Fertilizer and irrigation effects on the growth of potted citrus nursery trees

By Barrett Gruber, Brian Boman, Kevin Hancock, Prem Kumar and Jerry Britt

Huanglongbing (HLB, or "greening") and canker diseases have substantially affected Florida's citrus industry in the past decade. After their appearances, statewide guidelines were implemented to stop any additional spreading of HLB and canker. One such effort is a mandate that all commercial citrus nurseries in the state have to grow young trees in completely enclosed greenhouses. This mandate is part of the Citrus Nursery Stock Certification Program, and is described in detail as the Florida Department of Agriculture's rule 5B-62. The rule has dramatically changed how citrus nurserymen cultivate young trees in the state.

Today, young, budded trees are container-grown in soilless media in greenhouses. However, there are no specific guidelines to follow for efficiently growing small trees indoors. In addition, these growing practices are relatively new to the nursery industry, as the rule was enacted less than a decade ago. There has not been much — if any — formal research investigating optimal cultural practices for growing young, budded citrus trees in containers.

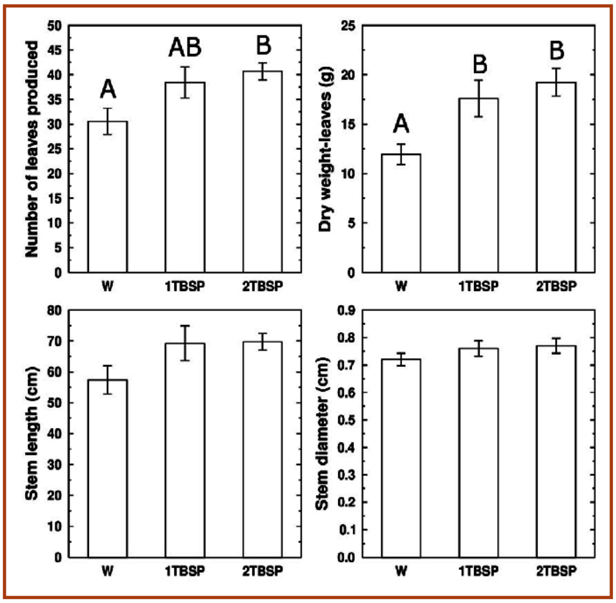

Figure 1. *Effects of controlled-release fertilizer rate [W = water only, no fertilizer; or, fertilizer = 1 tablespoon (1TBSP); 2 tablespoon (2TBSP)] on foliage growth and stem length and diameter of Ray Ruby grapefruit/sour orange potted trees. The controlled-release fertilizer had an analysis of 15-8-11 (N-P-K plus minors). Data are means and standard errors. Means marked with different capital letters are statistically different. No significant differences were observed among treatments for stem length and diameter.*

The research trials described here have evaluated the influences of some important variables capable of influencing the production of nursery trees. Specifically, the effects of fertilizer application rate on the foliage growth of Ray Ruby grapefruit/sour orange trees were quantified. Additionally, growth of Valencia orange/Kuharske trees were assessed with respect to fertilizer application rate, irrigation regime and plant spacing.

EFFECTS OF FERTILIZER APPLICATION RATE ON GRAPEFRUIT VEGETATIVE GROWTH

The primary goal of this trial was to determine if different rates of fertilizer application significantly affected the foliage growth of Ray Ruby grapefruit/sour orange budded trees. Approximately 9-month-old trees in 4-inch citripots were purchased from a commercial nursery and were kept in a greenhouse at the Indian River Research and Education Center (IRREC) in Fort Pierce for the duration of the trial. A controlled-release fertilizer (12 to 14 month release profile at 70°F) with the following analysis was used for this trial: [N (15 percent), P (8 percent), K (11 percent), Mg (1.3 percent), S (5.6 percent), B (0.02 percent), Cu (0.05 percent), Fe (0.46 percent), Mn (0.06 percent), Mo (0.02 percent) and Zn (0.05 percent)]. Three different fertilizer rates were used and implemented as top-dressings: Water-control (no fertilizer added); 1 tablespoon (1TBSP), or 2 tablespoon (2TBSP). New shoots were allowed to grow from May to August 2012, and leaves and stems were harvested after hardening-off of the flushes. Data collected included the total number of leaves produced, dry weight of leaves, scion stem length and scion stem diameter (measured 1 centimeter above the bud union).

