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2017-2018 FLORIDA CITRUS PRODUCTION GUIDE:

Root Health Management[1]

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IMPORTANCE OF ROOT HEALTH

Developing and maintaining a healthy root system is important for establishment and long-term productivity of trees. The roots take up nutrients and water from the soil to transport them to the tree canopy (leaves and fruit). The root system also acts as an anchor for the tree, which is important during high wind conditions, such as thunderstorms and tropical storms. At the same time, the leaves provide carbohydrates to grow and maintain a functional root system. In a healthy tree, the carbohydrate supply is balanced between new leaves, fruit, and roots. When root health is compromised, the root system has reduced nutrient and water uptake capacity.

FACTORS AFFECTING ROOT HEALTH

Root health can be compromised by pests, pathogens, and environmental factors. Root pests include *Diaprepes* root weevil, burrowing nematode, sting nematode, and others. Historically the most damaging root pathogens in citrus have been *Phytophthora* spp. that cause root and foot rot. The most common detrimental environmental factors in Florida citrus are soil pH, salinity, and flooding. An increase in soil pH above 7.0 results in precipitation of phosphourus, calcium, magnesium and other plant nutrients. Elevated soil pH also reduces the concentration of nutrients in solution and thus the potential for nutrient uptake by the roots. Likewise, salinity and water logging can cause root decline and death. These biotic and abiotic causes of root health decline can be reduced by site-specific decisions made during the preparation for planting or when they become a problem in a grove. These causes of root decline can be managed to varying degrees with cultural and chemical management tools.

ROOT STRUCTURE AND FUNCTION

The root system has two main types of roots, structural and fibrous, that serve different essential functions for the tree. The structural roots act as the major transport corridors for nutrients, water, and carbohydrate. Structural roots also provide the anchoring scaffold for the root system, similar to the branches of the canopy. The fibrous root system form the interface with the soil where water and nutrients are absorbed. Both kinds of roots are important for root and tree health and are affected differently by pests, pathogens, environmental factors, and their interactions. Structural roots often extend long distances down and out from the tree trunk, beyond the edge of the canopy. Fibrous roots only grow at high density from structural roots in clusters where water and nutrients are most abundant. In irrigated trees the fibrous roots are concentrated in the wetted zone of the irrigation system. For example, microjet irrigation concentrates 80% of the fibrous roots in the top 10 inches of the wetted zone under the canopy. It is important to understand this because root health management should be focused on these areas of high fibrous root density.

EFFECTS OF HUANGLONGBING ON ROOT HEALTH

Introduction of *Candidatus* Liberibacter asiaticus (Las), the cause of Huanglongbing (HLB), into Florida greatly complicates citrus root health management. Las infection causes severe damage to fibrous roots that exacerbates the effects of the other root pests and pathogens, and can reduce the efficacy of treatments. Root health management has become more challenging and more important because most citrus trees in Florida are now affected by HLB.

1. This document is modified from SL253, one of a series of the Soil and Water Science Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Original publication date: October 2007. Modified: May 2017. Visit the EDIS website at **http://edis.ifas.ufl.edu**. For a copy of the Florida Citrus Production Guide, request information on its availability at your county extension office.

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HLB severely affects root health causing 30-50% root loss early in disease development and later 70-80% root loss once canopy decline begins (sectored leaf drop and dieback). This root loss results from a shortened lifespan of the fibrous roots from a healthy 9-12 months down to a diseased 4-month lifespan. The shortened lifespan is accompanied by increased root growth, leading to an imbalance in carbohydrate demand and reducing the total uptake capacity of the root system. Currently, there is no proven management option for prevention of HLB-associated root loss. Treatments that stimulate root growth are not recommended because they may increase the root-canopy imbalance. Instead, growers should attempt to prevent further damage to the existing roots and try to maintain or improve root longevity. This includes irrigation and fertilization in small and frequent doses and adjustment of soil pH below 7.0 to avoid stressing the root system and to balance the water and nutrient supply with the root systems ability to take these resources.

MANAGING ROOT HEALTH

A healthy root system improves productivity of trees and improves their tolerance of major stresses, such as freezes and drought. Starting a grove with a healthy root system allows for rapid tree establishment and growth. Maintaining a healthy root system in existing groves lengthens the productive life of the trees.

