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HyperCard came with each Macintosh computer, only the crop files needed to be sent to clientele. As the demand for an IBM-compatible version of the Farmer's Bookshelf increased, the Windows version was created using a hypermedia program called Plus. In addition to the crop files, the runtime version of Plus was also distributed to clientele. Later, other files were added to the Farmer's Bookshelf, including files to diagnose problems of macadamia in the field, select ground covers, select landscape trees, recommend fertilization, calculate nut loss for macadamia growers, and calculate turfgrass irrigation. Cost of analysis spreadsheets for several crops were also added. Recently, the Farmer's Bookshelf was moved to the World Wide Web, which has the advantages of reaching a worldwide clientele, easier updating and modifications, and linking to sites of related information. We have added links to newspaper articles on agriculture in Hawaii, to related sites on a particular crop, to on-line agricultural magazines and newsletters, to agricultural software, to upcoming agricultural events, and to Y2K sites. Because of the benefits of the Web version, the diskette versions (Macintosh and Windows) are no longer supported. Putting the Farmer's Bookshelf on the Web has allowed us to better meet the needs of our clientele for up-to-date information.

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Dissemination via the Internet of Information on Pawpaw (*Asimina triloba*): A New Potential Tree Fruit Crop

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Kentucky State Univ. (KYSU) emphasizes research on developing alternative, high-value crops and sustainable agriculture methods for use by limited-resource farmers. Since 1990, KYSU has maintained a research program to develop pawpaw into a new high-value tree fruit crop. With its high tolerance for many native pests and diseases, pawpaw shows great potential as a crop for organic and sustainable production. The objectives of KYSU's pawpaw research program include: 1) variety trials; 2) development of new or improved methods of propagation; 3) collection, evaluation, preservation, and dissemination of germplasm; and 4) sharing of information on pawpaw with scientists, commercial growers and marketers, and the general public. To aid in dissemination of information on pawpaw, a web site has been developed (<http://www.pawpaw.kysu.edu>) that includes information on current and past pawpaw research at KYSU and information on the PawPaw Foundation. On this site, there are a selected bibliography of publications on pawpaw and related species; pawpaw recipes and nutritional information; a guide to buying and growing pawpaws; photos of pawpaw trees, flowers and fruit; and links to other web sites with pawpaw information. In the future, the site will include results from the pawpaw regional variety trials and the database for the National Clonal Germplasm Repository for *Asimina* spp., located at KYSU. The pawpaw information web site will be an increasingly useful aid in the introduction of pawpaw as a new, potentially high-value, tree fruit crop.

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Estimation of Environmental Impact of Two Cropping Systems Using PLANETOR

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Long-term goals of reducing environmental impacts associated with agricultural activities must include economic sustainability as well as production feasibility. This study compared the potential economic and environmental impact of two specific cropping systems [wheat/soybeans (w/s) vs. selected vegetable crops with wheat/soybeans (veg/w/s)]. Profitability of w/s was lower than the veg/w/s system but demanded a smaller, less extensive resource base of labor and machinery with fewer conflicts in resource utilization rates. The PLANETOR computer program (Univ. of Minnesota) was used to analyze the potential negative environmental effects of growing a particular crop mix within these two systems. Although some of the vegetable crops exceeded the targeted soil loss tolerance value (T-value) of 3 t/ha, the weighted average of the veg/w/s system was below the target T-value for soil erosion. Analyses suggest that the profits from vegetables in the veg/w/s production more than offset the negative impacts on soil erosion and the veg/w/s system would be more economically feasible than w/s. Potential impact of pesticide leaching and runoff from vegetable production as calculated by PLANETOR was less than that from w/s. Specific cultural practices, including soil/tissue testing to manage nutrient applications, could reduce nitrogen/phosphorus movement. The veg/w/s system may offer the necessary profit margins to allow adoption of more environmentally friendly production alternative.

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Oklahoma Department of Agriculture Inspector Training

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Oklahoma Dept. of Agriculture field inspectors are rarely horticulturists. Yet, they are often expected to provide inspections and suggestions to nursery, greenhouse, and garden center operators. Because of their lack of formal training in ornamental horticulture and related fields, Oklahoma State Univ. extension faculty set out to provide training in horticulture, entomology, and plant pathology-type issues. Results of statewide training workshops will be discussed, including, but not limited to, specific topics such as plant identification and culture, phytotoxicity in the greenhouse and nursery, and worker protection standards. Last, evaluation feedback regarding inspectors' interest for future training workshops will be addressed.

