Importance of Controlling ACP In HLB Infected Groves
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http://www.imok.ufl.edu/
The ACP Juggernaut: Challenge and Response

• Why control ACP?
  – Increase yield: make more money
  – Bring new plantings into rapid and profitable production

• Efficient and sustainable ACP control in mature blocks
  – Yield benefits of ACP management
  – Using economic thresholds
  – Spray timing
  – Border vs whole block sprays
  – Value and use of beneficials
  – Economical and effective pest management plan
Why spray if my trees are already infected with HLB?

Objective: Evaluate effect of insecticidal control and foliar nutritional on ACP populations HLB incidence, yield and quality

- 13 acres ‘Valencia’ on ‘Swingle’
- Planted June 2001
- Defoliated 2005 and 2006 for canker control
- HLB detected spring 2006
- 2 x 2 factorial (RCBD 4 reps)
  - 16 plots
  - Average 108 trees per plot
  - Treatments began Feb 2008
Cumulative of ACP adults per tap sample taken at two week intervals:

- Two taps/tree

- **2008-2010**: 10 randomly selected trees in the middle bed of each plot

- **2010-2014**: 6 randomly selected trees per two randomly selected stops per plot

Sprays (Avg 5/year) dormant + threshold based on 0.5, 0.2 and finally 0.1 APC/TAP
Incidence of HLB:
Assessed by PCR from most infective branch on 20% of trees
Rose from 30% to > 90% in 18 months
Highest initially in Nutrient Only plots
If treatments will help, it will be by reducing intensity of HLB
Yield and Quality Evaluation

Oranges hand picked into 10-box tubs by supervised crews. Tared weight of oranges in each tub was recorded in the field using a Gator Deck Scale 500 ± 1 lb.

A 10 lb composite fruit sample was taken from each plot and evaluated at the CREC fruit quality laboratory.
Bottom Line: Both insecticides and foliar nutrients reduced intensity of HLB. Insecticides contributed to yield every year but the first, whereas nutrients contributed only 3 out of 7 years.
HLB Infection Process: Latency and Symptom Expression

Transmission cycle explains what we see.

<table>
<thead>
<tr>
<th>Time</th>
<th>Stage</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 day</td>
<td>1</td>
<td>Transmission of Clas to the shoot by adult</td>
</tr>
<tr>
<td>15 days</td>
<td>2</td>
<td>Acquisition &amp; amplification of CLAS by nymphs</td>
</tr>
<tr>
<td>30 days</td>
<td>3</td>
<td>Emergence of infected adults</td>
</tr>
<tr>
<td>3 months‡</td>
<td>4</td>
<td>Incapacitation of phloem</td>
</tr>
<tr>
<td>6 months‡</td>
<td>5</td>
<td>Dysfunction of root system</td>
</tr>
<tr>
<td>6 months‡</td>
<td>6</td>
<td>Appearance of foliar symptoms</td>
</tr>
</tbody>
</table>

‡ Depends on tree age

Protecting HLB+ trees from ACP allows formation of healthy new flush reversing the downward spiral

Reducing costs (1): Economic thresholds for mature trees with high incidence of HLB

Mathematical relationship between yield loss and ACP densities??

\[ \text{Yield Loss} = f(\text{ACP densities}) \]
**Economic Injury Level (EIL):**
Balance point where pest damage equals management costs.

Two 4-year studies:

Randomized Complete Block Design w/ 4 reps and 4 Treatments:

**Bob Paul (Block 1):**
- No insecticide
- Monthly sprays
- 0.2 ACP threshold + 2 dormant sprays
- 0.7 ACP threshold + 1 dormant spray

30 acres
Early Gold (10 years old)
Estimated HLB infection: 98%

**Moreno Farms (Block 2):**

12 acres
Valencia (10 years old)
Estimated HLB infection: 80%
Materials and Methods

