Rootstocks and HLB: What's happening below ground?

By Evan Johnson, Jude Grosser and Jim Graham

As HLB has marched through Florida, many growers and researchers have made anecdotal observations that citrus trees with different rootstocks suffer HLB decline at different rates. In some cases, these observations appear contradictory, making it difficult to determine which rootstocks to consider when replanting a grove. There are multiple reasons that one rootstock outperforms another, including soil characteristics and pest problems. In the pre-HLB era, multiple rootstocks would perform adequately to grow a productive tree. HLB changes this picture because as it spreads through the tree, it sensitizes the tree to stress.

In many of the observed cases with well-known rootstocks, the differential response is likely due to the rootstock's intolerance of the soil and/or irrigation water quality in the grove site. This is commonly observed where Swingle is planted in high pH soil or in groves with high bicarbonate irrigation water, as detailed in the May 2015 issue of *Citrus Industry*. However, in many sites, including some rootstock trials, Swingle continues to perform well compared to most other rootstocks. Pest pressures such as phytophthora and nematodes can also compound stress on HLB-affected trees, and appear to accelerate tree decline (May 2011 and July 2015 issues of *Citrus Industry*).

With many of the fast-release rootstock varieties that are or soon will be in nurseries, there is limited knowledge about soil adaptability. Most of them were selected for tolerance to salinity, calcareous soil and vigorous growth in the presence of phytophthora, but data on their optimum pH range and production characteristics in different soil types are still very preliminary. Despite the limited knowledge, some of them appear to be less susceptible to HLB than existing rootstocks in multiple field trial locations. In these new, complex breeding lines, it is possible that specific traits exist to make them less susceptible to HLB, rather than just reducing other stresses on the tree. One possibility is that they could be less susceptible to the early stage HLB root loss that was described in the August 2015 issue of *Citrus Industry*.

ROOT SAMPLING STUDIES

To investigate the susceptibility of these rootstocks to early-stage HLB root loss, roots were sampled at the University of Florida's Citrus Research and Education Center (CREC) St. Helena rootstock trial conducted by the CREC plant improvement team. Rootstocks for sampling were selected based on the general canopy appearance of infected scions, early-yield performance (2010–2013), breeder recommendations and a few random selections [Orange series: 1, 3, 4 (UFR-2), 14, 18, 19 (UFR-4) and 21, Green 2, Green 7, Changsha + 50-7, Cleo + Carrizo, FG1733 and 68-1G-26-F4-P6]. Initial root sampling of commercial rootstocks (Swingle, Kuharske Carrizo, Cleopatra mandarin, Volkamer lemon) showed no difference in response to HLB, so Swingle was used as a conventional rootstock for comparisons of root density.

When sampling began in 2013, many of the trees were still asymptomatic. However, most tested positive for *Liberibacter* by PCR (polymerase chain reaction) in the roots, so resistance still remains elusive. The few trees that were presumed healthy at the beginning of sampling became positive within two months, so it is not possible to directly compare a healthy root system of these rootstocks to an infected root system. Nevertheless, we can observe how the roots respond to disease over time.

Most of the rootstocks produced diseased root systems with similar root densities to diseased Swingle rootstock at the trial. For these rootstocks, the improved performance probably has more to do with adaptation to the soil or other pests than reduced susceptibility to HLB. When sampling began, trees were tested for phytophthora. All conventional rootstocks were infested with phytophthora, whereas the new breeding lines had no detectable phytophthora. This is a possible reason for the improved performance.