The final foliage growth of the trees from this trial are shown in Figure 1. The water-only control treatment produced trees with the fewest leaves, the 1TBSP treatment produced trees with an intermediate amount of leaves, and the 2TBSP treatment produced trees with the most leaves. Leaf weight was the same for both the 1TBSP and 2TBSP treatments. Scion stem length and diameter were not different among the three treatments. The N-P-K leaf analyses for this trial are graphed in Figure 2 (page 15). The mean leaf N percentage of the 1TBSP and 2TBSP treatments did not differ appreciably from each other. Leaf K was lowest in trees that received only water, and the 1TBSP and 2TBSP treatments had nearly similar concentrations. No

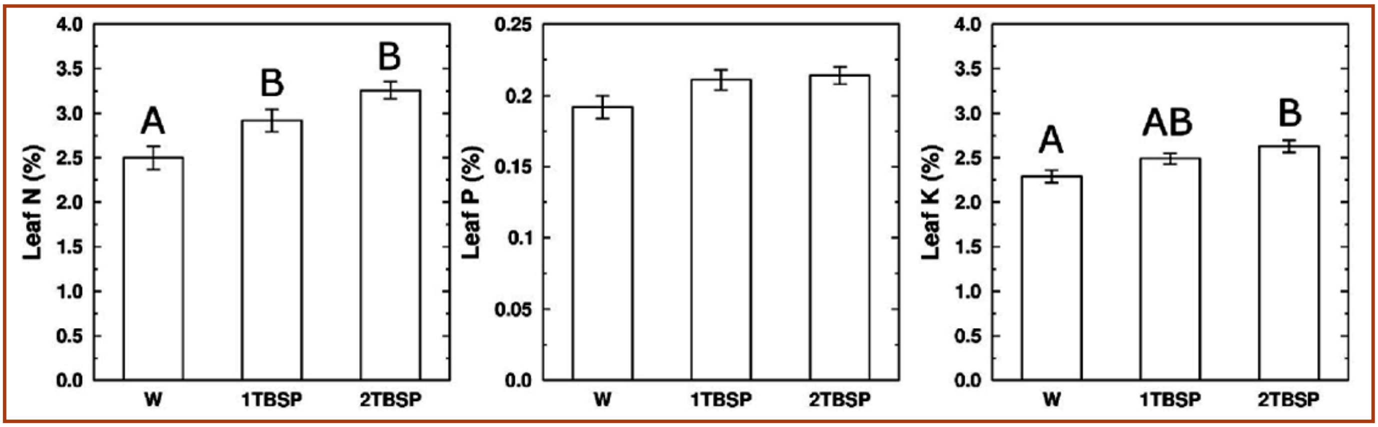

Figure 2. *Effects of controlled-release fertilizer rate [W = water only, no fertilizer; or, fertilizer = 1 tablespoon (1TBSP); 2 tablespoon (2TBSP)] on leaf nutrient status of Ray Ruby grapefruit/sour orange potted trees. The controlled-release fertilizer had an analysis of 15-8-11 (N-P-K plus minors). Data are means and standard errors. Means marked with different capital letters are statistically different. No significant differences were observed among treatments for percentage of leaf P.*

substantial differences were observed among the treatments regarding leaf P. According to previously published IFAS guidelines for the nutritional status of non-fruiting citrus foliage, the water-only, 1TBSP and 2TBSP treatments had "optimum," "high" and "excessive" mean leaf N percentages, respectively. Leaf K percentages were "high" for the water-only treatment and "excessive" for the 1TBSP and 2TBSP treatments. Mean leaf P was "high" for all of the treatments.

EFFECTS OF PLANT SPACING, FERTILIZER APPLICATION RATE AND IRRIGATION REGIME ON ORANGE VEGETATIVE GROWTH

The primary goal of this trial was t o determine if different rates of fertilizer application, irrigation regime, and plant spacing significantly affected the foliage growth of Valencia orange/Kuharske budded trees. Newly budded trees in 4-inch citripots were purchased from a commercial nursery in April 2012 and kept in a greenhouse at the IRREC in Fort Pierce for the duration of the trial. A week after the plants were moved into the greenhouse, the liners were lopped approximately 15 centimeters above the bud union. The scions were headed at about four months to allow for multiple branching of axillary shoots.

