

Root health of HLB-affected groves: What are the issues and can we manage them?

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Current situation and questions about HLB expression in Florida

Situation

- HLB incidence is approaching 100%, especially in young groves
- This season was dry before July and after September
- Fruit drop statewide has led to four reductions in the USDA crop estimate (unprecedented)
- Most of the Hamlin and Valencia drop appears to be due to HLB

Questions

- Why do HLB-affected trees drop fruit?
- Why is fruit drop greater than in past seasons?

Bacterial infection of the phloem causes carbohydrate disruption and fruit starvation

- About two months before harvest sugars move from the leaves into the fruit such that the Brix and sugar/acid ratio increases
- In HLB trees starch accumulates in the leaf cells and disrupts the chloroplasts (leaf mottling)
- Movement of sucrose from the leaves to the fruit through the phloem is disrupted (sugar/acid ratio may decrease in HLB fruit)
- Lack of carbohydrate supply causes fruit starvation and premature drop



Aborted fruit that drop have stem-end break-down



Drop of early, mid and late season oranges due to HLB

Midsweet



Hamlin

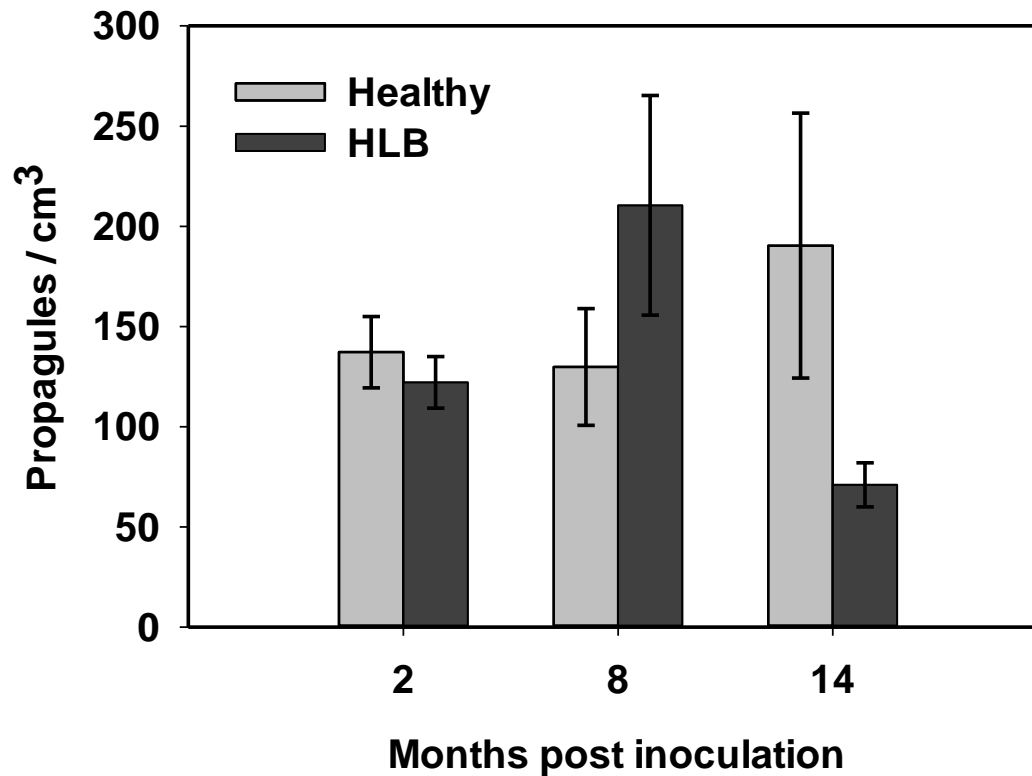


Valencia

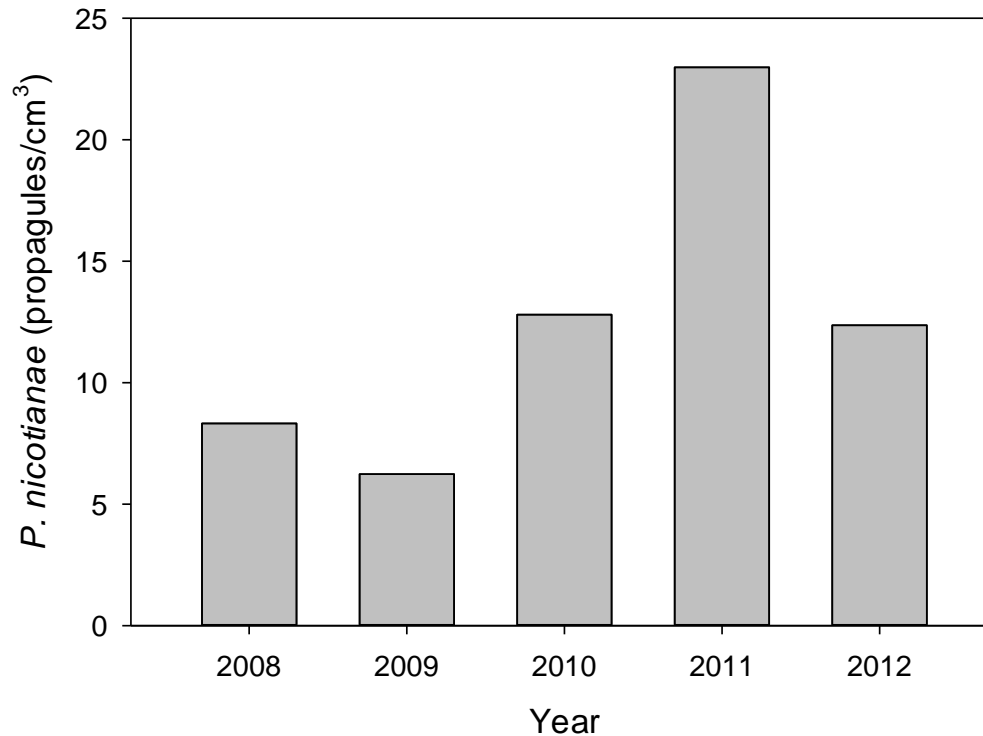
Findings from our recent greenhouse and field studies on root health of HLB-affected trees

