Update on advanced citrus production system trials

By Arnold Schumann, Brian Boman and Barrett Gruber

This article updates the progress of four advanced citrus production system (ACPS) experiments with Hamlin, Valencia, Vernia sweet orange, and Ray Ruby grapefruit trees in the Florida cities of Auburndale, Lake Alfred, Lake Placid, and Fort Pierce, respectively. The purpose of multiple experiments was to validate the horticultural benefits of ACPS across different geographic regions with different soil, scion, rootstock and disease pressure combinations.

AUBURNDALE ACPS EXPERIMENT AT 5 YEARS

The oldest Hamlin orange ACPS field experiment near Auburndale was planted in December 2008, and progress was reported in previous August editions of *Citrus Industry* (2009 to 2013). The original purpose of this experiment was to test and adapt the open hydroponics (OH) concepts of fruit production in Florida's subtropical climate and soils, and with Florida citrus varieties and rootstocks.

One year ago, at age 4, we were still measuring increasing yields in this research block (average yields for the best high-density ACPS treatment in years 2 to 4 of 39, 222, and 622 boxes/acre, respectively). Due to a doubling of the HLB incidence from about 50 percent in 2013 to practically 100 percent in 2014, the yields measured in December 2013 (year 5) were static or declining, and are expected to continue on a downward trend (Figure 1). Loss of fruit production from HLB-affected trees was severe in both the 2012–13 and 2013–14 seasons, much of it from fruit that dropped to the ground before harvest.

The detrimental impacts of HLB were equally severe across all tested treatment combinations (Figure 1), and at current high costs of production and low-to-average fruit prices, the Hamlin block is not expected to reach economic break-even. It is important to note that trees in this citrus block are being simultaneously challenged by at least five known pest and disease complexes (sting nematode, *Diaprepes* root weevil, *Phytophthora*, citrus canker and HLB), of which HLB is the most recent and severe. With the

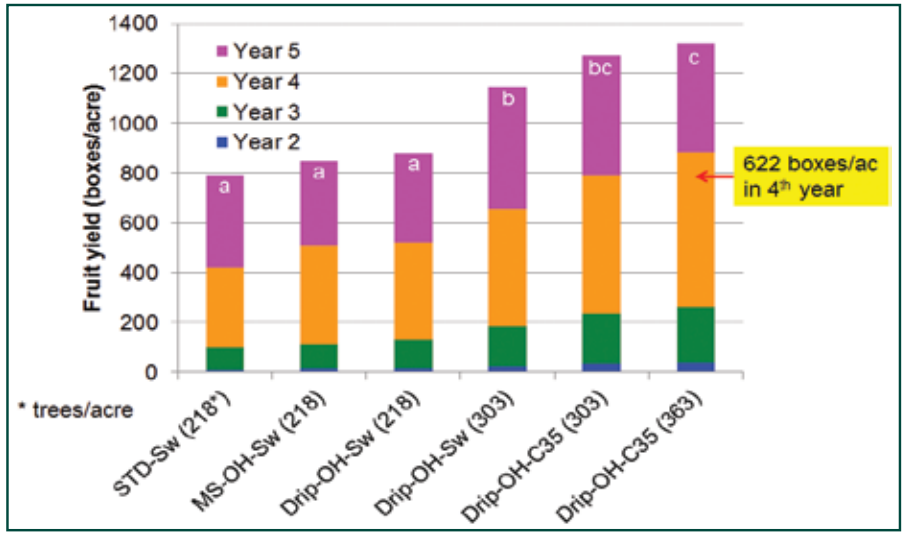

Figure 1. Cumulative fruit yields for the Hamlin orange ACPS experiment in Auburndale. Treatment yields identified with different letters (a-c) are significantly different from each other.