The following treatments were implemented immediately after the newly budded trees were placed in the greenhouse.

• A controlled release fertilizer (12 to 14 month release profile at 70°F) with the following analysis was used for this trial: [N (15 percent), P (8 percent), K (11 percent), Mg (1.3 percent), S (5.6 percent), B (0.02 percent), Cu (0.05 percent), Fe (0.46 percent), Mn (0.06 percent), Mo (0.02 percent), and Zn (0.05 percent)]. Trees were subjected to one of four different fertilizer rates that were implemented as top-dressings: 0.5 teaspoon (0.5 TSP); 1 teaspoon (1TSP); 1.5 teaspoon (1.5TSP); or 2 teaspoons (2TSP).

• Trees were subjected to one of two different irrigation regimes (standard or cyclic) that were implemented via

Figure 3. *Valencia orange/Kuharske trees. (A-B) Budded trees were spaced pot-tight (shoulder-to-shoulder), in April 2012 and April 2013, respectively. (C-D) Budded trees were alternately spaced in every other row, in April 2012 and April 2013, respectively.*

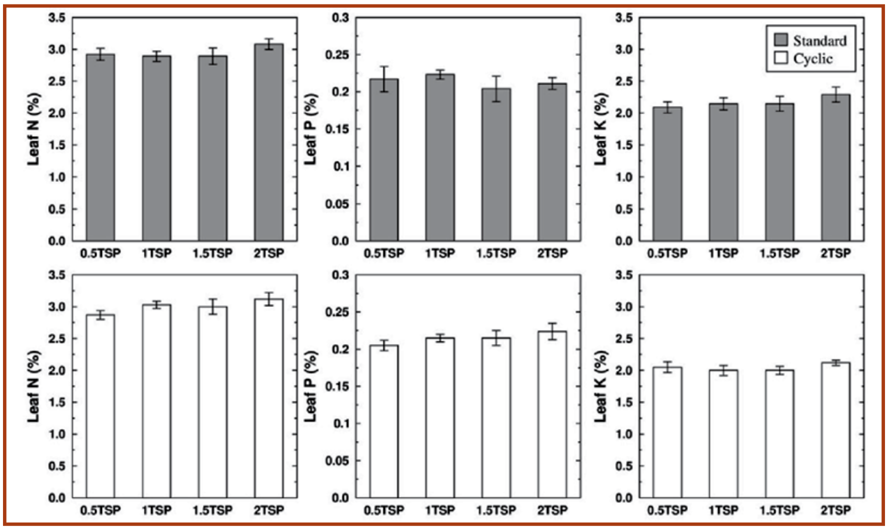

Figure 4. *Effects of controlled-release fertilizer rate [0.5 teaspoon (0.5TSP), 1 teaspoon (1TSP), 1.5 teaspoon (1.5TSP), or 2 teaspoons (2TSP)] on leaf nutrient status of Valencia orange/Kuharske potted trees. The controlled-release fertilizer had an analysis of 15-8-11 (N-P-K plus minors). Trees were spaced pot-tight (shoulder-to-shoulder) and subjected to either the standard or cyclic irrigation regime. Data are means and standard errors. No significant differences were observed among treatments for percentage of leaf N, P or K for either the standard or cyclic irrigation regime.*

