Managing Fibrous Root Loss due to HLB

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Current situation and questions about HLB expression in Florida

Situation

- HLB incidence is approaching 100%, especially in young groves
- USDA crop estimate is 15% lower than last season (lowest since the 1960s)
- Drop occurring on all varieties in all regions

Questions

- Why is fruit drop again greater than in past seasons?
- Will drop continue this season?

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 the 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 reduced
- Lack of carbohydrate supply causes fruit starvation and premature drop

Aborted fruit have stem-end break-down

Findings on root health of HLB-affected trees and management considerations

- 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 but does not cause plugging
- Initial root infection causes fibrous root loss of 30-50% before symptoms appear in the canopy
- Later root loss increases to 70-80% as the canopy thins

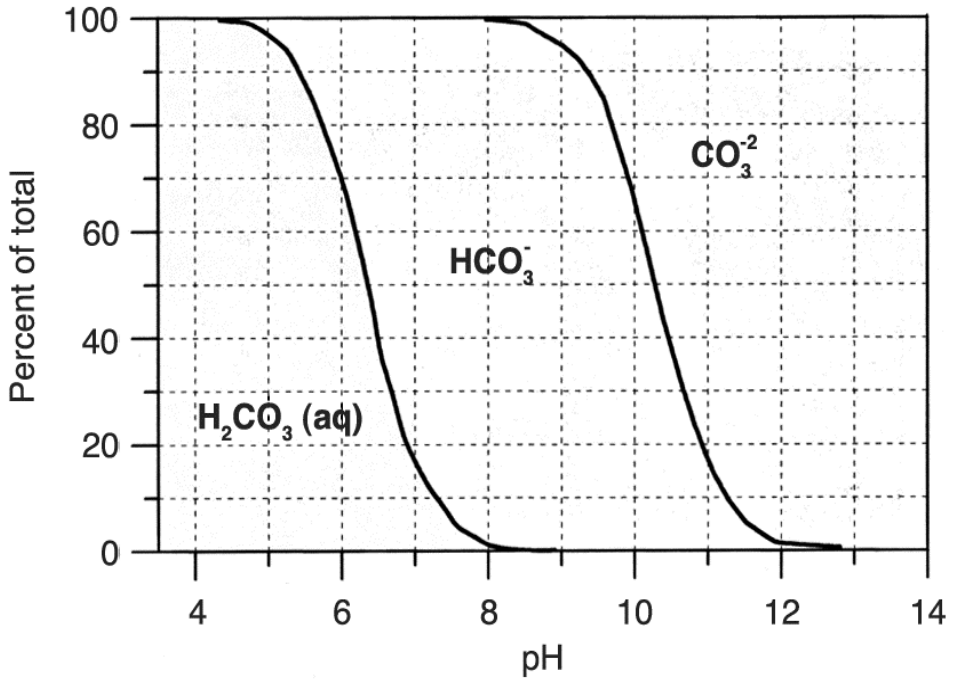
Management considerations:

- Stimulating root growth is not likely to help and may increase roots at the expense of fruit!!
- Minimize root stress in the wetted zone where 80% of the fibrous roots are located

Soil pH and well water quality affect root health and HLB disease expression

- Microjet irrigation concentrates fibrous roots in the wetted zone
- Some groves (e.g. fresh fruit blocks) have history of dolomite liming for control of copper toxicity
- Common condition: pH > 6.5 in wetted zone is associated with well water high in bicarbonate (>100 ppm) and > HLB expression (i.e. fruit drop)
- Bicarbonate reduces root uptake of Ca, Mg, K, Fe (e.g. high Ca in soil/moderate levels in leaves)
- Groves with bicarbonate stress may be experiencing > deterioration in fibrous root density, lifespan and function in root uptake
- Rootstock sensitivity: Swingle > Carrizo > Sour orange > Cleopatra

Percent of carbon species in solution for various pH ranges. H_2CO_3 = carbonic acid, HCO_3^- = bicarbonate, and CO_3^{-2} = carbonate