Legend of treatment labels used in the graph:

1. STD-Sw (218) = the standard control, consisting of 10 x 20 feet planting density (218 trees/acre), Swingle rootstock, IFAS-recommended dry granular fertilization program and grower-scheduled irrigation with microsprinklers
2. MS-OH-Sw (218) = advanced hydroponics fertigation using microsprinklers, 218 trees/acres and Swingle rootstock
3. Drip-OH-Sw (218) = same as (2) but with drip emitters instead of microsprinklers
4. Drip-OH-Sw (303) = same as (3) but with 8 x 18 feet planting density (303 trees/acre)
5. Drip-OH-C35 (303) = same as (4) but with the C35 rootstock
6. Drip-OH-C35 (363) = same as (5) but with 8 x 15 feet planting density (363 trees/acre)

exception of canker, they all directly caused severe root damage and dieback in the block, and cumulatively caused the rapid tree health decline and lack of response to nutritional therapy treatments.

LAKE PLACID ACPS EXPERIMENT AT 3 YEARS

This is the second-oldest ACPS field experiment planted with Vernia orange on X639, C35 and rough lemon rootstocks at an 8 x 18 feet (303 trees/acre) planting density. The trial is located in the IFAS citrus research farm on the western shores of Lake Istokpoga, just off the Lake Wales Ridge but planted without raised beds. Other treatments being evaluated in this experiment are drip versus microsprinkler fertigation, and controlled release fertilizer (CRF). Both fertigation and CRF sources were comprehensive hydroponic nutrient packages equivalent to the nutrient program in the Auburndale experiment.

The trees established and grew very well overall, despite the early incidence of HLB originating from the surrounding managed mature groves and neighboring abandoned groves. By age 3, the 4.7-acre block was 50 percent HLB-symptomatic, but so far the affected trees have continued to grow vigorously with foliar and soil-applied nutritional treatments (Figure 2). Tree height at age 3 averaged 9 feet to 11.5 feet, depending on the rootstock (Table 1). Vernia orange on rough lemon rootstock grew significantly taller (by 2.5 feet) than on either X639 or C35 rootstocks, but the three different fertilizer programs performed equally well in this experiment. Although tree establishment and growth was highly successful with ACPS in this experiment despite HLB, fruit set and yield were sparse in the third year and the first economic fruit yield will be measured in year 4 (2014–15 season).

LAKE ALFRED ACPS EXPERIMENT AT 22 MONTHS

This new ACPS field experiment was planted near

Figure 2. Vernia orange on rough lemon rootstock at 3 years of age grown with ACPS at Lake Placid. HLB incidence is 50 percent.

Table 1. Average tree height (in feet) of Vernia orange trees at 3 years of age on three rootstocks and with three ACPS fertilizer programs. Average heights identified by different letters (a, b) are significantly different.

	Microsprinkler Fertigation	Microsprinkler CRF	Drip Fertigation
Rough Lemon	11.4[a]	11.6[a]	11.4[a]
C35	9.1[b]	8.9[b]	8.9[b]
X639	8.9[b]	9.0[b]	9.0[b]

Lake Alfred in August 2012, using Valencia orange on Swingle and US-897 rootstocks planted either in a single-row, high-density 6 x 15 feet (484 trees/acre) or dual tramline row configuration at 538 trees/acre. In order to assess the role of calcium and nitrate-nitrogen nutrition on young tree establishment, the drip fertigation system is divided into two zones, so that half of the block receives a hydroponics fertilizer blend with calcium nitrate, and the other half receives no additional calcium nitrate fertilizer. At 2 years of age, the trees are very well established, growing rapidly, and already carrying a small crop of fruit (Figure 3). Due to the very high planting density being used, the yield per acre may be economically viable to harvest in the 2014–15 season at 2.5 years of age. At this early stage, there are no apparent differences between rootstocks or fertilizer treatments.

Figure 3. Valencia orange on Swingle rootstock at 22 months age, grown with ACPS at Lake Alfred. HLB incidence is about 5 percent.

ACPS FRESH GRAPEFRUIT TRIAL AT THE IRREC

In November 2013, a new ACPS trial was conducted at the UF-IFAS Indian River Research and Education Center (IRREC) in Fort Pierce. The trial at the IRREC is especially focused on the fresh grapefruit market and was initiated to evaluate the feasibility of high-density tree planting on raised beds. Tree planting on raised beds presents added complication for citrus growers in southeastern Florida because land that could be potentially used for growing trees is lost for drainage provision. Taking into consideration the pressures of raising trees in an environment with HLB and canker diseases, maximizing the use of all available grove space could be considered a top priority.

