



Figure 1. Rhizotron root analysis with root growth is traced in infected (green) and non-infected (red) roots. Dieback of infected roots is clearly visible in the photo on the right.

Studying citrus roots in the HLB era

By Lorenzo Rossi, Ute Albrecht and Evan Johnson

Citrus root systems are confronted with many challenges that limit resource availability needed for tree productivity. Challenges are compounded by huanglongbing (HLB), which now affects nearly all citrus trees throughout Florida's production areas. Contrary to the above-ground portion of the tree, study of the below-ground portion is considerably more difficult. This article provides a brief overview about root function and methodologies to study root growth and development.

THE ROLE OF ROOTS

A healthy root system provides the anchor and support needed to secure a tree in place. More importantly, roots are the lifeline of a plant, taking up water and nutrients from the soil and moving them up into the leaves, where they can interact with sunlight to produce sugars and energy for tree growth and fruit production.

Roots also secrete different organic compounds, such as sugars and organic acids, into the soil that attract and promote growth of microorganisms that are beneficial for protection from soil-borne pests and diseases. Other microorganisms also improve the root structure and therefore the capacity of the roots to take up water and nutrients. (See citrusindustry.net/2018/11/09/components-of-a-healthy-citrus-soil/ for more information on soil health.)

Nutrient uptake is mainly conducted by the fine roots (fibrous roots smaller than 1 millimeter in diameter). In addition to taking up nutrients, roots also secrete ions and various organic acids that increase solubility and therefore availability of otherwise non-available nutrients that are essential for plant growth.

Continued on page 14

Keep your investments growing

with

SPROUT GUARDS

Sprout Guards may also be custom ordered to any size needed, regarding mechanical harvesting.

30 YEARS EXPERIENCE



Don't have time to sprout trees?

Grow them tall and straight with Sprout Guards.

Call today for pricing

Black Sprout Guards, 8"x18"

BEST WRAP, BEST PRICE AND BEST SERVICE

Mike Hurst Citrus Services, Inc. (863) 443-0531, hurstcitrus@gmail.com

Tropicana®

1001 13th Avenue East, Bradenton, FL 34208

Tropicana Sr. Procurement Manager
Eddie Wertz
Office: (941) 742-2646 or (863) 494-5658
Mobile: (863) 990-1852

Sean McCoy
Buyer - Northern Area
Office: (941) 742-2406
Mobile: (863) 632-1141



Steve Riffle
Buyer - Central Area
Mobile: (863) 214-3222

Tim Sink
Buyer - Southern Area
Office: (941) 742-2371
Mobile: (941) 256-6250



Figure 2. Minirhizotrons (left) and a camera system (right) are used for in-field imaging of young citrus tree roots.

HLB DYNAMICS

HLB causes severe nutritional imbalances in affected citrus trees. This is partially due to the damage HLB imposes on the fibrous roots. It is now recognized that improved nutrient management, particularly higher applications of specific micronutrients, is of great importance to maintain or improve health and productivity of HLB-affected trees. As a result, many growers in Florida are now implementing a constant and balanced supply of nutrients to their trees, while planting HLB-tolerant varieties and rootstocks.

Understanding the dynamics of how HLB affects the root system may lead to development of new and improved management strategies. Fertilization guidelines in the pre-HLB era are based on content of nitrogen, phosphorus, potassium, calcium, magnesium and micronutrients in leaves of healthy trees. These guidelines are currently being revisited given the prevalence of HLB-affected trees throughout the state, many in early or pre-symptomatic stages of the disease. New guidelines can focus on optimal nutrient concentrations to maintain healthy roots, but gaps exist in our understanding of how HLB progression is affected by different nutrient management strategies.

An ongoing project funded by the Citrus Research and Development Foundation is testing different nutrient management strategies and aims to rehabilitate declining trees while restoring root health. Several field trials have recently been established using variable rate soil management techniques for oranges and grapefruit in

different Florida production regions. The results will determine the optimal fertilizer dose and irrigation techniques and will relate these to indicators of root health, growth and yield performance. Through this approach, optimal nutrient and irrigation management techniques will be identified and quantified.

Improved nutrient management, particularly higher applications of specific micronutrients, is of great importance to maintain or improve health and productivity of HLB-affected trees.

ROOT SYSTEM ARCHITECTURE

One aspect of roots that is receiving greater attention is root system architecture. The root system architecture is defined by its shape and its structure. The root shape is the three-dimensional arrangement of the roots in its environment. It can be described by the number of roots, root depth and root length throughout the soil. The root structure describes the different components of the root system and their characteristics and relationships. This includes root age, root diameter, root color and branching pattern, which are directly associated with root physiological properties.

The citrus root system architecture



DON'T MISS AN EPISODE!

Podcast topics have included:

- Keeping groves productive
- What to plant now
- Improving citrus health
- Fresh fruit packing
- Citrus pathogen research
- Planting economics
- Citrus production guide
- International citrus programs
- Extension updates

New episodes monthly!