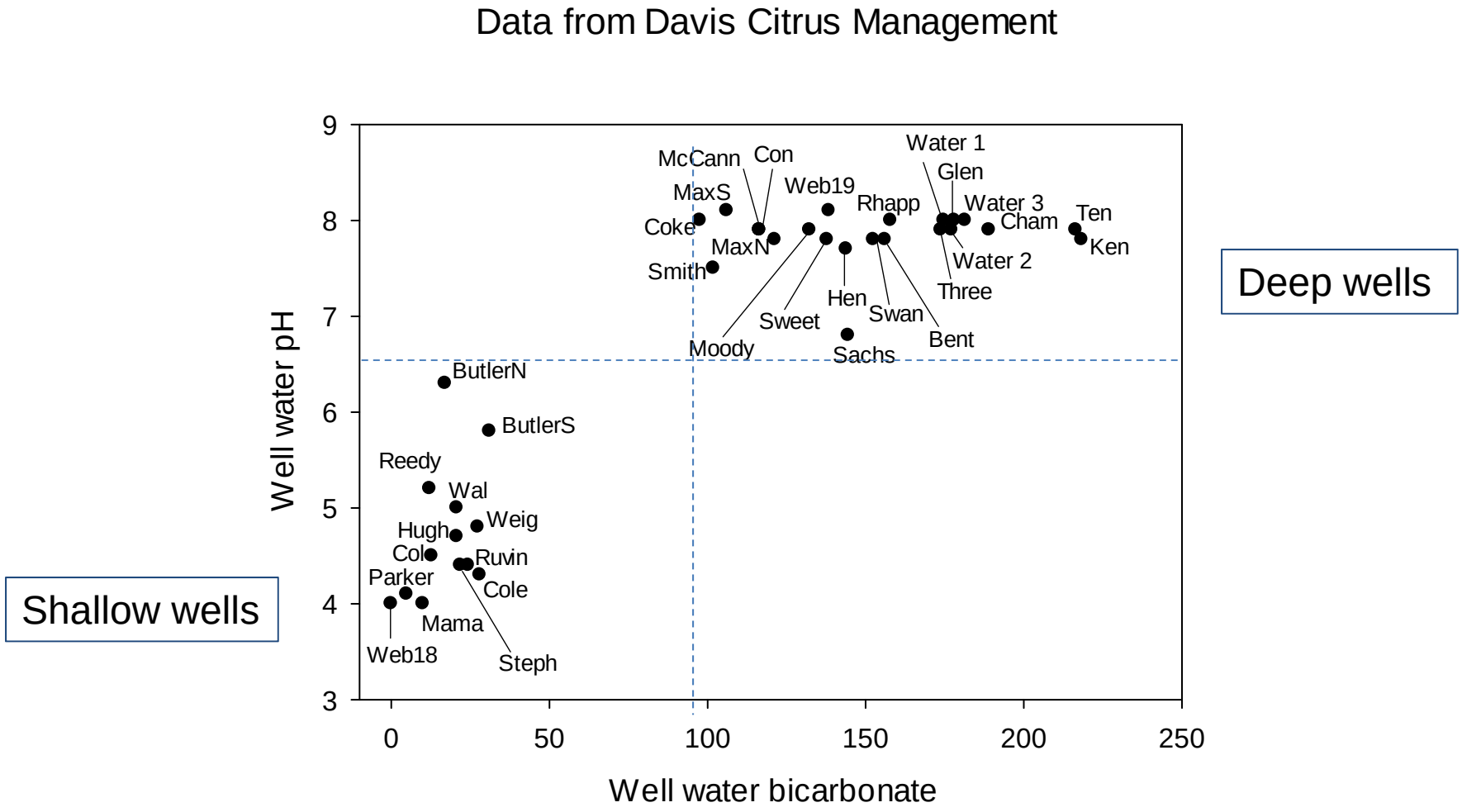
Health and fruit drop for 6 yr old Valencia/Swingle trees planted in different sub-blocks in 2007 from same nursery

Reset in Valencia half of block	Solid set in former grapefruit half of block)