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Ornamental Treatment-production Wetlands for Water Quality Improvement

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Degraded water quality is a growing concern across the northeast and in many cases may be linked back to agricultural operations as nonpoint sources of nitrate and phosphorous pollution. Constructed wetlands have emerged as effective, low-cost methods of water treatment that have the potential to reduce agricultural nonpoint source pollution and contribute to agricultural sustainability. However, the costs of implementing treatment wetlands as a BMP are high, with little opportunity for cost recovery. We have initiated, at a wholesale plant nursery in Rhode Island, an economical solution to treating nursery runoff that incorporates into a treatment wetland the wholesale production of native and ornamental wetland plants. Our goal is to demonstrate how nursery growers may produce a high-demand crop while addressing nonpoint source pollution on their land. Over the next few years, we will evaluate the economic impact of converting nursery production space into treatment wetland production space. We also will research the feasibility of enclosing treatment wetlands in passively heated polyhouses to facilitate the year around treatment of agricultural runoff. Information gathered from both the on-farm demonstration and research sites will be extended to farmers and other agricultural businesses or professionals through outreach programming. The theory, objectives, and construction of the demonstration treatment-production wetland will be presented.

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A Closed-capture Irrigation Effluent Apparatus for Large Nursery Containers

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A closed capture irrigation apparatus was designed and constructed for the purpose of monitoring irrigation effluent volume and nutrient analysis from 121-L redwood tree boxes. Measurements were taken monthly from Apr. 1997 to Oct. 1998. Tree boxes were filled with either a 3 pine bark : 1 sand : 1 peat or 3 pine bark : 1 soil media and planted with 'Little Gem' magnolia [*Magnolia grandiflora* (L.) 'Little Gem'] or Southern live oak (*Quercus virginiana* var. *virginiana* Mill.). In-line, pressure-compensated drip emitters provided irrigation water at the rate of 2 L/h. Daily irrigation volume ranged from 8 L in the fall and spring to 16 L during the summer months. The collection apparatus was constructed from 1-cm angle iron, neoprene rubber, a small drain assembly, and a 22-L plastic container. A square metal frame (43 x 43 cm) was supported by 31-cm legs and draped by a neoprene rubber mat with a drain assembly installed in the center. The drain was positioned into the plastic container creating a closed system to reduce effluent evaporation. The container capacity was adequate to store at least 24 h of collected effluent. This apparatus proved to be an efficient method of collecting irrigation effluent from large containers.

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Nursery Crops for Nutrient Recovery in Treatment Wetlands

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Constructed wetlands are an effective, low-cost method of water treatment that may reduce agricultural pollutants from nursery runoff. It has been suggested that the expense of implementing such systems could be recovered by growing aquatic plants that could be sold to retail and wholesale markets. However, this demand could probably be satisfied through a few wetlands. It would be desirable if more traditional nursery crops could be incorporated into treatment wetlands. Several taxa of Cannas, Iris, and ornamental grasses are selected cultivars of wetland plants that have been used in treatment wetlands for decades. However little data exists on these cultivar's nutrient uptake rates and survivability in treatment wetlands. Nutrient uptake and growth rates of *Canna x generalis* cultivars 'Aflame', 'King Humbert', and 'Pretoria', *Glyceria maxima* 'Variegata', *Iris pseudacorus*, *Iris versicolor*, *Phalaris arundinacea* 'Luteo-Picta', *Pragmites australis* 'Variegata', and *Spartina pectinata* 'Aureo-marginata' were compared to the widely used *Typha latifolia*. Single divisions of each were established in a constructed wetland and batch fed weekly a commercial fertilizer solution reconstituted to 100 ppm-N. Plants were harvested after 75 days and biomass and tissue nutrient content was determined. Mean biomass of *Typha latifolia* was 212 g/division and nitrogen and phosphorus accumulation was 4.5 and 0.8 g/division, respectively. The biomass of the other species ranged from 101 to 175 g/division and had total accumulation of nutrients ranging from 2.5 to 3.8 g nitrogen/division and 0.35 to 0.85 g phosphorus/division.

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Antitranspirant Treatments Affect Stock Plant Growth and Rooting Percentage in Two Members of the Oleaceae Family

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Syringa vulgaris L. 'Montaigne' (French hybrid lilac) and *Chionanthus virginicus* L. (white fringetree) stock plants were sprayed with two film-forming antitranspirants, Clear Spray and sodium silicate, and one stomate-regulating antitranspirant, atrazine. After 30 days of growth, cuttings were taken from both species. Shoot calipers of antitranspirant-treated lilacs increased at a slower rate than the control lilacs. There were no long-term shoot length changes in lilac due to antitranspirant treatments. Shoots of Clear Spray-treated fringetrees increased in length significantly less than other treatments. Rooting was evaluated once a week from week 3 until 6 weeks after cuttings were taken for lilac and every 2 weeks from week 6 to 12 weeks after sticking for fringetree. All treatments resulted in 80% to 85% rooting in lilac after 6 weeks, but Clear Spray-treated plants rooted more quickly. Fringetree cuttings treated with Clear Spray had a significantly lower rooting percentage (15%) than the other treatments (35% to 50%).

