Overview of Citrus Grower Nutritional Spray Programs for HLB Management

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Introduction

- Huanglongbing (HLB) is caused by a phloem-limited bacteria vectored by the Asian citrus psyllid
- Infection results in small, misshapen, lopsided fruit that drop prematurely
- Juice from symptomatic fruit is similar in quality to juice from immature fruit (Dagulo et al. 2010)
- Groves can become unproductive in as little as 2-4 years (Ke et al. 1988)
- Yield can be reduced by 10 to 80% depending on percent of canopy affected (Bassanezi et al. 2006)
- What happens to yield and quality over time if trees are “managed”?
Counties with HLB

- As of February 2010
  - 34 counties
What Options Do Growers Have?

- Tree / Inoculum Removal
- Nutritional Management to maintain tree health and yield
To push... or not to push?
Tree / Inoculum Removal

- Cannot eradicate the disease
- Goal is to keep infected tree population low (2% ?)
- Requires a strong commitment to:
  - Scouting for infected trees
  - Psyllid control (disease vector)
  - Timely infected tree removal
  - Replanting to maintain productivity
- Must be repeated continuously since psyllid control and scouting are not 100% effective
Limitations to Tree / Inoculum Removal

• **Detection of HLB infected trees**
  – Until a tree is detected and removed it can serve as a source of inoculum

• **Visual detection may not happen until 6-24 months after infection**
  – Only 50-60% effective

• **PCR is not reliable on asymptomatic trees**

• **Timeliness**
  – Willingness to remove trees prior to harvest?

• **Cost**
  – Scouting, tree removal, yield loss (and recovery lag), new tree cost, new tree management
The Bad Neighbor Effect

• Psyllid control is unlikely to be effective over small areas
  – Edge effects

• Inoculum removal most effective if done in large areas
  – Can you effectively manage inoculum levels if your neighbor is not, or if your neighbor is an abandoned grove?
The Success of Inoculum Removal

• In Brazil and Florida appears to be successful at maintaining low infection rates on large acreages – 5-10,000 acres?
• Must replant to maintain productivity
• Can inoculum and psyllid levels be kept low enough to bring new trees into production?
• Long term???
  – Only have 6 years of data (Brazil)
• What about the small grower?
Foliar Nutritional Sprays

• Does not eliminate the bacterium / inoculum
• Goal is to maintain the productivity of existing trees
• Psyllid control must be maintained in order to minimize continuous inoculation
Limitations to Nutrition Program

- **Inoculum remains in the grove**
  - Must control psyllids
- **Grove will, in time, become 100% infected**
- **Duration of effect?**
- **Quality of fruit?**
  - Important to maintain fruit quality, not just yield
- **Cost**
  - We don’t yet know the exact recipe needed
The Success of Nutrition Programs

• Grove in SW Florida with HLB since late 2005 has not removed any trees and is still productive

• Trial plots initiated in spring 2008 at IFAS/SWFREC rehabilitated trees and they are now productive
  – Replicated in two commercial groves

• Long term sustainability?
What is being applied to the fruit in a “nutritional program”?

What is the yield and quality of fruit?
What’s being applied?

• If there’s a salesman selling it, it’s being applied somewhere

• IFAS recommendations
  – Don’t apply any products not fully labeled for use on citrus
  – Don’t apply any products without full label disclosure of ingredients
  – Avoid products with “magical” inert ingredients
The Application of Salicylic Acid

• SA (methyl salicylate) is a chemical capable of inducing **Systemic Acquired Resistance (SAR)**
  – No evidence that SAR is effective against HLB

• There are products containing SA as an active ingredient labeled for use on citrus

• There are no tolerance limits established for SA in orange juice and byproducts

• Research need
  – Fate of SA applied to fruit
Foliar Nutrition and Tree Health – