Managing the Health and Productivity of HLB-Affected Groves[1]

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In 2005, Huanglongbing (HLB), or citrus greening disease, was first discovered in Florida. Florida orange production declined from 242 million boxes (90 lbs/box) in the pre-hurricane, pre-HLB, 2003–04 season to 81.5 million boxes in 2015–16. This dramatic reduction in yield is attributable to multiple causes, including a reduction in citrus acreage and the presence of citrus canker and other citrus diseases, with HLB now recognized as the primary reason for declining citrus yields. Growers are urgently looking for strategies to maintain fruit production in their groves under endemic HLB conditions.

After years of extensive research from across the world, we still do not have a cure for HLB; however, we have learned a lot about this disease, the plant's response to the disease, and the disease vector. Based on scientific and observational information gathered in the last decade, a number of tools and strategies are currently available for growers to maintain the health and productivity of HLB-affected trees. In this article, we will shed light on these currently available horticultural inputs and practices that can be implemented immediately by growers to maintain and improve citrus tree health.

Fertilization

Plant nutrition is essential for optimum growth and yield of high-quality fruit. A fertilizer program should include all mineral nutrients required by the plant. Every nutrient is indispensable (Figure 1), and an excess or deficiency of any single nutrient can adversely affect tree performance. The goal of mature tree fertilization is to promote fruit set, growth, and development, and at the same time, ensure maintenance of tree health and fruit bearing surfaces in order to optimize yields for subsequent seasons. Fertilizer recommendations depend on a wide range of factors, such as soil characteristics, age of tree, variety and rootstock, and cultural practices (for more information see *Nutrition of Florida Citrus Trees, 2nd* Edition http://edis.ifas.ufl.edu/ss478).

HLB-affected trees have smaller and weaker root systems than healthy trees. Therefore, it is suggested that growers apply fertilizer in frequent small doses because this maintains a constant supply of nutrients and reduces potential nutrient leaching. Controlled release fertilizer and fertigation can be strategic alternatives to multiple applications of conventional dry granular fertilizer. With the use of controlled release fertilizer and fertigation, the amount of nutrients applied can be reduced by 10–20% and still achieve comparable yields and quality of fruit.

In a recent greenhouse study, HLB-affected sweet orange leaves had lower concentrations of potassium, calcium, magnesium, copper, iron, zinc, manganese, and boron than healthy leaves. These results suggest that HLB-affected trees require higher rates of some essential mineral nutrients than healthy trees in order to circumvent the development of nutrient deficiencies.

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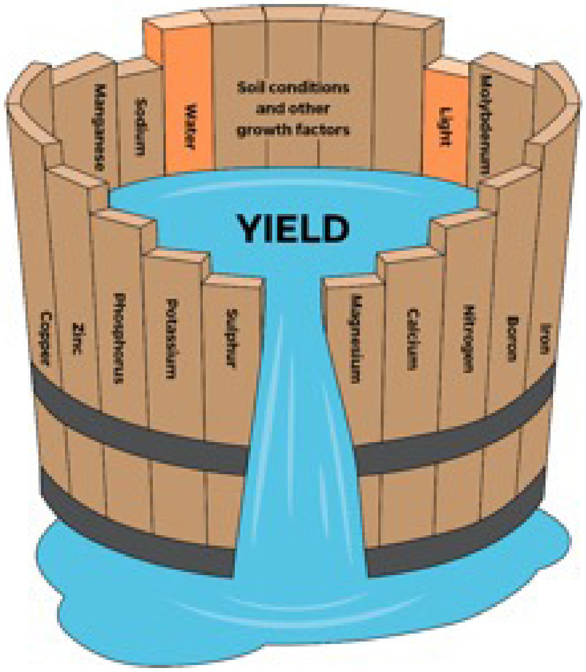

Figure 1. A leaky water barrel depicting that the yield is dependent on a number factors and on Liebig's Law of the Minimum, which states that "growth is controlled not by the total amount of resources available, but by the scarcest resource."
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It is highly recommended that leaf and soil nutrient analysis be performed and taken into consideration before making any changes to a fertilizer program for HLB-affected or healthy trees. When developing a fertilizer program, attention should be paid to all the essential mineral nutrients, and the concepts of the 4Rs of plant nutrition should be implemented. The 4Rs are right source, right rate, right timing, and right placement.

Right source involves the source of a nutrient (dry, liquid, foliar, or controlled release). Ease of application of a nutrient, cost per unit of nutrient, and availability of nutrient must be taken into consideration. For example, a controlled-release nitrogen source may be preferred in delivering small amounts of nutrients throughout the growing season.

Right rate refers to the amount of fertilizer needed during the growing season for the production of profitable crops. The right rate may be dependent on the source of the nutrient.

Right timing of nutrient applications takes into consideration the growth pattern of the crop and the natural changes in nutrient demand that occur during the season.

