducing the gas but its concentration was reduced to less than 1% within 3 to 4 days. O₂ was maintained very high (higher than 10%) in all packages. Water loss and shriveling were very low. However, decay incidence was high in all packages. In-package atmospheric conditions were not appropriate in all treatments to suppress decay activities. Further studies will be carried out with films less permeable to atmospheric gases, and fruits will be evaluated after shorter storage periods.

764 (PS 14)

EFFECT OF SIMULATED RAINFALL ON RAISIN QUALITY

R. Keith Striegler*, Carter D. Clary, David R. Wineman, Gina A. Waggy, and Steve Glossner, Viticulture & Enology Research Center, California State University, Fresno, Fresno, CA 93740-0089

Natural sun-dried raisins are susceptible to crop loss and quality reduction when rainfall occurs during the 2-3 week drying period. The purpose of this experiment was to determine the effect of rainfall at selected stages of the raisin drying period on raisin quality. Thompson Seedless grapes were harvested and dried in the field using normal commercial practices. Raisins were moved to a humid chamber at the green, brown, turn, and roll stages of the drying period. Then, raisins were misted with 6.4 or 25.4 mm of water to simulate rainfall. Samples remained under humid conditions for approximately 48 hours after which they were returned to the field to complete the drying process. Raisin quality was evaluated by USDA incoming inspection procedures. The amount of rainfall had little effect on raisin quality at the levels in this experiment. However, raisin quality was significantly reduced when rainfall occurred at the green and brown stage of drying. Raisins which received rainfall at the turn and roll stages of drying were of comparable quality as control raisins.

765 (PS 14)

DECAY CONTROL IN TABLE GRAPE CULTIVARS BY FUMIGATION WITH DECCODIONE SMOKE TABLETS FOR PROLONGING THE STORAGE LIFE

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Fruit of table grape cvs. Black Monukka, Flame Seedless, Thompson Seedless and Himrod were fumigated with 2, 4 and 6

Deccodione tablets for 30 minutes in a fumigation chamber. Fruit was brought to the cold rooms and stored at 32 F and high relative humidity for upto 10 weeks. Decay control index, freshness of stems and bleaching around the capstem were recorded at 2, 4, 6, 8 and 10 weeks of storage. Size of the smoke particles was determined using an electrical aerosol analyzer. Fruit was kept in good condition by fumigation with 6 smoke tablets upto 10 weeks. Lower doses failed to control the decay. No bleaching around the capstems commonly associated with sulfur dioxide fumigation was noticed. Majority of the smoke particles were between 0.18 and 0.32 micrometers. Fumigation with Deccodione tablets could be a viable alternative to sulfur dioxide fumigation.

766 (PS 14)

EFFECTS OF 2% O₂, 50% CO₂, AND THE COMBINATION ON FLAVOR QUALITY AND FERMENTATION PRODUCTS OF STRAWBERRIES AND BLUEBERRIES

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Low O₂ and high CO₂ concentrations can be used effectively to slow respiration and retard decay, but anaerobic and CO₂-injurious conditions must be avoided. The objective of this research was to: 1) determine the effects of low O₂ and very high-CO₂ on flavor quality and accumulation of fermentation products. Strawberries and blueberries were stored in 2% O₂/0% CO₂, 20% O₂/50% CO₂, 2% O₂/50% CO₂, and 20% O₂/0% CO₂ for 0, 2, 4, 6, and 8 days at 20°C. A taste panel evaluated the berries at the end of each storage period and again after 2 days under ambient conditions. Ethanol was the primary fermentation product that accumulated in response to low O₂ and high CO₂ concentrations. However, acetaldehyde was produced preferentially in response to elevated CO₂ levels. The flavor quality of the strawberries and blueberries was only acceptable for 2 days for treatments containing 50% CO₂. The most intense off-flavors were detected in the 2% O₂/50% CO₂ and 20% O₂/50% CO₂ samples. 50% CO₂ was highly effective in preventing decay, but this concentration was too high for acceptable flavor quality for storage periods greater than 2 days.

767 (PS 14)

CALCIUM UPTAKE IN SEALED PLASMALEMMA VESICLES ISOLATED FROM POST HARVEST CaCl₂-TREATED SOUR CHERRIES

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Calcium chloride (CaCl₂) enhances turgidity and quality of post-harvest sour cherry, *Prunus cerasus* L., fruit. Mechanisms by which plasma membrane (PM) ATPase maintains the electrochemical gradient in cell turgor were studied in isolated PM vesicles isolated from tap-water-, CaCl₂- and chelated amino acid-calcium-treated Montmorency sour cherry fruit. Electron microscopy and periodic-chromic-phosphotungstic acid staining indicated 85-90% closed PM vesicles. Protein activity associated with the PM was four times higher in both Ca treatments than in untreated cherries. ATPase activity was insensitive to NO₃ and Na₃, but inhibited by vanadate, indicating absence or low levels of tonoplast and mitochondrial ATPases. PM vesicles exhibited a pH jump in the presence of acridine orange (A₄₉₃₋₅₃₀ nm). Cherry fruit appeared to have a PM ATPase similar to that of other plant species. Generation of a positive membrane potential across the PM was dependent upon ATP.

768 (PS 14)

STUDIES ON THE MECHANISM OF FIRMNESS RETENTION OF APPLES HEAT-TREATED BEFORE STORAGE

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Prestorage heating of apples lead to enhanced retention of fruit firmness of as much as 10 N upon removal from storage, compared to unheated fruit. Further enhancement of firmness retention was obtained by dipping fruit in 2-3% calcium chloride after heating prior to storage. Cortical tissue of heated fruit had more insoluble and less water soluble pectin than unheated fruit, although the total pectin content was similar in both treatments. During the heat treatment neutral sugars were lost from the pectic fractions, with no accompanying decrease in galacturonic acid. No effect of heat treatment on degree of methyl esterification was observed in pectic fractions or in critical-dried whole tissues, using colorimetric and NMR techniques, respectively. Treatment differences in

dissolution of the middle lamella were not observable in electron micrographs. We suggest that loss of neutral sugar side chains during the heat treatment may have lead to closer packing of the pectin strands and in turn hindered enzymatic cleavage during and after storage.

769 (PS 14)

TOLERANCE OF NECTARINE AND PEACH CULTIVARS TO INSECTICIDAL CONTROLLED ATMOSPHERES

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The tolerances (based on time before detection of off-flavor) of nectarine and peach cultivars to an insecticidal controlled atmosphere of 0.25% O₂ (balance N₂) at 20C were 2.8, 4.0, 4.0, 4.4, 5.1, and 5.3 days for 'John Henry' peaches, 'Fantasia' nectarines, 'Five Red' peaches, 'O'Henry' peaches, 'Royal Giant' nectarines, and 'Flamekist' nectarines, respectively. The greater sensitivity of 'John Henry' peaches to low O₂ stress was associated with a higher respiration rate; faster accumulation rates of acetaldehyde, ethanol, and ethyl acetate; and a more mature and larger fruit. The tolerances of 'Fairtime' peaches to 0.21% O₂ + 99% CO₂ at 20C, 0.21 O₂ + 99% CO₂ at 0C, and 0.21% O₂ at 20C were 3.8, 5.0, and 6.0 days respectively. There was a good correlation between tolerance of nectarines and peaches to insecticidal atmospheres and the accumulation rates of acetaldehyde ($r=-0.94$, $p<0.01$) and ethanol ($r=-0.88$, $p<0.01$).

770 (PS 14)

INFLUENCE OF NON VISIBLE MECHANICAL DAMAGE ON INTERNAL QUALITY AND RIPENING OF KIWIFRUIT (*Actinidia deliciosa* L.)

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Kiwifruits were picked by hand and gently placed in pulp trays. Impact tests were conducted by dropping the fruits from heights of 30 cm onto different sandpapers to provide a uniform abrasion surface. Abrasion tests were conducted by compressing the fruits with a fixed load of 3.5 N (Instron equipment) onto different sandpapers and pulling out the fruits. Compression test was performed by using the previous procedure with a fixed load of 4.5 N for different period of time (minutes). Increase of transpiration rate and ethylene production was observed in fruits abraded with sandpaper which slight wounded the peel. Impact onto sandpaper, caused the appearance of white lignified filaments in the flesh. Increase in soluble solids and softness of flesh and core was observed in injured fruits. Healing process and polyamines effect will be discussed.

771 (PS 14)

STUDIES ON PEACH AND NECTARINE SKIN DISORDER INCIDENCE: ANATOMICAL OBSERVATIONS

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Peach and nectarine skin discoloration or inking (SD) has become a fruit industry problem in the last decade. Spots on the skin may be black, tan, purple or brown and vary in shape. SD was related with physical abuse of the fruit occurring during handling (harvest and transport operations) within the orchard.

An anatomical study comparing healthy and damaged (black and brown) tissue of different peach and nectarine varieties was done with the Scanning Electron Microscope (SEM) and Light Microscope (LM). This study indicated that only exocarp cell (epiderm and cuticle) damage was associated with SD. The internal compartmentation of the damaged cells was often disrupted with the contents of the cytoplasm and vacuole mixed and expelled. Mesocarp cells were always intact and turgid. The same anatomical and visible tissue injury symptoms were induced on fruit by abrasion treatments.

772 (PS 14)

CONTROL OF ENZYMATIC BROWNING OF APPLE SLICES

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The control of enzymatic browning of apple slices with papain is presented. Fresh apple slices dipped in a 1% Papain solution for 2 min did not brown for more than 12 hours at room temperature. Papain also gave good browning control of sliced pears. Further study indicated that polyphenoloxidase, a key enzyme involved in browning, was inactivated by this treatment.

773 (PS 14)

EFFECTS OF VAPOR HEAT TREATMENT ON MANGO FRUIT QUALITY

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Mature green mango (*Mangifera indica* L.) fruit were heated (100% RH) at 50C for 120, 180 or 240 min or 46C for 160, 220 or 280 min. The rate of mesocarp color (CIE a*) development was reduced in treated fruit, particularly in inner tissue. Rate of softening of mesocarp tissue was reduced after heat treatment; inner more than outer. Fruit treated at 50C remained more firm than control fruit 9 days after treatment, whereas fruit treated at 46C were more firm than controls 3 days after treatment, but were similar by 9 days. Electrolyte leakage from inner mesocarp tissue disks increased with increasing time at 50C, but was unchanged in fruit treated at 46C. However, after 3 days, electrolyte leakage returned to control levels. Ethylene-forming enzyme (EFE) activity of inner mesocarp tissue was greatly reduced in fruit treated at 50C (all times), and at 46C (220 and 280 min). After 3 days, EFE activity of fruit from most treatments had recovered to levels higher than controls. These data indicate that fruit may be able to recover from heat stress. Mild heat stress may increase postharvest shelf life by reducing the rate of softening.

774 (PS 14)

RESPONSE OF 'HASS' AVOCADO TO METHYL BROMIDE FUMIGATION

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Postharvest quarantine treatments of methyl bromide fumigation (MB) or a combination of MB and cold storage are allowed for the Mediterranean Fruit Fly (*Ceratitis capitata*) and other fruit flies. A study was undertaken to address the effect of MB on the fruit quality of 'Hass' avocados. Fruit were obtained from two growers at a commercial packinghouse three times during the 1991 season. Fruit were fumigated at 21C or 30 C within 24 hours after harvest or after 1 week of storage. Fruit were evaluated after 0, 1, 2 or 4 weeks of storage at 5 C. Fruit quality was determined by flesh firmness, days to ripe, ease of peeling, weight loss, external discoloration, flesh or vascular discoloration and the presence/absence of decay. There was considerable variability between grower lots, however fruit that were fumigated had higher levels of weight loss, vascular or flesh discoloration and decay after 4 weeks of storage. The timing of fumigation had little effect on fruit quality. Generally, fruit which were fumigated at 30 C had less damage. These results suggest that 'Hass' avocado could withstand MB as long as the fruit is marketed within 2 weeks of harvest.

775 (PS 14)

THE EFFECT OF DELAYED COOLING ON THE POSTHARVEST LIFE OF AVOCADO (*PERSEA AMERICANA* CV. HASS)

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In southern California, avocados are often left in the field for up to 12 hours after harvest. Fruit in the bin may reach up to 40C during the summer months and may take up to 24 hours to cool to the recommended storage temperature. A study was conducted using 'Hass' avocados over two growing season during the months of July and August to determine the effect of delayed cooling on fruit quality. Fruit were held at 20, 30 or 40 C for 0, 6, 12 or 24 hours before storage at 5C for 0, 2, 4, or 6 weeks. Fruit quality was determined by flesh firmness, time to ripe, vascular and flesh discoloration and the presence or absence of decay. The level of damage seen in storage varied with the harvest. Overall, after 4 or 6 weeks in storage, there was a considerable increase in either vascular or flesh discoloration and decay especially when fruit had been held at 30 or 40C prior to storage. The results indicate that harvested avocados should be kept as cool as possible in the field and that fruit should be processed within 12 hours for storage periods greater than 2 weeks.

776 (PS 14)

THE EFFECT OF CALCIUM ON PAPAYA FRUIT RIPENING
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Over ripe and abnormally soft fruits occur often during papaya shipments to the mainland U.S.A. Calcium fertilization to the soil did not always increased Ca concentration in the mesocarp. Calcium plus K treatment was more effective at increasing the Ca concentration in the mesocarp than Ca treatment alone. Calcium and K fertilization did not affect the fruit color development. There was a positive correlation between mesocarp Ca concentration and ripe fruit firmness, with no relationship between K or Mg concentration and ripe fruit firmness. Vacuum infiltration with CaCl_2 , MgCl_2 , KCl to mesocarp plugs *in vitro* showed that Ca significantly delayed softening and reduced C_2H_4 production, and that MgCl_2 and KCl also slowed the softening. Use of the chelating agent sodium citrate increased the rate of softening, probably, by removing Ca from the cell wall. We conclude that Ca is an important factor in fruit firmness and that the increase of Mg and K by infiltration has different effects on fruit firmness from that by soil fertilization.

777 (PS 14)

EXTENDING STORAGE LIFE OF PAPAYA WITH EDIBLE COATING
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Application of edible coatings that can simulate controlled atmosphere storage has become a popular concept. An experimental coating developed at the USDA Winter Haven laboratory, Nature-Seal (patent application #07/679,849), or a commercial composite coating was applied to papaya fruit at the green (immature) stage for comparison to uncoated fruit. Both types of coatings contain a polysaccharide base and therefore have different properties than most commercial "wax" coatings. The fruit were stored continuously at 21C or 3 days at 13C then ripened at 21C with 95 to 98% RH. Sample fruit from each treatment were analyzed for color, weight loss, CO_2 , ethylene, & % decay and softening. Results showed substantial extension of papaya shelf-life when the fruit were coated with Nature Seal while the commercial coating was less effective. This effect was due to retardation of ripening as evidenced by delayed color development, softening, and effect of coating permeability to CO_2 and O_2 on climacteric CO_2 and ethylene production.

778 (PS 14)

ALLEVIATION OF CHILLING INJURY OF PONKAN DURING AND AFTER LOW-TEMPERATURE QUARANTINE TREATMENT BY USING SUCROSE FATTY ACID ESTERS

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Ponkan (Citrus reticulata Blanco), that is chilling sensitive, must undergo a quarantine treatment to disinfest fruit fly before export to Japan from Taiwan. Pitting caused by chilling injury tends to induce a poor fruit quality in a market.

The alleviation of chilling injury of ponkan during and after low temperature disinfestation (at $1^\circ \pm 0.2^\circ\text{C}$, for 15-16 days) was investigated by treatment with 0.35% sucrose fatty acid esters (C-10:0, 12:0, 14:0, 16:0, 18:0 and 18:1 acid esters).

Development of pitting on the fruit surface after transfer to 20°C from low temperature quarantine treatment was suppressed significantly by the treatment with the sucrose fatty acid esters. Sucrose myristate ester (C-14:0, M-1695) was most effective among the used esters to inhibit the occurrence of pitting. In addition, the treatment with esters influenced fruit quality and weight loss. However, the treatment did not affect respiratory rate of the fruit.

779 (PS 14)

SIMULATION OF THE EFFECT OF HEATING ON DISINFESTATION PROTOCOLS FOR PAPAYA

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The disinfestation protocol for fruit often requires a delicate balance between suppression of the pest and avoidance of fruit damage. In Hawaii both hot-water and hot-air treatments are used for papaya destined for export. A computer simulation of the heat flow can be used to obtain the temperature $T_\alpha(x,t)$ at every point x in the papaya and every time t for any

given heating protocol α . The activity of the ethylene forming enzyme (EFE) has been used as a measure of fruit damage and the "kill" of fruit-fly larvae/eggs as a measure of pest control. The degradation of the EFE measured experimentally for a fixed temperature T and at several times t can be analyzed to yield a rate expression $R_1(T,t)$. Similarly the survival of fruit-fly larvae/eggs can be used to establish a rate expression $R_2(T,t)$.

The temperature space-time expression, $T_\alpha(x,t)$, for a chosen heating protocol α , and the rate laws $R_1(T,t)$ and $R_2(T,t)$ can be used to calculate the effect on EFE activity, $\text{EFE}_\alpha(x,t)$, and pest control, $\text{PC}_\alpha(x,t)$, at every point in the fruit and time of the protocol. For example the effect of different heating schedules, different heating fluids or even the role of "pre-conditioning" can be assessed.

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THERMAL PROCESS EVALUATION FOR QUARANTINE HEAT TREATMENTS.
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Heat treatments have been used to control diseases and insect infestation of fruit. The development of heat treatments have been the result of empirical experiments based on the efficacy on the insects coupled with parallel experiments on the phytotoxicity of host fruit. Such heat treatments while approved as quarantine treatments have occasionally produced fruit of poor quality. Thermal processing of foods, an established science, employs kinetics of enzyme inactivation, thermal death times evaluation of various time-temperature relationships to determine the adequacy of the heat process to ensure the safety of the product as well as minimize over-processing to preserve the products quality. There is a need to develop thermo-processing guidelines in the development of quarantine heat treatments and also to enhance product quality. We will report methods that we have developed to determine the thermal death kinetics of insects, fruit pathogens and kinetics for thermotolerance of the fruit.

781 (PS 14)

PILOT COMMERCIAL PRODUCTION OF CONCENTRATED JUICES FROM CITRUS FRUITS GROWN IN NIGERIA.

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The development of a natural base for beverage products covers key steps including raw materials identification and sourcing, process development, product testing and market introduction. Agege 1 - a widespread sweet orange cultivar was compared with Parson Brown sweet orange type in the production of concentrated juice (approximate 30° Brix). Yield for Agege 1 was 14-16% while Parson Brown had 9-11% based on the processing modules adopted. Analysis of samples showed 40-110 milligram percent and 125-350 microgram percent for vitamins C and A respectively. Sensory testing revealed that concentrated juice for Agege 1 had superior appearance characteristics particularly in terms of color.

782 (PS 14)

VARIATION IN ORNAMENTAL TRAITS OF DALEA PURPUREA

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Dalea purpurea Vent. (Purple Prairie Clover) is a perennial herbaceous plant found growing in the United States from North Dakota to Texas and from the Mississippi River to the eastern edge of the Rocky Mountains. It produces excellent forage for livestock on many grasslands and has potential as an ornamental landscape plant. Two seedling populations of *D. purpurea* were field grown and traits including foliage color, height, lodging and stem number per plant were measured. Large differences existed within populations for these traits. A progeny population grown from seed of 5% of the plants collected from each of the two populations with the most desirable traits were also evaluated. The mean number of stems per plant varied from 8.7 and 4.2 in the parent populations to 20.2 in the progeny population. The correlation coefficients between traits varied from -0.54 to +0.39. *D. purpurea* does have potential as a landscape plant and selections with improved traits can be found within existing populations.

INHERITANCE OF DIAPHORASE AND GLUCOSE-6-PHOSPHATE ISOMERASE IN *EUSTOMA GRANDIFLORUM*
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Segregating progenies from controlled pollinations of *Eustoma grandiflorum* Griseb. were investigated to determine the inheritance of diaphorase (DIA) and glucose-6-phosphate isomerase (GPI) isozymes. Phenotypic data supported the hypotheses that DIA1 is tetrameric and is controlled by a single locus with two alleles (Dial-1 and Dial-2) and that GPI1 is dimeric and also is controlled by a single locus with two alleles (Gpi1-1 and Gpi1-2). Examination of isozyme phenotypes for over 70 cultivars of *E. grandiflorum* revealed polymorphism for DIA1 and GPI1. These isozymes may be useful for marker-assisted selection and cultivar identification.