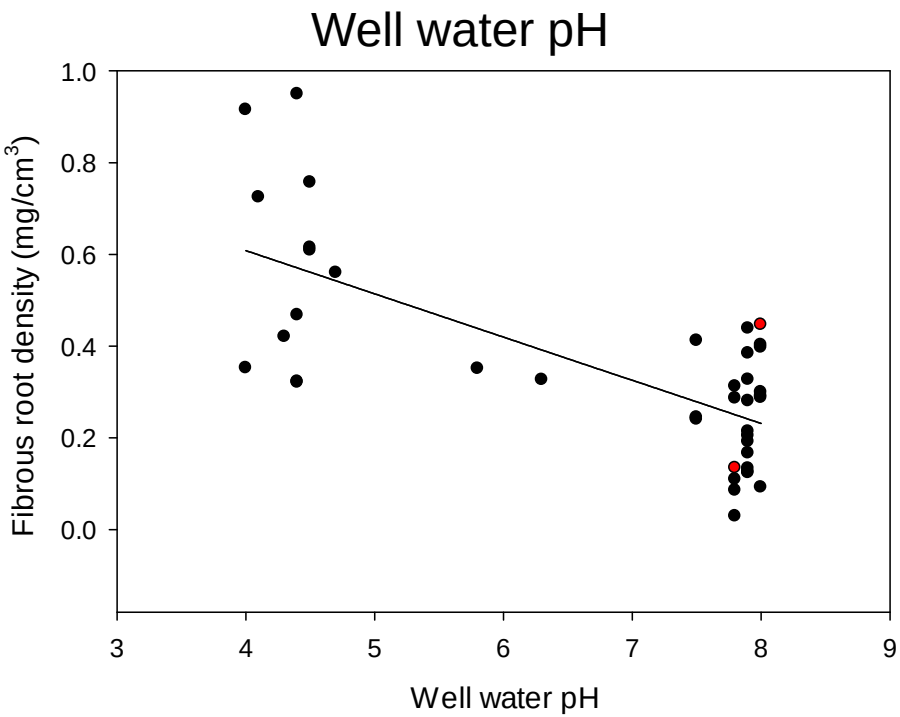
Soil pH 6.4: Fruit drop minimal

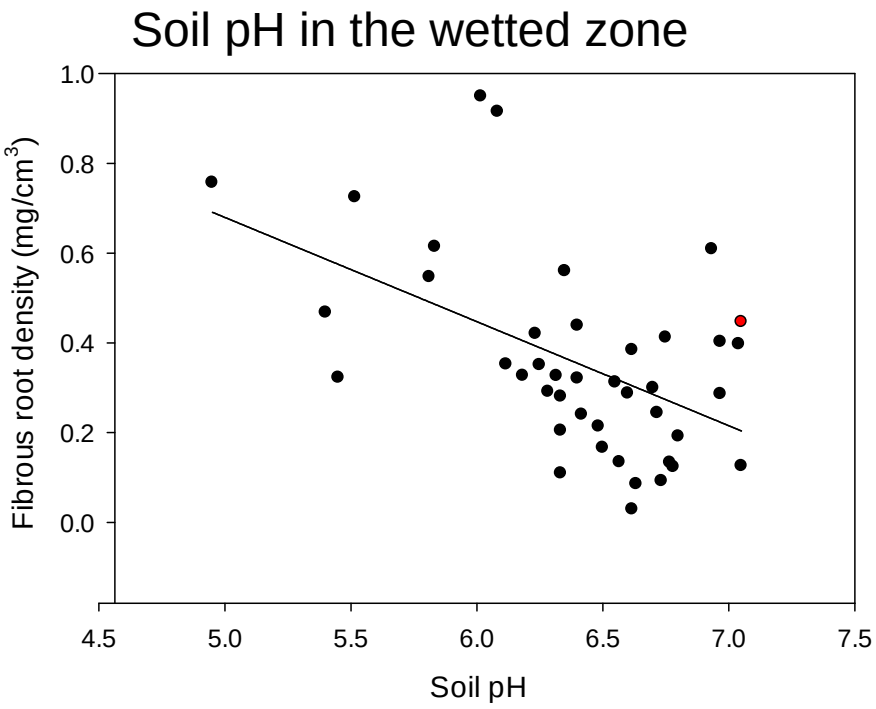
Soil pH 7.2: Fruit drop result in early harvest

