Advanced Citrus Production Systems in Florida

By Arnold Schumann, Kelly Morgan, Bill Castle and Jim Syvertsen

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The rapid spread of huanglongbing (greening disease) to all Florida citrus producing counties has created considerable interest among researchers and growers in novel production systems in order to survive the disease and remain competitive until a long-term genetic solution to this disease has been developed.

The goal of the Advanced Citrus Production System (ACPS) is a sustainable, profitable citrus grove designed and managed in a way that produces higher, earlier yields in order to reach economic payback sooner and improve disease and pest management efficiency. In addition to higher tree densities, the ACPS is based on the Open Hydroponics System (OHS) already being used for intensive production of citrus in climates different from Florida, notably with less summer rainfall. The ACPS is largely untested in Florida, but could enhance citrus production by optimizing daily water and nutrient levels. The net result would be the promotion of rapid canopy development with high planting densities that would increase cumulative yield over a shorter period of time. In this article we will report initial results from developing and testing the ACPS in Florida.

MAJOR REQUIREMENTS OF ACPS

- Intensive daily fertigation with computerized monitoring and remote control. Drip fertigation is usually the preferred delivery method.
- Balanced, complete plant nutrition.
- High planting densities for rapid canopy development and early yield with some redundancy to compensate for losses caused by removal of diseased trees.
- Scions and rootstocks suitable for high planting densities, frequent fertigation, and early fruit production.
- Good psyllid control is essential, especially during the establishment phase because of rapid flushing. Young greening-infected trees will likely never become productive.
- ACPS may be beneficial in existing mature groves by increasing yields and tree longevity in the presence of diseases.

EARLY RESEARCH HIGHLIGHTS

Several ACPS field experiments are being conducted by UF/IFAS in Florida. The first is a recently planted "concept grove" on a flatwoods soil (Immokalee fine sand) at the Southwest Florida Research and Education Center (SWFREC) near Immokalee. Treatments include four rootstocks, two scions, three planting densities and two methods of fertigation (drip, microsprinkler). Fertigation treatments are daily drip fertigation, daily reduced pattern microsprinkler irrigation with weekly fertigation and standard microsprinkler scheduling with monthly fertigation.

In one year, drip irrigation resulted in just over 6 inches of water used while the standard irrigation scheduling used more than 16 inches of water for a water savings of more than 62 percent. Fertigation was started in the second year after planting, and tree trunk diameter increments in 2009 were 11 percent and 16 percent greater in the intensive daily fertigation treatments with microsprinkler and drip methods respectively, compared to the conventional monthly fertigation treatment with microsprinklers. The Valencia scions grew 26 percent more trunk diameter than Hamlin scions. The Volkamer lemon rootstock outgrew the Cleopatra mandarin and Swingle citrumelo by about 64 percent, and the Flying Dragon trifoliate orange by 100 percent.

A second 15-acre ACPS replant experiment with Hamlin trees on Swingle and C-35 rootstocks was established on a Ridge soil (Candler sand) in Auburndale. A prototype ACPS planting configuration is being tested here (Figure 1), involving a cone-shaped tree guard (Tree T-pee®), two 0.5 gph drip emitters 15 inches apart, and soil water sensors at 0-4 and 18-inch soil depths. The drip system and a low volume 7.7 gph microsprinkler irrigation system deliver balanced liquid fertilizer on a nearly daily frequency. A conventional replant configuration with 10.5 gph microsprinklers, tree guards, grower-scheduled periodic irrigation and granular fertilizer is included as the standard comparison.

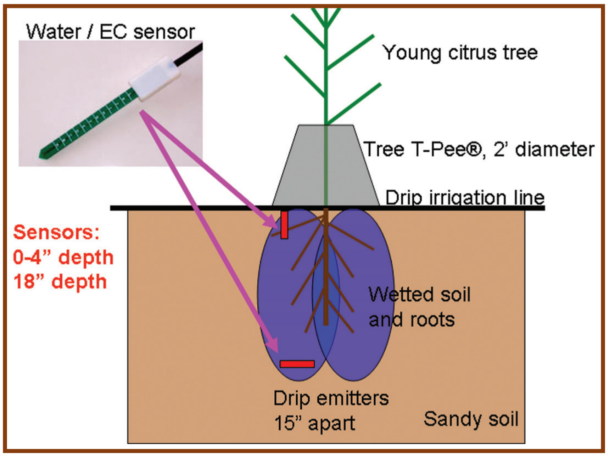

***Figure 1.** Tested configuration for planting Florida citrus in an ACPS (The tree guard is optional).*

The trees were planted in December 2008 and the first spring flush occurred after the last freeze in early March, at which time the intensive fertigation began. At 21 weeks after planting (nine weeks after fertigation started), the intensively managed trees with drip and microsprinkler fertigation treatments had 18 percent and 25 percent more trunk diameter, respectively, than the conventional grower practice — all on Swingle rootstock. The trees on C-35 rootstock with intensive drip fertigation (Figure 2, see next page) grew 37 percent more trunk diameter after 21 weeks than the standard conventional practice. If these growth enhancements from intensive fertigation can be sustained or accelerated, the trees should be on

Figure 2. *Young Hamlin trees after nine weeks of intensive drip fertigation.*

Figure 3. *A mature Hamlin orange tree nine months after conversion to pulse fertigation.*

track to produce more fruit earlier than in conventional production systems.