- The bacterium moves to the roots after initial infection /transmission in the shoots
- The HLB pathogen, *Candidatus Liberibacter asiaticus* (*Las*) infects structural and fibrous roots
- *Las* colonizes the roots before the shoots, phloem is not plugged
- This infection causes a rapid of fibrous root loss of 27-40% before symptoms in the canopy
- Phytophthora interacts to further reduce root health but the majority of the root loss is due to HLB
- Phytophthora populations of HLB trees initially increase then as roots are lost due to *Las* infection, the populations decline rapidly

Phytophthora population in potting soil at 2, 8 and 14 mpi for bud-inoc trees confirmed HLB+ and mock-inoc HLB- trees



Statewide drop in Phytophthora counts in 2012 may indicate more HLB-induced root loss which accelerates fruit drop



2012 count based on **2961** samples

Data courtesy of John Taylor, Syngenta Crop Protection

Crop loss for HLB symptomatic trees compared to matched healthy Valencia orange trees on two rootstocks in Hardee Co. from 2009 to 2011*

Rootstock	Health	2009 Fruit no. per tree	2009 Difference	2010 Fruit no. per tree	2010 Difference	2011 Fruit no. per tree	2011 Difference
Swingle	Healthy	849		896		777	
	HLB	519	-39%	561	-37%	532	-31%
Carrizo	Healthy	1043		803		873	
	HLB	673	-35%	621	-23%	613	-30%

*In 2011 measured a **45% reduction in fibrous roots** for HLB+ trees compared to HLB-

Data kindly provided by Davis Citrus Management, Inc.
and Magnolia Consulting, Inc.