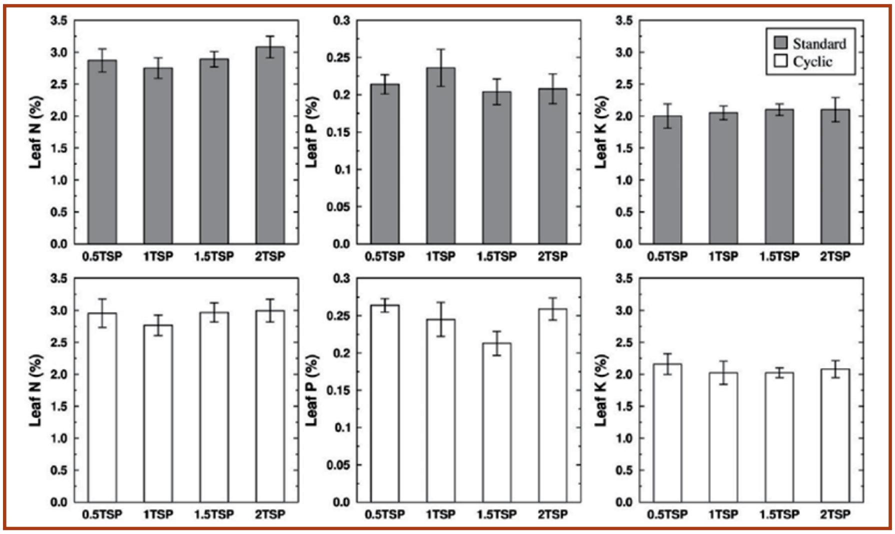

Figure 5. *Effects of controlled-release fertilizer rate [0.5 teaspoon (0.5TSP), 1 teaspoon (1TSP), 1.5 teaspoon (1.5TSP), or 2 teaspoons (2TSP)] on leaf nutrient status of Valencia orange/Kuharske potted trees. The controlled-release fertilizer had an analysis of 15-8-11 (N-P-K plus minors). Trees were alternately spaced in every other row and subjected to either the standard or cyclic irrigation regime. Data are means and standard errors. No significant differences were observed among treatments for percentage of leaf N, P or K for either the standard or cyclic irrigation regime.*

overhead microsprinklers (10.5 gallons/hour emitters with 4.5-foot spray radius and 90° quarter-circle pattern):

- o Standard irrigation regime: 10 minutes/day/every other day (April–July 2012); 20 minutes/day/every other day (July–December 2012); 20 minutes/day/every 10 days (December 2012–February 2013); 30 minutes/day/every 6 days (February–April 2013).
- o Cyclic irrigation regime: 5 minutes/twice daily (April–July 2012); 10 minutes/twice daily (July–December 2012); 10 minutes/day/every 5 days (December 2012–February 2013); 20 minutes/day/every 3 days (February–April 2013).

• Trees were subjected to one of two different plant spacing patterns: Pot-tight (pots placed “shoulder-to-shoulder”) or spaced apart by one pot-width (4-inches apart) (Figure 3, see previous page).

All scion foliage was allowed to grow from April 2012 to April 2013, and leaves and stems were harvested after hardening-off of the flushes. Data collected included the total number of leaves produced, dry weight of leaves, scion stem length, and scion stem diameter (measured 1 cm above the bud union).

The final foliage growth of trees was similar among all of the spacing, irrigation and fertilizer rate combinations (Figure 3). Average tree size after 12 months in this experimental trial approximated final tree size that is standard among most commercial nurseries. Thus, based on the conditions and results of this study, spacing, irrigation and fertilization did not have noticeable effects on Valencia nursery tree growth.

Leaf nutritional status of all trees assigned to the pot-tight and standard and cyclic irrigation regimes are shown in Figure 4. The N-P-K leaf percentages among all fertilizer rates in the pot-tight and standard or cyclic irrigation regimes were nearly identical. According to University of Florida-IFAS guidelines for non-fruiting citrus, leaf N levels of trees subjected to the standard and cyclic irrigation regimes ranged from “high” to “excessive” for the four different fertilizer rates. Leaf P and K levels for all of the different fertilizer rates were “high” and “high to excessive,” respectively, for all trees assigned to the pot-tight and standard or cyclic irrigation regimes.

The last production scenario that was investigated implemented a spacing pattern that placed pots alternately in every other row (Figure 5). Leaf N-P-K percentages were nearly identical among the different fertilizer rate treatments. Mean leaf N percentages for the spaced-pots scenario ranged from "high" to "excessive" for both irrigation regimes, according to previously published IFAS guidelines for non-fruiting citrus foliage. Leaf P and K percentages were "high" for the two irrigation regimes in the spaced-pots treatment.