Three different planting densities of 218, 303 and 363 trees per acre are also being evaluated; growth and yield responses are expected in the next several years. Irrigation amounts for the ACPS treatments were based on calculations for the Candler soil and the soil moisture sensor readings. Horizontal capillary movement of water in the soil was approximately 6 inches, so the wetted patterns from two drippers 15 inches apart should completely intercept the root system of the young trees, shown in Figure 1. During the dry weather in May, daily water requirements per tree were 0.50 gallons for the drip method and 0.65 gallons for the microsprinkler method. Without the tree guard, daily irrigation requirements for the microsprinkler method would be about 8.6 gallons because a larger ground area would be wetted. Irrigation water savings due to the tree guards were also noticed in the conventional grower-scheduled treatment, and were estimated to be 93 percent.

After 21 weeks, water savings from intensive drip and microsprinkler fertigation were 49 percent and 28 percent, respectively, compared with the conventional treatment. Fertilizer savings were 87 percent and 80 percent for drip and microsprinkler intensive fertigation, respectively. Despite the reduced fertilizer requirement in ACPS treatments, all treatments recorded the same high leaf nitrogen concentrations of 3 percent dr. wt. or higher in April. Leaf content of other nutrients was also adequate. We concluded that nearly 90 percent of the fertilizer applied with conventional production methods during the early phase of citrus establishment was not used by the trees and could end up in the subsoil or ground water.

A third ACPS experiment was established at the CREC (Citrus Research and Education Center, Lake Alfred) in 2.2 acres of mature 18-year-old Hamlin trees on Swingle citrumelo rootstock at a density of 168 trees per acre. This block was historically low yielding, and during the previous two years averaged about 250 boxes per acre. The main objective of this experiment is to convert mature citrus trees from conventional microsprinkler irrigation and granular fertilization to intensive daily fertigation with balanced nutrition and thereby increase production and survival in the presence of greening.

The first fruit harvest was measured in December 2008, after nine months of treatment. Intensive drip fertigation with 10 pulses per day (Figure 3) produced 30 percent more soluble solids per acre than infrequent twice weekly fertigation through microsprinklers. Fruit yield was nearly doubled (508 boxes per acre) in 2008 compared with the previous years. The drip system for retrofitting the mature trees consisted of a single drip line per tree row with integrated 0.4 gph emitters spaced 12 inches apart. The root systems of the trees adapted well to drip fertigation and no water stress was recorded during the dry spring months. Considerable water savings were achieved with sensor-based drip fertigation (71 percent) and microsprinkler fertigation (60 percent), compared to a conventional evapotranspiration-based microsprinkler irrigation schedule.

We have an additional ACPS system established on a one-acre site of newly planted and mature trees at the CREC. Here, we will be evaluating tree water use, root distributions and interactions of cover crops with an ACPS system.

SUMMARY OF EARLY RESULTS/ LESSONS LEARNED

• Both young replant and mature citrus blocks responded favorably to intensive drip fertigation in the ridge and flatwoods, with early growth or yield increases averaging 20 percent to 30 percent in less than a year. The ACPS offers environmental and economic benefits by substantially reducing fertilizer and water requirements.

• Two field experiments showed that intensively managed fertigation with microsprinklers can also increase young tree growth. Microsprinklers are crucial for freeze protection and are still the more popular choice for growers. Drip fertigation should use less water, but a dual microsprinkler system may also be needed just for freeze protection.

• Nutrient demand in the early spring season during bloom can exceed the daily nutrient supply from fertigation. Therefore for mature trees, a hybrid method of pre-bloom granular fertilization (15 percent to 25 percent of annual rate) followed by intensive fertigation for the remainder of the year will be tested in 2010.

• Soil water sensors are useful to detect the depth of water penetration in soil, but do not reliably quantify the water content of the soil. Daily fertigation was simply scheduled so that a wetting front is barely detected at the 18-inch soil depth. Water savings of up to 71 percent are achievable by using sensors instead of relying on irrigation scheduling with evapotranspiration and a crop factor.

• Daily drip fertigation of young trees may cause salt accumulation in the root zone and salinity damage in the foliage during the dry spring season. A remedy consisting of reduced fertilizer concentrations in solution and leaching by application of three to four times the rate to irrigate to a depth of 18 inches every two weeks during periods of no rain is suggested. Low quality irrigation water will exacerbate the problem and may require additional remediation. Some water sensors also respond to salinity in soil solution and can be used to monitor salt accumulation.

• Conical tree guards enhance freeze protection and conserve irrigation water in young tree blocks, but can hinder rootstock sucker removal and inspection for clogged microsprinkler emitters. Similar results may be achieved simply by inverting the microsprinkler emitters during the early stages of growth.

After a few more years of monitoring tree growth and yield, the economics of ACPS, the effects of different tree densities, rootstocks and the impacts of pests and diseases will be reported. For more information on these experiments and the ACPS, see the Research section at www.crec.ifas.ufl.edu/.

Other ACPS experiments in Florida are already under way or in the planning stages, many of them grower demonstration trials. Some examples are:

• Arapaho Citrus Management Inc. This 10-acre block planted with various varieties and rootstocks is the original OHS to be tested in Florida. Details are available at http://www.arapahocitrus.com/rockbottom.html.

• Duda Products, Inc. A trial is under way to compare Valencia, Vernia and a mandarin-type on several rootstocks planted at 218 or 360 trees/acre with drip or microsprinkler fertigation.

• Gardinier Florida Citrus, Inc. A project to be established this fall where fertigated trees of Hamlin or Valencia on a single size-controlling rootstock are planted in multiple rows on 60-foot beds at densities from about 270 to more than 500 trees/acre.

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