Insecticide treatments → Air-O-Fan airblast sprayer

ACP monitoring → Stem-tap sampling

HLB incidence → qPCR from leaf petiole tissue

Harvest evaluations → Volume of marketable fruit

Juice quality measures
### ACP Management

#### Calendar of applications 2012:

<table>
<thead>
<tr>
<th>Dates</th>
<th>Insecticide</th>
<th>Aim</th>
<th>Treatment sprayed</th>
<th>Cost per acre ($)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 19, 2012</td>
<td>Zeta-cypermethrin (Mustang)</td>
<td>ACP control</td>
<td>○ ●</td>
<td>28.7</td>
<td></td>
</tr>
<tr>
<td>March 13, 2012</td>
<td>Spirotetramat (Movento MPC)</td>
<td>ACP control</td>
<td>●</td>
<td>62.6</td>
<td>Valencia only</td>
</tr>
<tr>
<td>March 13, 2012</td>
<td>Chlorpyrifos (Lorsban 4EC)</td>
<td>Overspray</td>
<td>○ ○ ●</td>
<td>48.0</td>
<td>Valencia only</td>
</tr>
<tr>
<td>April 16, 2012</td>
<td>Diflubenzuron (Micromite 80WGS)</td>
<td>ACP control</td>
<td>●</td>
<td>62.3</td>
<td>Valencia only</td>
</tr>
<tr>
<td>May 24, 2012</td>
<td>Spinetoram (Delegate WG)</td>
<td>ACP control</td>
<td>●</td>
<td>61.8</td>
<td></td>
</tr>
<tr>
<td>June 22, 2012</td>
<td>Abamectine (Agri-Mek SC)</td>
<td>ACP control</td>
<td>●</td>
<td>39.2</td>
<td></td>
</tr>
<tr>
<td>August 3, 2012</td>
<td>Imidacloprid (Admire Pro)</td>
<td>ACP control</td>
<td>●</td>
<td>55.4</td>
<td></td>
</tr>
<tr>
<td>August 30, 2012</td>
<td>Dimethoate (Dimethoate 4E)</td>
<td>ACP control</td>
<td>● ○</td>
<td>29.6</td>
<td></td>
</tr>
<tr>
<td>October 12, 2012</td>
<td>Fenpyroximate (Portal)</td>
<td>ACP control</td>
<td>●</td>
<td>39.3</td>
<td></td>
</tr>
<tr>
<td>December 14, 2012</td>
<td>Zeta-cypermethrin (Mustang)</td>
<td>ACP control</td>
<td>● ○</td>
<td>28.7</td>
<td></td>
</tr>
</tbody>
</table>

#### # of insecticide sprays:
- Calendar applications: 10
- 0.2 ACP threshold: 4
- 0.7 ACP threshold: 2
- No insecticide: 1

#### Nutritional program:

<table>
<thead>
<tr>
<th>Nutrients</th>
<th>Rate/ac</th>
</tr>
</thead>
<tbody>
<tr>
<td>K-Phite</td>
<td>1 gal</td>
</tr>
<tr>
<td>13-0-44 fertilizer</td>
<td>12 lb</td>
</tr>
<tr>
<td>Techmangan</td>
<td>8.5 lb</td>
</tr>
<tr>
<td>Zinc Sulfate</td>
<td>2.8 lb</td>
</tr>
<tr>
<td>Sodium Molybdate</td>
<td>0.85 oz</td>
</tr>
<tr>
<td>Epsom Salts</td>
<td>8.5 lb</td>
</tr>
</tbody>
</table>
Cumulative ACP Adults in Stem Tap Samples

‘Earlygolds’

ACP cumulative per plot

‘Valencias’

ACP cumulative per plot
Relationship between cumulative ACP counts and Yield Loss

Valencias

Earlygoldens

100% with Calendar Spray
EIL implementation

Simulation:

1st growing season spray (at 4.5 cumulative ACP adults)
2nd growing season spray (at 6.1 cumulative ACP adults)
3rd growing season spray (at 7.7 cumulative ACP adults)
4th growing season spray (at 9.5 cumulative ACP adults)

(Threshold not reached in that season)
All Gulf CHMAs
Average of 50 Taps

Nominal Threshold Used EIL Studies
Conclusions

• An Economic Injury Level (EIL) Model is proposed to help decide when to spray bearing trees under high HLB incidence during the growing season.

• The model does not provide pre-fixed densities of the pest that trigger the sprays because management costs and juice prices are variable.

• The number of applications per season would vary depending on expected price, cost and efficacy of the insecticide treatments and pest pressure during the season.

• More research is needed to calibrate model to different varieties and growing conditions.
Reducing Insecticide Costs (2): Apply When Most Needed

Manjunath et al., 2008

Adults in suction trap

Highest risk

% Adults Infected

Apply When Most Needed

2006

Adults in suction trap

Jan* Feb* Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Jan Feb March April May June July Aug Oct Nov Dec

2006

Jan Feb March April May June July Aug Oct Nov Dec

% Adults Infected

2006

2007
# Reducing Insecticide Costs (3): Use the Right Stuff!

