Citrus Disease Solutions
Status of HLB in Florida

FUNDECITRUS Grower Discussion

Harold Browning, Chief Operations Officer

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Profile: Florida Citrus Industry at Risk

- Nearly 550,000 acres
- Juice and Fresh Marketing
- 6,000 small and large growers
- 76,000 employees
- 160-180 million boxes of fruit before HLB
- $1.2 billion farm gate value
- $8.9 billion economic impact
- Supplied >90% of U.S. OJ
Timeline of Recent Exotic Pests and Diseases

• *Diaprepes abbreviatus* root weevil 1968; spread in 1980’s
• Brown citrus aphid, *Toxoptera citricida* – 1980’s
• Post-bloom fruit drop, *Colletotrichum acutatum* – late 1980’s
• Citrus leafminer, *Phyllocnistis citrella* – 1993
• Asian citrus canker, *Xanthomonas axonopodis pv citri* 1995
• Asian citrus Psyllid, *Diaphorina citri* 1998
• Huanglongbing, *Candidatus Liberibacter asiaticus* 2005
• Citrus black spot, *Guignardia citricarpa* 2011
HLB Disease Spread in Florida

Oct. 2005: 2 Counties
Apr. 2006: 12 Counties
June 2007: 24 Counties
Aug. 2008: 34 Counties

Source: Southern Gardens Citrus
Economic Impacts of HLB

• Increased costs of production (~ $800 U.S. per acre to $2,000)
  • Psyllid vector treatments and auxiliary disease treatments
  • Scouting and tree removal/replacement
  • Fertilizer, irrigation inputs must be more timely and efficient
  • Supplemental materials to overcome tree symptoms and decline
  • Correcting soil, water conditions which are now more important

• Reduced fruit crop through short cropping and early drop
• Losses of efficiencies – managing resets, harvest, etc.
• Uncertainty – reluctance to invest and to replant
Florida Citrus Production

(Boxes of fruit per type)

Source: USDA, NASS Florida Citrus Statistics
Status of HLB in Florida

Growers Stopped Removing Infected plants
Infection Spread
  100% of Groves
  ~ 70% of trees
Chronic Tree Decline
Significant Fruit Drop
20% Groves Unmanaged
Widespread Inoculum
Early Infection of New Plants
Research Goals – Short-Term Delivery

- Retain Health of Existing Trees – Critical for Near-Term Industry Survival
- Provide Tools for Success of New Plantings – Necessary for Stabilizing Loss of Acreage
Time to Market – HLB Solutions

Vector | Pathogen | Host

3 YR | 6 YR | 9 YR

Time

Probability
Citrus Industry Research Investments (CRDF)

Research & Delivery Expense Summary

Pre-HLB Era

HLB Era
Approaches to Battle HLB

• Preventing Disease Spread (new plantings and resets)
• Reducing Disease in Infected Trees (remove trees or therapy)
• Sustaining/Improving Tree Health – cultural practices
• Affecting Fruit Drop and Fruit Quality
• Reducing Impacts of other Diseases and Stresses
### Project Profile by Topics – CRDF Research

<table>
<thead>
<tr>
<th>CRDF Research Category</th>
<th>Projects Ending &lt; 7/01/15</th>
<th>Projects Continuing &gt; 7/01/15</th>
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# Project Profile by Topics – CRDF Delivery

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Integrated Psyllid Management

• Measurement of populations and movement of ACP
• Suppression with insecticidal tools
• Manage modes of action to provide sustained activity
• Seasonal timing, application methods and rates
• Balance ACP management with other pests and diseases
• Don’t let ACP populations get out of hand
• Implement alternative management strategies as they emerge
• Utilize CHMAs to expand benefit of ACP management
48 CHMAs encompassing 486,000+/- acres of commercial citrus
Horticultural Practices to Complement HLB Disease Management

Tools to Prolong Health of Existing Inventory of Diseased Trees

• Chemical and Thermal Therapy to Reduce Bacteria in Trees
• Naturally Occurring Microbial Products
• Plant Growth Regulators - Fruit Drop due to HLB
• Integrated Root Health Practices

These tactics are not expected to affect disease levels but to prolong tree health. This approach should only be considered once tree removal is no longer possible.
Stepwise Assay System for Bactericides

Liberibacter crescens (laboratory) assay - tests bactericidal activity and dose response

Flush or detached leaf (laboratory) assay - tests activity against CLas, local movement, dose response, phytotoxicity

Whole plant (greenhouse) assay - tests phloem entry and mobility, activity against CLas, dose response and phytotoxicity

