Methods for profitable citrus production

University of Florida research using citrus undercover production systems and whole tree thermotherapy shows great promise.

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In 2009, University of Florida's Institute of Food and Agricultural Sciences (UF/IFAS) began research for developing the best possible citrus replanting and growing systems to help growers effectively replace groves that were rendered unviable by citrus greening disease or huanglongbing (HLB). The "advanced citrus production system" (ACPS) proved very successful in promoting rapid establishment and early high-fruit yields by year three, but failed to avoid infestation by Asian citrus pyllid (ACP) or adequately offset the symptoms of HLB once trees became infected.

In order to address these gaps in the ACPS and to develop a rapid solution for growing high-quality fresh fruit unaffected by HLB in Florida, we started integrated research in late 2013 to: a) physically exclude psyllids from the citrus trees by using protective screen houses, b) reverse the HLB disease with whole tree thermotherapy (WTT) on affected trees and c) further accelerate tree growth and boost early fruit production to permit harvesting economically viable yields by the end of the first or second year. The citrus undercover production systems (CUPS) concept was introduced in a December 2014 *Citrus Industry* article. In this article, we introduce the WTT concept and provide updates on the CUPS.

Although screen house–protected agriculture is the preferred method for comprehensively excluding systemic, vector-borne diseases like HLB, the high price of screen house construction is a major establishment cost which slows the rate of return on the investment. WTT — in which the potted root systems as well as canopies of HLB-affected trees are heat-treated for sufficient time at a high enough temperature to kill the systemic causal pathogen, *Candidatus* Liberibacter asiaticus (*C*Las) — is an alternative approach being investigated in this project for sustainable citrus production in HLB-endemic environments.

Figure 1. Hamlin orange trees showing the regrowth of healthy foliage on HLB-symptomatic canopies 19 days after whole-tree thermotherapy (WTT), left, and seven months after WTT, right. *C*Las was no longer detectable by PCR when tested six months after WTT, and new foliage was asymptomatic.

WTT EARLY EXPERIMENTS

Preliminary experiments at the UF/IFAS Citrus Research and Education Center successfully reversed HLB on mature fruit-bearing Hamlin trees growing in 5-gallon pots by a steam-heating treatment at 104°F to 108°F for 48 hours (Figure 1). We based this thermotherapy technique on longer-term studies reported by M.T. Hoffman and others in 2013, where *C*Las was eliminated from smaller 1-gallon potted citrus trees for more than two years. If WTT-treated trees are protected from reinoculation by the ACP vector, they should remain HLB-free and productive.

In practice, we anticipate that hydroponic, outdoor, container-grown trees will require periodic thermotherapy retreatment because they will be subject to reinoculation with *C*Las due to feeding by the ACP vector. The following cyclic steps are proposed for this method:

1) Identify HLB symptomatic trees on the trellis (Figure 2).
2) Remove trees from the trellis and heat-treat them in a steam chamber to eliminate HLB.
3) Return the trees to the trellis and continue an aggressive ACP control program to limit reinfection to about 3 percent to 5 percent per year.
4) Repeat from step 1.

WTT-treated trees typically drop all current fruit and leaves, but rapidly regrow the canopy and even set fruit again in about six months, and resume normal fruit production within 12 months. We envisage that by annually treating HLB-affected trees with WTT in a precisely targeted fashion, only a small fraction (less than 3 percent to 5 percent) of a productive, insecticide-protected grove will be HLB-positive. This small fraction of affected trees should not increase over time. Thus, more than 95 percent of the trees in the grove will be sustained in a healthy state for long-term profitable fruit production (Figure 2).

Figure 2. Ray Ruby/US897 grapefruit trees in the outdoor trellised grove during June 2015. The trees were planted in September 2014 at 5 feet by 10 feet (871 trees/acre) using container hydroponics, which allows the ability to use whole tree thermotherapy to eliminate *C*Las and reverse HLB disease.

The research is only 1 year old, but if successful, WTT coupled with aggressive ACP vector control to minimize reinfection could allow sustainable, high-yielding, container-grown, hydroponic fresh citrus production without the need for expensive, protective screen houses. Our preliminary economic projections indicate that the WTT method could halve the economic break-even time of fresh fruit production when compared to the screen-house method, and could yield much higher returns on investments.

CUPS PROJECT UPDATE

For growers who consider pursuing fully covered and protected fresh citrus fruit production, there are other potential benefits to such a production system aside from preventing psyllid colonization and HLB development. The protected environment provided by the screen enclosures may also promote faster, early tree growth and improved water use. Researchers at the trial site at the UF/IFAS Indian River Research and Education Center in Fort Pierce have monitored covered grapefruit trees (compared with open-air check plots) for canopy growth and fertigation use (Figures 3, 4 and 5, page 12).

Grapefruit trees (on US-897 rootstock) grown inside the covered structure developed more canopy area in the same amount of time when compared to the open-air check trees (Figure 3, page 12).

In addition, the total amount of fertigation solution applied to each tree in each of the separate growing environments is also reported (Figure 4, page 12). In each of the months examined in 2014 (May, July, September and November), less fertigation solution was applied to trees grown in the protective screen houses. The screen-grown trees effectively grew more (Figure 3) with less fertigation solution.