TRANSMISSION PATTERNS OF SELECTED MORPHOLOGICAL TRAITS IN INTERSPECIFIC *EXACUM* HYBRIDS

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The morphology of interspecific *Exacum* hybrids was investigated in order to determine transmission patterns of several horticultural traits and to confirm interspecific hybrid status of plants. The evaluations utilized 557 accessions from interspecific hybridization of the following species: *Exacum macranthum*, *E. pallidum*, *E. pedunculatum*, *E. trinervium* ssp. *ritigalensis*, and *E. trinervium* ssp. *trinervium*. Transmission patterns are proposed for stem shape (three phenotypes- cylindrical, winged-cylindrical and quadrangular; no dominance), petal shape (two phenotypes- rounded and acuminate; rounded dominant to acuminate) and flower form (two phenotypes- imbricate and separate; imbricate dominant to separate). Examination of the progenies confirm interspecific hybridization by the appearance of combinations of traits from the parental species and/or the observation of unique forms not previously observed.

STUDIES ON GENETIC RESOURCES OF ORNAMENTAL PLANTS IN WESTERN HUBEI PROVINCE (e.g. SHENNONGJIA REGION)

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Shennongjia mountain region is famous for its various kinds of species. Through one year's deep-going expedition in the area, lots of valuable plant species were collected, among them many are very useful and had not been used in landscape. Such as *Arisaema lobatum* var. *variegatum* n.v. LuDiFei, *Cremastra appendiculata* var. *fulva* LuDiFei, *Strylophorum lasiocarpum* (Oliv.) Fedde, *Sedum filipes* Hems., *Iris wilsonii* C. H. Wright, *Amaranthus caudatus* L., *Cotoneaster dammeri* Schneid., *Meconopsis quintupinaria* Regel., *Lyssimachia paridiformis* Franch., *Dysoma versipellis* (Hance) M. Cheng, *Adiantum pedatum* L. and so on. Some genera are quite rich in this region, especially in *Rosa*, *Sorbus*, *Cotoneaster*, *Lonicera*, *Impatiens*, *Aconitum*, *Gentiana*, *Adiantum* etc. All these are marvelous material for direct appliance in garden and for breeding. There are many rare plants in the area, large communities of *Davidia involucreata* Baillon and *Chimonanthus praecox* (L.) Link were found during the expedition, and what interesting more is that various natural variations do exist in the communities. Detail description and evaluation were given to the important species, and some suggestions of protection and utilization were offered in the paper.

Introduction and Cultivation of Wild ornamental plants

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Due to the large area and the complex topography and climate, a great deal of wild ornamental plants are still hidden in the depth of forests and on the highland plateaus--places difficult to approach by man. In the Three N Regions only, there are 51 species of *Rhododendron*, 27 of *Lilium*, 83 of *Rosa*, 30 of *Iris*, 40 of *Clematis*, etc., yet to be explored and utilized. Aiming at this, we made extensive introduction of plants in general and intensive introduction of certain families and genera in particular, with good results. At present we have in our living collection 12 species of *Clematis*, 24 of *Rosa*, 13 of *Lilium*, 10 of *Iris*, 8 of *Tulip*, 6 of *Aquilegia*, 10 of *Thalictrum*, 20 of *Gentiana*, 80 of ferns, 40 of *Begonia*, 50 of the Araceae. Seed germination tests, micropropagation, breeding for new varieties and other experiments and researches have been carried out on many of these plant groups.

THE INTRODUCTION AND ACCLIMATION OF PITTOSPORUM TOBIRA IN JINAN, SHANDONG PROV.

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Tobira Pittosporum (*Pittosporum tobira*) is an evergreen and broadleaf shrub with fragrant flowers. The introduction began in 1978. The plants blossomed and bore fruits in 1981. The seedlings grew up from seeding in 1982, then the freeze resistances of seedling were experimented with the Spartan Training System according to follow proper sequence and make steady progress rule. Some excellent plants were sifted out progressively. In order to enrich the afforestation materials in Jinan, it offers a new species.

Nitrogen assimilation in orchids

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The uptake of nitrate and ammonium by a terrestrial (*Bromheadia finlaysonia*) and an epiphytic (*Dendrobium hybrid*) orchid in solution culture has been studied. The rates of nitrate and ammonium were relatively linear, with higher rate of uptake for ammonium. The rates of nitrate uptake in terrestrial and epiphytic orchids were 0.4 and 0.9 $\mu\text{mole gm fw}^{-1} \text{hr}^{-1}$ respectively and they were considerably lower than those of most major crops. SEM studies show that the velamen of *Bromheadia* was 2 cells thick whereas that of *Dendrobium* was 8-10 cells thick. It is unlikely that the velamen is the major factor in restricting influx of nitrate or ammonium. Nitrate reductase (NR) and glutamine synthetase (GS) were present in roots and leaves of both orchids. NR was high in roots but low in leaves. The reverse was for GS. The activities of NR and GS was low but high enough to account for the rate of nitrate or ammonium uptake. It appears that the movement of ions across the transfer junction at the exodermis plays a major regulatory role in ion uptake by orchid root.

THE INTRODUCING AND CULTURING FOR ORNAMENTAL PLANT -- PAVIDIA INVOLUCVATA BAILL.

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We have introduced and cultured for *Pavida involucreata* Baill in the arboretum of Forest Research Institute of Guizhou province. The both of the bionomics and ecological characters for this species also have observed detailed. The results shown that the conditions of areas of Guiyang is suitable for normal growth for this species. On the average, the height is 18m height and diameter breast high is 25 cm when 18 years old. At present this species has become one of the important ornamental plants in Guiyang areas, which has beautiful flowers and tree forms.

DESIGN AND FUNDING OF PLANT INTRODUCTION AND EVALUATION PROGRAMS IN TENNESSEE

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Efforts have been underway since 1988 to establish a nursery research station in McMinnville, TN. Approximately 80 acres of farm property has been conveyed to Tennessee State University (TSU) for this purpose. Scientists at TSU, Tennessee Technological University, University of Tennessee, and USDA's National Arboretum and Shade Tree Laboratory have cooperated in obtaining funding via the Capacity Building Grants Program to initiate a plant evaluation and introduction program at the new station. Initial trials of woody genera include *Acer*, *Castanea*, *Cornus*, *Lagerstroemia*, *Quercus*, *Syringa*, and *Ulmus*. Herbaceous genera are *Echinacea*, *Hemerocallis*, and *Hosta*. Plantings will be made over a three year period as infrastructure at the new station develops. Complementary grant proposals have been recently submitted. Design, funding and support of all Tennessee introduction and evaluation programs will be discussed.

EVALUATION OF PETUNIA CULTIVARS FOR THE LANDSCAPE IN A SUBTROPICAL CLIMATE

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Petunia (*Petunia x hybrida*) cultivars were evaluated for earliness of flowering, flower diameter and color, plant dimensions, plant habit, uniformity, overall appearance, lodging, floriferousness

and sensitivity of flowers to spray damage during the spring and fall of 1991. Fifty-eight cultivars in the spring and 59 in the fall were grown in field beds under full sun. **Spring:** The range of time from sowing to the first flower was 54 to 73 days. Plant heights ranged from 15 to 40 cm. Red flowered types were the shortest, while blue and white types the tallest. Flower diameter ranged from 5.3 to 10.0 cm with grandiflora types 2.5 cm larger than multiflora types. Spray damage to flowers was absent in all blue and white colors as well as 'Supercascade Red' and 'Falcon Pink'. **Fall:** The range of time from sowing to flowering was 52 to 76 days. Plant heights were similar to the spring. Flower diameter ranged from 5.1 to 10.2 cm, with grandifloras 2.0 cm larger than multiflora types. Lodge resistance was related to plant height, which was strongly linked to flower color. Generally red flowered types lodged slightly if at all.

792 (PS 14)

INVESTIGATION AND STUDY OF WILD ORNAMENTAL PLANTS IN MOUNTAIN AREA OF NORTHERN CHINA

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Taking Beihua shan and Wuling shan mountain as examples, the author investigated the Wild Ornamental Plants (WOP) resources in mountain area of northern China in detail with ecological systematic sampling method. The meteorological data of no meteorological observed plots was reckoned theoretically using statistics. And then the main factors that influence the WOP distribution were sifted out by the progressive regression analysis. At last the optimized chains of adaptability with which the WOP will be introduced from mountain to urban area and of most suitable place on which certain plants will be introduced were defined. In order to enrich the capital Beijing's afforestation materials, this paper offers a reliable basis in terms of theory.

793 (PS 14)

INVESTIGATION OF NATIVE ORNAMENTAL RESOURCES IN MOUNT HUANGSHAN (EASTERN CHINA)

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The author investigated, recorded, observed and analyzed the major wildflowers in Mount Huangshan—the natural and cultural heritages listed by the ESCO of UN for the first time. On the basis of their desirable characteristics, more than 300 wild ornamental species are divided into 8 categories—historical old trees, rare and endangered species, ever-green ornamentals, blooming trees and shrubs, plants with colored foliage and fruit in fall, vines, herbaceous ornamentals and ground covers, and ornamental ferns. Mount Huangshan is one of the richest regions of native ornamentals in Eastern China and the most famous natural beauty in Pan-China. There are about 1500 wild landscape plants in and around it. Finally the paper puts forth some proposals and methods for introduction and utilization of wild ornamental plants. That is, investigation, classification, acclimatization and cultivation of them, and building a sort-out botanical garden for the germplasmic preservation and the flourishing landscape tourism.

794 (PS 14)

SURVIVAL AND FLOWERING OF WILDFLOWERS/NATIVE PLANTS IN BUFFALOGRASS

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Wildflowers/native plants are increasingly being used in landscapes, especially in low maintenance areas. Buffalograss is also receiving attention as a low maintenance grass. Establishing wildflowers in buffalograss would be useful in sites where mowing occurred only once in the fall, such as with minimeadows. Four experiments were conducted to study the establishment of wildflowers in buffalograss. Survival of wildflowers after one year was 88% when wildflowers were planted as greenhouse grown transplants and buffalograss plugged in 2 weeks later, 67% when one-year-old field grown wildflowers were transplanted into buffalograss plugged at the same time and 48% when greenhouse grown wildflowers were transplanted into established buffalograss. Establishment of wildflowers overseeded into established buffalograss sod was very low. There were significant differences in wildflower survival within each study. Species which performed well in buffalograss included Leadplant, Blue Fox, Purple Prairie Clover, Little Bluestem and Stiff Goldenrod.

795 (PS 14)

EFFECT OF SEED WEIGHT ON SEEDLING GROWTH AND SUBSEQUENT PLANT PERFORMANCE IN MANGROVE INTRODUCED INTO KUWAIT.

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Mangrove (*Avicennia marina*) (Forsk.) Vierh. is an indigenous plant species of the intertidal coastlines of the Arabian Gulf. Research is in progress for protection of mangrove habitat and for introduction of mangrove into the coastlines of Kuwait. This study was initiated to determine factors affecting seed germination, seedling growth and establishment of propagules into suitable sites, and the efficacy of utilizing seed weight as a parameter for early genetic evaluation. Seeds of open pollinated wild stand of *Avicennia* were obtained from the State of Bahrain. *Avicennia* seeds varied in size and weight. Seed weight ranged from 0.3 to 6.3 grams, 89% of the seed ranged from 1 to 3 grams. The median seed weight varied from 1.3 to 1.9 depending upon the source and the collection time during the seed maturation season. Seedling survival, early appearance of epicotyl and height were affected positively by seed weight. Early branching and number of root primordia were not correlated with seed weight.

796 (PS 15)

CULTURAL MODIFICATION TECHNIQUES FOR ALLEVIATION OF HEAT STRESS IN BELL PEPPERS

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Bell pepper (*Capsicum annuum* L.) was grown in 1989, 1990, and 1991. Cultural modifications were used in an effort to alleviate heat stress, improve fruit set, reduce sunscald, and improve yield quantity and quality. Treatments included bare soil, plastic mulch (both black and white), straw mulch, living rye (*Secale cereale*) mulch, and row covers (white and black) suspended above the foliage. Soil temperature at 2.5, 10, and 20 cm, soil moisture at 20 cm, and yield parameters were recorded. In general, plots containing white rowcovers produced good yields each year, straw mulched plots produced good yields two out of three years, plots with black plastic mulch gave poor yields two out of three years, and plots with living rye gave consistently poor yields. Yield inconsistency from year to year was correlated with, and can be explained by, soil temperatures. Sunscald was reduced by rowcovers.

797 (PS 15)

POTENTIAL FOR CYCLIC REUSE OF SALINE DRAINAGE WATER FOR IRRIGATION OF TOMATOES.

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Reuse of saline drainage water for crop irrigation has been proposed as one strategy to reduce the drainage volume requiring disposal in California. A 6 y study to assess the feasibility of cyclic saline drainage reuse in a processing tomato/ cotton /cotton rotation was conducted. Treatments were: 1. fresh water applied throughout, 2. saline water applied after 1st flower to tomatoes, 3. saline water applied to tomato and the next cotton crop. Saline water generally improved tomato fruit quality, but did not reduce yields during the first 4 years. In year 6, yields were reduced 17% (n.s.) and 30% (p<0.05) in treatments 2 and 3 respectively, relative to the control. Monitoring of the root zone showed that boron has accumulated over time in saline treatments and may be limiting crop production more than soil salinity. Selenium was readily leached by periodic fresh water use and did not accumulate to levels of concern in tomato tissues. Other work has shown that salinity can enhance tomato susceptibility to root rot which may limit this practice in some areas. However, the data show that high value crops like tomato can be incorporated into saline reuse schemes if managed appropriately.

798 (PS 15)

GROWTH, WATER DEMAND, AND YIELD OF CHERRY TOMATOES UNDER DIFFERENT WATER QUALITY IRRIGATIONS

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Cherry tomatoes growth, water demand and yield were measured under different water quality conditions in order to assess their performance in

arid and saline soils. Treatments were: i) desalted seawater and humid conditions, ii) fresh water and dry conditions, and iii) saline water and humid conditions. No fertilizers were added. Differences highly significant were found in all treatments. The highest yield (6 Kg/plant) was observed in the plots irrigated with desalted seawater, and the lowest (0.4 Kg/plant) in the plots irrigated with saline water. Water demand and some hydric parameters were higher in the salt affected soils. Fruit size was similar in all treatments. The results suggest that the establishment of cherry tomatoes in saline non-productive soils is feasible, as an alternative to other varieties.

799 (PS 15)

IRRIGATION OF TOMATOES WITH DESALTED SEAWATER THROUGH A COASTAL SELF-SUFFICIENT SYSTEM

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Water scarcity delay the social development in the coastal arid zones of México. In these areas, fresh water can be obtained from the ocean using different methods. In this work, a design of a self-sufficient system for desalting seawater, using the sun and the wind, is applied to irrigate a small horticultural plot. A daily mean water production of 160 l was obtained from a 60 m² solar desalter, which was supplied with seawater with an aeolian pump. Three varieties of tomatoe were assayed: ACE-55, Cherry, and Saladette. Cherry tomatoe showed the highest yield with a consumption of 45 l/plant per month. A plastic mulch was used to minimize evaporation. The system may represent an economic alternative with low-maintenance requirements for self-supplying vegetables in marginal coastal zones.

800 (PS 15)

ABA AND STOMATAL RESPONSES IN TEPARY AND COMMON BEAN

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Tepary beans (*Phaseolus acutifolius* Gray) are more drought tolerant and have stomata that are more sensitive to low leaf water potentials (Ψ_w) than common beans (*P. vulgaris* L.). This study was designed to examine the role of ABA in controlling stomatal behaviour in these species. Comparison of the bulk leaf ABA content does not explain why tepary stomata are more sensitive to low leaf Ψ_w compared to common bean (at -1.4 MPa ABA content increased 40-fold in common bean and 25-fold in tepary). We hypothesize that the greater sensitivity of tepary stomata to low leaf Ψ_w is related to a higher concentration of ABA in the xylem sap, and/or to a greater sensitivity of tepary stomata to ABA. Xylem sap of well-watered and water stressed plants is analyzed to determine the concentration of ABA, and whether ABA is a putative candidate serving as a chemical root signal in response to water stress in *Phaseolus*. To test stomatal sensitivity to ABA, epidermal strips and detached leaves are exposed to a range of ABA concentrations. The relationship between stomatal aperture and different ABA concentrations is discussed.

801 (PS 15)

ETHYLENE EVOLUTION BY CROP STANDS GROWN IN A CLOSED, CONTROLLED ENVIRONMENT

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Ethylene concentrations were monitored using gas chromatography (GC/PID) throughout growth and development of wheat, soybean, and lettuce stands grown hydroponically inside a large, closed growth chamber (20 m² area, 113 m³ vol.). For wheat (cv. Yecora Rojo), ethylene concentration increased from < 10 ppb to about 120 ppb at about 28 days after planting (pre-anthesis) and then declined sharply over the next 4 weeks to a plateau of about 10 ppb during canopy maturation and senescence. A similar pattern of evolution was measured for soybean stands (cv. McCall), with peak concentrations of 40 to 70 ppb occurring near 50 days after planting. Un-

like wheat, a slight increase in ethylene was noted in the latter stages of soybean stand senescence. For lettuce stands (cv. Waldmann's Green), ethylene increased slowly to 10 to 15 ppb by 24 days after planting, and then rose sharply to 40 ppb by 28 days, when plants were harvested. Data will be used to define ranges for phytotoxicity studies and to project atmospheric contaminant control needs for tightly closed plant growth systems.

802 (PS 15)

PHYSIOLOGICAL CHANGES ASSOCIATED WITH WATER STRESS IN SWEETPOTATOES

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Proline content, leaf water potential (LWP), and leaf diffusive resistance (LDR) were determined for eight sweetpotato genotypes under water stress conditions. Changes in fatty acid compositions of leaf polar lipids were determined in two sweetpotato genotypes during declining soil moisture. Proline did not accumulate and LWP did not decrease until soil moisture dropped below 10%, but LDR increased as soil moisture decreased. Genotypic differences in proline accumulation and LWP were found. Changes in fatty acid compositions occurred more in glycolipids than in phospholipids. Fatty acid changes were more pronounced in genotype MS20-2 than in "Vardaman"

803 (PS 15)

A CROPPING SYSTEMS APPROACH TO IMPROVING WATER USE EFFICIENCY IN SEMI-ARID IRRIGATED PRODUCTION AREAS

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Sustainable alternatives for saline drainage water management in areas such as California's San Joaquin Valley are needed. Previous work has demonstrated the short-term potential for reuse of saline drainage water for irrigation in this area. Results from our 6-year cyclic drainage reuse study, however, indicate that soil structural problems may occur which can greatly reduce stand establishment and crop yields in periodically salinized soils. To prevent these problems, we are evaluating the effectiveness of winter cover crop incorporation and gypsum applications relative to conventional fallows, for improving/maintaining soil physical properties and crop productivity in cyclically salinized soils. Six winter cover crop/fallow treatments have been imposed upon a rotation of tomatoes, tomatoes and cotton as summer crops. By monitoring water use, relevant soil physical and chemical properties as well as crop performance during the course of this 3-year rotation study, we are assessing the potential benefits and constraints of using winter cover crops in drainage water reuse systems.

804 (PS 15)

GERMINATION AND GROWTH OF COWPEA AND PIGEONPEAS AT CONTROLLED LOW TEMPERATURES

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Twenty cowpea (*Vigna unguiculata*) and 10 early maturing pigeonpea (*Cajanus cajan*) genotypes were grown at 20/10 C, and 17/10 C day/night and 16 hr. photoperiod to assess their germination and growth. At 20/10 C eighteen cowpea genotypes including the line MN13, and the cultivar, Pinkeye Purple Hull commenced germination at 6 days after planting and showed at least 80% germination 21 days later. Generally, genotypes did not differ significantly in germination and seedling growth up to 45 days later. At 17/10 C two of the cowpea genotypes IT 82E-16 and IT 84E-124 attained at least 90% germination within 21 days after planting. Seedling, growth of these genotypes did not differ and plants began to die 70 days after planting. The pigeonpeas at 17/10 C commenced germination at 9-10 days like many of the cowpeas. Most had at least 50% germination and did not differ in shoot elongation and leaf production. All pigeonpeas flowered between 109 and 136 days after planting and produced pods with immature seeds.

805 (PS 15)

INFLUENCE OF POLYAMINES ON TOLERANCE OF ZUCCHINI SQUASH TO CHILLING INJURY

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Temperature conditioning of zucchini squash (*Cucurbita pepo* L.) at 15°C for 2 days enhanced polyamine levels and delayed the development of chilling injury during storage at 5°C. Direct treatment of zucchini squash with polyamines

increased the endogenous levels of polyamines and reduced chilling injury. However, treatment with polyamine inhibitors after harvest but before temperature conditioning suppressed the increase of endogenous polyamines and reduced the benefit obtained from temperature conditioning. These results suggest that the resistance of squash to chilling injury may be related to the endogenous levels of polyamines.