Conclusions from HLB root health studies

- Measured a 27-40% reduction in root density for presymptomatic and recently symptomatic HLB trees
- Root loss equates with the $\geq 30\%$ yield losses on early symptomatic trees in Florida treated with good irrigation and nutritional management
- Phytophthora interacts to further reduce root health but the majority of the root loss is due to HLB

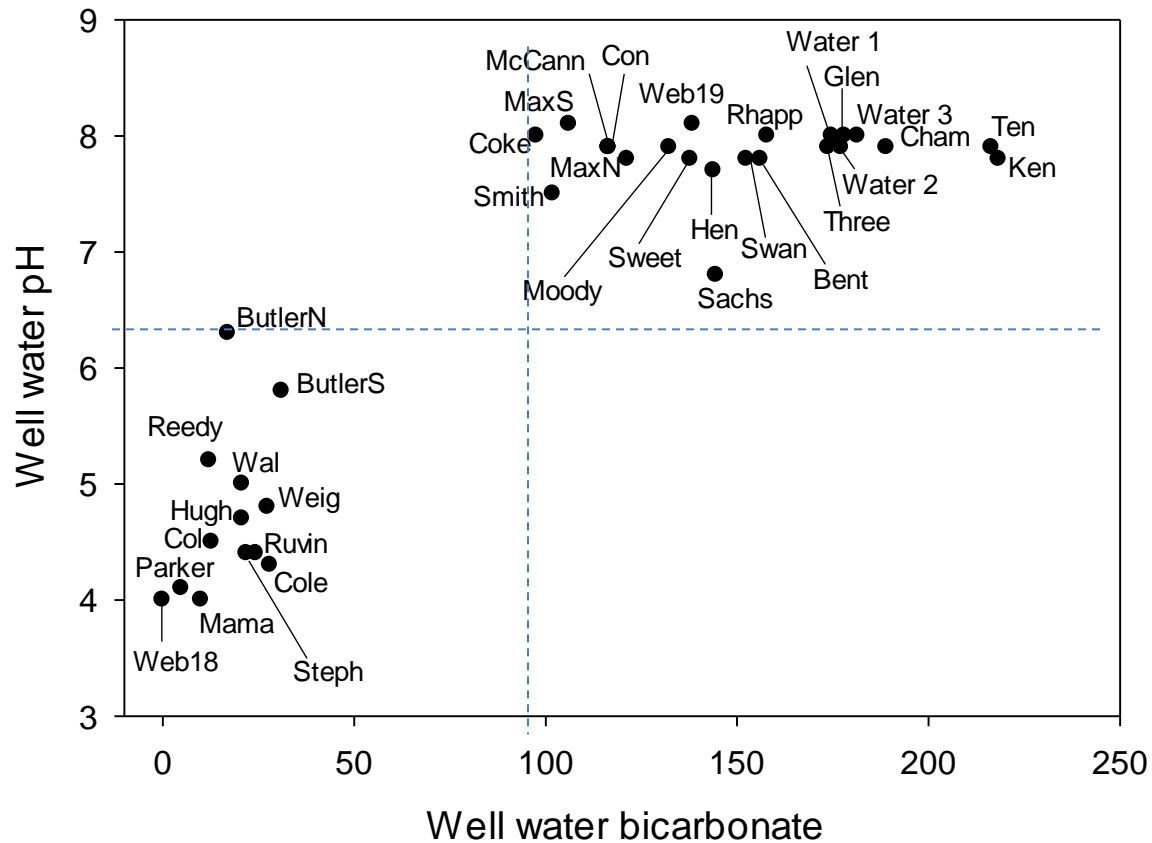


Another factor affecting root health and HLB disease expression – Soil pH and well water quality