Compared 39 grove locations in Highlands and Desoto Co with varying liming history and irrigation with deep vs. shallow wells on Swingle and Carrizo



Lower root density is related to well water pH>6.5 ($r^2 = 0.50$) and soil pH>6.2 ($r^2 = 0.25$)





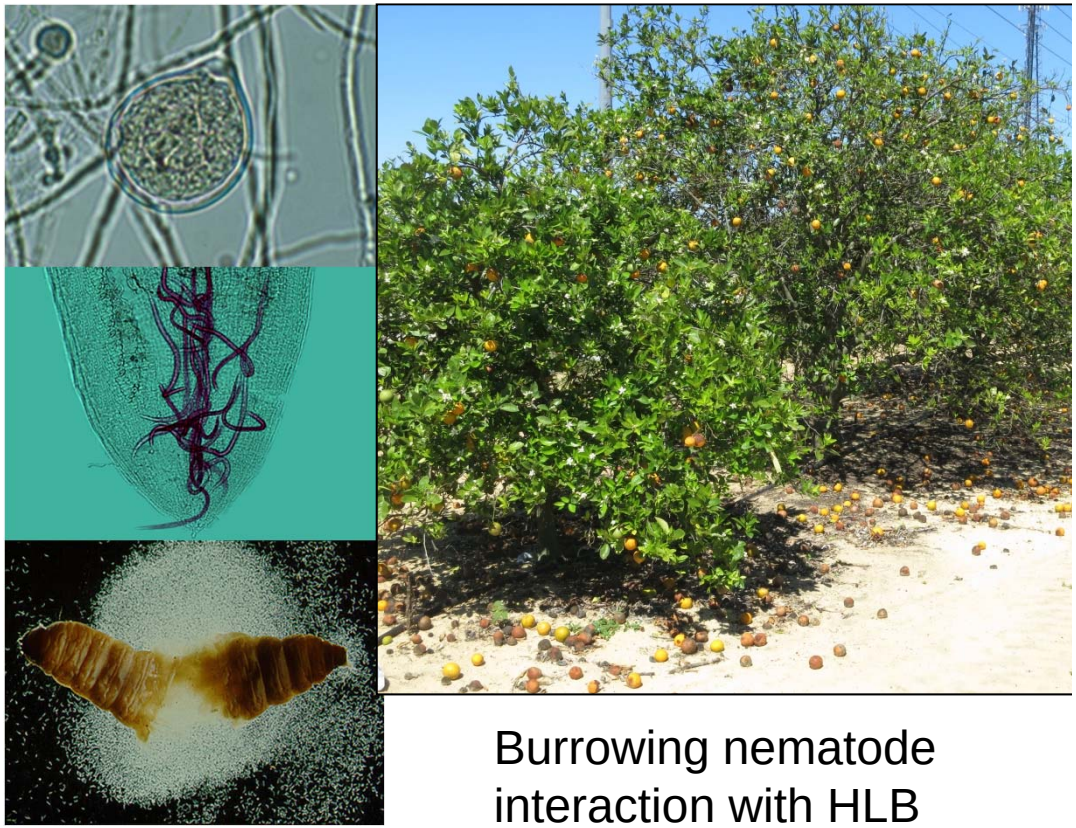
Relationship between bicarbonate status, root mass density and change in yield from 2009-12*

Grove status	No. of blocks surveyed	Root mass density (mg/cm^3)	Change in block yield from 2009-12
Low pH stress Ridge	14	0.6	Increased 6%
High pH stress Ridge	10	0.4	Decreased 3%
High pH stress Flatwoods	13	0.2	Decreased 20%