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Three New Cultivars of Flowering Dogwood Resistant to Powdery Mildew

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Powdery mildew (*Microsphaera pulchra*) of flowering dogwood (*Cornus florida* L.) has become a significant problem of trees in nursery production as well as in the landscapes and forests of the eastern United States. The disease significantly reduces growth and berry production by older established trees and may contribute to the inability of younger trees (liners) in production to survive winter dormancy. Disease resistance in named cultivars is limited to partial resistance found in 'Cherokee Brave'—all other cultivars are extremely susceptible. Until now, the only disease control measure was to establish an expensive, labor-intensive, preventive fungicide program. We examined >22,000 seedlings and identified 20 that were extremely resistant to powdery mildew. Three trees with white bracts were selected from the 20 and released as patent-pending cultivars. 'Karen's Appalachian Blush' has long, non-overlapping, pink fringed bracts with a delicate appearance. 'Kay's Appalachian Mist' has creamy white, slightly overlapping bracts with deeply pigmented clefts. 'Jean's Appalachian Snow' has large, strongly overlapping bracts with non-pigmented clefts. The three powdery mildew-resistant cultivars will be entered into an existing breeding program with 'Appalachian Spring', a cultivar released by the Tennessee Agriculture Experiment Station and

resistant to dogwood anthracnose, in an attempt to produce trees that are resistant to both diseases.

98 ORAL SESSION 18 (Abstr. 550-557)**Vegetable Crops: Genetics/Breeding/Biotechnology****Tuesday, 25 July, 2:00-4:00 p.m**

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Mapping of QTL for Partial Physiological Resistance and Field Reaction to White Mold, Plant Architecture, and Plant Height in Common BeanSoon O. Park*, Dermot P. Coyne¹, James R. Steadman¹, Paul W. Skroch², and Geunhwa Jung², ¹Univ. of Nebraska, Lincoln, NE 68583; ²Univ. of Wisconsin, Madison, WI 53706

The objective was to detect molecular markers associated with QTL for partial physiological resistance (PPR) to two white mold (WM) isolates, partial field resistance (PFR), plant architecture (PA), and plant height (PH) in a genetic linkage map constructed using recombinant inbred lines (RILs) from the cross 'PC-50' (resistant to WM) x XAN-159 (susceptible to WM). Significant correlations (+0.39 and +0.47) were noted between the WM reactions in the greenhouse and field. A significant but negative correlation (-0.33) was observed between the WM reaction and PH in the field. Six QTL affecting PPR to isolate 152 were found on LGs 4, 5, 7, and 8. Six QTL affecting PPR to isolate 279 were found on LGs 2, 3, 4, 7, and 8. Five QTL for PFR were observed on LGs 2, 5, 7, 8, and 11. Two QTL affecting PA were detected on LGs 7 and 8. Two QTL affecting PH were identified on LGs 7 and 8. On one end of LG 8 marker H19.1250 was significant for PPR to both isolates. On the other end of LG 8 the region closely linked to the *C* locus was significantly associated with PPR to both isolates, PFR, PA and PH. Marker J09.950 on LG 7 was significantly associated with PPR to both isolates, PFR, PH and seed weight. Marker J01.2000 on LG 2 was the most significant locus for both PPR to the isolate 279 and PFR. QTL on LG 5 were found for PPR to the isolate 152 and PFR. Overall, four of the five QTL affecting PFR were also found for PPR to one or both isolates.

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Inheritance of Tomato Late Blight Resistance Derived from *Lycopersicon hirsutum* LA1033 and Identification of Molecular Markers