- Deep well water is often high in pH (≥ 7.5) and calcium bicarbonate (≥ 100 ppm)
- Trifoliate hybrid rootstocks, Carrizo and Swingle are severely stressed by bicarbonate, e.g., perform poorly on calcareous soils
- In Ridge groves with history of dolomite liming for control of copper toxicity and/or microjet irrigation with soil pH >6.5 and /or high bicarbonate well water are associated with $>$ HLB decline
- Groves with soil pH <6.5 and/or low bicarbonate water may be experiencing $>$ deterioration in root health
- In cooperation with Davis Citrus Mgmt, compared trees in 9 yr old Val/Swingle blocks planted with or without liming and deep vs. shallow wells

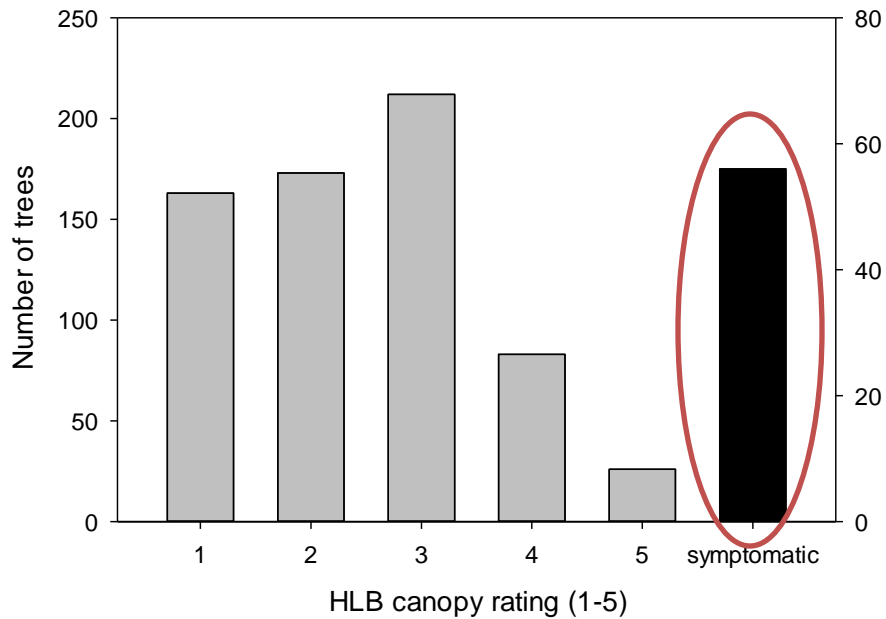
Deep well water is fundamentally different in pH (> 6.5) and bicarbonates (>100 ppm)

Data from Davis Citrus Management

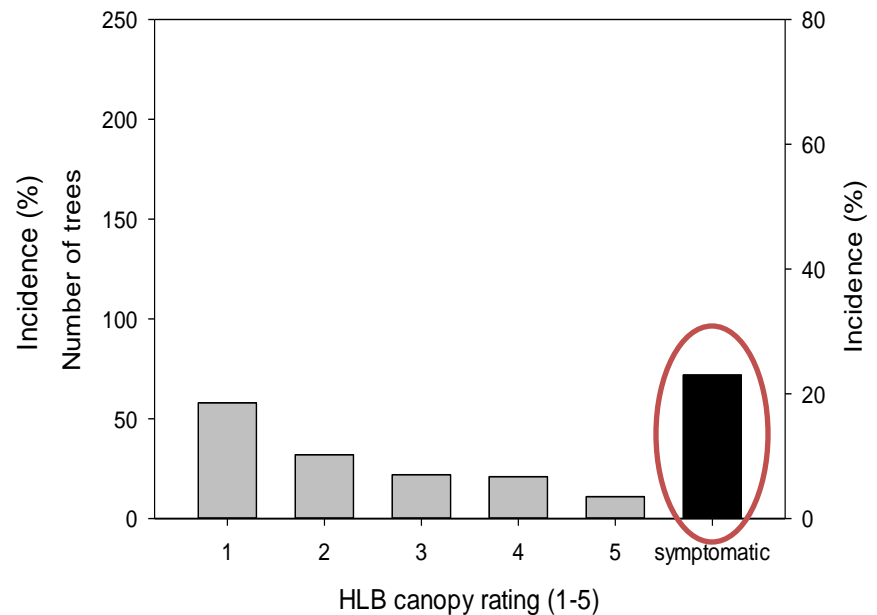


HLB canopy decline is more severe in the Swingle block irrigated with deep well water (56%) vs. shallow (23%)