806 (PS 15)

ELECTROLYTE LEAKAGE AND EVOLUTION OF ETHYLENE AND ETHANE FROM PEPPER LEAF DISKS FOLLOWING TEMPERATURE STRESS AND FATTY ACID INFILTRATION

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Electrolyte leakage (EL) and ethane:ethylene ratio (EER) responses of pepper (*Capsicum annuum* L. Early Calwonder) leaf disks to temperature stresses were in close agreement. Midpoints of sigmoidal response curves following freezing stress were -4.6 and -4.4°C for EL and EER, and 49.0 and 48.8°C following high temperature stress. Evolution of ethane and EL were measured from disks infiltrated with a saturation series of 18-carbon fatty acids ranging from 0 to 3 double bonds. Only linolenic acid (18:3 n-3) stimulated ethane production and EL. In a second fatty acid experiment with 18- and 20-carbon acids with a double bond 3 (n-3) or 6 (n-6) carbons from the nonpolar end of the molecule, n-3 fatty acids stimulated more ethane than n-6 acids with the same number of carbons. Trienoic 18-carbon fatty acids stimulated more ethane than trienoic 20-carbon acids. Both 18-carbon acids yielded significantly greater EL than controls. Propyl gallate, a free radical scavenger, reduced ethane production without decreasing EL or K⁺ leakage.

807 (PS 15)

CHILLING INJURY AND THE DEVELOPMENT OF MAIZE LEAF EPICUTICULAR WAX

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Chlorotic bands across sugarcane leaves were first described as symptoms of cold chlorosis in 1926 and later described in sorghum and maize. The injury develops after exposure of seedlings to temperatures in the 0°C to 12°C range. The severity of injury in maize seedlings may be reduced by high relative humidity during the post-chilling period suggesting a temperature induced water stress. An early visible chilling response is the appearance of a glazed area in the region in which the chlorotic band will develop. This area of the young expanding maize leaf was studied with scanning electron microscopy (SEM). Maize seedlings were grown for 6 days at 24°C with a 15/9 h light/dark cycle. Plants were chilled at 10°C for 9 h during the 7th dark period and leaves sampled 39 h after the end of chilling. SEM photomicrographs revealed a gradient of epicuticular wax deposition from the tip to the base of the leaf. In the region of chill-induced chlorotic band formation, the control leaves exhibited a greater amount of wax deposition than the chilled leaves. It is suggested that the reduced epicuticular wax in a band across the chilled leaves might lead to a water stress resulting in chlorosis and eventually developing into the typical necrotic band.

808 (PS 15)

DIFFERENTIAL RESPONSE OF TWO TARO CULTIVARS TO ALUMINUM

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Aluminum toxicity is one of the major factors limiting plant growth in acid soils. Taro [*Colocasia esculenta* (L.) Schott] cultivars 'Lehua maoli' and 'Bun long' were grown in hydroponic solution at six levels of aluminum (0, 110, 220, 440, 890, and 1330 µM Al), to determine the differential response of taro to Al. Increasing Al levels resulted in significantly depressed fresh and dry weights of leaves, petioles, and roots, as well as leaf areas and root lengths. Significant cultivar differences were found, with 'Lehua maoli' exhibiting greater leaf fresh weights and root lengths in the presence of Al, compared to 'Bun long'. These cultivar differences were not associated with differences in Al concentrations of the leaves, petioles, or roots.

809 (PS 15)

INDUCTION AND INACTIVATION OF PHENYLALANINE AMMONIA-LYASE IN LETTUCE IN RESPONSE TO TEMPERATURE AND PROTEIN SYNTHESIS INHIBITORS

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Activity of phenylalanine ammonia-lyase (PAL) is critical in the induction of russet spotting (RS) in leaves of Iceberg lettuce (*Lactuca sativa* L.). RS is a major postharvest disorder of lettuce caused by exposure to ppm levels of ethylene at ≈ 5°C. Both PAL and RS are decreased when lettuce tissue previously exposed to ethylene is stored at ≈ 15°C or is transferred from ≈ 5°C to ≈ 15°C. To study the induction and inactivation of PAL, we exposed lettuce leaves to air ± 10 ppm ethylene at 5°C for four days to initially induce high PAL levels. After four days, leaves were treated with water ± 2 mg/L cycloheximide, and transferred to air at 5 or 15°C. In leaves previously exposed to ethylene, PAL activity decreased rapidly to baseline levels within two days in non-cycloheximide treated leaves transferred to 15°C. PAL activity remain elevated in the same treatment held at 5°C. In leaves treated with cycloheximide and transferred to 15°C, PAL did not begin to decrease until after four days. Cycloheximide treated leaves held at 5°C showed increased PAL activity both two and four days after treatment.

810 (PS 15)

POLLEN VIABILITY AND VIGOR IN TOMATO PLANTS UNDER HIGH TEMPERATURES

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High temperatures during flowering have been implicated in reducing seed set and fruit set in tomatoes (*Lycopersicon esculentum*). Pollen viability and vigor were studied by measuring *in vitro* germination and pollen tube development in pollinated pistils of four processing tomato cultivars under normal (25° C day/15° C night) and high (32° C day/23° C night) temperatures. Preliminary studies were carried out to determine the length of pollen tubes in styles collected in times ranging from 3 to 48 hours after pollination. Under normal temperatures the pollen tubes reach the end of the style between 12 and 18 hours. At high temperatures there are fewer pollen tubes moving through the style and the time to reach the end of the style is longer. In pollen vigor studies, crosses were made between pollen and pistils of plants grown under different temperature treatments, then pollinated pistils were collected at 4, 8 and 12 hours after pollination. There were differences in *in vitro* pollen germination percentage and pollen tube length in the pollinated pistils, suggesting that high temperatures act to slow down pollen activity.

811 (PS 15)

EFFECT OF THE INTERACTION BETWEEN NaCl LEVELS AND ROOT-ZONE TEMPERATURE ON GROWTH AND SEED PRODUCTION OF CUCUMBER.

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Cucumber plants (*Cucumis sativa* cv. Beta-al-pha) were grown in a glasshouse in pots of sand with 3 NaCl levels in the nutrient solution (0.40 and 60 mM) and placed in four large water baths controlled at different temperatures (13, 18, 23, and 28°C.). The increase of NaCl levels decreased the vegetative growth, seed yield, and seed quality, while the increase of root zone temperature up to 23°C increased the vegetative growth, seed yield and quality. Whereas, 28°C showed lower effect than 23°C. Ethylene production and the content of proline and free amino acids were increased with increasing NaCl levels. The increase of root zone temperature till 23°C decreased ethylene production, proline, and free amino acids contents. Zero NaCl (as control) obtained with 23°C root zone temperature appeared to be the best for the over-all growth, seed yield and seed quality of cucumber plants.

812 (PS 15)

INCREASED LEAF STOMATAL CONDUCTANCE AT VERY HIGH CARBON DIOXIDE CONCENTRATIONS

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Leaf stomatal conductance was monitored with a steady-state porometer throughout growth and development of soybean and potato plants grown at 500, 1000, 5000, and 10,000 (potato only) µmol mol⁻¹ carbon dioxide (CO₂). All plants were grown hydroponically with a 12-hr photoperiod and 300 µmol m⁻² s⁻¹ PPFD. As expected, conductance at 1000 was < 500 µmol mol⁻¹ for both species, but conduc-

tance at 5000 and 10,000 $\mu\text{mol mol}^{-1}$ was $\geq$ that at 500 $\mu\text{mol mol}^{-1}$. Subsequent short-term (24-hr) tests with potato and wheat plants grown at 1000 $\mu\text{mol mol}^{-1}$ showed that raising CO_2 to approx. 10,000 $\mu\text{mol mol}^{-1}$ or lowering CO_2 to 400 $\mu\text{mol mol}^{-1}$ increased conductance compared to 1000 $\mu\text{mol mol}^{-1}$ for potato, while only lowering CO_2 to 400 $\mu\text{mol mol}^{-1}$ increased conductance for wheat. Furthermore, raising the CO_2 to 10,000 $\mu\text{mol mol}^{-1}$ increased dark-period conductance in comparison to 1000 $\mu\text{mol mol}^{-1}$ for potato, while dark-period conductance for wheat leaves was low regardless of the CO_2 concentration. Results suggest that very high CO_2 levels (e.g. 5000 to 10,000 $\mu\text{mol mol}^{-1}$) may substantially increase water use of certain crops.

813 (PS 15)

INVESTIGATING CULTIVAR DIFFERENCES IN STRESS-INDUCED ABSCISSION IN BELL PEPPER (*CAPSIUM ANNUM* L.) WITH GROWTH ANALYSIS A.D. Turner* and H.C. Wien, Dept. of Fruit & Vegetable Science, Cornell University, Ithaca, NY 14853

Cultivars of bell pepper differ in susceptibility to bud/flower abscission. Reduction in the level of assimilate, and alterations in assimilate partitioning may be involved in the processes leading to bud/flower abscission. Four growth analysis experiments were conducted to determine whether two pepper cultivars differing in susceptibility to stress-induced abscission showed corresponding differences in growth and rates and dry matter partitioning when subjected to shade stress. The reduction in RGR and NAR with shading was significantly greater for the abscission-susceptible 'Shamrock' than the more tolerant 'Ace'. Partitioning of dry matter to reproductive structures was reduced by shading. There were no cultivar differences in the proportion of dry matter partitioned to young developing leaves. Fully expanded leaves comprised a larger proportion of total dry matter in 'Shamrock'. The lower NAR of 'Shamrock' under stress may have led to greater bud/flower abscission than 'Ace' under shade stress. If preferential partitioning of dry matter to competing structures (developing leaves) is also involved, it was not detected using this technique.

814 (PS 15)

AIR CIRCULATION IN GROWTH CHAMBERS STUNTS TOMATO SEEDLING GROWTH

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Air circulation, generally an integral part of environmentally-controlled plant growth chambers, retarded tomato (*Lycopersicon lycopersicum* Karstens) seedling growth seismomorphogenetically. Continuous air movement at a speed of 0.5 to 0.7 m s^{-1} inhibited growth by about 40%. Growth inhibition was noticeable with as little as 15 min of daily exposure to the air circulation; a continuous exposure gave the greatest amount of growth inhibition. The retarding effect of air on seedling growth was transient and required a continued daily exposure to air movement. Continuous aeration of seedlings inhibited growth to such an extent that in a two factor experiment, i.e. aeration and water stress, the water stress effects were completely masked in the aerated chamber by the aeration effect. The results have important implications for plant growth experiments in chambers equipped with air circulation: seedling growth may be affected more by the air circulation in the growth chamber than by an experimental treatment.

815 (PS 15)

ACCUMULATION OF SODIUM AND CHLORIDE IN DIFFERENT TISSUES OF NAVY AND TEPARY BEANS

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Navy (*Phaseolus vulgaris* L.) and tepary (*P. acutifolius* Gray) beans were grown hydroponically in a growth chamber with no NaCl or -0.25 MPa NaCl for 9 days beginning 22 days after planting. Chloride and sodium distribution in leaves and roots as well as percent ion leakage as an indication of membrane integrity in leaves were determined. Chloride and sodium levels in NaCl treated plants were significantly higher than in controls. Chloride distribution was not significantly different between plant parts or between plant species. Sodium distribution was significantly different between roots of the two species, but not between leaves of the two species. The navy root tissues contained twice as much sodium as the leaves, whereas, in tepary sodium levels were similar in roots and leaves. Percent ion leakage showed no notable trends relative to plant species or to NaCl treatments, but a significant difference was observed between younger and older leaves on the same plant.

816 (PS 15)

EFFECT OF SALT STRESS ON SUGAR TRANSPORT IN TOMATO

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We examined the effect of salt stress on sugar transport across the plasma membrane of source leaf tissue. We initiated the present study by investigating the effect of salt stress on the sugar transport into mature leaf tissue by measuring sucrose influx into leaf discs. In order to determine if there is a common response to salt stress, we selected two species which have been described as moderately salt-sensitive, faba bean and tomato. We found these two plants exhibit different responses to salinity with regard to sugar transport across the plasmalemma. Whereas salinity decreased sucrose uptake into leaf discs of tomato, it had little effect on faba bean. Also, the inhibitory effect of salinity in tomato was not just limited to freshly cut discs but was observed in aged discs as well. We isolated the plasma membrane from tomato and faba bean using the aqueous two-phase technique and found that although plasma-membrane vesicles obtained from faba bean were able to maintain an acetate gradient, vesicles from tomato were not, thereby eliminating any comparative study on pH-dependent sugar uptake. Studies on passive uptake into these vesicles indicate that the passive uptake in tomato may be different than faba bean.

817 (PS 15)

HISTOLOGICAL ANALYSIS OF BORON DEFICIENCY-INDUCED HOLLOW STEM DEVELOPMENT IN BROCCOLI

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Broccoli (*Brassica oleracea* L. var. *italica* cv. 'Premium Crop') plants grown in perlite were supplied with nutrient solutions containing three levels of added boron (0.04 (severely deficient), 0.08 (moderately deficient) or 0.80 (normal) mg L^{-1}). These treatments produced plants exhibiting either obvious (0.04 mg L^{-1}) or no visual boron deficiency symptoms (0.08 and 0.80 mg L^{-1}). At horticultural maturity, cross sections were taken in the upper and mid stem regions. The specimens were mounted on slides after being processed through a biological staining series. Boron availability was found to be correlated with the progressive internal deterioration of the stem which was observed histologically. An examination of staining patterns indicated that possibly a lignification process accompanies and contributes to hollow stem development. We have previously noted an increase in phenolic compounds and fiber content of broccoli produced under boron deficient conditions. The histological evidence of lignification further substantiates that boron deficiency induces changes in cell wall structure which may contribute to the development of hollow stem.

818 (PS 15)

BIOCHEMICAL CHANGES DURING BEAN SEED IMBIBITION MEASURED BY INFRARED SPECTROSCOPY

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Infrared spectroscopy was used to measure biochemical changes during bean (*Phaseolus vulgaris* L.) seed imbibition. Transmission spectroscopy of excised embryonic axes revealed changes in lipid phase (gel to liquid crystalline) and protein secondary structure within the first 15 min of hydration. Spectral changes in seed coats, cotyledons, and axes during the first 2 hr of imbibition (measured *in vivo*) were detected using photoacoustic sensing. Onset of seed respiration could be detected as early as 15 min after addition of water. CO_2 production, demonstrated by the appearance of a double peak centered at 2350 cm^{-1} , increased with time of imbibition. Infrared photoacoustic spectroscopy of intact seeds holds promise as a method for non-invasive viability assessment.

819 (PS 15)

BIOCHEMICAL ANALYSES OF SEED EXUDATES DURING EARLY IMBIBITION

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Short term soaking of seeds does not appear to be detrimental to seed viability and may provide a means of testing seed viability non-destructively. Seeds of corn (*Zea mays* L.) and rice (*Oryza sativa* L.), differing in viability, were soaked for 0.5, 1, 2 and 4 hr in distilled water at room temperature. Analyses of pH, protein/polypeptides (BCA assay and absorbance at 280

nm), and potassium (and other metals), were done on individual seed leachates. After each time period seeds were germinated for 7 d to determine viability. For both corn and rice, pH remained constant between 0.5 and 4 hr of soaking. Protein concentration gradually increased during the 4 hr soak in both corn and rice, but varied with seed lot. Potassium was the most common metal excreted and increased 3 to 4 fold between 0.5 and 4 hr of soaking. Although seed to seed variability in any given lot was high, in general, low viability seeds lost more cellular constituents than high viability seeds.

820 (PS 15)

CALORIMETRIC MEASUREMENTS OF STRATIFYING PEACH SEEDS AND SEEDLING GROWTH

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'Lovell' peach seeds were stratified for 0 to 13 weeks at 4°C under moist conditions. Heat of metabolism and CO₂ evolution, measured by Differential Scanning Calorimetry, increased with stratification time. The calorespirometric ratio increased between 0 and 6 weeks and then remained constant until 13 weeks. Germination percentages paralleled this ratio and reached 80% only after 6 weeks of stratification.

After radicle emergence, seedlings from different stratification treatments were grown for 3 weeks. Increasing stratification time resulted in taller seedling growth. Calorimetrically measured CO₂ evolution and the calorespirometric ratio of the apex (one cm) of the seedling increased with longer stratification time. Contrary to the observations of the seeds, metabolic heat rates decreased as stratification time increased. Yet, seedling sustained higher growth rates. These data suggest that the stratification treatment resulted in an improvement in metabolic efficiency.

821 (PS 15)

THE EFFECTS OF THE INTERACTION BETWEEN LIGHT AND EXOGENOUS ABSCISIC ACID ON COLD ACCLIMATION OF 'ALASKA' PEA SEEDLINGS.

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Alaska peas (*Pisum sativum* 'Alaska') were germinated in the dark at 25°C. After three days, when the shoots were approx. 1.5 cm, treatments were initiated. ABA, at 10⁻⁴M, was exogenously applied through the root solution. The control peas remained in distilled water. All treatments involving the application of ABA were applied under green safe light. Light treatments were applied using overhead fluorescent lights for designated timed intervals (0 to 20 min) over 3 days. A methanol bath was then used to induce freezing stresses from 0 to -9°C. The combination treatment of light and ABA had the lowest LT₅₀ (more cold tolerant) followed by light, dark, and dark with ABA (least cold tolerant). Extensin levels, plant growth, and stem bendability were also recorded.

822 (PS 15)

PROTEIN CHANGES IN ENDODORMANT SHOOTS, SPURS, AND FLORAL BUDS OF VARIOUS FRUIT CROPS DURING WINTER

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We have previously demonstrated that a protein of ~62 kD decreases in response to temperature during the final stages of chilling unit accumulation in dormant peach flower buds (Lang and Tao, 1991, HortSci. 26:733). To further examine proteins that potentially may be associated with endodormancy, floral buds, spurs, and/or shoots were collected during winter from 'Anna' apple, various blueberry cultivars, 'MidSouth' grape, '20th Century' pear, 'Hawthorne' peach, and 'Santa Rosa' plum. Soluble proteins were extracted and analyzed by one-dimensional SDS-PAGE. A major protein of ~62 kD was present in plum, and lesser amounts of one or two similar proteins were found in blueberry, but not in apple or grape. The 62 kD peach protein originally found in buds was also present, in lesser proportions, in peach shoot xylem and phloem tissues, but not in petioles or seeds. Apple exhibited a major protein band at ca. 31 kD that may be a storage protein. The similarities and disparities in protein profiles between fruit crops, as well as changes that occur during winter, will be discussed with respect to dormancy, cold hardiness, and storage compounds.

823 (PS 15)

PRE-FORCING TREATMENTS HELP BREAK BUD DORMANCY OF FORCED WOODY PLANT SPECIES

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A certain period of cold is needed to break bud dormancy for almost all woody species. A pre-forcing bleach soak has been demonstrated to at least partially replace this requirement (Yang and Read, 1989). Therefore, new softwood growth can be produced in the off-season. Such supple softwood growth is excellent material to be used either as explants for *in vitro* culture, or as cuttings for macropropagation of woody species. Further studies on pre-forcing bleach soaks were conducted to investigate optimum concentration and duration of soak, and to find the most suitable depth of bleach solution soak, in order to maximize the breaking of bud dormancy. Optimum bud break was obtained by soaking the basal 1/3 of dormant stems in 10% bleach solution for 10 minutes prior to forcing. Soaking dormant woody stems in alcohol solutions prior to placing stems in the forcing solution was also studied. The alcohol soak had negative effects on bud break of spirea, although it showed positive effects for lilac and privet.

824 (PS 15)

IN VITRO HARDENING AND BUD FORMATION IN AMELANCHIER ALNIFOLIA NUTT.

(SASKATOON BERRY 'SMOKY')

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In vitro shoot cultures of saskatoon berry were subjected to a 6 week acclimating treatment (4°C/8h day). Acclimated cultures survived freezing to -27°C. Control cultures (24°C/16h day) killed at -6°C. Addition of ABA (5.0 x 10⁻⁵M) to growing medium did not increase hardiness of plants under acclimating conditions, but increased hardiness of control plants from -6°C to -10°C.

With standard BA concentration (1.1 x 10⁻⁵M) decreased by half, addition of ABA (5.0 x 10⁻⁵M) to growing medium resulted in formation of swollen axillary buds with red bud scales. Plantlets on similar medium to which ABA was not added did not show arrested growth or swollen red buds. Following defoliation, removal of shoot apex and transfer to hormone-free medium, buds on ABA-treated plantlets did not resume growth within 30 days. When ABA-treated plantlets were transferred to media supplemented with BA, dormant-looking buds resumed normal growth. Dormant buds collected from field-grown plants and placed in culture broke dormancy on BA medium and maintained the dormant state on hormone-free and ABA medias.

825 (PS 15)

"NEAR-LETHAL" STRESS EFFECTS ON ENDO DORMANCY, COLD ACCLIMATION, AND RECOVERY OF RED-OSIER DOGWOOD PLANTS.