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During the last century *Phytophthora infestans* (Mont.) de Bary, which causes the devastating disease late blight of tomato and potato, has been controlled with pesticides. Recently, the difficulty of controlling late blight has increased due to the appearance of new strains of *P. infestans* that are more virulent and are resistant to metalaxyl. Numerous *P. infestans* resistance genes exist within the Solanaceae; however, most of these are race-specific and have the potential of being overcome. To achieve durable resistance, it may be necessary to utilize multi-genetic resistance or gene pyramiding. The *Lycopersicon hirsutum* Kunth accession LA1033 is highly resistant to *P. infestans*. To incorporate resistance into a useful background, the *L. esculentum* Miller inbred line NC215E was used as a recurrent parent in backcrossing with *L. hirsutum* LA1033. A population of 264 BC₃F₁ plants derived from 11 BC₂F₂ families was planted at Fletcher and Waynesville, N.C., in July 1998 in a replicated field trial. BC₃F₂ seed were collected from a single highly resistant BC₃F₁ plant. The BC₃F₂ population was tested for resistance using a detached leaf screen. To verify growth chamber test results, BC₃F₃ seeds were collected from the BC₃F₂ individuals and were planted in a field trial at Fletcher in July 1999. The ratio of resistant to susceptible progeny fit the expected ratio for an incompletely dominant trait controlled by two loci. To identify molecular markers linked to the resistance loci, DNA was extracted from the highly resistant and susceptible BC₃F₂ individuals, and bulks of DNA were constructed. The resistant and susceptible bulks were screened with AFLP (amplified fragment length polymorphism) markers. Results of the AFLP study indicate marker linkage to resistance.

flesh firmness ranges between 44.5 and 58 N (10 and 13 lbf). Use of softer pears reduces postcutting life due to flesh browning. Firmer pears may have longer postcutting life but lack good flavor. Dipping pear slices in a mixture of 2% (w/v) ascorbic acid + 1% (w/v) calcium lactate + 0.5 (w/v) cysteine (pH 7) for 5 min at 20 °C extended their shelf-life by inhibiting flesh softening and surface browning during storage at 0 °C for 10 days. After 3 days at 0 °C, ascorbic acid and cysteine residues dropped below detectable levels, while calcium content was double that of untreated slices. Preliminary sensory evaluation indicate no negative impact on flavor from this dip treatment. Exposure of intact pears to heat (35 or 40 °C) or controlled atmospheres (0.25 kPa O₂ and/or 40 kPa CO₂) for 24 or 48 h did not influence postcutting cut surface browning of pear slices. Storage of 'Bartlett' pears at -1 °C in 2 kPa O₂ (balance N₂) resulted in longer postcutting life of the slices as compared to those made from air-stored pears at -1 °C. The longer the storage duration of whole pears, the shorter the shelf-life of their slices was. Fruit size did not affect the postcutting life of the pear slices, provided that they were treated with the ascorbic acid + calcium lactate + cysteine mixture. Untreated slices made from small pears exhibited surface browning faster than those made from large pears.

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Changes in Quality and Maturity of Late-season Peaches (cvs. O'Henry and Nos 21) during Maturation and Ripening

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Our objectives were to characterize the quality and maturity changes of peach [*Prunus persica* (L.) Batsch.] fruit cvs. O'Henry and Nos 21 during maturation and ripening and to identify harvest maturity indices by relating nondestructive and destructive variables. After fruit set, 400 fruit of similar diameter and tree position were tagged to follow maturation and ripening on the tree. During commercial harvest, 48 fruit were randomly harvested every 4 to 6 days. Ethylene evolution rate (EER) at 20 °C, fresh weight, and peel ground and cover color (L*, a*, b*, C* and Hue value) were measured to all 48 fruit. Flesh color, firmness at several fruit points, soluble solids (SS), pH, titratable acidity (TA), and SS/TA ratio were measured only to 24 fruit, and the rest were held for up to 7 days at 20 °C as a ripening period to measure the same characteristics previously mentioned. Pearson correlation coefficients were determined between variables to explore possible harvest maturity indices. The most significant changes occurred in EER and ground color (a* value) for both varieties and fresh weight only for cv. O'Henry. For 'O'Henry' peaches the highest correlation ($P < 0.001$) was obtained between EER-shoulder firmness ($r = -0.61$). For cv. Nos 21 the highest correlation was between EER-shoulder firmness ($r = -0.69$). It was also found that fruit softening occurred mainly in the fruit shoulder for both cultivars. Therefore, no harvest maturity indices could be established for these cultivars.

