# Root health in the age of HLB

By Evan Johnson and Jim Graham

By now, most citrus growers in Florida are well aware of the foliar symptoms and damage caused by HLB. It is important to remember that only half of the tree is visible. The root system is equally important for tree health and fruit production, but is difficult to observe.

*Candidatus Liberibacter asiaticus*, the bacteria that causes HLB, lives in and interferes with the function of the phloem. This phloem is present in all parts of the citrus tree transporting sugar from "sources" of sugar (photosynthetic production or storage tissues) to "sinks" of high sugar demand (new growth and fruit). This means that Liberibacter moves to and grows in all parts of the tree. Under most environmental conditions and at most times of the year, the roots of citrus trees act as sinks. The sugar from leaves provides energy for

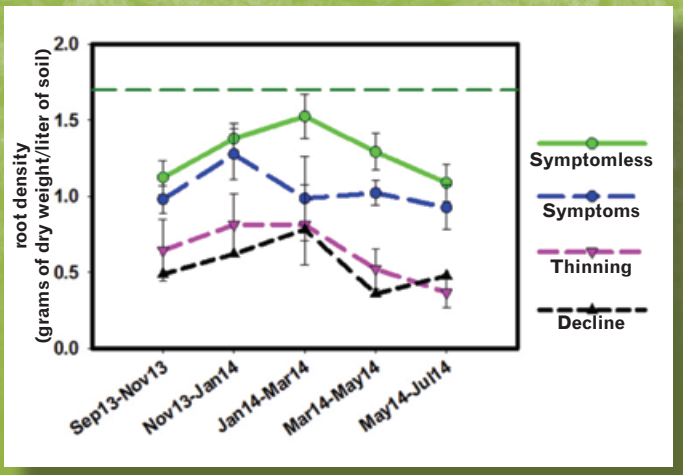


**Figure 1:** Two phases of root loss on Hamlin/Swingle due to HLB (top) compared to the average root mass of a healthy or presumed healthy tree (green dashed line). Examples of presumed healthy tree root mass from eight soil cores (left), symptomless infected tree (middle) and early decline or thinning tree (right).

root growth and normal root functions like nutrient uptake. The flow of phloem sap to sustain root functions transports Liberibacter to the roots quickly after initial tree infection.

Just as the pathogen infects and multiplies in the root system soon after psyllid inoculation of a leaf, it also causes damage to the root system early in the development of HLB. Before foliar symptoms of disease are expressed, the infection has already significantly damaged the root system, causing a 30 percent to 50 percent loss in fibrous root density (Figure 1, page 14). Root density continues to gradually decrease as symptoms develop in the canopy. As HLB symptoms spread to most of the canopy and it begins to decline with leaf drop and dieback reducing its density, root density collapses to just 20 percent to 30 percent of a healthy tree, as was previously described by Bernard Aubert in the 1980s (Figure 1, page 14).

This second phase of root loss is probably due to carbohydrate starvation, as plugging in the phloem restricts movement of sugars to the root system. Loss of 70 percent to 80 percent of the roots greatly reduces the ability of the tree to withstand water stress from extended dry periods. This root loss greatly impairs the regular functioning of the tree and creates new challenges in trying to maintain production in groves with HLB.

Fibrous roots are the site of water and nutrient acquisition, so the total water and nutrient uptake capacity of the root system early in HLB development has been reduced by 30 percent to 50 percent. With reduced uptake capacity, putting more water or nutrients on the soil at a given time will not lead to increased absorption by the root system. Instead, more of what is applied will flow through the root zone and into the groundwater.

## FERTILIZER AND WATER USE

Smaller, more frequent doses of fertilizer and water are a more effective way to manage compromised root

## Where Are We with Tools to Manage HLB?

*By Harold Browning*

The array of grower meetings held across the state is a good way to keep up with progress on identifying and demonstrating tools for HLB management, and the June Florida Citrus Mutual Annual Grower Meeting was no exception. The Educational Seminar provided a broad look at HLB management from a grower perspective, with updates and summaries from scientists who are in the fight as well. Those in attendance got a glimpse of how growers are incorporating new ideas and tools into good management practices, and heard details of some of the tools that are emerging. Attendees heard that there are reasons to be optimistic. A few of the highlights are presented here.

- Many growers are including newly released rootstocks from the U.S. Department of Agriculture and University of Florida/Institute of Food and Agricultural Sciences breeding programs in their new plantings. These rootstocks have shown advantage over conventional ones in the presence of HLB, and need broader evaluation in grower hands.

- Irrigation and fertilization programs make a difference, and there are a wide range of programs that growers are implementing specific to their site, soils and tree health situations. While we don't fully understand the cause/effect with various nutritional and irrigation programs, field evidence indicates that aggressive cultural practices are slowing decline of infected trees.

- Advances in understanding the interaction of HLB with citrus root systems have enabled growers to apply specific management to improve or sustain root health, including altering pH, adjusting for high bicarbonates, treatment for complicating root issues like Phytophthora and Diaprepes, and considering application of mulches, soil microbes and other treatments.

- With help from federal funding, thermal therapy is being scaled up, and a number of companies have built and are testing steam application methods to reduce HLB disease and restore tree health.

- Asian citrus psyllid (ACP) management continues to be important, and there is a great opportunity to make it better through more cooperative, large-scale ACP management programs as well as increased understanding of specific tactics and how they affect ACP populations. The Florida Department of Agriculture and Consumer Services is rearing and releasing ACP parasitoids in areas where pesticide treatments are not being applied in an effort to dampen the populations of ACP in these refuges.