In this trial, weather stations provide guidance as to how much fertigation solution is applied each day (liquid fertilizer is injected with each irrigation event). The weather stations monitor potential evapotranspiration (also called reference evapotranspiration), an estimate of plant water demand, in each growing environment. Thus, on warmer days, more fertigation is applied relative to cooler days. If needed, the automated irrigation controller fertigates trees daily in the open-air check plots and inside the protective screen houses, separately. In 2014, less fertigation solution was applied to trees inside the screen-house structures because daily evapotranspiration water demand inside the structures is typically about 20 percent less overall, compared to the open-air check values of evapotranspiration.

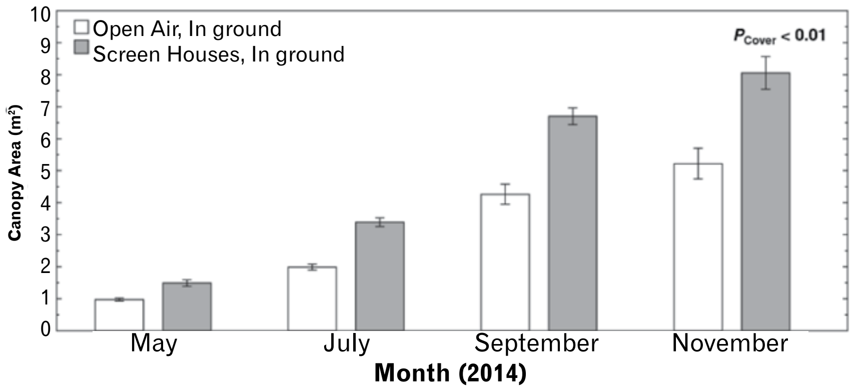

Figure 3. Ray Ruby grapefruit trees grown in ground, in the open air (check, control) and inside protective screen houses. The effects of growing environment on average tree canopy area are shown for screen-grown trees from May to November 2014.

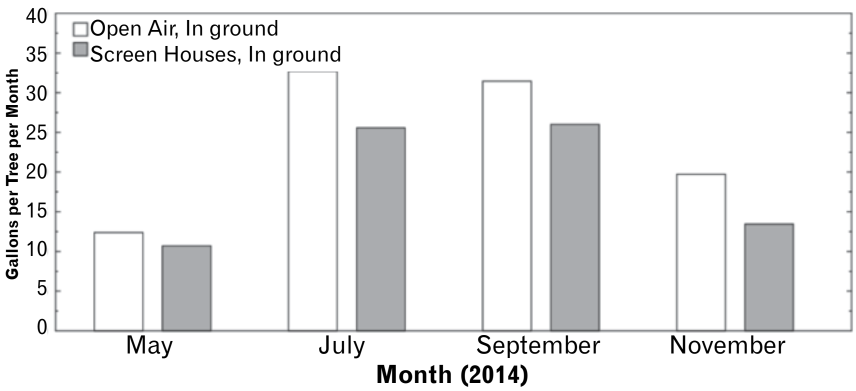

Figure 4. Ray Ruby grapefruit trees grown in ground, in the open air (check, control) and inside protective screen houses. The total gallons of fertigation solution applied to each tree per month is shown for the period from May to November 2014.

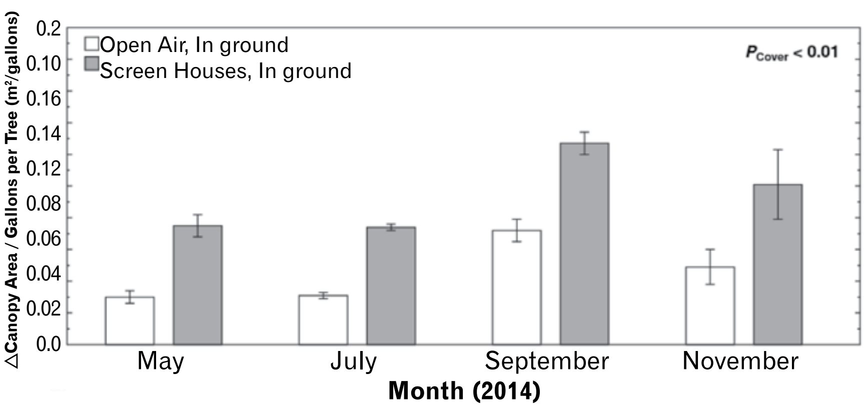

Figure 5. Ray Ruby grapefruit trees grown in ground, in the open air (check, control) and inside protective screen houses. The effects of growing environment on the average change in canopy area, divided by applied gallons of fertigation solution, are shown.

Covered citrus tree production might also grow trees more efficiently. In Figure 5, the change in tree canopy growth was divided by the total gallons of fertigation applied per tree. For all of the months examined in 2014, we were able to demonstrate that more tree canopy area was grown per gallon of fertigation solution inside the protective screen structures, compared to the open-air check plots. Thus, the protective screen houses not only yield larger trees, but can potentially yield larger trees with less fertigation solution. We are optimistic that improved growth of healthy citrus following WTT and CUPS methods will produce profitable, high-quality fresh Florida citrus unaffected by HLB.

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