Right placement—since most nutrient uptake occurs through the root system, placing the nutrients in the root zone maximizes the likelihood of absorption by the plant. In case of foliar fertilizer, attention should be paid to scheduling sprays to coincide with the vegetative flush pattern of the tree. In addition, foliar nutrient absorption is higher in young and tender leaves than mature hardened-off leaves.

Irrigation

There is no doubt that water is the primary contributor to the health and productivity of citrus trees. Attention should be paid to the proper irrigation of trees throughout the year. Water stress can result in physiological changes in tree growth and fruit development. For example, drought stress in the fall can result in pre-mature fruit drop, which can then result in reduced yields. Additionally, the ending of drought stress can result in off-season flowering. Off-season flowering may contribute to a higher incidence of post bloom fruit drop; therefore, drought stress should be avoided throughout the year.

It was shown in recent greenhouse and field studies that irrigation schedules with frequent irrigation of smaller amounts of water benefited HLB-affected trees. HLB-affected trees receiving small, frequent doses of irrigation displayed improvement in tree canopy density, greater leaf area, and reduced leaf drop (Morgan 2016). In light of these studies it is suggested to schedule frequent irrigation of smaller amounts of water to manage HLB-affected trees.

Soil pH, Water Quality, and Bicarbonates

Root zone soil pH is a very critical factor that affects nutrient uptake, especially of micronutrients. Irrigation water in Florida is often high in bicarbonates. Irrigating with high pH, high bicarbonate water over long periods of time can increase the soil pH and therefore can affect tree health and reduce yields. The effect of irrigation water quality on soil pH depends on the bicarbonate concentration in the water, irrigation timing and quantity, the buffering capacity of soil, and the rootstock variety.

Field studies suggest that, in groves where soil pH is high and the irrigation water contains bicarbonates, these groves exhibit increased HLB symptoms and severely declining trees. Leaf and soil nutrient analysis of such groves exhibit a reduced root uptake of calcium, magnesium, potassium, and iron. In another survey it was found that the groves that have soil pH higher than 6.5 and greater than 100 parts per million (ppm) bicarbonates in irrigation water suffered from increased fibrous root loss as well as reduced yields. A clear correlation of yield loss was observed in trees under bicarbonate stress and lower fibrous root density when compared to low-bicarbonate stress trees (Graham and Morgan 2015).

Growers should test their soil pH and irrigation water quality (pH and bicarbonates) regularly. If the soil and irrigation water pH is greater than 6.5 and/or the bicarbonates concentration is more than 100 ppm, acidification should be done. Acid injections or combinations of acids and urea can be used for the conditioning of irrigation water. Acid injections are usually very effective in reducing soil pH, but the major limitation is during the rainy season. An alternative to acid injections is the application of elemental sulfur products to the wetted zone for acidification. The soil pH should be maintained close to 6.0 to 6.5.

Pruning

Pruning adjusts tree shape, modifies the ratio of framework to fruit bearing surface of the canopy, alters the shoot/root ratio, and changes the carbohydrate (food storage) status of the tree.

HLB-affected trees have a smaller root system leading to an imbalanced root-to-shoot ratio. In order to correct the imbalance, some amount of pruning could be useful. Pruning also promotes rejuvenation of the citrus tree canopy. An ongoing pruning trial suggests that if trees are significantly pruned, a substantial yield decrease in year 1 should be expected (Figure 2; Vashisth and Gainey 2016). Removal of a large portion of the canopy can also result in excessive vegetative growth at the expense of fruit set, growth, and development during the first year. After pruning, the rate of nitrogen should be adjusted, corresponding to reduction in canopy volume. High rates of nitrogen may promote excessive vegetative growth and fruit with thick and puffy peels (some of the fruits produced from severe pruning treatment exhibited these symptoms). During this regrowth period, attention should be paid to leafminer and psyllid control and other foliar pests because pruning will result in the simultaneous emergence of new flush on all pruned trees, which is more attractive to foliar pests.

Ongoing pruning trials will provide conclusive results on the effect of pruning on HLB-affected trees, meanwhile it is suggested that growers may opt to do light pruning to rejuvenate the trees, improve light interception, and to remove any dead wood. Buckhorn pruning is not recommended because substantial yield loss occurs in the first four years with this method, which may not be overcome in following years of production.