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"Near-lethal" (NL) stresses from varied sources, e. g. NL-heat (47°C-1hr), NL-freeze (-7°C-1hr), and NL-hydrogen cyanamide (0.5-1 M), overcame endo-dormancy in red-osier dogwood (*Cornus sericea* L.) plants. Near-lethal heat stress applied at early rest (Oct.) had a slight effect on cold acclimation, whereas at late rest (Dec.), NL-stress resulted in the rapid loss of hardiness at warm or natural environment conditions. Recovery of plants from NL-stresses was dependent on the stage of development and temperature. Less dieback occurred with later stage of endo-dormancy, and at warmer temperatures. Dormant plants in October exposed to other NL-stresses, e. g., freezing temperature and hydrogen cyanamide, also caused plant dieback at 0°C and recovered at 23°C post-environment treatment. Conditions that favored recovery also favored production of glutathione.

826 (PS 16)

EFFECT OF FERTILITY SOURCE AND LIME ON THE PERFORMANCE OF HYDROPHILIC POLYMERS USED WITH SEVEN FOLIAGE PLANT SPECIES. Melinda S. Conner* and Gerald Klingaman, Department of Horticulture and Forestry, University of Arkansas, Fayetteville, AR 72701

Studies were undertaken to compare plant growth and water use in a new commercially produced media that contained a hydrophilic polymer combined with a traditional peat-lite media. Rooted cuttings of nephytis, spathiphyllum, parlor palm, pothos, corn plant, 'Dallas' fern, and gold dust dracaena were planted into 15cm plastic pots containing either a peat-lite media or the media with hydrophilic polymer. Both mediums were amended with 2.4 kg/m³

gypsum and then treatments of 0, 1.5, or 3 kg/m³ of dolomitic limestone were added. Plant height, width, growth index, top fresh weight and dry weight were measured. Preliminary tests indicated that the media with the hydrophilic polymer performed better with slow-release fertilizer than a constant liquid fertilization program. Plant growth appeared to be optimum at the 0 or 1.5 kg/m³ rate of dolomite. Plants grown in the media with the hydrophilic polymer produced plants of comparable quality to those in the peat-lite media.

827 (PS 16)

PLANT GROWTH IN COAL GASIFICATION SLAG-AMENDED MEDIA

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Coal gasification slag is an ash byproduct remaining after the volatilization process. This material is currently under utilized. A series of experiments were conducted to determine the suitability of coal gasification slag as a growing medium or growing medium amendment. Chrysanthemums, lettuce, poinsettias and some bedding plants were grown in slag or slag amended media in an ebb and flow fertigation system. Slag alone has a high pH and initial slag samples had some very small particle sizes. Plant growth in slag alone was poor because of high pH and low aeration. When slag was amended with moss peat, the pH was lowered to an acceptable range and the aeration was better. Plant growth in peat-slag media was equal to plant growth in a peat-perlite mix. Media composed of peat-slag and bark were also successful in producing crop growth equal to peat-perlite. There were no nutritional problems growing in slag amended media except that boron uptake by chrysanthemum was greater than in other media. Eliminating the small particle sizes by washing the slag makes the slag easier to handle, but does not produce crop growth equal to slag amended media.

828 (PS 16)

GROWTH OF BEDDING PLANTS IN MINERAL WOOL AND MINERAL WOOL/PEAT MIXES

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The objective of this research was to develop a mineral wool based growing medium for the horticultural industry. Two types of hydrophilic mineral wool, clean wool (CW) and unclean wool (UC) were used unamended, as well as both types in combinations with 25, 50, and 75 percent peat moss (PM). A control of 100 percent (PM) was also used. Unamended CW had a low bulk density, excellent water holding capacity, good aeration, but high pH. Once PM was added to CW, bulk density still remained low, water holding capacity and aeration remained good, and the pH dropped to a more suitable level. Unamended UW had a high bulk density, good water holding capacity, poor aeration, and high pH. Once PM was added to UW, bulk density decreased, water holding capacity remained good, aeration increased, and pH decreased to a more optimal level. Impatiens 'Violet' and Begonia 'Whiskey' were grown in the nine treatments for six and nine weeks respectively. At harvest, plant growth was evaluated by height, diameter, fresh weight, dry weight, and tissue analysis. Plant growth response showed plants grown in unamended CW, UW, and PM were smaller in size and lighter in fresh and dry weights than those in 50 percent wool/50 percent PM. The plants grown in 25 and 75 percent PM were similar to the 50 percent wool/50 percent PM in size and weight.

829 (PS 16)

MARKETING STRATEGY FOR A GROWING MEDIUM AMENDED WITH COMPOSTED BROILER LITTER

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Increased consumer demand for poultry products has created a poultry waste disposal problem. Previous research demonstrated that a growing medium containing 50% composted broiler litter sustained plant growth as well as commercially available alternatives with no objectionable odor. The objective of this research was to determine consumer perceptions to develop a marketing strategy for this product. One-hundred eighty consumers participated in an intercept-survey. Consumers rated fertility of the growing medium as the most important attribute (4.0 on 5.0 scale), followed by mix price (3.8), and color (3.4). "Organic gardening" was important to 82% while the addition of organic material to a growing medium was important to only 56% of the sample. Adding cow manure to a growing medium was desirable to more consumers (65%) than adding horse (39%) or poultry manure (40%). A marketing strategy should include "organic" terminology rather than a specific manure incorporated to de-emphasize the negative perception of composted broiler litter.

830 (PS 16)

COMPOSTED AND FRESH EUCALYPTUS CHIP MULCHES PROMOTE EARLY ESTABLISHMENT OF CALIFORNIA SYCAMORE.

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Forty eight California sycamores (*Platanus racemosa*) were planted (5/91) from one gallon containers and mulched (8/91) with, pine bark, composted sewage sludge and wood products, fresh *Eucalyptus cladocalyx* chips (large 2-6cm), fresh eucalyptus chips (small <1cm), composted large eucalyptus and untreated. Mulches were applied to a depth of 10cm in a 6m² area around each tree. Irrigations were based on soil moisture depletion and water content was measured by time domain reflectometry. Mulched trees developed more caliper, lower stomatal resistances and lower trunk temperatures. Soil moisture (top 15cm) was greater under mulched trees. Rooting was evident in the sludge, and composted eucalyptus mulches but absent in the pine bark and fresh eucalyptus mulches.

831 (PS 16)

COMPACTION AFFECTS COMPOST EFFICACY IN DWARF OLEANDER PRODUCTION

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Three compost products made from urban waste materials, municipal solid waste (MSW), yard trash (YT), and a co-compost made from 1 part sewage sludge and 3 parts yard trash (S-YT), were used as growing media for production of dwarf oleander (*Nerium oleander* L.) in 25 cm. diameter containers. In one test the composts were used as stand-alone growing media and in a second test they were blended with pine bark (PB) and sand (S) in 2 ratios: 4 compost: 5 PB: 1 S and 1 compost: 1 PB: 1 S. The S-YT co-compost produced plants with the highest biomass in both tests. Reduced growth of dwarf oleander in each test was associated with the degree to which the media compacted during the 5.5 month production period. The MSW compost compacted an average 8.5 cm. per container when used as a stand-alone medium, while the S-YT mixes compacted much less, typically < 4.0 cm.

832 (PS 16)

INFLUENCE OF LIME ON GROWTH AND QUALITY OF SELECTED FOLIAGE PLANTS

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A series of studies has been conducted to determine the optimum dolomitic lime rate for the production of foliage plants in a peat/perlite potting mix. Treatments consisted of 10 rates of dolomitic lime from 0 to 6 kg/cu m on 6 species of ornamental foliage plants. In all cases to date the 0 lime rate resulted in as good or better plant growth and quality as the other lime treatments. In general, as lime rate increased there was a reduction in growth and increase in chlorosis under the condition of this trial.

833 (PS 16)

FURTHER EVIDENCE THAT THE LEGUME *CLADRASTIS KENTUCKEA* (AMERICAN YELLOWWOOD) DOES NOT FORM NITROGEN-FIXING SYMBIOSES WITH RHIZOBIA

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The capacity to form nitrogen-fixing symbioses with rhizobia is common among species in the Papilionoideae subfamily of the Leguminosae, but nodulation and nitrogen fixation have never been documented in *Cladrastis kentukea* (Dum.-Cours.) Rudd (American yellowwood). The purpose of this study was to test the hypothesis that *C. kentukea* is nodulated by rhizobia. Seedlings were grown in sterile vermiculite and irrigated with a nitrogen-free nutrient solution. In one experiment, the vermiculite was inoculated with rhizobia that nodulate *Mauackia amurensis* Rupr. & Maxim., a closely related tree species. During a second experiment, the vermiculite was inoculated with samples of soil collected near trees of *C. kentukea* in a native stand in Alexander County, Illinois. There were no nodules on roots of seedlings harvested 6 weeks after inoculation in either experiment. These results represent strong additional evidence that *C. kentukea* does not form nitrogen-fixing symbioses with rhizobia.

834 (PS 16)

NITROGEN LEACHING FROM A UREA-FORMALDEHYDE AMENDED PINE BARK MEDIUM

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Columns (4 x 15 cm) of a pine bark medium amended with the equivalent of 4.2 kg per cubic meter of dolomitic limestone and either 0, 2.4, 4.7, 7.1 or 9.5 mg of urea-formaldehyde (38% N) per cubic centimeter of medium were leached daily with 16 ml of deionized water (pH 5.5). Leachate total N, NO₃⁻-N and NH₄⁺-N concentrations were determined on day 1, 3, 5, 7, 14, 28, 49, 91, 133, 203, 273 and 343. Leachate total N ranged from 600 ppm on day 1 for the 9.5 mg treatment to 4 ppm on day 273 for the 2.4 mg treatment. Leachate NH₄⁺-N concentrations ranged from 38 ppm on day 3 for the 9.5 mg treatment to less than 1 ppm on day 7 for the 2.4 mg treatment and were less than total N concentrations at each sampling time. Leachate NO₃⁻-N was not detectable during the experimental period. Eleven, 16, 20 and 25% of the applied N leached from the columns amended with 2.4, 4.7, 7.1 or 9.5 mg of urea-formaldehyde per cubic centimeter of pine bark, respectively, during the 371 day experiment.

835 (PS 16)

THE EFFECT OF ALTERING THE N:S RATIO ON CUT ROSES

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Previous hydroponic studies have shown that nitrogen rates applied to roses can be cut in half as long as known quantities of sulfur are added. A two-year study began in February, 1991, to determine if roses potted in a 2:1:1 mix (soil:peat:perlite) would respond similarly. Six cultivars and three treatments (300 ppm N 20-30-10, N:S at 2:1 and N:S at 4:1 with N being approx. 155 ppm) were replicated three times in a split-plot design. Data included number of flowers and length of stems cut daily. Plants were allowed to grow for 4 months, were cut back, then allowed to grow for 7 months and cut back again. After the second pruning, shoots were harvested for N and S analysis. Soil samples were also taken. Initial data, analyzed through September, indicates that across cultivars the total number of flowers produced was not influenced by the N:S treatments. Certain cultivars, however, were more productive than others. Champagne and Bridal White consistently produced more flowers than Samantha and Amorous, regardless of fertilizer treatment. Certain treatment cultivar combinations were also significant indicating that cultivar response may limit N:S recommendations.

836 (PS 16)

RESPONSE OF CATHARANTHUS ROSEUS "GRAPE COOLER" TO MEDIA AND FERTILIZER SOLUTION CONCENTRATION USING SUBIRRIGATION

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Seedlings of *Catharanthus roseus* "Grape Cooler" was transplanted to cell packs of media: peat-vermiculite-perlite (MM220), peat-hydrophilic rockwool (ABS), and peat-hydrophobic rockwool (REP) and grown in subirrigation trays using 20N-4.4P-17K fertilizer at 50, 150 or 250 ppm N applied at each irrigation. Shoots of four plants in each of two replications were harvested 2, 3, 4 and 5 after transplant. Leaf samples from the third harvest were analyzed for essential elements. Electrical conductivity (EC) was measured in saturated media extracts at each harvest. Significant media by fertilizer interactions were obtained for fresh weight and leaf area at the final harvest. Greatest growth was obtained with 50 ppm N in ABS, but with 150 ppm N in MM 220 and REP. In these, growth was similar at 50 and 150 ppm N, but less growth REP than MM220 at 250 ppm. More growth was produced with ABS at 50 ppm N, but less at 150 or 250 ppm N. Leaf tissue N increased 38.5 to 54.5 mg g⁻¹ dry wt. as fertilized increased 50 to 150 ppm, while other nutrients were not significantly affected. Media EC increased with time and fertilizer concentration, with EC in all media fertilized with 250 ppm N exceeding 4.5 dS m⁻¹ at the final harvest.

837 (PS 16)

NITROGEN PARTITIONING IN POTTED CHRYSANTHEMUM AS INFLUENCED BY SOURCE AND QUANTITY OF N SUPPLIED

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Chrysanthemum morifolium Ramat. cv. 'Yellow Favor' was grown single stem in 10cm pots on an ebb and flow benching system. A 2x2 factorial design was employed with

2 sources of N (100 NO₃⁻ and 50 NO₃⁻:50 NH₄⁺), delivered at 18 mM, and 2 quantities of N supplied, (200 mg and 400 mg), with 200 mg supplied by wk 3 and 400 mg supplied by wk 5. Plants were harvested at two wk intervals, separated into leaves, stems plus petioles and inflorescence (when developed) and analyzed for total and NO₃⁻ N, with reduced N being estimated as the difference between these two values. Plant tissue (leaves and stems plus petioles) NO₃⁻ levels showed similar trends for the 200 and 400 mg N supply, with a maximum at the 4th to 6th wk. At flowering, (wk 10) significant tissue NO₃⁻ levels were found only in plants supplied 400 mg of N. Plants supplied with 50:50 NH₄⁺:NO₃⁻ initially had significantly greater reduced N and leaf area than NO₃⁻ supplied plants, although differences diminished towards flowering. During floral development (wk 8 to 10), at which time no additional N was accumulated by the plant, significant amounts of reduced N was remobilized from the stem plus petioles and leaves to the developing inflorescence.

838 (PS 16)

MICRONUTRIENT TOXICITY IN *PETUNIA HYBRIDA*

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Foliar micronutrient toxicity symptoms of *Petunia hybrida* 'Ultra Crimson Star' were induced by elevated levels (from 0.25 to 6 mM) of boron (B), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo) and zinc (Zn) in the nutrient solution. Foliar toxicity symptoms of most micronutrients (except Fe) were characterized by leaf yellowing, interveinal chlorosis, and marginal necrosis. Mo toxicity was most severe. Leaf abnormality was not induced by Fe in the concentration range tested. Visible foliar toxicity symptoms developed when nutrient solution contained 5.4, 32, 28, 24, and 16 mg·liter⁻¹, respectively, of B, Cu, Mn, Mo and Zn. Biomass yield was reduced when the fertilizer solution contained (in mg·liter⁻¹): 22 B, 64 Cu, 335 Fe, 28 Mn, 24 Mo, and 33 Zn.

839 (PS 16)

INFLUENCE OF INCREASED ROOT MEDIA PHOSPHORUS LEVELS IN POINSETTIA PRODUCTION

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Acidification of the irrigation water with phosphoric acid is a common practice to avoid nutrient deficiencies/toxicities from alkaline root media. It has been suggested high phosphorus levels could cause phosphorus toxicity.

Euphorbia pulcherrima Willd. cultivars Supjibi and Celebrate 2 cuttings were potted on June 6, 1991 in a root medium of peat, perlite and soil (40:40:20 by volume) amended with N, K, Ca and micro-nutrients, plus six phosphorus (0-40-0) rates of .89, 1.78, 3.55, 7.11, 10.67, and 14.22 kg/meter³. Foliar samples were analyzed for NH₄, P, and K every two weeks after the start of short days. Root media samples were also collected and analyzed pH, SS and NO₃, P, K and NH₄. Bract diameter, bract edge burn, days to anthesis, and plant height were recorded at anthesis.

Media P levels increased as the phosphorus rate increased, but a significant treatment*harvest interaction for media P was observed. There was decreased bract size and increased incidences of bract edge burn as phosphorus rate increased. Root media P levels did not affect the levels of other nutrient elements in the foliar samples. No visual symptoms of phosphorus toxicity was observed except for bract edge burn at anthesis.

840 (PS 16)

ELEMENTAL TISSUE LEVELS FOR ANTHURIUM FLOWER PRODUCTION

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Critical tissue levels for flower production of field grown *Anthurium andraeanum* Andre were established. Maximum flower production was obtained when leaf tissue levels were 1.87% N, 0.17% P, and 2.07% K. A range of elemental leaf tissue levels associated with optimum flower production were also determined for Ca, Mg, B, Mn, Fe, Zn, Cu and Mo.

841 (PS 16)

CONTAINER ELECTROCONDUCTIVITY STRATIFICATION IN METROMIX 350 AFTER HARVEST OF TOP- AND SUBIRRIGATED GERANIUMS

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Excessive electroconductivity measurements have been observed in the surface layer of subirrigated substrates. A hydrophilic gel and rockwool

were used as pot mulches in order to reduce the surface layer salt buildup by absorbing the salts and/or reducing evaporation.

Six treatments of 'Crimson Fire' and 'Victoria' CVI geraniums were grown in 11 cm. pots. Treatments were: Trt 1 - top irrigation, N source 20-10-20; trt 2 - subirrigation, N source 20-10-20; trt 3 - subirrigation, N source in equal portions of 20-10-20 and CRF, gel mulch; trt 4 - subirrigation, N source CRF, gel mulch; trt 5 - subirrigation, N source in equal portions of 20-10-20 and CRF, wool mulch; trt 6 - subirrigation, all N source CRF, wool mulch.

Pots were divided into 3 equal volume portions. Electroconductivity, as a measure of soluble salt (SS) level, was taken. All treatments had increasing SS levels with increasing pot height. Trt 2 had surface layer salt levels significantly higher than trt 1. 'Victoria' trts 3, 4, 5 and 6 surface layers had significantly lower SS levels than trt 1 surface layers. 'Crimson Fire' trt 4's surface layer had significantly lower SS levels than the surface layer of trt 1. Trts 4 and 6 bottom layers of both cultivars had significantly lower SS levels than all other treatments.

842 (PS 16)

EASTER LILY GROWTH AND NUTRIENT UPTAKE FROM POTTING MEDIA AMENDED WITH COMPOSTED MUNICIPAL SLUDGE

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Easter Lilies (*Lilium longiflorum*) were grown in potting media containing 50% peatmoss and 50% vermiculite V/V or amended with 25, 33, or 50% (V/V) composted municipal sludge.

Macro and micro nutrient levels were determined for the various media formulations using either a water or a Mehlich III extraction procedure. Foliar levels of micro and macro nutrients were determined at anthesis. Final plant height and number of buds per plant were measured for each treatment.

No media formulations were phytotoxic; however, several micro element levels increased with increasing composted sludge content in foliar samples. These increasing foliar levels of Cu, Fe, Zn correlated well with media levels when Mehlich III was the extraction method. A similar correlation was not found with water as the extractant.

843 (PS 16)

RESPONSES OF HERBACEOUS PERENNIAL SPECIES TO HIGH IRON LEVELS

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Problems with iron toxicity are documented for the bedding plant species of geranium and marigold. It was suspected that observed nutrition problems of *Chrysanthemum Xsuperbum* 'Snow Lady' were due to iron toxicity. The objectives of this study were to determine which if any perennial species were sensitive to iron toxicity (iron efficient) and to document any symptoms. Using a sand culture method, C. *Xsuperbum* 'Snow Lady' and 'Alaska', and *Pelargonium Xhortorum* 'Red Elite' (as a check) and 3 other perennial species were watered twice daily with a modified Hoaglands I solution with 0.00, 0.02, 0.04, 0.08, 0.16, or 0.32 mM FeEDTA. Only *Pelargonium* had toxic foliar iron levels (462.2 ppm Fe averaged over all treatments) and showed classic iron toxicity symptoms. C. *Xsuperbum* 'Alaska' showed possible iron toxicity symptoms at 0.08 and 0.16 mM FeEDTA with foliar iron levels of 301.0 ppm Fe and 282.7 ppm Fe, respectively. Below average foliar levels of Mn were observed in all species except *Pelargonium*. Also noted were: toxic levels of boron in *Achillea* and deficient levels of copper in *Aquilegia*.

844 (PS 16)

RESPONSE OF NEW GUINEA IMPATIENS TO FERTILITY LEVEL IS AFFECTED BY APPLICATION FREQUENCY

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New Guinea impatiens (*Impatiens* sp. hybrids) are particularly sensitive to growth medium soluble salts level during the first four to six weeks after potting. Results of this experiment show that this response is affected by the interaction of fertilizer rate and application frequency. Solutions containing 20N-4.3P-16.6K at 0.5, 1.0, 1.5, or 2.0 g·liter⁻¹ were applied to 'Selenia' growing in 520 ml pots 4, 8, 12, or 16 times (evenly-spaced) during a 70 day experiment. A significant interaction occurred between fertilizer rate and application frequency. Shoot dry weight (DW) increased linearly with application frequency at 0.5 g·liter⁻¹. Overall 16 applications

of 0.5 g·liter⁻¹ resulted in the most growth of all rate and frequency combinations. Maximum DW at 1.0 g·liter⁻¹ was achieved with 12 applications and 8 applications resulted in the most DW with 1.5 and 2.0 g·liter⁻¹. In treatments where growth was inhibited, growth medium EC exceeded 1.0 dS·m⁻¹. EC did not exceed 0.4 dS·m⁻¹ at any application frequency with 0.5 g·liter⁻¹.

