An HLB-tolerant citrus rootstock: What exactly does that mean?

By Bill Castle, Jude Grosser, Kim Bowman and Ed Stover

Given the rising promise of rootstocks within the context of HLB in Florida today, a meaningful — if not historic — event took place in Polk County in 1956. In a Davenport grove of sweet orange trees on rough lemon rootstock, burrowing nematodes had completely invaded the grove. However, there was one apparently unaffected tree. The rootstock of that tree was named Clone X. It was propagated, tested and eventually described as tolerant to the nematode. It was named after the owner, Mr. Milam.

Milam rootstock was classified as tolerant. What does that mean? The classic concept of tolerance is one of endurance. In pre-HLB Florida, "tolerant" as observed in the field meant enduring or thriving in the presence of the pathogen or pest, but also implied certain expectations. One assumed that *all the trees* planted on a tolerant rootstock would behave essentially the same regarding the pest or disease. In other words, if Milam was selected as the rootstock to be used in planting a grove site where burrowing nematodes were present, it would be expected that as those trees became infested, they would all remain capable of growing and producing profitable yields.

Now that Florida is in a post-HLB world, can that same expectation be applied to the "HLB-tolerant" rootstocks? The short answer at the moment is *no*. Nevertheless, the good news is that evidence continues to accumulate indicating that rootstocks may be important in helping to maintain productivity in the presence of HLB.

Some insights were collected in an informal survey taken in June 2013 to assess grower observation on scion varieties. Many rootstock observations were also volunteered (www.crec.ifas.ufl.edu/extension/pdf/hlb_scion_survey.pdf). Rootstocks such as x639, Swingle citrumelo, Carrizo citrange, grapefruit, rough lemon and Volkamer lemon drew mixed opinions.

The survey results were general in nature and did not provide any detailed information about the degree or consistency of the rootstock-HLB relationship. Those broad-spectrum grower observations are being complemented with detailed data obtained from a multitude of field trials ranging in age from several years to 7 to 9 years old, planted by the authors with grower-cooperators. Most trials are being assessed annually for horticultural performance, and tree HLB status is rated within the University of Florida (UF) program using a scale of 0 to 4 or 5 where typically 0 = dead and 4 or 5 = healthy. The in-between ratings reflect the degree of HLB incidence and the amount and appearance of the crop. We have shifted over the last two years from looking only at canopy condition to ratings that combine tree condition and the crop. It has become clear that HLB-infected trees (ones on "tolerant" rootstocks

Figure 1. A healthy-appearing, 7-year-old red grapefruit tree (right) on a somatic hybrid rootstock growing at a cooperator's site along Highway 60 in Vero Beach. The adjacent tree is also on the same rootstock.

Figure 2. A healthy-appearing Marsh grapefruit tree (left) on a rootstock rated highly by growers attending a field day at Premier Citrus in Vero Beach in October 2014. Both trees in the photo are on the same rootstock.

or a combination of a tolerant scion and rootstock?) can have good crops of normal-looking fruit.

Citrus Research and Education Center (CREC), St. Helena Trial, Dundee is a large-scale project of Valquarius and Vernia scions replicated on a broad range of rootstocks produced by Drs. Jude Grosser and Fred Gmitter, along with ones imported from Argentina and Italy. The property was provided by Orie Lee and first planted in 2008. The site is nearly 100 percent HLB infected, but so far, the trees on the tetraploid somatic hybrid — white grapefruit + trifoliate orange 50-7 — have remained productive with excellent tree health. The rootstock selections UFR 1-6 and UFR 13 and 14 have been released though the Fast Track program.

Premier Citrus, Cooperator Project, Vero Beach consists of two trials planted in 2007 with replicated, moderately sized plots: Marsh grapefruit trees propagated on 42 seedling rootstocks and red grapefruit trees propagated on eight somatic hybrid rootstocks. Both trials illustrate the scope of HLB-rootstock possibilities. While visiting the site with the grove manager to prepare for a field day in July 2014, Castle was taken immediately to one particular tree (Figure 1). That red grapefruit tree on a somatic hybrid rootstock looked like something from pre-HLB days. The rootstock is being propagated by propping up cut roots to force shoots to develop, and using them to produce clean trees for further propagation and testing.

A field day was held in October 2014 to allow for grower assessment of HLB and overall tree status. The nearly 50 attendees were given a map of the Marsh part of the trial and asked to walk through and rate all trees individually. Of the 40 maps returned, the data summary showed that there was one rootstock in which all the trees were rated "good" by at least some participants and four other selections in which 80 percent of the trees were rated good. On an individual tree basis, one tree was rated good 33 times (Figure 2), and several others also had high marks that suggest grower acceptability.

What we learned from this evaluation was that no rootstock provided 100 percent, high-performing trees regardless of whether its source was from seed or somatic hybridization. Among all the trees, there were some rootstocks with some good trees and other rootstocks in which there were no good trees. That situation leaves the research team a bit perplexed in trying to sort out where to draw the line in declaring a rootstock commercially promising or labeling it "tolerant." Is it a rootstock in which 75 percent or more of the trees were rated highly; is it a rootstock in which only 45 percent were rated highly, but that 45 percent received mostly the highest rating? And, of course, all that we've observed so far could easily change.