CONCLUSIONS

The current trials investigated one analysis of controlled release fertilizer (15-8-11, N-P-K, plus minors) at different application rates. There were no statistically significant differences observed in foliage growth for the Ray Ruby and Valencia trees among the different fertilizer application rates. Additionally, leaf nutrition statuses were similar among the fertilizer application rates for both the grapefruit and orange trees.

According to the conditions under which these trials were conducted, and the results that were observed, young, potted citrus trees likely do not require any more than 2 teaspoons to 1 tablespoon of controlled-release fertilizer of the same analysis that was investigated. Overhead irrigation duration for commercial nursery production also may not be needed any more frequently than 20 minutes every other day (at 10.5 gallons/hour) during the summer months, based on the conditions and results of these trials.

Nursery tree production conditions were limited in these trials. It would be an immense undertaking to simultaneously investigate all possible factors that could potentially influence the growth of young, potted citrus plants. Additional trials conducted in the future could focus upon the effects of different irrigation deliveries (for example: hand vs. overhead vs. drip vs. bench flood), pot sizes, soilless media, fertilizer analyses and types (for example: liquid vs. controlled release), and rootstock genotypes on young tree foliage and root growth.

Nevertheless, the results of the trials reported here should provide an initial step toward optimizing commercial nursery production of potted citrus trees.

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CRDF Research Update: Projects Focusing on Citrus Tree Response to HLB

By Harold Browning

Last month we discussed research projects funded by CRDF that address various aspects of the Asian citrus psyllid (ACP), its biology, ecology and control in relation to managing HLB. Understanding the vector and being able to reduce ACP populations greatly affects rates of HLB spread.

This month, we discuss projects that focus on the citrus host plant — another component of the HLB system. There are 30 research projects that are directed at the plant, development of HLB symptoms and efforts to affect symptoms of the disease. These are summarized below.

Detecting HLB-infected trees is an important feature of monitoring and responding to HLB infection. This is currently being accomplished primarily through DNA testing of suspect trees showing early symptoms. CRDF currently is providing support to two PCR (polymerase chain reaction) laboratories in place to analyze grower samples and to assist research projects in processing samples. The complexity and lack of sensitivity of PCR methods limit the use of this diagnostic method, and thus several other projects are evaluating alternative detection methods. These include sensory-based detection systems as well as detection relying on physiological or chemical changes to leaves following *Candidatus Liberibacter asiaticus* infection. A third approach is to develop additional molecular or serological tests. All of these methods seek quicker, more sensitive diagnostics.

The **epidemiology of HLB** continues to be an important area of research supported by CRDF. Projects are evaluating spatial and temporal incidence of HLB across Florida, determining factors most important in infection increase and disease movement. An additional element of this research is determining the extent to which seeds from infected citrus trees foster HLB transmission.

Another group of projects focuses on **plant defense and how applied methods can affect the ability of citrus trees to withstand symptom development.** Projects are evaluating innate responses in the plant to *Liberibacter* infection and the physiology of disease symptom development. Focusing on HLB effects on phloem tissue, researchers are looking at the onset of symptoms as well as the response of defense-inducing chemicals in infected trees. Applied projects in this realm are evaluating application of materials to affect symptom development, including SAR (systemic acquired resistance) products, antibiotics and other therapeutics.

A final component of research that relates to the citrus tree is looking at **cultural practices and their role in disease management,** including nutrition and flush management through pruning and plant growth regulators. While short-term results will impact current citrus production and disease management, research in this area also is relevant to new plantings. Combining numerous principles, intensively-managed production systems are being developed and evaluated under field conditions in Florida, with goals of optimizing early productivity and defense against disease. While current cultural practices are being modified in various ways to combat HLB, future groves are being envisioned to produce earlier in their lives and to accommodate higher levels of inputs management. Field trials exhibiting some of these enhancements are currently being evaluated by researchers and growers alike.

Author's note: An important element of the CRDF mission is to communicate results of HLB research to growers and other interested parties. Please let us know what you would like to hear more about at hwbr@citrusrdf.org

Harold Browning is Chief Operations Officer of CRDF. The foundation is charged with funding citrus research and getting the results of that research to use in the grove.

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