Five different production scenarios are being compared in the ACPS trial at the IRREC. All trees were planted on 50-feet wide beds (furrow-to-furrow), and all scion material in this trial is Ray Ruby grapefruit. Treatment #1 is considered the "grower standard" and was planted with Ray Ruby grapefruit on sour orange rootstock at a density of 152 trees/acre. These trees are irrigated with 10 gallon-per-hour (gph) microsprinkler jets and are fertilized with dry, granular fertilizer. Treatments #2-5 were planted at high density with four staggered rows per bed top, at a rate of 421 trees/acre. Treatment #2 was planted on sour orange rootstock and is fertigated with 10 gph microsprinkler jets (1 microsprinkler for two trees). Treatment #3 was planted on sour orange rootstock and is fertigated with 1 gph drip emitters (2 emitters per tree). Treatment #4 was planted on US-897 rootstock and is fertigated with 10 gph microsprinkler jets (1 microsprinkler for two trees). Treatment #5 was planted on US-897 and is fertigated with 1 gph drip emitters (2 emitters per tree; Figure 4, see page 15).

This ACPS trial is investigating two different rootstocks: sour orange

Figure 4. Ray Ruby grapefruit on US-897 rootstock with drip irrigation, planted at 421 trees/acre.

and US-897. Sour orange rootstock is usually highly favored in southeastern Florida because it grows well in soils with high pH and areas with saline irrigation water, and it produces good fruit yields and quality. The US-897 rootstock is a cross between Cleopatra mandarin and Flying Dragon trifoliate. This trial is assessing the growth performance of both these rootstocks in the ACPS scenarios described.

The sole source of nutrients for ACPS treatments #2–5 are liquid fertigation. In addition, a key feature of this ACPS trial is that irrigation/fertigation runtimes are calculated by a weather-guided irrigation controller. The irrigation control system monitors evapotranspiration (ET) to generate the required runtimes for each irrigation/fertigation zone. The ET value represents an estimate of water vapor lost from the soil and vegetation to the atmosphere and is used to determine a plant's water need. When accrued ET values reach a user-defined threshold, the controller's software determines the appropriate runtimes. Within this trial, we hope to identify key elements to advancing fresh grapefruit production systems for growers.

SUMMARY

• The benefits of using ACPS when establishing and growing new citrus groves in Florida are especially important in an HLB-endemic environment. The higher nutrient and irrigation water efficiencies achieved with open hydroponics coupled with faster growth and higher planting densities mean that trees start bearing sooner and need fewer pesticide applications and other inputs to reach a given stage of production.

• Early and rapid encroachment of new groves by psyllids and HLB continue to be the top concerns. ACPS alone without HLB-resistant/-tolerant trees or completely effective psyllid control measures will not ensure the economic break-even and profitability of new groves, especially in the presence of multiple other pests and diseases.

• Lessons learned from five years of ACPS processed citrus research are now being applied for the first time in research for Florida's fresh citrus industry. A new ACPS field study with Ray Ruby grapefruit at the IRREC was established by Barrett Gruber and Brian Boman in November 2013.

• ACPS experiments at two other locations are now 3 years old (Lake Placid) and 22 months old (Lake Alfred). Both are thriving but becoming rapidly infected with HLB, despite aggressive psyllid control efforts. Fortunately the new experiments do not have the same multiple soil pest and disease problems superimposed with the HLB complex as we experienced in the Auburndale experiment. So far, the Lake Placid ACPS experiment is coping well with 50 percent HLB incidence, especially with the very vigorous rough lemon rootstock.

The authors would like to thank Jerry Britt, Cassie Kirkland, Darren Cole, and Diego Ramirez for their help with the grapefruit trial at the IRREC. Also we thank Kevin Hostler and Laura Waldo at the Citrus Research and Education Center (CREC) in Lake Alfred and Nolan Rayburn who is stationed at the IFAS Lake Placid research grove. The Citrus Research and Development Foundation, the Southwest Florida Water Management District, the Fluid Fertilizer Foundation, Yara International and the UF/IFAS Research Dean's office are gratefully acknowledged for funding this research, and we also thank Gapway Grove Corp. for their in-kind contributions during five years of collaborative ACPS research.

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