<table>
<thead>
<tr>
<th>Efficacy</th>
<th>Resistance</th>
<th>Conservation</th>
<th>Cost!</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adults/nymphs</td>
<td>management</td>
<td>of</td>
<td></td>
</tr>
<tr>
<td>Secondary pests</td>
<td>Frequency of use</td>
<td>beneficials</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rotation MoAs</td>
<td>of use</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Selectivity</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Dormant or Border

### Growing season/whole block

<table>
<thead>
<tr>
<th>Months</th>
<th>Nov-Dec</th>
<th>Jan</th>
<th>Feb-Mar</th>
<th>Apr</th>
<th>May - June</th>
<th>July - Aug</th>
<th>Sep-Oct</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Products</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OP¹³ (e.g. Imidan, Dimethoate, chlorpyrifos)</td>
<td>Pyrethroid¹⁴ (Mustang Danitol Baythroid)</td>
<td>*Sivanto⁹</td>
<td>*Movento¹</td>
<td>*Portal²</td>
<td>*Micromite⁴</td>
<td>Portal²</td>
<td>Movento¹</td>
</tr>
<tr>
<td></td>
<td></td>
<td>*Intrepid⁵</td>
<td>Exirel⁶</td>
<td>Portal²</td>
<td>Micromite⁴</td>
<td>Exirel⁶</td>
<td>Delegate¹⁰</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Apta⁸</td>
<td>Exirel⁶</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sivanto⁹</td>
</tr>
<tr>
<td><strong>Pests</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACP Weevils</td>
<td>ACP Weevils</td>
<td>ACP Mites Leafminer Weevils Scales Aphids</td>
<td>ACP Mites Leafminer Weevils Aphids</td>
<td>ACP Rustmite Leafminer Scales</td>
<td>ACP</td>
<td>ACP Rustmite Leafminer</td>
<td></td>
</tr>
</tbody>
</table>

### Efficacy
- Adults/nymphs
- Secondary pests

### Resistance
- Management
- Frequency of use
- Rotation MoAs

### Conservation
- of beneficials
- Frequency of use
- Selectivity

### Cost!

- Oil
- Sivanto
- Delegate
- Apta
- Knack
- Exirel
- Apta
- Sivanto
- Exirel
- Apta
- Sivanto

**Notes:**
- ACP+++1,6,8,9,13,14
- ACP++2,10
- ACP+4,7,11
- Leafminer⁴,5,6,10
- Rustmite¹,4,7,8,11
- Scales¹,12
- Aphids⁹
- Mealybugs¹
Reducing Insecticide Costs: (4) Border Sprays / Edge Effect

High ACP and HLB

Fruit drop average 213 fruit/tree

Fruit drop average 114 fruit/tree

Eucalyptus windbreak
Reducing Insecticide Costs: Take Advantage of Biocontrol

Qureshi and Stansly, Biological Control 50: 129-136.

Working everywhere every day!
How Good is Insecticidal Control?

Reduction in ACP compared to check 4 days after application 12 June 2017

- **Minecto + Oil**
- **V.Flexi + Oil**
- **Abba Ultra + Oil**
- **Oil Alone**

- **Adults**
- **Nymphs**
1.2 inches of rainfall 12 hrs after application

Applications made during the day had time to dry, but overnight there was 1.2 inches of rainfall. As a result, control of psyllids caged the following day was less than 70%.

(Christine Weaver, M.S. Student, Rogers’ lab)
The threshold approach permits inclusion of biological control as a supportive tool to reduce pest pressure and consequently the frequency of applications.

Beneficial arthropods (#cumulative stem taps).

- Coccinellids cumulative
- Spiders cumulative
- Brown lacewings cumulative
- Arboreal ants cumulative

The graphs show the cumulative number of beneficial arthropods over time, with significant differences indicated by asterisks.
Summary: Ways to Lower ACP Control Costs

1. Use thresholds to guide spray frequency.
2. Target control to reduce ACP in flush
   - Preemptive sprays may be best.
   - Damage potential of ACP least in summer
3. Choose the best product for the job at hand.
4. Use border sprays to control psyllids where they congregate and reduce sprays to whole block
   - Selective products for whole block sprays
   - Cheap products for border sprays
5. Conserve beneficials by eliminating unnecessary sprays and using selective insecticides to treat whole blocks during the growing season
An ACP Management Plan

• Make sure of at least 2 good dormant sprays
  – Use pyrethroids or OPs
  – Try and avoid rain and spray again if it does rain
• Mop up with bloom sprays using any of the 4 registered products
• Don’t use pyrethroids or OPs again except for perimeter sprays
• Use selective chemistries on whole block sprays during rest of the growing season
  – Base when and what to spray on pest pressure (thresholds)
  – Create reservoirs for beneficials in block interiors
• Make every effort to protect new blocks and resets
  – Insecticides as needed
  – Reflective mulch
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