845 (PS 16)

ANTHURIUM HYDATHODE STRUCTURE AND GUTTATION OF GLUTAMINE IN RELATION TO NITROGEN NUTRITION AND RATE OF BACTERIAL BLIGHT INFECTION

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Infection of *Anthurium andraeanum* Andre by *Xanthosomas campestris* pv. *dieffenbachiae* appears to be through hydathodes. Hydathodes occur around the entire margin of the leaves. A small vein that runs parallel to the margin delimits the outer edge of the mesophyll chlorenchyma and the inner edge of the hydathode. External to the vein, epithem cells and intercellular spaces occur adjacent to the xylem vessel elements. Hydathode pores mostly occur on the adaxial surface of the leaf margin. Hydathode structure is consistent and does not appear to differ among cultivars. Glutamine may occur in the guttation liquid with higher levels of nitrogen nutrition. At the same level of nitrogen, more susceptible cultivars appear to produce more glutamine than cultivars more tolerant to the blight. More glutamine appears to increase the rate of blight infection.

846 (PS 16)

ROOT INOCULATION WITH A P-SOLUBILIZING FUNGUS ALTERS GROWTH AND P UPTAKE OF SEVERAL GREENHOUSE CROPS.

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Root zone inoculation with P-solubilizing *Penicillium bilaji* (PB) has increased P uptake and yields of several field crops. We examined the influence of applying 0 - 5 x 10⁵ C.F.U./plant of PB to geranium and petunia grown in the greenhouse in a low P soil amended with rock P. All rates of inoculation increased growth and enhanced flowering of both crops. A second study examined the interaction between PB and rock P amendments in poinsettia. Inoculation with PB accelerated growth through to pinching as did addition of rock P to the media. The combined PB + rock P treatment enhanced bract development resulting in better red color at market time. These results suggest that PB inoculation can enhance growth and/or improve P use efficiency in greenhouse crops.

847 (PS 16)

VESICULAR-ARBUSCULAR MYCORRHIZAL (VAM) FUNGI ALTER ROOT GROWTH OF *PROSOPIS ALBA* (CHILEAN MESQUITE) IN CONTAINERS

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Effects of VAM fungal inoculum, *Glomus intraradices* Schenk & Smith, on the growth of Chilean mesquite in containers were investigated as part of a nursery container system for production of xeric trees. Seedling liners of Chilean mesquite were transplanted into 27-liter containers filled with a 3 pine bark : 1 peat moss : 1 sand medium. Before transplanting, 50% of the trees were band-inoculated at a depth of 8 to 12 cm below the growth medium surface with 35 g per container of *Glomus intraradices* (Nutrilink, NPI, Salt Lake City, UT), approximately 1,000 spores g⁻¹. All trees were top-dressed with 15 g Osmocote 18N-2.6P-9.9K (Grace-Sierra, Milpitas, CA) and 3 g Micromax (Grace-Sierra, Milpitas, CA) fertilizers and grown in a fiberglass greenhouse under 50% light exclusion. After 4 months, all inoculated tree root systems were colonized, and the percent infection was 47%. Noninoculated trees remained nonmycorrhizal. There were no differences in height, total shoot length, shoot dry weight, or root dry weight between inoculated and non-inoculated trees; however, total root length and specific root length of inoculated trees were less than those of non-inoculated trees. These results suggest that the VAM fungi altered the root architecture of inoculated trees such that root systems of these trees had thicker roots with fewer fine roots elongating into the growth medium profile.

848 (PS 16)

DEGRADATION OF A BARK STORAGE PROTEIN IN POPLAR.

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A 32kDa bark storage protein (BSP) which accumulates in the fall and is degraded in the spring has been identified in *Populus deltoides* bark. The BSP gene has been shown to be regulated by short day (SD) photoperiod (8 h). The physiological condition of the plant and the environmental factors necessary for the degradation and retranslocation of BSP are of considerable interest for determining the role of this protein in the remobilization of nitrogen in trees.

Poplar plants were placed in a SD growth chamber for 4 or 7 weeks to induce growth cessation (bud set) or dormancy, respectively. BSP accumulated to high levels in bark tissues after 3 weeks SD and remained high through 7 weeks SD. Plants in which growth had stopped (4 weeks SD), or in which dormancy (7 weeks SD) was broken with hydrogen cyanamide (0.5 M) or chilling (4 weeks OC) broke bud within 1 week of being placed into long day (LD) conditions. Dormant plants which were not chilled broke bud after 3 weeks LD. BSP levels decreased around the time of budbreak, suggesting that the degradation of BSP is dependent on the need for a nitrogen sink, i.e. budbreak and new shoot growth.

849 (PS 17)

ACTIVE SUBSTANCES IN CHINESE CHIVE AND RAKKYO PLANTS FOR BREAKING BUD DORMANCY IN GRAPEVINES

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We previously found that volatile substances in chinese chive (*Allium tuberosum*) and rakkyo (*A. chinense*) as well as garlic (*A. sativum*) stimulated budbreak in vines. But the active substances stimulating budbreak in chinese chive and rakkyo have not yet been identified.

The volatile sulfur-containing substances in fresh chinese chive and rakkyo were identified by GC-MASS. The main volatile substances in chinese chive and rakkyo were allyl and methyl mercaptans, and dimethyl disulfide, respectively.

Cuttings with a single bud obtained from 'Kyoho' vines in dormancy were exposed to vapors of different concentrations of the three compounds for 12 or 24 hr in a desiccator, and they were kept at 25°C, mounted on styrofoam plate floated in water. Diallyl disulfide, a main component in garlic, was also tested for comparison. Irrespective of concentrations and exposure periods of sulfide compounds, sprouting was greatly accelerated with diallyl disulfide. In mercaptan homologues, allyl mercaptan accelerated sprouting more effectively than in methyl mercaptan. A solution of 75% dimethyl disulfide accelerated sprouting on exposure for 12 hr, while inhibited budbreak for 24 hr.

850 (PS 17)

GA₃-INDUCED FRUIT SET OF RABBITEYE BLUEBERRY

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The effects of different GA₃ concentrations and application times on fruit set, fruit development period, and fruit quality in rabbiteye blueberry (*Vaccinium ashei* Reade) were studied. Flower clusters were sprayed with 100 or 250 ppm GA₃ at 90% full bloom and again 7 days later, or with 125 ppm GA₃ at 90% full bloom and again 7, 21, and 42 days later, under greenhouse conditions. Fruit set was monitored every 10 days and fruit weight, fruit development period, soluble solids, and titratable acidity were measured at harvest.

Fruit set in GA₃ treatments averaged 69 to 76% compared to an average of 43% for the pollinated control. Weight of GA₃ treated berries averaged 1.2, g while that of pollinated berries averaged 2.0 g. However, calculated total yield was greater for the GA₃ treatments compared to the pollinated control, averaging 244 and 206 g/treatment, respectively. GA₃ increased the fruit development period by 2 to 11 days, depending on the treatment. Soluble solids and titratable acidity were not affected by any treatment.

851 (PS 17)

'TIFBLUE' BLUEBERRY BUDBREAK BY H₂CN₂ AT DIFFERENT DORMANCY STAGES

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'Tifblue' Blueberries (*Vaccinium ashei*) have poor or delayed budbreak in warm growing regions due to a lack of chilling temperatures. Hydrogen cyanamide (H₂CN₂) is known to break dormancy in buds. We tested the response of 'Tifblue' blueberry buds to concentrations

of hydrogen cyanamide at different dormancy stages with respect to budbreak and phytotoxicity. Blueberry bud sticks were harvested during the growth season at three week intervals. H₂CN₂ (0.05, 0.125, 0.25, 0.5 M), hot water (47°C) and a control (distilled water at 0°C) were used. Treated bud sticks were forced to break under light at 18-26°C. Flower and leaf buds broke after 10-14 days. H₂CN₂ above 0.25 M was highly phytotoxic to flower buds, but not leaf buds. H₂CN₂ at 0.125 M was most effective in breaking flower and leaf buds at all dormancy stages. ABA and polyamine levels in buds shall be analyzed.

852 (PS 17)

YIELD AND QUALITY OF THE RED GLOBE GRAPE VARIETY AS INFLUENCED BY GRAFTING ON DIFFERENT ROOTSTOCKS
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Grafted and non-grafted vines of the Red Globe cultivar were planted in May, 1985 in a randomized block design to determine the effects of grafting on different rootstock on vine growth, yield, and fruit quality. The rootstocks used in this trial were Harmony, Freedom, Couderc 1613, and Thompson Seedless; non-grafted vines included rooted cuttings and one-year-old rootings. Vines grafted on Freedom were more vigorous than any other vines. The levels of nitrogen and potassium were significantly higher in vines grafted on Freedom than non-grafted vines or those grafted on other rootstocks. Yield was significantly influenced by the different rootstocks. Vines grafted on Freedom produced significantly lower yield than other vines. Vines grafted on Harmony and Couderc 1613 were not significantly different from each other or non-grafted vines that were established from a rooted cutting.

853 (PS 17)

GIBBERELIC ACID AND COLD STRATIFICATION TREATMENTS AFFECT KIWI SEED GERMINATION AND ROOT ELONGATION

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Rapid and timely production of kiwi (*Actinidia deliciosa*) seedlings is often hampered by poor and erratic seed germination. This investigation was conducted to assess the effect of gibberellic acid, cold stratification (5°C), and their combinations on seed germination and subsequent radicle elongation. Germination counts and radicle elongation measurements were made two weeks after incubation at 25.4°C under continuous light and approximately 100% RH. GA treatments broke dormancy and increased germination and radicle elongation with increasing concentration up to 2500 ppm. At 5000 ppm, germination and radicle elongation were reduced. Cold stratification (1 and 2 week durations) alone did not affect germination nor break dormancy. Combined cold stratification and GA treatments significantly enhanced seed germination and radicle elongation with the best response at the highest GA concentration (5000 ppm) and longest stratification (2 weeks), regardless of whether the seeds were stratified prior to or after GA treatments.

854 (PS 17)

BUDBREAK OF 'PERLETTE' SINGLE-NODE CUTTINGS INDUCED BY CHILLING AND HYDROGEN CYANAMIDE.

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Grapevines growing under our desert conditions have inadequate chilling accumulation and require dormancy-breaking chemicals to induce uniform and early budbreak. Depending on concentration and application date, these treatments could delay or damage rather than accelerate bud development. We evaluated the budbreak response of 'Perlette' grapevines to hydrogen cyanamide after different chill units (CU) were accumulated. Cyanamide (0.0, 0.025, 0.050, 0.100, 0.200, and 0.400 M) were applied to single node cuttings every 50 CU. After treatments, the cuttings were placed in a warm, long day greenhouse with additional light. Budbreak was recorded every 2 days, and final percentage budbreak was determined after 3 weeks. Cyanamide broke dormancy 10 to 14 days after application. All cyanamide treatments induced 60% budbreak above the control when applied before any chilling accumulation. Highest percent of budbreak of untreated cuttings occurred after 150 CU were

accumulated. Concentrations in the range from 0.1 to 0.4 M were best for overcoming dormancy. Optimum concentration varied depending on the CU accumulated before treatments.

855 (PS 17)

EFFECTS OF HYDROGEN CYANAMIDE ON APPLE AND PLUM FRUIT THINNING

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Influence of various concentrations of hydrogen cyanamide (HC) on fruit thinning of 'Rome Beauty' apple (*Malus domestica* Borkh.), 'Friar,' and 'Simka' plums (*Prunus salicina* Lindley) were studied. A full bloom application of HC at all tested concentrations decreased 'Rome Beauty' apple fruit set and yield, and increased fruit weight. Hydrogen cyanamide at 0.25% (V/V) resulted in adequate apple thinning, indicated by the production of an ideal fruit weight. Prebloom and full bloom applications of HC at greater than 0.75% reduced plum fruit set and yield in 'Friar.' Full bloom application of HC at 0.25% to 0.50% showed a satisfactory fruit set, yield, and fruit size in 'Friar' plum. Full bloom application decreased fruit set and yield in 'Simka' plum. Hand thinning, as well as chemical thinning, is recommended for plums.

856 (PS 17)

INCREASE IN ENZYME ACTIVITIES RELATED TO ASCORBATE AND GLUTATHIONE METABOLISM DURING THIDIAZURON-INDUCED BUD BREAK OF APPLE.

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An increase in ascorbic acid, reduced form of glutathione (GSH), total glutathione, total non-protein thiol (NPSH) and non-glutathione thiol (RSH) occurred as a result of induction by thidiazuron during bud break, whereas dehydroascorbic acid and oxidized glutathione (GSSG) decreased during the same period. Thidiazuron also enhanced the ratio of GSH/GSSG, and activities of catalase, superoxide dismutase (SOD), ascorbate free radical reductase (AFR), ascorbate peroxidase (POD), dehydroascorbate reductase (DHAR), ascorbate oxidase (AAO), and glutathione reductase (GR). The ascorbic acid content and the activities of catalase, SOD, AFR, POD, AAO, and DHAR peaked when buds were in the side green or green tip stage just prior to the start of rapid expansion, and declined thereafter. The GSH, NPSH, RSH, ratio of GSH/GSSG, and activity of GR increased steadily during bud development.

857 (PS 17)

EFFECTS OF FALL APPLICATIONS OF ETHEPHON AND GA₃ ON PEACH TREES

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A factorial arrangement of four replications of ethephon (0, 25, 50, 100, or 150 mg·liter⁻¹) and GA₃ (0, 25, or 50 mg·liter⁻¹) treatments in a Randomized Complete Block Design were applied to 'Redhaven' peach trees in mid-September. Each tree received the same treatment in 1987-1990. Development of flower buds (after endodormancy completion) was significantly delayed by GA₃ and ethephon. The date of 50% bloom was significantly delayed by GA₃ (approximately 1 day) and by ethephon (4.7 days with 150 mg·liter⁻¹ treatment). Increasing the concentration of each chemical resulted in more delay of bloom. There was no interaction of the effects of the two chemicals on bloom date. Application of 50 mg·liter⁻¹ GA₃ plus 150 mg·liter⁻¹ ethephon caused the greatest bloom delay (6.5 days compared to untreated trees). Gummosis on scaffolds was evident in the fall and following spring on trees treated with the 2 highest rates of ethephon. During the summer and following fall, little gummosis was evident. By September 1991, evidence of gummosis was insignificant and no tree mortality occurred.

858 (PS 17)

EFFECTS OF ETHEPHON ON THE ABSCISSION OF PISTILLATE AND STAMINATE FLOWERS OF ENGLISH WALNUT

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The ability to remove the pistillate flowers and young nuts from precocious lateral-bearing English walnut (*Juglans regia* L.) cultivars during the first several years following planting would be useful both in reducing competition with vegetative growth and eliminating potential infection sites for blackline disease (cherry leafroll virus). Applications of ethephon shortly after full bloom were shown to effectively remove all or most pistillate flowers depending upon spray timing and ethephon concentration. Moderate phytotoxicity and reduced seasonal growth limit the usefulness of this technique in the field. Removal of staminate flowers (catkins) prior to pollen release may reduce the excessive pistillate flower abscission of the 'Serr' cultivar. Applications of ethephon shortly before the onset of pollen shedding were shown to be ineffective in catkin removal.

859 (PS 17)

EFFECT OF GROWTH REGULATORS WITH CALCIUM ACETATE ON FRUIT GROWTH AND MATURATION IN NIITAKA PEARS (*PYRUS PYROFOLIA*).

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Fruit maturity was hastened by 5 to 7 days with the application of GA₃ and GA₄+7 paste on petioles 4 weeks after full bloom and 3 to 4 days with the spray of both ethephon (1,000ppm) and dichloroprop (30ppm) 62 days after full bloom. Fruit size was significantly increased by GA₃ treatment but there was a tendency of decreasing fruit size by ethephon and dichloroprop treatments. Excessive softening of flesh was found in ethephon or dichloroprop treated fruits while no significant difference was observed with GA₃ treatment until maturity. Calcium acetate partially prevented the enhancement of fruit softening and fruit size decrease induced by ethephon and dichloroprop. Other fruit qualities such as soluble solids contents were not affected by the addition of calcium acetate except some delay in fruit maturity.

860 (PS 17)

ETHYCHLOZATE AS A NEW CHEMICAL THINNER ON 'FUJI' APPLE

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Since 1987 some chemicals have been examined for thinning of apple, while considering the safety for humans, animals and bees. Ethyl 5-chloro-3(1H)-indazolylacetate (Ethy-chlozate) had the same effect as Carbaryl on 'Fuji' cultivar. Suitable results were obtained by 40ppm solution spray at 2 to 3 weeks after full bloom. An addition of 300ppm Ethephon increased thinning effects on 'Fuji'. But over thinning occurred on 'Tsugaru', 'Jonagold' and 'Jonathan' by same concentration of Ethychlozate or Ethychlozate plus Ethephon.

Thinning effects were more severe on the lateral fruits than on the center fruits. The results were advantageous for apple growing in Japan as center fruits are very important. Epinasty, russet and other injuries caused by Ethychlozate sprayed were not recognized.

861 (PS 17)

EFFECT OF DORMEX ON REPLACING LACK OF WINTER CHILLING IN PEACHES

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Lack of winter chilling periodically becomes a serious problem for commercial peach producers in the Southeast, especially along and near the Gulf Coast areas. Studies were conducted over 3 years (1989-1991) to evaluate the effects of hydrogen cyanamide (Dormex - SKW) on replacing lack of winter chilling in 7 varieties of peaches.

Initial findings using whole tree sprays to point of runoff indicated a problem with efficacy and phytotoxicity. A combination of hydrogen cyanamide rates (0, .5, 1, 2 and 4% V/V) and timings (0, 25, 50 and 75% of chilling level) were evaluated in 1991. Rates above 2% were phytotoxic. Rates of 0.5 to 1.0% were safe and effective when applied at 75% chilling.

SURVIVAL AND ROOTING OF NECTARINE CUTTINGS UNDER FIELD CONDITIONS

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Quiescent nectarine cuttings of 'Karla Rosa', 'Carolina Red' and 'Early King' were taken in the fall of 1988. The cuttings were inserted in Jiffy 7 pellets, Jiffy pots filled with Jiffy mix and pots filled with sand and vermiculite (1:1 by volume). The pellets and pots containing the cuttings were placed in rows in field propagation beds. A control (cuttings placed directly in field propagation beds) was used for comparison. In addition, cuttings of 'Karla Rosa' under mulch treatments were propagated in 1990. Percentage cutting survival and percentage of cuttings of 'Karla Rosa' and 'Carolina Red' was greatest when cuttings were propagated directly in the field and when inserted in vermiculite and sand mixture. Percentage cutting survival for 'Early King' was not significant, regardless of treatment. When propagated in pots filled with vermiculite and sand mixture, rooting for 'Early King' was 41 percent. In 1990, sawdust and hay mulches enhanced rooting and survival of 'Karla Rosa' cuttings when compared to the control (no mulch).

863 (PS 17)

COMPARATIVE STUDIES ON NEWLY DEvised AND CONVENTIONAL METHODS OF GRAFTING IN ONE-YEAR-OLD 'FUJI' APPLE TREES/ M.26 /MALUS PRUNIFOLIA SEEDLINGS.

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Experiments were carried out to evaluate some newly devised and conventional methods of grafting using 'Fuji' apple trees on M.26/M. *prunifolia* rootstocks. Out of various methods of grafting, the modified inverted-veneer grafting and the inverted bark grafting showed a complete healing of the grafting union leaving no part of xylem tissue exposed in the air. However, owing to the longer period of growth for the trees grafted by the modified inverted-veneer grafting than the inverted bark grafting during the period of one growing season, the modified inverted-veneer gave slightly better shoot growth than the inverted bark grafting. It was clear that the former two methods were superior to the all other grafting methods, i.e., whip-and-tongue grafting, modified veneer grafting, inverted-veneer grafting, bark grafting, and chip budding in the grafting union healing, shoot growth, and tree form performance.

864 (PS 17)

PROPAGATION OF PECAN BY LAYERING

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At present, a clonal rootstock for pecan is unavailable. Studies were initiated to evaluate the effectiveness of air-layering, stooling and trench layering techniques for propagation and field survival of clonal pecan rootstocks and to obtain an estimation of the relative responsiveness of genotypes.