Field trials - tests activity, dose response, phloem entry and mobility, phytotoxicity, application methods, residues, fruit drop and quality

Field Trials/Use

Increase in biological relevance

Decrease in throughput

(Slinski 2015)
Field Trials of Bactericides

- Best Candidates Progress from Assays to Field Trials
- Small-scale Field Trials of Candidates
  - Dose Response and Phytotoxicity
  - Formulation and Application Methods
- Multi-Year Field Evaluation of Commercially Available Materials
  - Bactericides/Fungicides & Naturally Occurring Microbe Products
- Large-plot Grower Trials of Promising Candidates
- Full-scale Field Trials Conducted by Registrants
  - Multi-site Evaluation of Activity, Dose, Application, Residues
Thermal Therapy

• Solar tent and supplemental heat with steam or hot water
• Thousands of trees treated
  • Time/temperature refinement
  • Evaluation of CLas reduction and tree response
• More growers treating small trees with tents
• Commercial scale-up
How to Succeed with New Plantings of Citrus?

• Widespread inoculum in managed and unmanaged citrus
• Psyllid vectors moving into new plantings from unmanaged groves
• Increased costs
• Citrus Nurseries all protected and regularly inspected for HLB, citrus canker
• Most growers do not have geographic separation from neighbors

Success in new plantings is the key to survival of Florida citrus. It is a very difficult challenge with the level of unmanaged citrus around the farms that are replanting.
Current IPM Practices for New Plantings

Asian citrus psyllid control

- Neonicotinoid soil drenches to protect trees up to 3-5 years of age
- Organophosphates, carbamates, pyrethroids, neonicotinoids
- 10-12 or more foliar applications required to suppress psyllids in addition to soil drenches in young plantings
- Citrus Health Management Areas (CHMAs) coordination of sprays
- Biological control with *Tamarixia radiata* in untreated areas
# HLB Infection Rates in New Plantings

**Groves ~2 years of age (2014)**

<table>
<thead>
<tr>
<th>Psyllid pressure</th>
<th>HLB infection range</th>
<th>Average infection rate</th>
<th># of groves</th>
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<tr>
<td>1 - low</td>
<td>0 – 4.05%</td>
<td>1.02%</td>
<td>20</td>
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<tr>
<td>2 – medium</td>
<td>1.73 – 65.6%</td>
<td>17.7%</td>
<td>20</td>
</tr>
<tr>
<td>3 - high</td>
<td>0 – 36.9%</td>
<td>20.96%</td>
<td>21</td>
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Premier Grapefruit Rootstock Trial – Fort Pierce
HLB-infected trees in the St. Helena Project – differences in infection frequency & disease severity

- Kuharske – 86% HLB frequency
- Swingle – 70% HLB frequency
- Orange #15 – 14% HLB frequency
- Orange #19 – 23% HLB frequency
Commercial Scale Field Trial of Tolerant Rootstocks
Long-Term Disease Management Practices

• Remove unmanaged citrus - reduce inoculum and psyllid pressure
• Field trials of conventional breeding progeny
  • Poncirus trifoliata, lime, pomelo, kumquat sources of variation
  • Rootstock and scion development
• Field trials of engineered resistance to HLB
  • 3 permitted sites in Florida for evaluation of engineered citrus
  • peptides, PR genes, genomic approaches
• RNAi strategies
  • Primarily focused on ACP, but also targeting CLas
• Build or select a Psyllid population that cannot transmit CLas

August 20, 2015
Ultimate HLB Management

Asian Citrus Psyllid Population
- Monitoring
- Attract/Repel
- Psyllid Suppression
- CHMAs
- Biological Control
- Defective ACP

CLas Bacterial Inoculum
- Better Detection
- Inoculum Removal
- Bactericides
- Thermal Therapy
- Tree Defense
- Other Therapy

Tree Susceptibility To HLB and Injury
- Optimal Nutrition/Irrigation
- Increase Plant Defense
- Tolerant Rootstocks
- Breeding for Resistance
- Root Health Impacts
- Accelerate Production
- Replant Citrus Trees

Transmission Low
Infection Low
Tree Injury Low

X X X = Reduced HLB Disease Severity
Cooperation

U.S. and Brazil citrus growers and research communities need to cooperate more in discovering, testing and delivering solutions to HLB.

There is much that we can learn from the aggressive management in place in Sao Paulo citrus farms. It is working and is based on sound disease management principles. Unfortunately, Florida growers were slow to adopt this strategy and now we have a big challenge.
Thank you for your hospitality!

CRDF is proud to provide support to the Florida citrus industry