*Yield data kindly provided by Davis Citrus Management

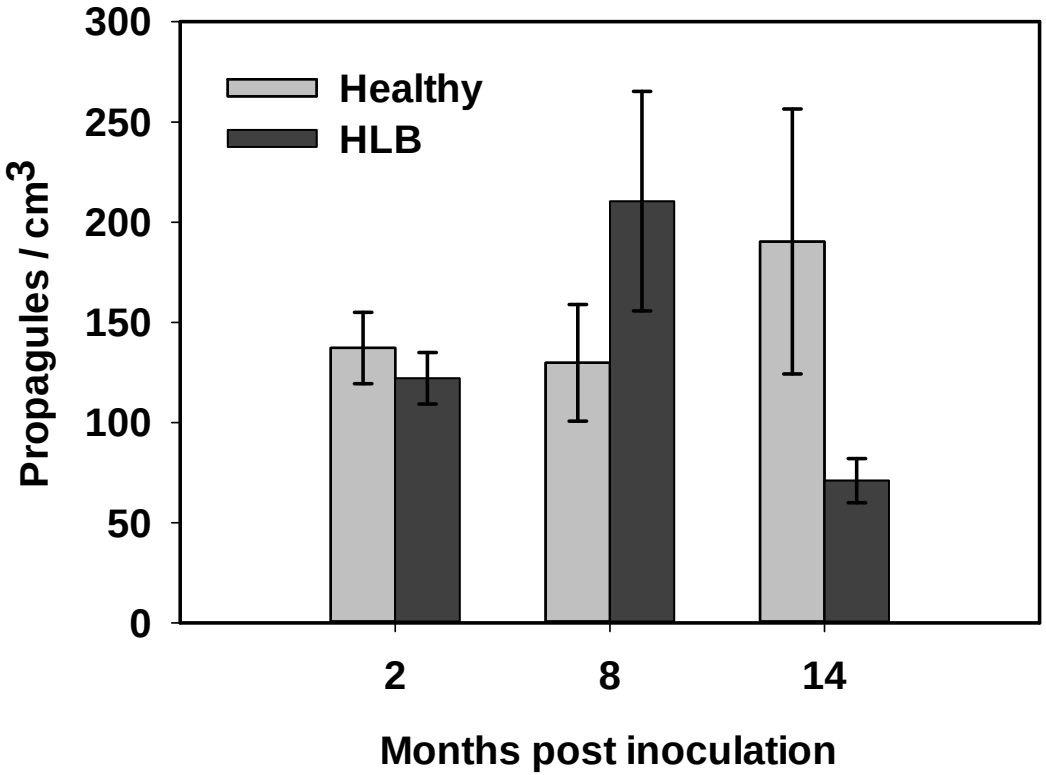
Bicarbonate stress/pH increases susceptibility of fibrous roots to pests and pathogens

- Increases root damage caused by Phytophthora interaction with HLB
- Increases populations of nematodes and reduces control with nematicides
- Reduces entomo-pathogenic nematodes (EPNs) that biocontrol larvae of Diaprepes