Lykes/UF/U.S. Department of Agriculture Cooperator Trial, Basinger was also planted in 2007 with Vernia on nearly 70 rootstocks. There are multiple plots of eight trees of each rootstock from which yield and juice quality data have been collected for several years. This past winter, each plot was independently rated on the same day by one of the authors and a representative of a large citrus company. When comparing each person's ratings of combined tree HLB status and crop and fruit appearance, they were remarkably similar (Figure 3). The trees on several rootstocks rated at 4 or above on a scale of 0 to 5. But, as with the grapefruit trees at Premier, there were no rootstocks in which all the plots rated 5. Once again, no rootstocks were consistently affected by HLB, an observation repeated in other trials of various ages. The most surprising outcome was a statement by the grower who concluded that the

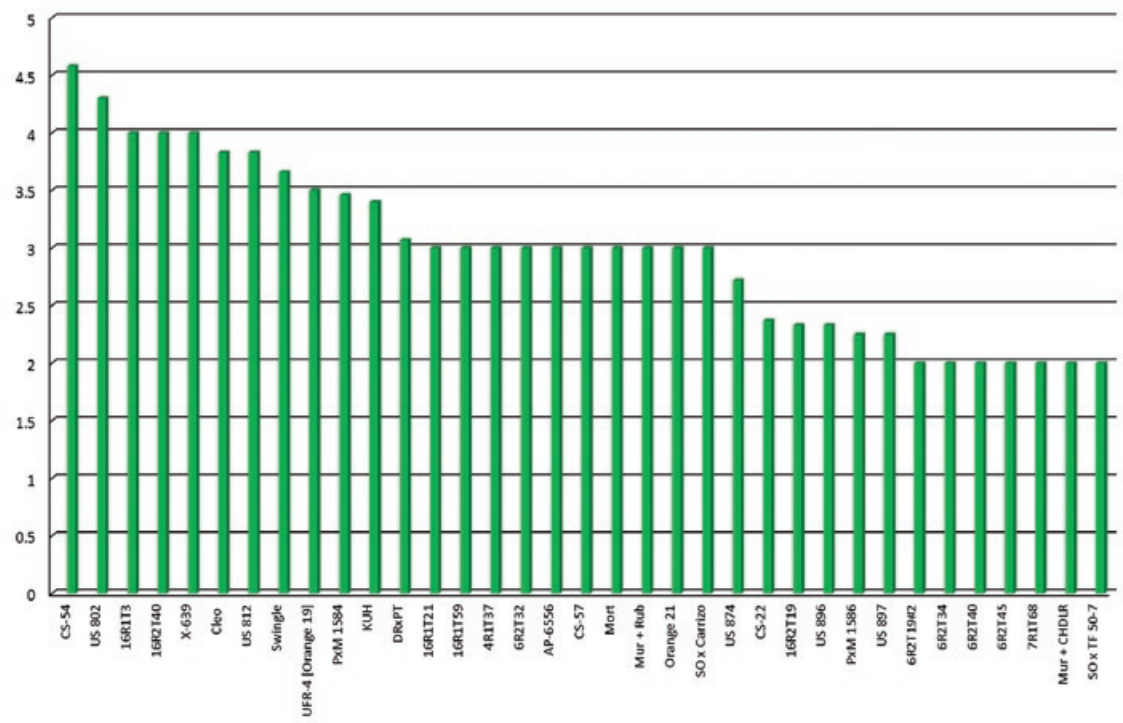

Figure 3. Selections rated 2 or higher on a 0 = dead to 5 = healthy scale by a grower in a 7-year-old Vernia rootstock trial located in Basinger, Fla., in February 2015. The ratings represent a combination of tree canopy condition, crop and fruit appearance in relation to HLB. The same trees were also independently rated at the same time by one of the authors. The ratings and order of rootstocks were nearly identical.

trees on rootstocks rated 3 to 4 were perfectly acceptable for commercial use primarily because of good crops and normal-looking fruit, suggesting that perhaps Vernia is a "tolerant" scion.

So what exactly is an HLB-tolerant rootstock? Presently, the definition is strongly tied to field experiences where apparently healthy trees are often observed in blocks otherwise decimated by HLB. There are many possible explanations for such trees including site and cultural factors, scion-rootstock genetics and their interaction with each other as well as with various specific cultural factors such as nutrition, the psyllid vector and the presumed HLB pathogen. There may be variability in the bacterium itself.

Furthermore, one must be aware of the role of randomness that results in some "lucky" trees, even when an epidemic is quite advanced. It appears that the rootstock affects a tree's ability to "tolerate" HLB. However, it is not yet clear how reliable or consistent this tree tolerance will be in the field. What is missing is clear evidence that such rootstocks exist.

Why isn't that clear yet? Setting aside luck as a factor, one reason is that labeling a rootstock as HLB tolerant could be confusing. Doing so might lead to certain unproven expectations. Our field observations clearly show that, so far, trees on virtually any rootstock are not uniformly affected by HLB, and it is sobering that trees on standard rootstocks such as Swingle and Carrizo are not always among the poorest performers. There are plenty of instances where trees on the same rootstock in a trial display a mixture of HLB symptoms; some trees appear to endure HLB while others are badly affected. What is the expectation if an apparently surviving tree in a trial (Figure 1) or ones found in commercial groves are propagated and then used as the rootstock for new plantings? Would *all* such trees show tolerance to HLB, or would the outcome be the same, i.e., some trees endure while others succumb?

Therefore, until we understand more about HLB and rootstocks, it is best to keep in mind that some combination of at least four components may be involved in rootstock reactions to HLB. They are: (1) the proportion of trees that become affected by HLB after a certain time (**incidence?**), (2) the proportion of trees that show visible symptoms of HLB (**tolerance?**), (3) the severity of HLB symptoms after infection (**tolerance?**) and (4) cropping and fruit characteristics (**tolerance?**).

The choice of rootstock may play an important role in post-HLB Florida. Ongoing and additional studies are necessary to verify HLB-tolerant rootstocks that confer real economic advantages in the context of commercial Florida citrus production.

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