These studies demonstrated that clonal rootstocks and scion materials can be produced for pecan genotypes by either of the air-layering, stooling, or trench layering techniques. Survival and health of clones were generally best from ramets produced by the stooling and trench layering methods if girdling plus IBA is used to induce rooting. Of the three methods evaluated, stooling would appear to be the most practical method of producing rootstock materials since it produces the most healthy clones, although its yield per tree is probably a little less than that of trench-layering. The influence of the 'girdling plus IBA' treatment on overall physiology of the rooted shoot appears to be relatively minor when compared to that of the 'check'.

865 (PS 17)

PROPAGATION OF PECAN BY STEM AND ROOT CUTTINGS

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Certain key experiments on the clonal propagation of pecan by stem and root cuttings are described. Juvenile cuttings of

pecan cv. 'Stuart' produced more roots and a larger percentage of rooted cuttings than adult cuttings when treated with 1% solution of (IBA) in Feb. and Aug. Successful propagation from 'Stuart' stem cuttings was high from July to September. This study also fails to support the hypothesis that auxins are necessary to increase the level of rooting by pecan hardwood cuttings. Pecans were propagated using root cutting techniques and successfully transplanted to containers. Root cutting sections collected in either March or August from two-year-old 'Curtis' seedling, responded yielding high rooting success and survival. The data also provides evidence that IBA could enhance the production of roots of root cuttings but BA (Benzyl Adenine) offers no benefit. Girdling the sprout shoots from root cuttings with the use of IBA doubled the percentage of shoots producing roots and increasing root length.

866 (PS 17)

GROWTH REGULATORS AND PRUNING AFFECT FLOWER AND FRUIT DEVELOPMENT IN COFFEA ARABICA L.

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Unsyncronized flowering and fruit ripening of coffee prohibits mechanical harvesting and results in high labor costs. Coffee (*C. arabica* c. Guatemalan) trees were sprayed at the beginning of the 1988 and 1989 flowering season with solutions of benzyladenine (BA), gibberellic acid GA₃ (GA), and Promalin (PR) or were pruned in 1988 to determine effects on synchronizing flowering and ripening. Growth regulators affected the time to flowering and harvesting compared to the control, however, treatment effects were dependent on the time of growth regulator application. Application of PR and GA at 100 mg/l in Jan 1988 shortened the average days to flowering by 16 and 13 days, and the average days to harvest by 15 days compared to the control. Pruning of three apical nodes of primary lateral branches in Feb 1988 caused delays in flowering, reduced flower and fruit number per tree, and caused branch dieback.

867 (PS 17)

PROPAGATION OF CARICA PAPAYA 'HONEY GOLD' CUTTINGS

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Many small, pen-sized papaya side shoots were formed after injecting a BA/GA, solution into the bases of stems of one-year old plants of the 30-year old clone 'Honey Gold', followed by topping the stems a day later. Standing small, leafy cuttings in various fungicidal solutions for 10 or 30 minutes resulted in phytotoxic basal burn, whereas a short immersion gave good results. Benlate® and Follicur® were best, especially with the addition of paclobutrazol. There is a distinct seasonal variation in the rooting of cuttings, with those that have been exposed to cold winter conditions giving poorest results. For best results (95% rooting in 4 weeks in perlite with intermittent mist), stock plants are maintained in a protected environment, especially in cool weather. Uniform side shoots, are harvested regularly, leaving stubs to produce new shoots, while maintaining enough leaf canopy.

868 (PS 17)

SIMULATION OF PINEAPPLE GROWTH AND DEVELOPMENT

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A simulation model of pineapple growth and development (CERES-Pineapple) was developed, using the structure of CERES-Maize and a heat unit model for pineapple inflorescence development. The model is process-oriented and incremented daily. It simulates the effects of planting date, plant population, plant size at planting and at forcing, and weather on pineapple crop growth and development. CERES-Pineapple was calibrated to field data collected from a plant population trial at Kunia, Hawaii, and validated using data from 11 plantings of pineapple grown in Hawaii. The model accurately simulated pineapple growth and development for most Hawaii conditions but underpredicted fruit yields for pineapple grown at high elevations. CERES-Pineapple also provides a frame-work for the conduct of pineapple research and has potential to serve as a decision aid for pineapple farmers.

INCORPORATING PESTICIDE TRANSPORT INTO THE AGNPS (AGRICULTURAL NONPOINT SOURCE) POLLUTION MODEL

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A pesticide transport submodel has been incorporated into a distributed parameter simulation model. AGNPS (AGRICultural NonPoint Source Pollution Model) can evaluate the effect of agricultural pollution sources on surface runoff. Six pesticide classes are used: herbicides, insecticides, fungicides, nematocides, plant growth regulators, and desiccants/defoliants. User inputs for the model include the time of pesticide application (preplant, preemergence, or postemergence), application rate, application efficiency, percent canopy cover, soil and foliar pesticide residues, soil and foliar pesticide decay, water solubility, foliar washoff threshold and fraction, incorporation depth and efficiency, and sorption coefficient. Areas of pesticide losses and accumulations are indicated in tabular and graphical outputs. Alternative management practices can be simulated, and therefore assist in the optimization of practices to reduce pesticide runoff.

870 (PS 17)

COMPUTER DECISION SUPPORT TOOL FOR HEIGHT CONTROL OF POINSETTIAS

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Height control is a major challenge in the production of high quality poinsettia crops. Graphical tracking is a technique where growers make height control decisions by comparing actual measured plant height with a desired height. A computer decision support tool, the *Poinsettia Care System*, is being developed to combine graphical display of plant height with an expert system to provide height control advice. A simulation model is used to predict future growth of the crop based on greenhouse temperature, growth retardant applications, plant spacing, plant maturity, and light quality. Growth retardant and temperature recommendations are made based on a crop's deviation from the target height, expected future growth rate, and crop maturity. The program was beta tested by 8 Michigan growers over the 1991 poinsettia season. The test growers reacted positively to the program in a follow-up survey. Perceived benefits included improved height control, consistent crop recording, and a 'second opinion' when making height control decisions. Improvements were suggested to combine the advice of different crops within the same greenhouse zone, to improve the predictive growth model, and to streamline data entry and output.

871 (PS 17)

A MODEL FOR THE GROWTH AND DEVELOPMENT OF MULTIPLE SHOOTS GROWING IN A ROSE CROP CANOPY

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The main objective of this project was to develop a crop simulation model for greenhouse cut flower roses. An intermediate step towards the completion of that objective is the building of a model for the growth and development of a collection of shoots of various ages throughout the canopy. The canopy is represented as ten 20 cm thick layers. The shoot and leaves (age and location) are tracked as they grow into and through these layers using a model developed previously. Leaf area (LA) and leaf area index (LAI) for each layer is computed. A light distribution submodel, based on cumulative LAI, estimates the amount of radiation intercepted by each leaf. It is assumed that multiple shoots originating the same day from the same layer are identical. The model also simulates the effect of harvest of the shoots in the canopy. Currently, work is proceeding on data collection for prediction of carbohydrate partitioning within the canopy. Future work will focus on model validation.

872 (PS 17)

MODELING INFLORESCENCE DEVELOPMENT OF AFRICAN VIOLETS

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The effects of temperature and irradiance on flower initiation and development were quantified to provide a basis for an inflorescence development model. The percentage of leaf axils forming an inflorescence increased as the daily integrated PPF increased from 1 to 4 mol m⁻² d⁻¹, while the rate of inflorescence development was a linear function of temperature from 18 to 26C. The appearance of a visible flower bud in the

leaf axil was correlated with leaf blade length of the subtending leaf. Mathematical functions were used to describe leaf blade length at the time of visible flower bud as a function of temperature and irradiance, and also to describe the influence of temperature on the rate of leaf extension. The time of visible flower bud in the leaf axil was then predicted by measuring the current length of the subtending leaf blade and estimating the time required for the leaf blade to extend to the length required for visible flower bud appearance. A phasic development scale was used to describe the developmental status of an inflorescence from visible flower bud to anthesis. A model was then created which predicted time to anthesis based upon temperature and the current stage of inflorescence development.

873 (PS 17)

MODIFICATION OF A MODEL PREDICTING ROSE FLOWER GROWTH UNDER DIFFERENT IRRADIANCE REGIMES

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Three-year-old *Rosa hybrida* L. 'Royalty' and 'Red Success' plants were pinched 20 Oct. and 22 Dec. 1990 to time production for Christmas and Valentine's Day, respectively. Two greenhouses received ambient solar radiation while two additional houses had 50% reduction in irradiance using a shading thermal blanket. All temperature set points were 23C/17C day/night. Every 10 days and at flowering shoots were measured for leaf (node) number, stem diameter, stem length, and fresh weights of stem, leaves, and flower bud. Time to visible bud and to flowering from pinch were recorded.

A computer model, ROSESIM, had been formulated in SLAM II and converted to both FORTRAN and BASIC code to make the program more portable. Although ROSESIM closely predicted 'Royalty' fresh weights when irradiance was high before Christmas, underprediction occurred in the lower irradiance before Valentine's Day, and time to flowering was predicted earlier than was observed under all conditions. Corrective coefficients were added to ROSESIM to improve accuracy of prediction under actual greenhouse conditions.

874 (PS 17)

A COMPUTER SIMULATION MODEL FOR EVALUATING GREENHOUSE IRRIGATION SCHEDULING TECHNIQUES

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A computer simulation model was developed to be used in evaluating irrigation scheduling techniques and assisting irrigation scheduling decisions under greenhouse conditions in Colorado. The model simulates variable greenhouse conditions and shows how each of four irrigation scheduling techniques responds to these conditions. Reports from the model detail numbers of irrigation events, sensitivities to parameters, and forecasts water usage. The model was also used to determine appropriate accumulation triggers for Colorado conditions.

Four techniques evaluated here include: time clock control; accumulated radiation; accumulated vapor pressure deficit; combination method (radiation and vapor pressure deficit). The model has shown the combination method to be the most sensitive to changes in environmental conditions, while the time clock method proved to be least sensitive (and most wasteful of water).

The model may evaluate additional irrigation scheduling techniques by including additional parameters in the model, and may readily be adapted to different climatic regions.

875 (PS 17)

IMAGE ANALYSIS, SPREADSHEETS, AND GEOGRAPHIC INFORMATION SYSTEMS: AN INTEGRATED APPROACH FOR FRUIT AND VEGETABLE MANAGEMENT?

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Effective management of site variability has been shown to improve efficiency of chemical use, enhance of fruit quality, optimize irrigations and increase profits. Techniques for localizing and quantifying spatial variation through computer analysis of aerial imagery exist, but the detailed knowledge of soils, site history, and nutrition required for effective management of the variation often are not available in a readily accessible or timely fashion. As a consequence, the benefits of site-specific management have not been fully realized by horticultural managers. These limitations have been partially overcome by developing an information management system which integrates image analysis functions to identify crop stress, a

geographic information system to relate stresses to resident and non-resident site factors, and custom spreadsheets that provide a cost/benefit analysis of various management decisions. The system allows a manager to visualize the probable impact of an intervention on variability, yield, and profits in a timely manner.

876 (PS 18)

THIDIAZURON: A POTENT GROWTH REGULATOR FOR INDUCING HIGH-FREQUENCY ORGANOGENESIS AND SOMATIC EMBRYOGENESIS IN VITRO
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In vitro regeneration by shoot organogenesis and/or somatic embryogenesis is accomplished by culturing the explants on a nutrient medium supplemented with phytohormones. Auxins in general, and 2,4-D in particular, have been shown to induce somatic embryogenesis whereas shoot regeneration is stimulated by cytokinins. In studying the morphoregulatory role of thidiazuron (TDZ) - a substituted urea with cytokinin-like activity - we found that it induces a high frequency of both organogenesis and somatic embryogenesis depending upon the plant species. For instance, whole seedlings of peanut developed somatic embryos and those of bean and pea produced shoots in response to culture on TDZ (1-40 μ M)-supplemented media. In cultured explants of geranium, the use of TDZ (0.2-1 μ M) effectively replaced the requirement of 2,4-D or BAP and IAA for obtaining somatic embryos. The frequency of regeneration was two to ten times higher than that achieved with auxin-cytokinin combinations. While no direct evidence is currently available to establish a relationship between TDZ and endogenous phytohormones, our results suggest that it may act by establishing endogenously the auxin:cytokinin ratio permissive of induction and expression of morphogenically competent cells.

877 (PS 18)

IMPROVED MULTIPLICATION OF MATURE HAZELNUT (*CORYLUS AVELLANA* L.) IN VITRO
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Multiplication and elongation of shoot cultures established from mature trees of hazelnut cvs. Nonpareil and Tonda Gentile Romana were affected by changes in basal medium, carbon source and concentration, cytokinin and agar concentration. Explants on DKW medium produced significantly more shoots than those on Anderson medium or modified woody plant medium for chestnut. Explants on DKW medium with 3% glucose or fructose gave more and longer shoots than those with the other carbon sources. Cytokinins 6-benzylaminopurine (BA) and zeatin were more effective in producing shoots than kinetin and 2iP. On BA supplemented medium, the best multiplication rate was obtained with 1.5 - 2.0 mg/l. Explants grown on 0.4% agar produced more shoots than those on 0.6%, however, prolonged culture on 0.4% agar caused vitrification of lower parts of the plants. Shoot multiplication rates of these two cultivars were similar, but 'Nonpareil' produced longer shoots than 'Tonda Gentile Romana'.

878 (PS 18)

CRYOGENICS AND TISSUE CULTURE FOR PRESERVING PECAN GERMPLASM

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A study was conducted to develop protocol for the preservation of pecan genetic variability by cryogenic storage of zygotic embryos and subsequent in vitro plant regeneration. Parameters evaluated for their influence on embryo survival included the amount of intact kernel, liquid nitrogen (LN) treatment, desiccation, and genotype specificity. Optimum germination with minimum contamination occurred with 12% of the kernel intact. Treatment of explants with LN reduced the percentage of embryos developing into intact plants. 'Curtis' and 'Shoshoni' had a significantly higher morphogenic response in shoots only than all other cultivars. In summary, cryogenic storage of pecan zygotic embryos was determined to be a feasible means for preservation of pecan germplasm. However, the procedures used in the current study should be altered to increase the probability of embryo survival.

879 (PS 18)

SOMATIC EMBRYOGENESIS AND PLANTLET REGENERATION FROM SHOOT EXPLANTS OF *Hamelia patens*

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A variety of *Hamelia patens* (firebush) explants (nodal and internodal segments, leaf blade pieces, floral buds, shoot tips) were cultured on Murashige and Skoog's revised medium containing various concentrations of 2,4-D and kinetin. Embryogenic callus was produced only from shoot-tip explants placed on media containing 2,4-D or 2,4-D plus kinetin. None of the other explants produced embryogenic callus. Somatic embryogenesis from callus was greatest on media containing both 2, 4-D and kinetin. Direct somatic embryogenesis was observed on the roots of callus-derived primary embryos maintained on media containing 2,4-D or 2,4-D plus kinetin. Conversion of somatic embryos into plantlets only occurred on media containing 2,4-D, kinetin and activated charcoal.

880 (PS 18)

INDUCTION AND MORPHOLOGICAL CHARACTERISTICS ASSOCIATED WITH EMBRYOGENESIS OF *OENANTHE STOLONIFERA* DC.

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The study was carried out to examine the appropriate media, explant sources, and suitable growth regulators for somatic embryogenesis to establish a rapid mass production system via somatic embryogenesis in *Oenanthe stolonifera* DC. Modified MS media containing higher concentrations of $\text{NO}_3\text{-N}$ were more effective for the formation and development of the somatic embryos from embryogenic callus. Liquid media were more effective for the production of somatic embryos than solidified media. Immature florets were found to be the most competent explant sources for embryogenic callus formation. 2,4-D at 1mg/l was highly effective for the formation of embryogenic callus but inhibitory for the development and differentiation of somatic embryo. Somatic embryos were developed from the translucent and friable embryogenic callus. Addition of BA promoted the callus growth synergistically with NAA and 2,4-D, but the production of embryogenic callus was inhibited by BA.

881 (PS 18)

EMBRYOGENESIS IN EGGPLANT COTYLEDON CULTURE

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Eggplant (*Solanum melongena* L.) cotyledons were used to form somatic embryos for somaclonal induction and for selection of salt tolerant genotypes in a genetic improvement program. Naphthalene acetic acid at concentrations ranged from 5 μ M to 85 μ M induced embryogenesis when cultures were incubated under 16 hrs of light photoperiod. NAA was the only growth regulator required, and the addition of kinetin and benzyl adenine inhibited embryo formation. High frequency embryogenesis formed in 2 week old cotyledons when cultured on a medium supplemented with 43 μ M NAA. Data showed that varieties varied in their embryogenesis potential and that cotyledons were the most responsive tissue. Somatic embryos germinated into plantlets when transferred into media without any growth regulators. Somatic embryos were plated on germination media supplemented with Kuwait brackish water to increase the total dissolved salts in the medium from 4,770 ppm to 30,000 ppm in seven equal increments. Brackish water at all concentrations caused embryos to revert into profuse callus growth.

882 (PS 18)

SOME FACTORS AFFECTING ISOLATION OF MESOPHYLL PROTOPLASTS FROM APPLE (*MALUS DOMESTICA* BORKH CV. FUJI)

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Experiments were conducted to investigate the factors influencing mesophyll protoplast isolation in 'Fuji' apple. Half an hour pretreatment in 0.6M mannitol gave the highest protoplast yield. The enzyme solution containing 2% Cellulase Onozuka R-10 and 0.5% macrozyme R-10 with CPW 0.6M mannitol

at pH 5.5 was most effective for protoplast isolation from leaf. Effective incubation time for the enzyme treatment was found to be 15-20 hrs at 25°C in the dark. Use of 1.0-2.0% PVP and 0.5mM MES was essential for higher yield and viability of protoplast. Supplementation of BA and IBA to the shoot culture media gave the higher yield of viable protoplast. From these protoplast, new cell walls were regenerated and 4 cell structures developed from one protoplast by cell division in K8P medium supplemented with BA and NAA. Planting density higher than 10 protoplasts/ml was required for cell division from protoplast in liquid or 0.5% agarose culture.

883 (PS 18)

ANTHOCYANIN PRODUCTION BY DAUCUS CAROTA ROOT CELL CULTURE IN VITRO

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The effects of various media, varying concentrations of sucrose, plant growth regulators, and inorganic salts such as KNO₃, KH₂PO₄ and NH₄NO₃ on callus formation and anthocyanin synthesis in carrot cell culture were studied. The greatest calli and anthocyanin pigments were obtained by SH and Nitsch & Nitsch medium, respectively. Nitsch & Nitsch medium supplemented with 55g/l sucrose, 0.2g/l NAA and 0.1g/l BA was effective for both callus and anthocyanin production. Anthocyanin synthesis was accelerated by increasing concentration of KNO₃, while suppressed by NH₄NO₃. However, KH₂PO₄ promoted anthocyanin synthesis at half strength. These results suggest that physiological factors on anthocyanin production by plant cell culture could provide the possibility of application to other crops for secondary metabolites production and mass production system establishment of anthocyanin as an important natural pigment in cosmetic and food industry.

884 (PS 18)

ENHANCED ANTHOCYANIN PRODUCTION IN HAIRY ROOT CULTURE OF DAUCUS CAROTA BY FUNGAL ELICITOR

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Secondary metabolite production by plant cell culture has been become of interest because of its commercial value in use. However, cultured plant cells usually yield lower levels of secondary metabolites than those of intact plants. In order to improve the anthocyanin productivity in hairy root culture of Daucus carota, fungal elicitors from 8 species of fungi were examined. Through the studies of fungal elicitors in this work, it was turned out that fungal elicitors were very effective to improve the yield of anthocyanin. Despite of its low yield of anthocyanin, high density culture of hairy roots is achieved in fluidized-bed bioreactor. Anthocyanin production in fluidized-bed bioreactor with fungal elicitor treatment was increased greatly. We are currently researching more detailed aeration effects and scale-up in air-lift bioreactors. And these studies could provide important data to establish mass production system for secondary metabolites.

885 (PS 18)

DIRECT SOMATIC EMBRYOGENESIS AND PLANT REGENERATION FROM IMMATURE OVULES IN YOOZA(CITRUS JUNOS SIEB. ET TANAKA)

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From one week through 7 weeks after artificial pollination, immature ovules of yooza(Citrus junos Sieb. et Tanaka) were excised and cultured in vitro on MT media. Even though there was only a little difference in percentage of somatic embryo formation depending upon the time of excision, immature ovules of 4-week-old showed the highest ratio of somatic embryo formation without callus outgrowth. Various growth regulators or other stimulators were added to the MT media to increase the somatic embryogenesis. In general, BAP was more effective than 2,4-D for somatic embryo formation and the combinations of 0.01mg/l 2,4-D and 0.01 or 0.1mg/l BAP were particularly effective in stimulating somatic embryo formation. When 500mg/l malt extract was added to the medium, the percentage of somatic embryo formation increased reaching as high as 86.7%. Plant regeneration from somatic embryos reached to 66.7% on the medium containing 1.0mg/l zeatin. Isozyme banding patterns were also analyzed to confirm the variations of characteristics of the plantlets derived from direct somatic embryos.