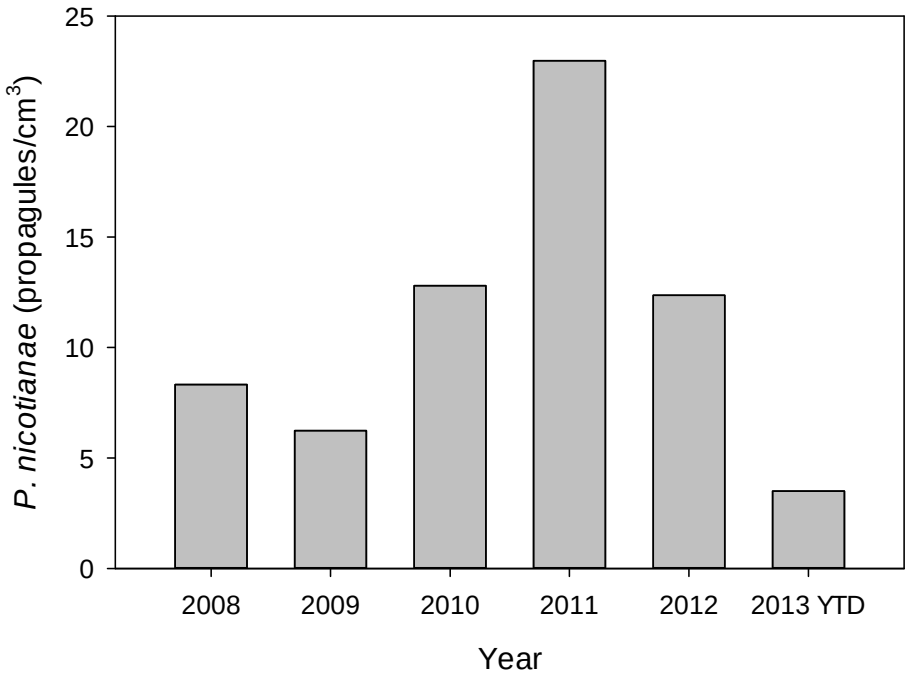


Burrowing nematode interaction with HLB

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

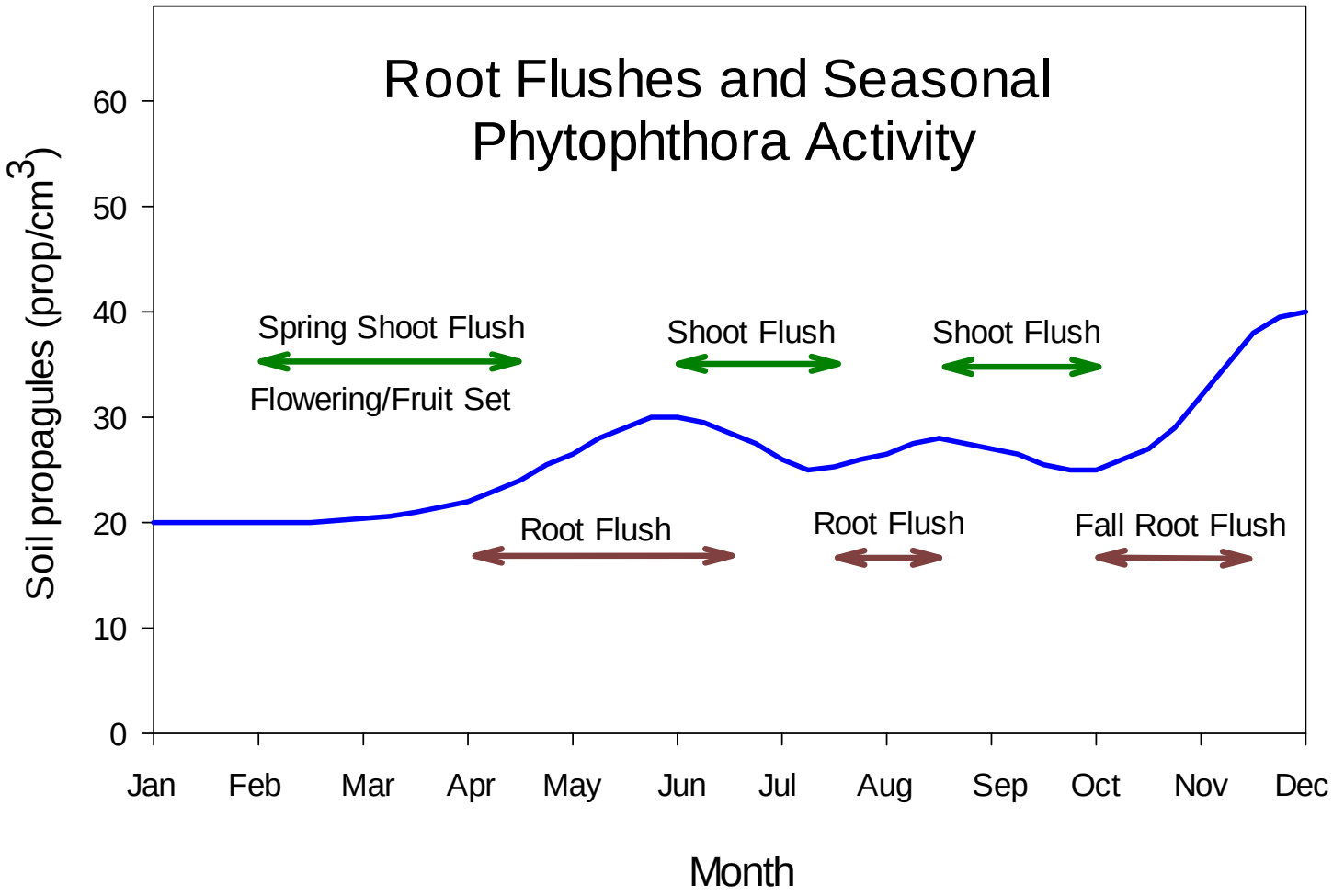


Drop in Phytophthora counts reflects HLB-induced root loss and the cause for more fruit drop this season



Data courtesy of John Taylor, Syngenta Crop Protection

Target applications of fungicides to root flushes



Acidification of the soil and water will reduce root zone pH and promote release of Ca, Mg and K for root uptake

e. g. Water conditioning

Faster, lower soil bicarbonate

Injection of N-furic acid or sulfuric acid (40%) **to adjust irrigation water to pH 6.5**