Deep well water



Shallow well water

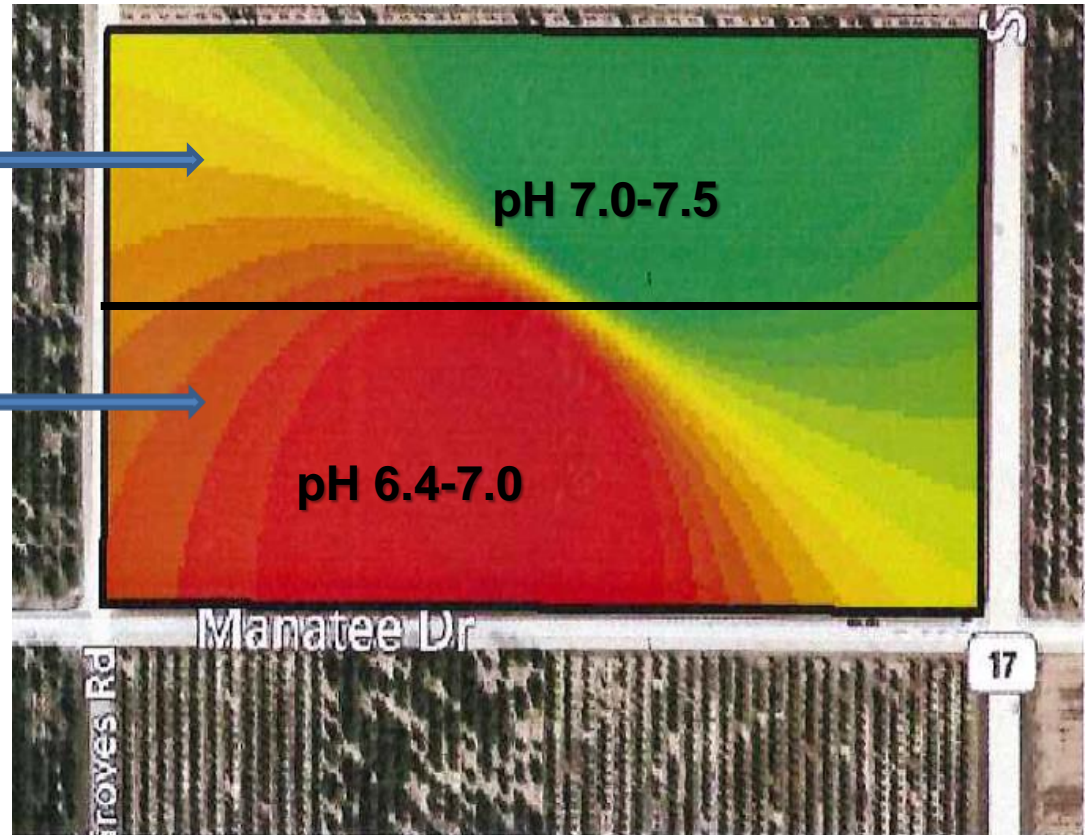


HLB canopy rating (1-5) is 1= symptoms on one limb, 2= mild, 3= moderate, 4= severe, 5= canopy dead

Dolomite history in McCann block: Is soil pH making a difference in tree health?