886 (PS 18)

THE EFFECT OF CECROPIN B ON CELLS AND PROTOPLASTS OF PEACH

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Pathogenic bacteria, such as Xanthomonas campestris pv. pruni, cause diseases of significant economical implications in the Prunus genus. Cecropins are naturally occurring bactericidal peptides found in the hemolymph of insects. Cecropins cause channel formation in membranes and lysis of bacterial cells. We are interested in engineering the gene for cecropin into peach (Prunus persica) and other fruit tree species. The objective of this study was to determine the effect of cecropin B on viability, using fluorescein diacetate staining, and on changes in transmembrane electrical potential (PD) using the fluorescing probe merocyanine-540. Protoplasts were isolated from shoot-tip cultures in a CPW13M (salts + 0.71M mannitol) solution containing 2% cellulase and 0.5% macerage, while cells were isolated in CPW15.4S (salts + 0.45M sucrose) containing 0.5% cellulase and 0.5% macerage. Cecropin B (1µM) had no effect on viability and changes in PD, while 10µM had a slight effect, and 100µM cecropin B caused significant depolarization and lysis of peach protoplasts. No effect on viability and change in PD were observed in cells when treated with 1-100µM cecropin B. These results suggest that cells and protoplasts of peach can resist cecropin B in the concentration range that causes lysis of plant pathogenic bacteria. The implication of using cecropin to increase microbial disease resistance will be discussed.

887 (PS 18)

IN VITRO FLOWERING OF MINIATURE ROSE CULTIVARS

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Premature deterioration and/or wilting of cut flowers such as roses ("bent neck") has been attributed to vascular blockage within the cut stem. Vascular blockage has been attributed to both the proliferation of bacteria in the cut flower water and/or to products exuded by the stem. Separation of these causative agents is prevented by the inability to obtain intact microbe-free flowers. With the objective to produce microbe-free flowers, 36 miniature rose cultivars were screened for their capacity to flower *in vitro*. Stem segments containing single lateral buds were surface sterilized in 1.05% (v/v) sodium hypochlorite and rinsed three times in sterile distilled deionized water. Buds were established on medium consisting of Murashige and Skoog mineral salts, Woody Plant Medium organics, 3.0% (w/v) sucrose, 0.5 mg/liter benzyladenine, 0.1 mg/liter indole-3-acetic acid, and 50 mg/liter each citric and ascorbic acids. Medium was solidified with 1.5 g/liter gelrite and 4 g/liter TC[®] agar. Of the 36 cultivars screened, eight (22%) grew poorly *in vitro*. Of the 28 responsive cultivars, 14 (50%) produced flower buds *in vitro*. However, only six cultivars produced open flowers *in vitro*.

888 (PS 18)

MEASUREMENT OF RELATIVE HUMIDITY IN IN VITRO CULTURES

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Research involving acclimatization of in vitro plantlets by reducing the relative humidity (RH) in vitro requires a suitable method for monitoring RH in the culture vessels. In this research we describe a method for measuring the RH dynamically in the culture vessels, based upon thermocouple psychrometry. Thermocouple junctions (.003 mm gauge) were used with a wet cotton thread on the wet bulb junction inserted from the side of the jar. Aspiration was provided by tiny fans run by miniature motors left outside the vessels. Pre-calibrated aspirated and non-aspirated experiments showed realistically reduced RH in the cultures covered with caps which allowed for gas exchange. The aspirated procedure resulted in greater precision. This procedure with some refinement could be a useful method for monitoring RH in in vitro cultures.

889 (PS 18)

EFFECTS OF PEG-INDUCED WATER STRESS ON MICROPROPAGATED GRAPES: EPICUTICULAR WAX, STOMATAL NUMBER, AND SURVIVAL EX VITRO

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Micropropagated grapes (Vitis sp. 'Valiant') were subjected to water stress while rooting with the addition of 2%

(w/v) PEG 8000. PEG-treated plantlets exhibited reduced growth, as compared to control (in vitro, no PEG), but developed greater leaf epicuticular wax. PEG-treated plantlets had three times the wax level of control. Although treated plantlets showed changes in leaf anatomy, no effect on stomatal frequency or stomatal index was evident. Differences in epidermal cell configuration were also observed among leaves from different treatments. PEG-treated plantlets resembled those grown in the greenhouse, morphologically and anatomically, and exhibited a higher survival rate than control upon transfer to the greenhouse.

890 (PS 18)

RAPID MICROPROPAGATION OF COCOYAM (*XANTHOSOMA SAGITTIFOLIUM* SCHOTT)

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Shoot tips, approximately 3-5mm, were isolated from corms of young greenhouse-grown plants of cocoyam, cultivar South Dade White. After preliminary evaluations, the initiation media evaluated were B5 basal salts supplemented with 0.05 μ M NAA with 5 μ M BAP, 20 μ M BAP or 2 μ M TDZ. The above media were in the form of liquid medium in flasks on a rotary shaker, liquid medium with filter paper bridges, stationary liquid medium without filter paper and solidified medium with 0.4% agar. TDZ stimulated greater growth with multiple shoot formation. Liquid media either in the shaker or stationary form were more effective in terms of growth. Shoots were subsequently evaluated for multiplication with 1 μ M TDZ and 5 μ M BAP with 0.05 μ M NAA producing greater shoot numbers. Over 30 plants have subsequently been rooted and acclimatized under mist or humidity tent.

891 (PS 18)

EFFECTS OF WALL EFFECT AND DISSOLVE OXYGEN ON SCALE-UP OF LETTUCE SUSPENSION CULTURE

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This study was initiated to solve the problem of wall effect and dissolved oxygen (DO) encountered during establishing a scale-up process of lettuce suspension culture in a fermentor. The wall effect could result in as high as 10% loss of inoculum within 24 hrs. The main reason causing wall effect was identified as foam formed from the interaction of air bubble and inoculum. Bubble isolation by a screen column could successfully solve the wall effect. The effect of dissolved oxygen was then investigated. The plantlet regeneration was increased as dissolved oxygen increased from 20% to 80%. The relationship among agitation and aeration rate as well as oxygen concentration in the air was discussed.

892 (PS 18)

MONOTERPENOID CONSTITUENTS OF ROSEMARY SHOOT TIPS CULTURED *IN VITRO*

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Shoot tips (7 to 10 mm long) of rosemary plant (*Rosmarinus officinalis* L. 'Lockwood de forest') were cultured on Murashige and Skoog (MS) medium supplemented with different concentrations of thidiazuron (TDZ) (0, 0.5, 1.0, 1.5, and 2 mg/l) alone or with 3-indole acetic acid (IAA) at 0.5 mg/l. The effect of TDZ and IAA on the proliferation of rosemary shoot tips has been reported in a previous meeting. Here, we report on the effect of TDZ and IAA on the monoterpene constituents identified in the oil of rosemary plants propagated *in vitro*. The proliferated explants were soaked in hexane as a solvent, then the extractions were used for monoterpene

analysis using GC/MS. A significant interaction of TDZ by IAA was found on most of the oil components identified. The highest levels of 1,8-cincole and borneol were obtained at 0.5 mg TDZ/l alone, while the highest level of camphor was obtained at 0.5 mg TDZ/l plus 0.5 mg IAA/l. The highest level of bornyl acetate was at 2 mg TDZ /l.

893 (PS 18)

EFFECT OF INDOLE ACETIC ACID (IAA) AND ZEATIN RIBOSIDE ON SHOOT INDUCTION FROM *SOLANUM TUBEROSUM* L. LEAF DISKS CULTURED *IN VITRO* AND VARIATION OF THE REGENERATED PLANTS.

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Leaf disks of potato cv. Kennebec and ND 860-2 (North Dakota potato breeding clone) were cultured on Murashige Skoog (MS) medium supplemented with 6 levels of indole acetic acid (IAA) and 7 levels of zeatin riboside (ZR). Shoots were induced at various combinations of hormone levels. The medium containing 3.5 mg/l IAA and 4.0 mg/l ZR produced the most shoots. Rooted plantlets were grown in the greenhouse. The growth of regenerated plants obtained from the MS medium supplemented with 7.0 mg/l IAA and 3.0 mg/l ZR was significantly greater than those grown from nodal explants. In ND 860-2, a leaf chimera with chlorophyll deficient (light yellow) sectors was found in plants regenerated from leaf disks (grown on MS medium supplemented with 3.5 mg/l IAA and 3.0 mg/l ZR) but not in plants grown from nodal explants. Phenotypic variability was also observed for tuber number, size and weight.

894 (PS 18)

CRYOPRESERVATION OF ALGINATE-COATED IN-VITRO-GROWN SHOOT TIPS OF APPLE

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In-vitro-grown shoot tips of apple (*Malus domestica* Borkh cv. Fuji) were successfully cryopreserved by dehydration of alginate-coated shoot tip. Cold-hardened shoot tips (at 5°C for 3 weeks) were precultured on a medium containing increasing concentrations of sucrose. The shoot tips were trapped into alginate coated beads containing 0.5M sucrose followed by preculture in a medium supplemented with 1.0M sucrose. Beads containing 1 shoot tip were dehydrated up to about 32% on sterile dry silica gel at 25°C followed by a plunge in LN. After rapid warming, approximately 80% shoot formation was achieved. This encapsulation-dehydration technique may permit storage of shoot tips at higher temperatures than that of LN.

895 (PS 18)

COLD STORAGE OF IN VITRO *RUBUS* GERMPLASM

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In vitro cold storage of *Rubus* germplasm was investigated using several environmental conditions and types of storage containers. Shoot cultures of *Rubus* species and cultivars were grown in either tissue culture bags or 20 x 150 mm glass tubes and compared for plant condition and survival under various storage conditions. Cultures stored at 10 C in the dark were in poor condition after 6 months. Cultures kept at 4 C were in much better condition and had higher survival rates after 18 months when stored with a 12 h daylength rather than total darkness. Overall there were no differences in survival or condition between cultures in tubes and bags. Contamination rates were 15% in tubes and 0% in bags. Plants in tissue culture bags could be stored for 9 months at 25 C with 16 h light when the nitrogen level of the MS medium was reduced to 25% and the medium volume was increased from 10 to 20 ml per bag. Genotype differences were apparent under all conditions tested. The best storage condition for *Rubus* germplasm was 4 C with 12 h light. Plastic tissue culture bags were preferred over tubes due to lower contamination rates.

SHOOT GROWTH AND PROLIFERATION OF PEACH UNDER VARYING ENVIRONMENTAL REGIMES.

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This study examined stage I peach shoot growth under various photoperiods in combination with different vessel closures and compared the influence of BA and Thidiazuron (TDZ) on peach shoot growth during stage II. The basal salts were as described by Almehdi and Parfitt (1986) with 1.0 μM BA, 0.02 μM IBA, 2% sucrose, 0.1% gelrite and 0.4% agar. Shoot growth of peach clone B612615, as determined by leaf number after one month, was similar in vessels capped with Kim-Kaps, Kaputs or PM caps. Plastic foam Ident-Plugs resulted in desiccation of the medium and stressed shoots with reduced growth. A 4 h light/2 h dark photoperiod four times a day provided better growth during stage I than a 16 h light/ 8 h dark photoperiod. For stage II, established shoots of Suncrest, Georgia Bell and Evergreen were grown on MS medium supplemented with 0.02 μM IBA in combination with 1.0 or 10 μM BA or 0.1, 1.0 or 10 μM TDZ. TDZ produced excessive callus resulting in minimal shoot proliferation. Shoot proliferation from axillary buds was greatest with 10 μM BA.

897 (PS 18)

SHOOT ORGANOGENESIS FROM CAMBIAL DISC EXPLANTS OF PEAR.

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Discs of cambial tissue were excised from actively growing shoots of 'Bartlett' pear, and explanted directly on regeneration induction media. The basal medium was 1/2 strength MS macro-nutrients, MS micro-nutrients and organics, 8 g/l agar, and 30 g/l sucrose. Phytohormone treatments consisted of a factorial design of NAA (0 and 5 μM) and TDZ (1, 2, 3, 4, and 5 μM). After 4 weeks incubation in the dark, the explants were transferred to auxin-free media with identical concentrations of TDZ. There was an absolute requirement for auxin in the induction medium, as all discs on auxin-free initial media died without callusing. Maximum shoot regeneration 4 weeks after transfer to expression media was obtained with an initial medium containing 5 μM NAA and 3 μM TDZ, from which 30% of the explants produced one or more adventitious shoots. This rate of regeneration is similar to that obtained in some experiments with *in vitro* leaf explants, and provides an alternative system for regeneration of pear.

898 (PS 18)

ENHANCEMENT OF SHOOT REGENERATION BY PARACHLOROPHENOXY ISOBUTYRIC ACID (PCIB) IN LEAF CULTURES OF *IPOMOEA* SPECIES IN THE SECTION *BATATAS*.

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Use of wild species for *in vitro* sweetpotato improvement has been limited, in part, by the lack of suitable regeneration systems for these species. Shoot regeneration in 4 closely related species, *I. batatas*, *I. cordatotriloba*, *I. trifida* and *I. triloba*, were evaluated. Callus was initiated using methods described by Otani and Shimada (1988). Calli were transferred to regeneration media containing 17.75 μM BAP and 0, 1, 10 and 100 μM PCIB. Organogenesis was enhanced by the presence of PCIB. With *I. cordatotriloba* calli grown on media with 10 μM PCIB, a 2-fold increase in the percentage of calli exhibiting shoot regeneration was observed as compared to calli grown on media with BAP alone. A significant increase in the average number of shoots per callus was also observed. The other species examined appeared to be less sensitive than *I. cordatotriloba* to the PCIB treatments.

899 (PS 18)

PLANT REGENERATION OF AVOCADO (*PERSEA AMERICANA* MILL) *IN VITRO*

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A procedure was developed to regenerate plants via tissue culture from embryonic axes of mature avocado seeds. Explants

were cultured in Murashige and Skoog (MS) medium supplemented with benzyladenine (BA) and naphthalene-acetic acid (NAA) or thidiazuron (TDZ) and NAA. Culture were kept in the dark for 7-10 days to reduce browning resulting from phenolic oxidation. Multiple shoots (5-8) were formed after transfer to light. Further multiplication were achieved using different combination of BA and NAA or TDZ and NAA. Shoots were cultured in MS supplemented with 2mg/l indolebutyric acid (IBA) for 2 weeks then transferred to MS supplemented with 1g/l activated charcoal for root induction. Complete plants were obtained *in vitro*.

900 (PS 18)

IN VITRO PROPAGATION OF GUAVA (*PSIDIMUM GUAJAVA* L.) FROM SEEDLING EXPLANTS

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Guava (*Psidium guajava* L.) is an exceptional source of vitamin C. It is also considered to be the most important cultivated species of the Myrtel family. Shoot tip and stem node were taken from seedling germinated in Murashige and Skoog medium (MS) and cultured in the same medium supplemented with 1-3mg/l benzylaminopurine (BA) and 0.1mg/l naphthalene-acetic acid (NAA) or 0.2-2mg/l thidiazuron (TDZ) and 0.1mg/l NAA. Multiple shoots (4-6) were obtained in 4-5 weeks from culture in 1-2mg/l BA and 0.1mg/l NAA, while TDZ caused abnormal shoot growth. Shoots were rooted successfully with 100% frequency in MS medium containing 2mg/l indolebutyric acid and further elongation of shoots was achieved in MS medium supplemented with 1g/l activated charcoal. Regenerated plantlets were successfully established in soil.

901 (PS 18)

EFFECT OF LIGHT, CO₂, AND SUCROSE CONCENTRATIONS ON THE IN VITRO GROWTH OF WHITE POTATO (*SOLANUM TUBEROSUM* L.)

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Growth measurements of potato (*Solanum tuberosum* L.) cvs. Norland (NL), Denali (DN), and Kennebec (KN) were taken from 21-day-old plantlets grown *in vitro*. Studies were conducted in a growth chamber, with nodal explants grown in culture tubes with loose-fitted Magenta 2-way caps containing Murashige and Skoog salts with either 0, 1, 2 or 3% sucrose. The cultures received either 100 or 300 $\mu\text{mol m}^{-2} \text{s}^{-1}$ photosynthetic photon flux (PPF), and the growth chamber was maintained at either 400 or 4000 $\mu\text{mol mol}^{-1} \text{CO}_2$. All cvs. showed significant increases in growth on 0% sucrose media at 4000 $\mu\text{mol mol}^{-1} \text{CO}_2$, indicating an autotrophic response. At 400 $\mu\text{mol mol}^{-1} \text{CO}_2$, all cvs. showed an increase in total plantlet dry weight (DW) with increasing sucrose under both PPF levels. Within any sucrose treatment, the highest total DW for all cvs. resulted from 300 $\mu\text{mol m}^{-2} \text{s}^{-1}$ PPF and 4000 $\mu\text{mol mol}^{-1} \text{CO}_2$. At 4000 $\mu\text{mol mol}^{-1} \text{CO}_2$, shoot DW declined with sucrose above 2% for DN and sucrose above 1% for NL at both PPF levels, suggesting that high sucrose levels may hinder growth when CO_2 enrichment is used.

902 (PS 18)

MICROPROPAGATION OF *MUSA* ON A STATIONARY LIQUID MEDIUM

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In vitro growth of banana, *Musa* sp., using a modified Murashige and Skoog liquid medium was compared with the same formulation solidified by the addition of agar. Plants grown on the stationary liquid weighed more and had a higher multiplication rate. The best volume of liquid and number of plants per vessel were determined.

Four hundred plants grown in liquid media were studied for one year after planting in the field. Flowering occurred at 7 months and harvesting 3 months later. The mutation rate observed was below 5%.

903 (PS 18)

EFFECTS OF CALLUS AGE, GENOTYPE, AND PLANT GROWTH REGULATORS ON PLANT REGENERATION FROM ONION SUSPENSION CULTURES

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Callus of five onion genotypes representing two species, *Allium cepa* and *A. fistulosum*, and their interspecific hybrid were used for establishing

suspension cultures. Cultures were derived from callus that had been maintained on solid media and routinely subcultured for four years and from callus induced within six months of this experiment. Long-term callus from which plants were routinely regenerated and newly-induced callus were composed of cells which were, for the most-part, meristem-like with higher mitotic indices than cells from long-term callus which had been maintained as callus but had lost its capability to regenerate plants, these cells were large with small nuclei. Callus from newly-induced and long-term regenerable cultures were selected for further studies. Eight liquid media with factorial combinations of plant growth regulators were tested. Cells cultured in BDS liquid medium supplemented with 0.5 mg/l ABA and 1.0 or 2.0 mg/l 2,4-D without 6-BA had higher mitotic indices and plant regeneration percentages than did cells cultured in the same media without ABA and with 6-BA. Suspension cultures from *A. fistulosum* and interspecific hybrids with *A. fistulosum* produced the highest numbers of plants regenerated.

904 (PS 16)

SEWAGE SLUDGE COMPOST AS A SOIL AMENDMENT FOR HORTICULTURAL CROPS

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Municipal sewage sludge, previously amended with *Eucalyptus* tree trimmings and composted, was incorporated to a depth of 30 cm at rates of 0, 12.3 and 24.6 dry MT/ha for a field planting of onion, snapdragon, turf and spinach. In a similar subsequent planting, the sludge compost was incorporated to a depth of 10 cm. Additional treatments address the residual effect of the material. The results indicated sludge compost incorporated to a depth of 30 cm had no effect on crop yields, but when incorporated to a depth of 10 cm there was a significant increase in yields for all test crops. No build-up of heavy metals, soluble salts or changes in soil pH that would depress crop growth were detected. Two greenhouse experiments employed equivalent rates and the same four crops. Two materials, sludge compost and heat-dried sludge were compared. The former contained composted *Eucalyptus* tree trimmings. The latter did not. The results showed both materials were equally beneficial to crop growth and the presence of *Eucalyptus* trimmings did not decrease yields

905 (PS 18)

THE EFFICACY OF BENZYLADENINE IN OVERCOMING ENDOGENOUS FLUCTUATIONS IN SHOOT TIP CULTURE INITIATION

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Although it is commonly recommended that shoot tip cultures be initiated from actively growing shoots, it has been demonstrated that shoot tips collected during the period of rapid shoot extension fail to produce shoot proliferating cultures. Shoot tips of *Halesia carolina* and *Malus* 'Golden Delicious' were collected at 2 week intervals from budbreak to summer dormancy and placed on medium containing 0, 4.5, 11.0, 22.5 and 44.5 μ M benzyladenine (BA) to determine if elevated BA concentrations could overcome seasonal patterns of shoot proliferation potential (SPP). Both species reached maximum SPP 4 weeks post-budbreak (PBB), and exhibited a second window of high SPP during weeks 10 and 12. Elevated BA concentrations failed to overcome poor SPP exhibited by shoot tips harvested 6 to 8 weeks PBB. Shoot tips collected at 10 to 12 weeks PBB responded more favorably to higher exogenous BA concentrations than shoot tips collected at 2, 4, 6, or 8 weeks PBB. It appears as though seasonal fluctuations in SPP involve other endogenous factors in addition to cytokinins.

