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

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**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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**Grower Dollars at work for you**

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