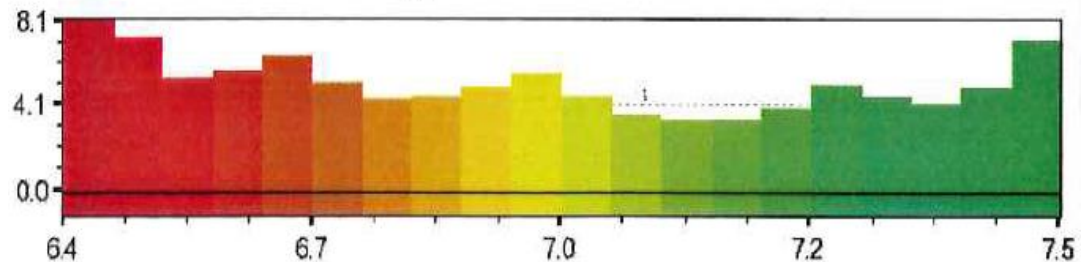
Old grapefruit block removed, dolomite treated and solid block set in 2003

Valencia block dolomite treated and periodically reset including in 2003



Min: 6.4 Max: 7.5 Avg: 7.0

Data from
Davis Citrus Management, Inc.



Current health and fruit drop status of Valencia/Swingle trees planted in 2003



pH 6.4: Fruit drop minimal



pH 7.2: Fruit drop resulted in early harvest

Swingle block on deep well water has 25% less fibrous roots, i.e. lower root health, than shallow well block

	Rootstock	Root weight (g)	Phytophthora positive samples
Cooper	Swingle	0.39 a	4/8
McCann	Swingle	0.29 b	0/6



Where to go from here?

California Central Valley Tour*

*Sponsored by Syngenta



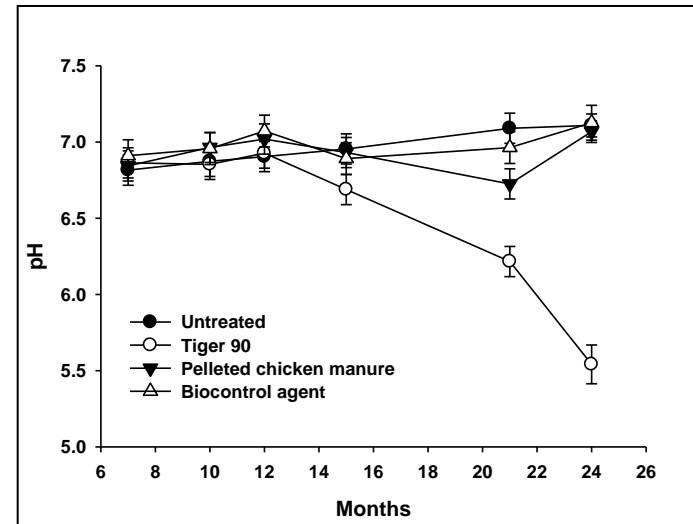
e. g. Water conditioning

N-furic acid (15-0-0) to adjust water to pH 6.5



e. g. Soil conditioning

Tiger 90 pelletized sulfur to drop soil pH from 7.0 to 5.5 (2 yr)



Ridge grove in Lake Garfield
Data from L. W. Duncan, CREC

Pathogen/pest recommendations

- Phytophthora, nematodes, weevils that damage roots should be managed more aggressively to sustain root health – details FCPMG
- www.crec.ifas.ufl.edu/extension/pest/
- e.g. Phytophthora count is $>10-20$ prop/cm³ recommend alternating fungicides
- After spring shoot flush - Aliette/phosphites
- 45 days later – mefenoxam (injection)
- 45 days later - Aliette/phosphites
- After fall shoot flush – mefenoxam (injection)



Final recommendations

- Match nutritional supply with tree demand using leaf testing
- Balance the costs of root health management with other resources for HLB, i.e. psyllid control, best mgt. of irrigation and nutrition, control of other pests and diseases
- Factors such as soil pH, bicarbonates, and salinity in irrigation water that may stress roots important issues on HLB-affected trees that require active management
- Check soil pH (wetted zone) and test well water for pH, bicarbonates, salinity, cations, anions
- Currently investigating whether tree health benefits from acidification of soil and/or irrigation water

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