e. g. Soil conditioning

Slower , high soil bicarbonate

300 lbs/treated acre of Tiger 90 sulfur **lowered soil pH in 9 months**

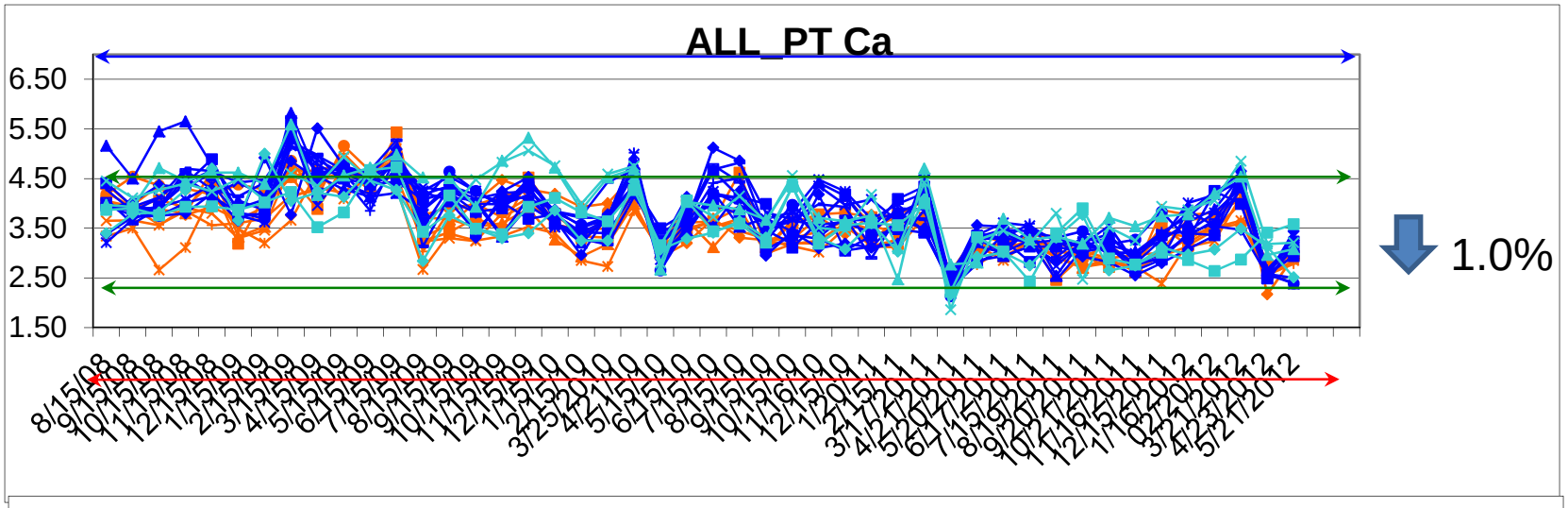
Valencia/Swingle - 10 yr old

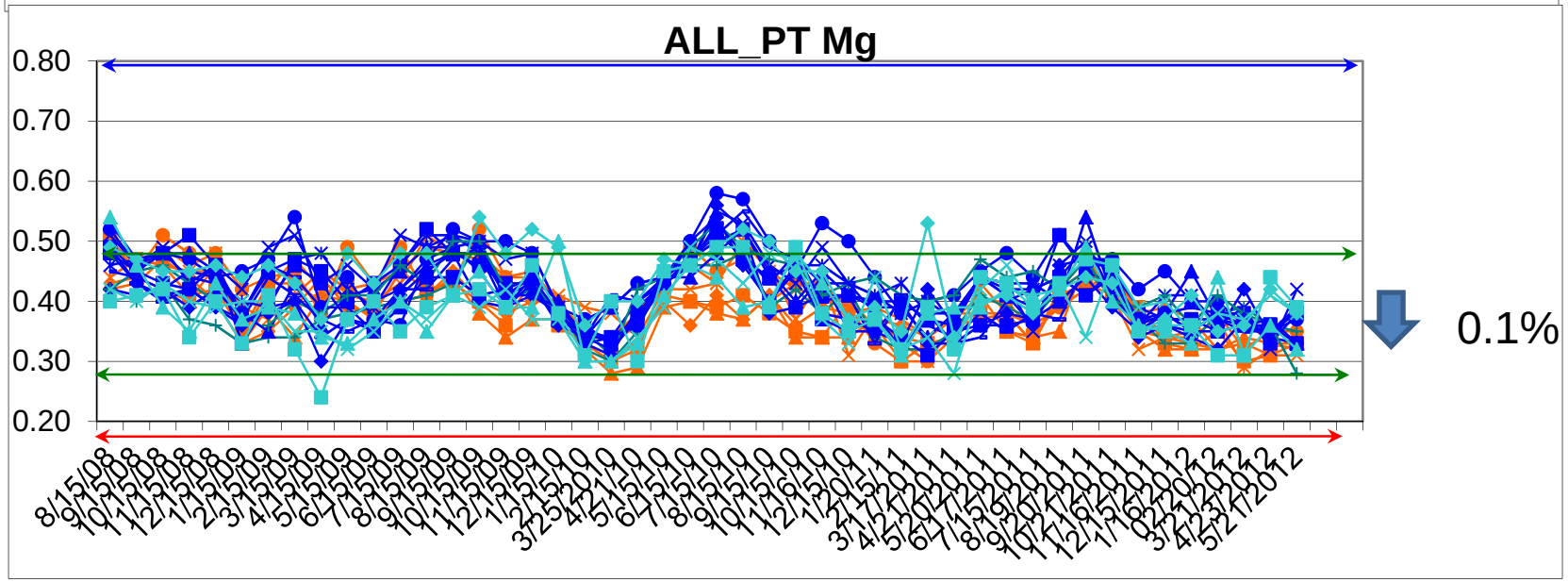
Sulfur	pH	Root density (mg/cm^3)
No	6.4	1.1
Yes	5.9*	1.4*

*Significant difference $P < 0.05$

Decline in Ca and Mg leaf status 2008-12 in 19 groves

Data from Bill Barber – Lykes Citrus





Conclusions

- Soil pH/bicarbonate management may reduce stress on roots and increase root functioning in nutrient uptake and root longevity
- Check soil pH (wetted zone) and test well water for pH, bicarbonates, salinity, cations, anions
- Acidification of the rhizosphere will increase uptake of Ca and Mg
- Check leaf test to determine if soil applications of Ca sulfate (gypsum) or Mg sulfate is needed (instead of dolomite)
- Soil Mn, Zn and Fe will be more available for root uptake
- Preliminary observations: acidification increases root density, reduces fruit drop,nutrient uptake and improves tree appearance

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