906 (PS 18)

IN VITRO SHOOT REGENERATION FROM WESTERN SOAPBERRY

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Surface sterilized stem nodal sections of western soapberry (*Sapindus drummondii* Hook. & Arn.) were cultured on Murashige and Skoog (MS) medium. The basal media consisted of one half and full strength MS medium each supplemented with the following (mg^{-1}): Nicotinic acid 0.5, pyridoxine HCl 0.5, Glycine 2.0, myo-inositol 100, sucrose 30,000 and agar 8000. Each medium also

was supplemented with either 0, 0.01, 0.1, 1.0 and 10 mg/l Thidiazuron (TZD) or 0, 0.5, 2.0 and 5 mg/l 6-Benzyladenine (BA). The pH of all media was adjusted to 5.8 ± 0.1 . The culture media were autoclaved at 120°C at 1.5 Kgcm^{-1} pressure for 15 min.

The highest percentage of nodal sections resulting in shoot regeneration occurred on 1/2 MS with TZD at 0.01 mg/l and MS medium containing 0.5 mg/l of BA. Increasing the TZD concentration above 0.1 mg/l resulted in callus formation on cut surfaces.

907 (PS 18)

MICROPROPAGACION DE NEPHROLEPIS EXALTATA L.

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In vitro propagation of *Nephrolepis exaltata* L., was accomplished in 4 phases: 1. Initiation explants taken from apical portions of the stolon were cultivated in M.S. inorganic salts plus 0.4 mg/l Hcl tiamine, 100 mg/l m-inositol, 30 g/l Difco Bacto Agar at pH 5.7. 2. Multiplication of that material in a similar medium as the one used before; but without kinetine. 3. Root of shoots took place in the multiplication medium devoided of the growth regulator substances, and decreasing sucrose to 10 g/l. 4. Plants were transplanted to sterilised medium (rice husk 8 parts, light sand 1 part, black soil 1 part, and horse manure 1/2 part), and placed under saran mesh. Starting with one explant, and considering 100% success in both the multiplicative and rooting phases, it's possible to obtain about 100.000 plants of *Nephrolepis exaltata* L. during a period of 6 months.

908 (PS 18)

USE OF A HIGH CO2 ATMOSPHERE FOR MICROPROPAGATION OF PISTACHIO D.E. Parfitt* and A.A. Almehdhi, Dept. of Pomology, University of California, Davis, CA 95616-8683

An improved medium for the in-vitro micropropagation of *P. vera* genotypes was developed. Several basal medium preparations were tested and DKW (Driver-Kuniyuki-Walnut) medium was selected. Macro and micronutrients were adjusted to provide optimum growth and multiplication of shoots, some of which have been grown and multiplied for more than 2 years. The use of thidiazuron as a growth regulator was tested, but was detrimental to the explants at all tested concentrations. Initial experiments were hindered by significant bacterial internal contaminants. This problem was eliminated through the use of plexiglass chambers to provide up to a 20,000ppm CO2 atmosphere, increased light levels to promote photosynthesis, and the elimination of all carbon sources (sugars) from the substrate. An additional benefit was better shoot growth, better survival when rooting and better acclimation. 3/7 plants were rooted using 2.5 ppm IBA. Continuing experiments are focused on the effect of support medium on growth and multiplication as well as media development for other *Pistacia* species.

909 (PS 18)

IN VITRO CALLUS PRODUCTION AND PLANT REGENERATION FROM PETIOLES OF WATERCRESS (NASTURTIUM MICROPHYLLUM BOENN. EX REICHB.)

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Watercress petioles were planted on Murashige and Skoog media containing 30 g/l sucrose and 8.5 g/l agar, as well as concentrations of 10 and 20 μ M benzylaminopurine (BAP) in combination with 5 and 25 μ M indoleacetic acid (IAA) or 5 and 25 μ M naphthaleneacetic acid (NAA). Calli were transferred to the same media or to media with 5 μ M IAA and 10 μ M BAP. Transfer to media with 5 μ M IAA and 10 μ M BAP resulted in an increased percentage of explants with shoots in the NAA plus BAP treatments while increasing the number of shoots per explant in the IAA plus BAP treatments. The greatest number of shoots per explant were obtained when explants were grown on media with 25 μ M IAA and 20 μ M BAP and then transferred to media with 5 μ M IAA and 10 μ M BAP. Thirty percent of the explants rooted on media with 25 μ M NAA and 20 μ M BAP followed by transfer to 5 μ M IAA and 10 μ M BAP.

910 (PS 18)

EFFECT OF BAP SHOCK, EXPLANT TYPE, AND EXPLANT ORIENTATION ON REGENERATION OF SWINGLE CITRUMELLO

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This study reports some factors effecting rapid regeneration of Swingle Citrumelo (*Citrus paradisi* x *Poncirus trifoliata*).

Inter-nodal stem and root sections from *in vitro* grown seedlings were shocked with 10, 6, 2 or 0 mg/l BAP for 48 h and then transferred to hormone-free Murashige and Tucker (1961) medium gelled with 2 g/l Gelrite. Explants were cultured horizontally or vertically to study the effect of orientation on shoot initiation.

BAP shock had a pronounced effect on shoot regeneration by root, but not by stem explants. Root explants shocked with 10 mg/l BAP had the highest regeneration frequency. Only vertically placed root and stem explants produced shoots. Shoot buds were first observed in root explants about 10 days after BAP shock. Stem cuttings were slow in producing shoot buds which were first seen after 25 days. A total of 53 shoots were regenerated from 48 root explants while the same number of stem cuttings produced only 11 shoots. When subcultured onto the same medium, more than 85% of the shoots rooted, and were recovered as plants. Explant type, explant orientation and cytokinin shock all influenced regeneration.

911 (PS 18)

THE USE OF *IN VITRO* MIST CULTIVATION FOR THE PROPAGATION AND HARDENING-OFF OF VIRUS-FREE POTATO PLANTLETS.

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The use of an *in vitro* mist culture systems for the growth of virus free shoots of several potato cultivars has been demonstrated using the "Mystifier*", several different media and growth regulator concentrations have been used to monitor the efficiency of shoot multiplication and growth. Nodal cuttings of sterile *in vitro* virus free cultures were used as inocula and the mist was applied at various rates in order to assess optimum sucrose concentrations and mineral concentrations. Murashige and Skoog medium was used and diluted to half and quarter strength.

Hardening off the resulting shoots was achieved by passing HEPA filtered air at various rates over the plantlets still in the culture vessel. Conditions for high efficiency hardening off of cultured material has been defined such that plantlets can be transferred directly to greenhouse conditions.

The implications and opportunities that are indicated by this work are discussed.

912 (PS 18)

CALLUS INDUCTION IN SOMATIC TISSUES OF *PRUNUS PERSICA* L.

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Leaf segments of *Prunus persica* L. (peach) collected from greenhouse-grown plants and from micropropagated shoots were cultured on a basal medium containing half-strength Murashige and Skoog (MS), Staba vitamins, sucrose (30 g/l) and agar (6.5 g/l); medium adjusted to pH 5.6. The influence of 6 different growth regulators at 3 concentrations (5, 10, 15 µM) were investigated using leaf explants from proliferating shoots of 'Elberta Queen' peach. With thiazuron (TDZ), compact and multiple green calli were obtained; with benzyladenine and zeatin, lower numbers of small sized calli were obtained; with kinetin, no callus development was observed. Among auxin treatments, both Dicamba and 2,4-D resulted in friable white and yellow calli. Most of the calli produced in all treatments were formed along the cut margins of the explants. In an another experiment, leaf explants of 'Bellaire' (greenhouse) and 'Elberta Queen' (in vitro shoots) were used to determine the influence of a large scale concentration of TDZ (3 to 23 µM). Explants from greenhouse and in vitro leaves resulted in higher levels of callus development at TDZ concentrations of 8-13 µM. Higher TDZ levels resulted in necrosis of leaf explants. The influence of different carbon sources on callogenesis was investigated. We observed more green and compact calli with glucose than with sucrose and fructose at 100 mM. The influence of the glucose at 10 different concentrations (30 to 300 mM) was also investigated.

913 (PS 18)

IN VITRO CULTURE OF IMMATURE *TAXUS EMERYI* SEEDS

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Embryo culture can by-pass yew (*Taxus*) seed dormancy and produce large population of seedlings to be screened for the anticancer drug, taxol, production. Immature linear embryos

from seeds of *T. baccata*, *T. brevifolia*, *T. cuspidata*, and *T. media* were dissected and cultured. B5 medium supported the best embryonic growth during the initial two week's culture for *T. cuspidata* and *T. baccata*. *T. brevifolia* grew faster on MS medium. Weak embryo dormancy was encountered in *T. brevifolia* and *T. cuspidata* from the mature seeds but not from the immature ones. No embryonic growth had been observed in *T. media* dissected from mature seeds due to strong dormancy. Developing embryos were subsequently transferred to 1/2X B5 medium for germination. Rooting percentage in the mature seed derived *T. brevifolia* embryos increased from 12.5 to 63.6 when 30 µM GA₃ was added to the initial medium. Several hundreds of seedlings of *T. baccata*, *T. brevifolia* and *T. cuspidata* had been acclimatized to the greenhouse conditions. The taxol content of resultant *T. cuspidata* seedlings was 0.027% (dry weight), while that of *T. brevifolia* obtained from the wild twig was 0.030%.

914 (PS 18)

ISOLATION OF *CUCUMIS MELO* L. MESOPHYLL AND SUSPENSION CELLS FOR HOST-PATHOGEN INTERACTION STUDIES.

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Mesophyll cells are desirable targets for studying responses to pathogens or pathogen-induced toxins. Based on host-pathogen or host-toxin interaction studies at the cellular level it can be determined whether a toxin can be used as a selective agent. Suspension cells are suitable selection units for *in vitro* selection of potentially useful somaclonal variants. Protocols for the isolation of muskmelon mesophyll and suspension cells were developed in order to study the effects of rosidin E, a toxin produced by *Myrothecium rosidum*, on leaf spot tolerant and sensitive muskmelon cultivars. Viable mesophyll cells were obtained by exposing leaf tissue to 1% cellulysin and 5% macerace in B5 medium with 0.4M sucrose for one hour. Viable suspension cells were maintained a medium consisting of MS salts, 3% sucrose, 3 µM thiamine-HCl, 555 µM myo-Inositol, 28 µM kinetin and 9 µM IAA. Fluorescein diacetate was used to determine viability over time. Membrane stability was monitored by measuring changes in the fluorescence of cells stained with Merocyanine 540 (MC 540), an optical probe for changes in transmembrane electrical potential (PD).

915 (PS 18)

REGENERATION OF CHINESE JUJUBE (*ZIZYPHUS JUJUBA* MILLER) FROM IMMATURE COTYLEDONS AND SEGMENTS OF SEEDLING

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Immature cotyledons within nucleolus of young fruits, 40-50 days old, were cultured on various media containing different concentrations of plant growth regulators. MS medium was most effective for callus formation, but cytokinins added to MS media containing 1.0 mg/l 2,4-D inhibited callus formation. Combination of 2,4-D and BAP was more effective than 2,4-D or BAP alone for somatic embryo formation from callus. Highest percent of somatic embryogenesis was observed on MS medium supplemented with 1.0mg/l 2,4-D and 50% sucrose. Cobalt and nickel, inhibitors of ethylene synthesis, reduced significantly the number of somatic embryos. Plantlets germinated freely from somatic embryos on MS medium containing 1.0mg/l zeatin and 0.01mg/l 2,4-D. Segments of hypocotyl, cotyledon and leaf blade were observed for callus formation, somatic embryogenesis and plant regeneration. Shoots were directly differentiated from the callus induced from segments of hypocotyl on MS medium containing 0.1mg/l 2,4-D after 4 weeks of culture.

916 (PS 18)

AN *IN VITRO* TISSUE CULTURE TECHNIQUE FOR EVALUATING SUSCEPTIBILITY TO NEMATODE AND TOLERANCE TO HEAT STRESS IN TOMATOES

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Susceptibility of tomato (*Lycopersicon esculentum* Mill) genotypes to the root-knot nematode *Meloydogyne incognita* and to heat stress can be evaluated in a single labor- and time-saving operation using a nondestructive *in vitro* excised root technique. Seeds are sterilized and germinated for 2 days on 1% water agar. Five-mm root sections are grown at 28 and 35 C for 30 days on Gamborg-B medium with and without nematode inoculum. Evaluation criteria include fresh and dry weight and the appearance of juveniles, adults, galls, and egg masses. Evidence will be presented on the breakdown of resistance to *M. incognita* under high temperature stress.

86 WORKSHOP 8 (Abstr. 936) Breeding Tropical Ornamentals

936 BREEDING STRATEGIES AND METHODS FOR FOLIAGE AND FLOWERING ORNAMENTALS

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Tissue culture labs based in countries with high labor costs are becoming more dependent on proprietary plants. This has increased the necessity of high profile plant breeding programs. Foliage and flowering plant breeding programs have evolved rapidly to take advantage of the benefits associated with tissue culture labs.

Breeding strategies and methods will be discussed on existing flowering and foliage programs for *Anthuriums*, *Euphorbia*, *Aloe*, *Spathiphyllum*, *Homalomena*, and *Dieffenbachia*. Embryo rescue in the lab has increased the survival of wide crosses from different species within a genera. Rapid multiplication of selected clones has increased the efficiency of screening for disease and insect resistance in the selection of new cultivars. Marketing, along with improved horticultural characteristics, determine the success of new releases.

110 WORKSHOP 10 (Abstr. 937) Breeding Tropical Fruit Crops

937 CONTEMPORARY APPROACHES TO CITRUS CULTIVAR IMPROVEMENT

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Traditional methods of genetic manipulation have proven ineffective or irrelevant for many citrus breeding objectives. Alternative approaches to genetic improvement of citrus are now available as a result of technological developments in genetics and tissue culture. Mapping DNA markers on the Citrus genome should lead to identification of markers closely linked to important loci, thereby facilitating early selection and minimizing costs associated with plant size and juvenility. Genetic transformation methods provide opportunities for trait-specific modification of commercial cultivars. The selection of beneficial variants from sectorized fruit chimeras, and the recovery of plants via somatic embryogenesis, can overcome the problems of nucellar embryony and the hybrid nature of commercial cultivar groups. Induced mutagenesis, using mature vegetative buds, may overcome size and juvenility, as well as nucellar embryony and hybridity. Ploidy level manipulation in vitro provides methods to overcome sterility, incompatibility, and nucellar embryony, and it can increase the number and diversity of tetraploid breeding parents available for development of seedless citrus triploids.

111 WORKSHOP 11 (Abstr. 938-942) Specialized Production and Utilization of Horticultural Crops in Korea

938

OUTLINE OF HORTICULTURE IN KOREA

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It is very important to understand horticulture of other countries neighbored in Pan-Pacific region for the better regional cooperation. Korea lies at the eastern extremity of Asia, having a typical temperate weather with four distinctive seasons. Her annual precipitation ranges from 900 to 1,300 mm, two thirds of which is concentrated during 3 months from June to August. Korea is a small (98,000 km²) and critically overpopulated (43 millions) country. Out of total 2.2 million hectares of cultivated land, about 453,000 ha. are under horticultural crop; 316,500 ha. for vegetables, 133,000 ha. for fruit trees and 3,500 ha. for ornamental crops. Twenty eight percent of average farm income was earned from horticultural crops. Horticultural farming in Korea is small in size but very labor intensive. Figures on per capita consumption and international trade of major horticultural crops will be presented. National organization for research, education and extension, and the Korean Society for Horticultural Science will be introduced.

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SPECIALIZED VEGETABLE GROWING IN KOREA

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Similar to many Asian countries, the production and utilization of vegetables in Korea are quite different as compared to western countries. Koreans were used to favor easy-to-grow leafy and root vegetables, but this preference is gradually shifting to other vegetables, due partially to the recent surge in per capita income and westernization of cultures. In Korea, most vegetables are being utilized in fresh state with only a few exceptions, such as Kimchi, spicy vegetables, etc. Growing techniques as well as the specialized production systems of several selected vegetable crops will be introduced. These include commercial production of vegetable seed and seedlings of special kinds (grafted or plug-grown), use of virus-free garlic cloves and potato mini-tubers, hydroponic culture of lettuce and other vegetables, automation of greenhouse crop production, off-season growing, and specific growing systems for minor vegetables.

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UNIQUE FEATURE OF KOREAN FRUIT GROWING WITH SPECIAL EMPHASIS ON PERSIMMONS, ORIENTAL PEARS, JUJUBE, AND DWARF APPLES

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As Korea is located 33-38° latitude in north hemisphere, her capacity availing deciduous fruit growing is enough in allowing successful production of persimmon, oriental pear, jujube and dwarf apple. There are two kind of persimmons, sweet and astringent, and the majority of persimmon production is the sweet one owing to the higher price and consumer preferences. Astringent persimmons are dried after peeling and served as a traditional, popular fruit punch in Korea. The most popular oriental pear cultivar in Korea is Shinko ('Niitaka'), occupying 38% of the total pear growing area. This cultivar is extending its popularity in world trade with 4,361 tons of fruits exported to Taiwan, Singapore, USA, Netherlands, etc. The future of oriental pear is quite promising along with the increasing acknowledgement of its crispness among westerners as well as oriental people living abroad. Production status of jujube and dwarf apple, mostly 'Fuji' and 'Tsugaru' on M.26 rootstock, will be presented with describing merits and problems of their production.

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FLORICULTURAL INDUSTRY IN KOREA AND VALUABLE ORNAMENTAL PLANTS NATIVE TO KOREA

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In spite of its rapid growth in recent years, the floricultural industry in Korea is rather small with respect to total acreage and number of growers engaged, product value, international trade, and production facilities and technics involved. The production status will be introduced with slides. Nevertheless, variable climatic conditions of the temperate zone such as the distinctive 4 seasons favor the prosperous growth of a variety of vegetation throughout the Korean peninsula. Thus, it has been wellknown that many ornamental plants native to Korea have good potentials for horticultural use. The morphological characteristics of a few selected plants will be introduced along with slides. These plants include *Aster* spp, *Iris* spp, *Gentiana soabra*, *Chrysanthemum zawadski*, *Pulsatilla koreana*, *Cymbidium* spp, *Calanthe* spp, *Dendrobium moniliforme*, *Abelophyllum distichum*, *Ardisia* spp, *Hibiscus syriacus*, and many others.

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UNIQUE FEATURES OF UTILIZATION OF HORTICULTURAL CROPS IN KOREA

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Kimchi is a kind of a spicy fermented pickle, and there are many varieties of kimchi depending on processing methods, seasons, and the availability of certain vegetables. Kimchi contains good amounts of nutrients and stimulates the appetite. The taste of kimchi is attributed to the unique blending and fermentation of ingredients. Detailed information about kimchi preparations and raw materials will be discussed. Various utilization methods of other horticultural products unique in Korea will be outlined. Types of processing include the salting, drying, and fermenting of fruits and vegetables. Soysauce, soybean paste, and red pepper paste are the important fermented products which will be summarized. Different types of traditional foods in Korea will also be introduced.

112 WORKSHOP 12 (Abstr. 943) People-Plant Relationships: Setting Research Priorities

943

PUTTING RESEARCH INTO ACTION

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Research on the role of horticulture in human well-being can have application among diverse groups. Dissemination and application of research results can be accomplished through Cooperative Extension Service, the horticulture industry, non-profit associations, and trade associations for users of horticulture products and services. One of the roles of the People-Plant Council is to increase availability of research information to these groups.

115 WORKSHOP 15 (Abstr. 944) The Need for a Strategic Approach to Integrate Biotechnology into Developing Countries

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THE LIMITING FACTORS DETERMINING THE INTRODUCTION OF BIOTECHNOLOGY

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Commercial sources of biotechnology have enormously outweighed non-market sources (e.g. the International Agricultural Research Center). Thus it is most obvious that growing R&D costs and intensified international technology competition have financially disabled developing countries from access to the new technology. Furthermore, biotechnology is a typical interdisciplinary subject based on many different principles of newly developed life sciences such as biochemistry, physiology, microbiology and molecular biology, which limits number of personnel in developing countries who are capable of incorporating the new technological innovation of developed countries into their agricultural production system. The protection of intellectual property rights (IPRs) of which private firms in developed countries have intensified put another limiting factor in the international flow of biotechnology. Financial aid, technical assistance for personnel training and execution of self-restrained IPRs towards developing countries will enable developed countries widen the potential market and contribute to sustainable development in the Third World.