CitrusIndustry.net/allinforcitrus

(See ad on page 35 for more info.)



Figure 3. A minirhizotron imaging system captured images of fibrous roots from young citrus trees grown in a Southwest Florida grove. The photo on the right shows the tracing to calculate root length and other root parameters.


can vary greatly among rootstock varieties and is also influenced by nutrient and water availability and diseases, particularly phytophthora and HLB. HLB causes substantial root loss, between 30 and 50 percent in the early stage of infection before visual symptoms are present and during early symptom development (see <http://citrusindustry.net/2017/06/02/hlb-and-root-longevity/>). Root loss increases to 70 to 80 percent during

the later stages of infection.

Identifying and developing new varieties with more efficient roots that can better tolerate the HLB-induced damage is critical. Research is underway to decipher differences in root system architecture among rootstock varieties and to determine the adaptive value of specific root traits, their genetic control and their agroecological impacts. Results will lay the foundations for a better understanding

of the dynamics of nutrient uptake and movement in HLB-affected citrus trees and their effects on root health and rhizosphere ecology.

Historically, studies on root traits have been limited due to the challenges of excavating root systems for phenotyping (i.e., assessing the physical characteristics of the roots). However, deciphering root system architecture including branching, number of roots, root diameter and root angle in various




MASSEY FERGUSON



**POWERFUL.
PRACTICAL.
PRODUCTIVE.**


Since 1847, Massey Ferguson has led the way in developing machinery to make farming more efficient. More functional. More comfortable. And more profitable. Stop by and see for yourself why Massey Ferguson is the name you should trust.

Visit Kelly Tractor to test drive the 2600 Series tractors.

 <p>KELLY TRACTOR CAT</p> <p>www.kellytractor.com/agriculture</p>	<p>Clewiston, FL 801 E. Sugarland Hwy</p> <p>Davie, FL 2801 Reese Road</p>	<p>Fort Myers, FL 9651 Kelly Tractor Dr.</p> <p>Miami, FL 8255 NW 58th St.</p>
	<p>Orlando, FL 144 W. Landstreet Rd.</p> <p>West Palm Beach, FL 5460 Okeechobee Blvd.</p>	

Visit Kelly Tractor to see our Massey Ferguson lineup or contact Garry Anderson at 239-438-2477 or Garry_Anderson@kellytractor.com

©2019 AGCO Corporation. Massey Ferguson is a worldwide brand of AGCO Corporation. AGCO and Massey Ferguson are trademarks of AGCO. All rights reserved.



root classes is of great importance as it will affect plant growth and health.

Modern technologies now permit the observation of root systems on location without the need for tree excavation and destruction. These technologies include rhizotrons (Figure 1, page 12), minirhizotrons (Figure 2, page 14) and 2-D root reconstructions (Figure 3, page 16), in combination with sophisticated camera systems and computer analysis software. In close collaboration with horticulturists, plant physiologists, molecular biologists and plant breeders, this work will aid in the identification and generation of new and superior citrus rootstocks that substantially improve productivity under HLB-endemic conditions.

To develop effective root health management strategies, it is important to understand how root loss occurs and what physiological changes HLB is causing in the roots.

CONCLUSION

The study of the belowground dynamics and the understanding of the interaction between HLB-affected citrus roots, cultural practices and tree productivity is imperative to develop irrigation and nutrient management recommendations in the HLB-era. To develop effective root health management strategies, it is important to understand how root loss occurs and what physiological changes HLB is causing in the roots. 🍊

Lorenzo Rossi is an assistant professor at the University of Florida Institute of Food and Agricultural Sciences (UF/IFAS) Indian River Research and Education Center in Fort Pierce. Ute Albrecht is an assistant professor at the UF/IFAS Southwest Florida Research and Education Center in Immokalee. Evan Johnson is a research assistant scientist at the UF/IFAS Citrus Research and Education Center in Lake Alfred.



Solicam® = Balance

*Tough on grasses and broadleaf weeds,
while safe on young trees*

Solicam® herbicide from NovaSource delivers the perfect balance between effective perennial grass and broadleaf weed control, along with safety for the young trees in your citrus grove.

And with the additional benefit of maintaining residual control late into the growing season, SOLICAM provides value that lasts and lasts.

Contact your crop protection advisor, visit us at novasource.com or call 800-525-2803 for more information.



Always read and follow label instructions.

NovaSource® and Solicam® are registered trademarks of Tessenderlo Kerley Inc. Pat. novasource.com. ©2018 Tessenderlo Kerley Inc. All rights reserved.

MAKE CRITICAL DECISIONS WITH REAL-TIME DATA

Frost | Soil Moisture | IPM

DAVIS | **ENVIROMONITOR**

CDF Sales and Associates Inc. Call us at 863-402-1072