ROOT HEALTH IN NEW PLANTINGS

The best way to manage root health is to prevent problems from starting. This requires careful consideration and planning before planting a new grove or even ordering trees for the grove. The largest contributor to root health that will affect pests, pathogens, and the tree itself is the soil and water at the site. The most cost effective way to manage root health is to prepare the field for planting and choose rootstocks based on site specific knowledge of the soil and irrigation water. Flooding and water table problems that affect root health can be managed with land preparation including drainage and bedding. Many of the soil, pest, and pathogen problems can be addressed by choosing the best adapted rootstock. This includes knowledge of the site history, such as existing nematode problems or previous infestations of Diaprepes. It may also be important to know what has been done in the past to modify soil pH. If recent efforts were made to change the soil pH with liming or sulfur, it is likely that the soil will slowly shift back to its native pH with time. To avoid the perennial expense to adjust the pH in your grove, a rootstock with an appropriate pH tolerance should be selected. Rootstock selection can be difficult because more is known about the soil preference and pest and pathogen resistance for some rootstocks than for others (including newly released ones). To help in the selection process, a summary of what is known for commercially available rootstocks can be found in the rootstock selection section of this guide and the Citrus Rootstock Selection Guide (http://www.crec.ifas.ufl.edu/extension/citrus_rootstock/templates/guide/). Some locations may have multiple pest, pathogen, and environmental problems. In these cases, a rootstock that addresses all the problems may not be available. It is important to consider which problems are the most severe at the site and which can be most easily and economically managed on a regular long-term basis. In situations where multiple problems cannot be addressed by proper rootstock selection, alternative crops should be investigated.

ROOT HEALTH FOR EXISTING GROVES

Unlike new plantings, in existing groves root health problems have to be managed instead of avoided. However, like new plantings, management of root health in existing groves has to be site specific. The first step should be to identify the problems present in the grove. Soil samples should be taken for pH, nutrient analysis as well as Phytophthora and nematode counts. Irrigation water samples should also be taken to determine pH, salinity, and bicarbonate content. Bicarbonates are leached from limestone in the aquifer and act as a buffer raising the pH in the water and irrigated soil. Groves should be scouted for the presence of Diaprepes root weevil and if they are known to be a problem (see Citrus root weevils chapter). Once the problems with root health are identified, a decision making process should be developed to determine which problems are the most severe and should be managed first. For example, if *Phytophthora* spp. are at damaging levels on roots but there are also problems with soil pH and Diaprepes, addressing soil pH or Diaprepes may effectively reduce Phytophthora populations in a grove soil because of their interactions with Phytophthora. Therefore, pH or Diaprepes should be treated first and Phytophthora counts reassessed to determine if chemical applications for *Phytophthora* spp. are still needed.

HLB-induced root damage also interacts with *Phytophthora* spp. by increasing the exudation of sugars from roots. This sugar exudation attracts Phytophthora zoospores increasing infection. HLB also reduces the efficacy of fungicides (phosphite, focetyl-Al, and mefenoxam) for control of *Phytophthora* spp. Timing is essential to maintain efficacy of Phytophthora management applications. Propagule counts should be monitored carefully for developing problems, so that late summer or fall root flushes (root flushes follow leaf flushes) can be protected. For more information, see the Phytophthora foot rot and root rot chapter for more detail.

Soil pH and irrigation bicarbonates have gained attention because HLB-associated root loss has reduced the tolerance for pH incompatabilities on rootstocks mismatched with the soil such as Swingle on high pH soils. In many cases, especially in the flatwoods, management of pH and bicarbonates has been shown to increase root density of trees with HLB. For yet to be determined reasons, groves on ridge soils do not respond as well to pH and bicarbonate management. Soil pH or high bicarbonate irrigation water can be treated with ground applied sulfur or by acidifying irrigation water with injections of sulfuric or N-phuric acid. For Swingle rootstock, the ideal pH range is 5.5 to 6.5. Recent field experiments have determined that maintaining soil pH in the 5.5 to 6.5 range increases nutrient uptake and root density. It is important to test the pH before and after treatment as over-acidification can lead to release of copper and other metals and depletion of essential nutrients from the soil. Depending on soil tests of nutrients such as calcium, supplemental application may be necessary to replenish those lost from leaching and to prevent copper toxicity to roots. When pH management is necessary, sources of calcium should be chosen to not counteract pH management, for example, gypsum ($CaSO_4$) instead of lime can add calcium without increasing the soil pH.