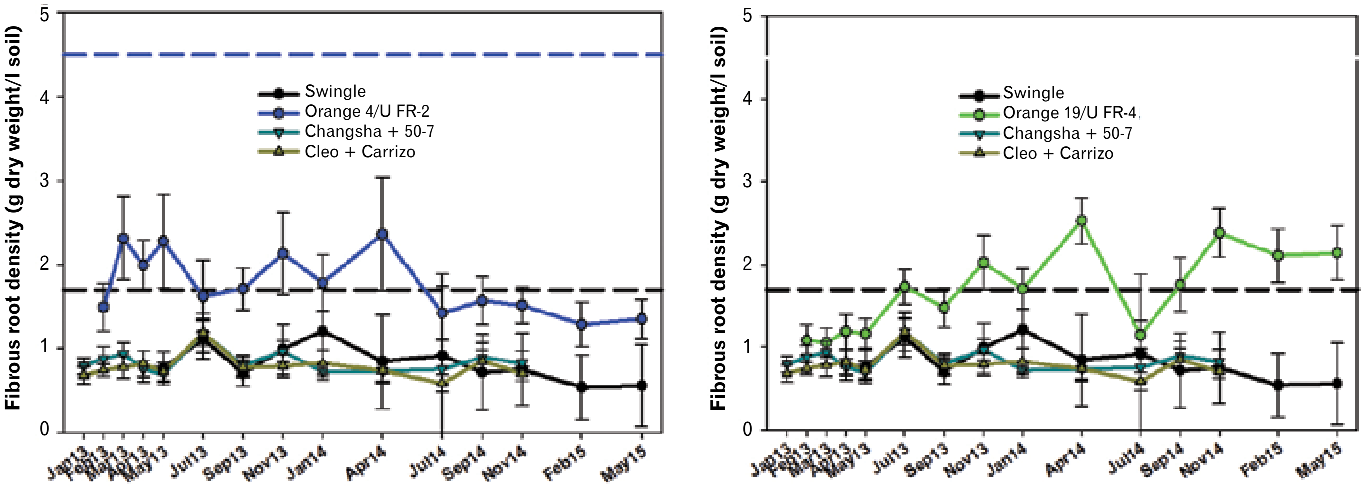

Figure 1. Root density of selected rootstocks at the St. Helena rootstock field trial highlighting two rootstocks with differential responses to HLB a) UFR-2 and b) UFR-4. The black dotted line represents the historical average healthy root density of Swingle. The blue dotted line represents the estimated healthy root density of UFR-2.

ROOTSTOCK STANDOUTS

Two of the new rootstocks (UFR-2 and UFR-4) had different root densities than Swingle. These were both progeny of the same cross of somatic hybrids; however, they differed in their response to HLB. A couple of the sampled UFR-2 trees were still PCR negative when sampling began, and these trees had double the root density of an average healthy Swingle. HLB-affected UFR-2 trees had a root density that equaled that of a healthy Swingle (Figure 1). While the rootstock still suffered 50 percent root loss, the root density could be considered sufficient assuming that the surviving roots functioned normally for water and nutrient uptake.

The scion canopies of these trees continued to look healthier than those on other rootstocks for about a year. However, substantial leaf drop coincided with a second reduction in root density. The root density no longer increased with expected root flushes, suggesting that UFR-2 entered the second phase of root loss. This delayed canopy decline may prove useful in reaching economic viability when combined with good CHMA (citrus health management area) management of psyllids.

The response of UFR-4 showed that there is genetic variability within citrus for the root response to *Liberibacter* infection. Unlike all other rootstocks tested, the root density of UFR-4 increased with infection and early symptom spread. Although experiments are still underway, this increased root density in UFR-4 is thought to result from *Liberibacter*-induced root growth (as described in the August 2015 issue of *Citrus Industry*) without undergoing HLB-induced root dieback.

Observations of the scion canopies coincident with this root density increase show that symptoms and leaf drop on UFR-4 spread more slowly through these trees than those scions on other rootstocks sampled in this study. This suggests that the root loss is linked to the increased susceptibility to stress, especially water stress, which can cause leaf drop. The carbohydrate-starvation-dependent root loss (normally referred to as second or late phase) has yet to be observed on UFR-4. This is probably because the tree has maintained sufficient carbohydrate supply due to the reduced leaf drop. It is expected that after enough damage has been done to the phloem in the canopy, root starvation will cause a root loss.

Assuming that horticultural properties of UFR-4 continue to look good, this prolonged delay in canopy decline holds promise for maintaining economically viable groves until a long-term solution is found. It also provides parent material for breeding even less susceptible rootstocks.

While there is hope and genetic variability for the breeding of rootstocks that are less susceptible to HLB, the best practice for new plantings is still to carefully match the rootstock to the grove site. Therefore, it is important to know the conditions and challenges of a new planting or replanting site and select the rootstock that is best adapted for those conditions and pest pressures. See the updated rootstock selection guide at www.crec.ifas.ufl.edu/extension/citrus_rootstock/templates/guide/index.html for assistance.

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