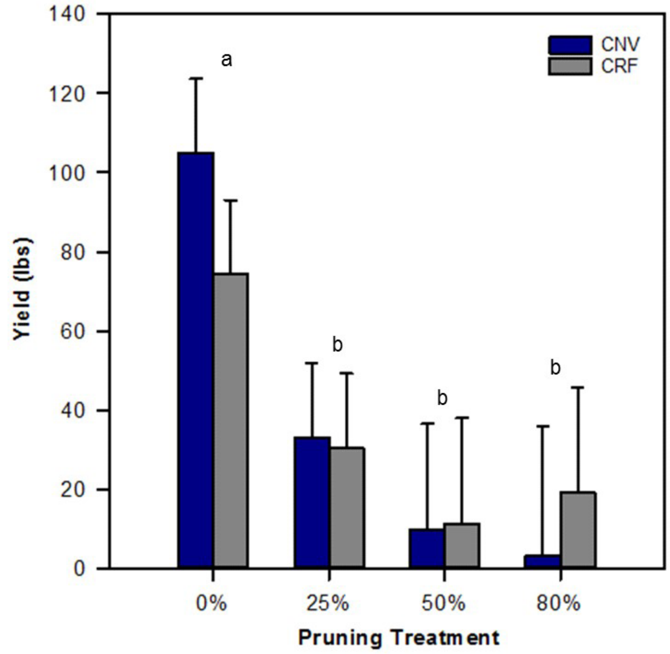

Figure 2. Mean yield (lbs/tree) for each of 4 pruning treatments. The blue bars represent trees that received conventional fertilizer (CNV) and the gray bars represent trees that received controlled release fertilizer (CRF) within each pruning treatment. The pruning treatments include (1) 0%, no canopy removal (control treatment); (2) 25% reduction, canopy topped at 9 feet; (3) 50 % reduction, canopy topped at 6 feet; (4) 80% reduction, canopy topped and all the major branches severely pruned (buckhorned). Different forms of fertilizer were found to be not significantly different. Therefore, the data within each pruning treatment was pooled for both the fertilizers. Sets of bars with the same letter are not significantly different.

Fruit Drop and Quality

Fruit drop can occur as the result of a number of factors, such as water stress, biotic and abiotic stress, carbohydrate shortage, and physiological disorders. Since 2012–2013, HLB-induced pre-harvest fruit drop has become a significant issue.

Plant growth regulators (PGRs) or plant hormones such as auxins, 2, 4-D (2, 4-Dichlorophenoxyacetic acid), IAA (Indole acetic acid), and gibberellins (GA) have been shown to reduce fruit drop in many fruit crops. In 2013, a number of trials were initiated to evaluate the use of PGRs to reduce HLB-associated pre-harvest fruit drop. The study showed that 2, 4-D and GA were not effective in consistently reducing pre-harvest fruit drop. Therefore, it is advised not to use PGRs to reduce pre-harvest fruit drop in HLB-affected trees (Albrigo and Syvertsen 2015).

In HLB-affected trees, phloem plugging disrupts the translocation of carbohydrates in the tree. Data collected on the total soluble solids content (TSS) and size of the dropped fruit suggests that potential disruption of carbohydrate translocation to fruit results in lower fruit quality and increased pre-harvest fruit drop. The TSS of dropped fruit ranged from 6–8 degrees brix, and the average diameter of dropped fruit was less than 2.2 inch. Dropped fruit are of low quality and therefore should not be picked from the ground. With increase in HLB severity, fruit size has decreased considerably. In 2010–2011, more than 60% of the fruit measured were more than 2.5 inches in diameter; whereas, in 2015–2016; less than 30% of the fruit measured were greater than 2.4 inches in diameter. Interestingly, the total soluble solids does not significantly change between small, medium, and large fruit from HLB-affected trees. In 2015–2016 there was less pre-harvest fruit drop compared to previous seasons. Figure 3 shows the average pre-harvest fruit drop data in Florida sweet orange.

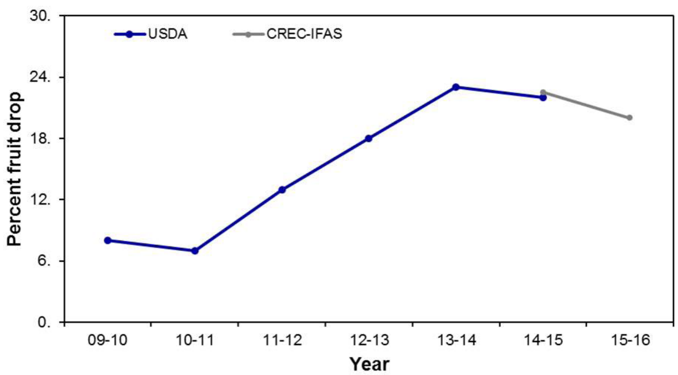

Figure 3. The USDA-reported average fruit drop (%) in oranges in Florida from 2009–2015. The gray line and markers shows the average fruit drop data from 2014–2016 (UF/IFAS CREC).

Summary

- It is advised that growers perform regular leaf and soil nutrient testing, especially before making any changes to nutritional programs or soil amendments.
- A complete, balanced nutritional program should be applied. The 4Rs, principles of plant nutrition, are very important.
- Irrigate frequently with small doses of water.
- Maintain optimum soil pH and regularly check irrigation water quality.
- Light pruning can be beneficial for trees and should be followed by good psyllid and leaf miner control.
- Minimize abiotic and biotic stress on the trees because any stress on HLB-affected trees can magnify the deleterious effects of stress.

The information presented in this article is a compilation of number of studies conducted by research and Extension faculty at UF/IFAS.

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