- Growers who are resetting trees or replanting groves have a range of strategies that can be applied to increase the odds of growing trees to maturity with limited HLB infection. In combination with planting incentive programs, many growers are removing least productive groves and replanting while incorporating aggressive management strategies.

- CRDF continues to fund research targeting these practices as well as other tools which are not yet available. Field trials of bactericides continue to make progress, while additional efforts to identify and field test a wide range of other HLB management tools continue.

***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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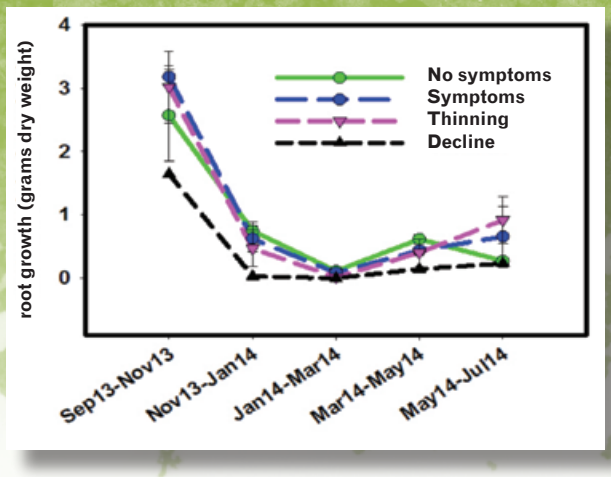


**Figure 2:** Root growth in trees with HLB as symptoms increase (above) showing prolonged root flushing for symptomatic and thinning trees resulting in more total root growth (March to July 2014) with examples of a presumed healthy tree (right) and an early decline or thinning tree (far right).

uptake capacity. Fertigation or slow-release fertilizers should be considered for nutrient delivery, although slow-release fertilizers may be cost prohibitive. More advanced irrigation systems (such as automated pulsing of irrigation monitored with soil moisture sensors) should be considered to provide water when and where it is needed. These practices target compromised root systems, but the ideal management of root loss would be to reduce the loss or increase root mass.

To develop effective root health management strategies, it is important to understand how the root loss occurs and what physiological changes Liberibacter is causing in the roots. Root density can be decreased in two ways. Either roots die before their normal life-span or root growth is inhibited, preventing replacement of old roots.

Investigations into HLB root loss have shown that trees with symptoms or in the early stages of decline actually have extended root flushes — with more total root growth — than symptomless or healthy trees in the field (Figure 2) and greenhouse. This means that Liberibacter is causing root death at a faster pace than the HLB-induced root growth can replace them.

Induced root growth with continued total root loss has implications for management options. Trees have limited sugar production capacity based on the photosynthetic area in the leaves. In a healthy tree, the partitioning of sugar between roots, fruit and new canopy growth is carefully regulated. When something disrupts this carbohydrate balance in the tree,

it must shift allocation from one sink tissue to another. To support increased root growth, the tree must sacrifice fruit production or new leaf production, especially in early decline (thinning) trees with reduced photosynthetic capacity due to leaf drop.

Therefore, inducing additional root growth may provide minor improvement in root density, but at the cost of fruit production either immediately because of fruit drop or in the future because of reduced leaf production (photosynthetic capacity).

Currently, there is no known way to counteract the effects of HLB on the root system. Other than modifying water and fertilization practices to address the reduced uptake capacity of the root system, the only other management option available is to reduce the impact of other causes of root loss.

Prior to the arrival of HLB, citrus trees could remain productive even when planted on suboptimal soil for the rootstock selected or in the presence of soil pest or pathogen populations, such as Phytophthora. The additive effect of these stresses on the root system with the root loss caused by HLB accelerates the decline of these trees. While the cost-benefit of treating these problems in existing groves is still uncertain, these treatments may extend the life and productivity of HLB-affected trees.

With HLB endemic in Florida and no cure or resistance likely in the immediate future, the primary goal is to prevent psyllids from bringing HLB into the grove. Even under the best psyllid program currently available, HLB will spread in a grove. Therefore, it is important to prepare the planting so that is remains productive as long as possible after infection to be economically viable.

## PLAN BEFORE PLANTING

Root health is one of the factors that can be most influenced by planning, preparation and decisions made before planting. When planting or replanting blocks, it is important to consider the soil and pest conditions




at the site and select the best rootstock available for the local conditions. Soil and water quality and prevailing pest problems (Phytophthora, nematodes, Diaprepes) are examples of issues to consider when choosing a rootstock for a new planting. More information about HLB and rootstocks will be presented in a future article.

It is also essential to prepare the site properly to maintain the optimum soil environment for the trees, including proper drainage and bedding where necessary. Planting of new blocks is also the best time to implement new irrigation/fertigation systems that provide smaller doses, when needed. That will get the tree into production quickly and prevent wasted fertilizer and water application from less frequent higher doses that can lead to groundwater contamination. Careful planning for psyllid control and maintaining root health (both before and after trees are infected with Liberibacter) can promote early production from new plantings and sustain economic viability.

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## COMING EVENTS

**August 19–20** Citrus Expo, Lee Civic Center, North Fort Myers, see www.CitrusExpo.net

**August 27–28** Florida Agriculture Financial Management Conference, Omni Orlando Resort at ChampionsGate, see www.fafmc.org