54 ORAL SESSION 8 (Abstr. 445-450)

Cross-commodity: Sustainable Agriculture

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Solid Matrices for Supporting Plant Growth in Space

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In preparation for a spaceflight experiment to measure photosynthesis of wheat (PESTO), four solid media were evaluated for use in the rooting modules of the Biomass Production System (BPS), a new plant growth unit for microgravity. The media were commercial peat-vermiculite (PV) mixture, zeolite developed at Johnson Space (Z/JSC), commercial zeolite developed by Boulder Innovative Technologies (Z/BIT), and arcillite (AR) with slow-release fertilizer. Wheat (cv. USU Super Dwarf) was grown in the media at 1500 $\mu\text{mol/mol CO}_2$, 350 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ PAR, 23 °C, and 75% relative humidity for 18 to 21 days. Water was delivered to the media through porous tubes imbedded in the media, and NDS pressures of -0.1 to -0.5 kPa were maintained with either a static or recirculating standpipe. Plant height, leaf area, and fresh mass were determined for each experiment. Results indicated that the AR and Z/BIT media resulted in larger and more uniform plants than Z/JSC or PV at the same NDS pressure. Additional experiments were conducted with AR to evaluate interactions between particle size and NDS

pressure. At ≈ 14 days after planting, there was a loss of NDS prime in AR > 2.0 mm when the NDS pressure was less than -0.3 kPa. This resulted in drying of the media and poor plant growth. There was excess water in the media, which resulted in reduced plant size, in AR < 1.0 mm at NDS pressures more than -0.3 kPa.

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Long-term Evaluation of Susceptibility of Selected Prairie Species to the Root Lesion Nematode *Pratylenchus penetrans*

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Because of the need to find plants that suppress root lesion nematodes for use in rotation or cover-crops, 16 native sand-prairie species were evaluated for host status for 6 years. Plants were grown on a Fox sand soil at a local prairie plant nursery. Soil cores were taken in the spring, summer, and fall and assayed for plant parasitic nematodes. Five species supported very low numbers (less than 100/kg soil) of root lesion nematodes. Brown-eyed Susan (*Rudbeckia hirta*) had no detectable nematodes for the duration. Switchgrass (*Panicum virgatum* L.) and Indiangrass (*Sorghastrum nutans* L., Nash) samples produced detectable nematodes on only two sampling dates over the 6 years and were statistically not different from brown-eyed Susan. Butterfly weed (*Asclepias tuberosa* L.) also had very low detectable nematodes as did sand dropseed [*Sporobolus cryptandrus* (Torr.) Gray.]. New Jersey tea (*Ceanothus americanus* L.), little bluestem [*Schizachyrium scoparium* (Michx.) Nash], and big bluestem (*Andropogon gerardi* Vitman) were poor hosts with < 200 nematodes/kg soil. Mountain mint (*Pycnanthemum virginianum* L.), wild bergamont (*Monarda fistulosa* L.), horse-mint (*Monarda punctata* L.), and dwarf blazing star (*Liatris cylindracea* L.) all had root lesion populations over 3000/kg soil. Horsemint and wild bergamont plants died out, possibly as a result of nematode infestation. Root lesion nematodes have an extremely wide host range in current agronomic and horticultural crops, and weeds and are difficult to manage using nonchemical means. Indiangrass, switchgrass, big bluestem, and little bluestem have all been used agriculturally for pastures and consequently have potential as beneficial long-term rotation crops for nematode management and soil building.

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Nutrient Removal by Five Ornamental Wetland Plant Species Grown in Treatment-production Wetland Biofilters

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We assessed the capacity for nutrient removal of ornamental water garden plants being grown in treatment-production wetland biofilters. Plant biomass, nutrient uptake, tissue nutrient content, and production potential were compared for five popular ornamental water garden plant species: *Typha latifolia* L., *Iris pseudacorus* L., *Phalaris arundinacea* L. 'Picta', *Canna glauca* L., and *Colocasia esculenta* (L.) Schott. Plants were grown in triplicate 0.3 m² x 0.3 m, deep gravel-bed mesocosms fed with 20N-20P-20K Peter's fertilizer (Scotts-Sierra Horticultural Products Co., Marysville, Ohio) reconstituted to 100 ppm N. After 120 days, mean species total biomass ranged from 1.4 to 5.6 kg \cdot m⁻², while producing 105 to 206 divisions per square meter. Growth for *Canna* and *Colocasia* was greatest, while *Typha* produced the most divisions. Mean tissue N and P concentrations ranged from 18 to 29 and 2.1 to 3.0 mg \cdot g⁻¹, respectively. Maximum plant accumulation of 144 g N/m² and 15.6 g P/m² accounted for 70% of the N and 15% of the P supplied by fertilizer. Mean removal of total N and P ranged from 42% to 90% and 18% to 58%, respectively, and was positively correlated with plant biomass. Nutrient removal ability was ranked as *Canna* = *Colocasia* > *Typha* > *Iris* = *Phalaris*.

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Soil Problems Affecting Date Palm Growth, Yield, and Fruit Quality in Coachella Valley

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A 3-year experiment was conducted to identify problems in Coachella Valley date palm (*Phoenix dactylifera*) orchards that limit vegetative growth, yield, and fruit quality. Major problems that were identified included soil compaction and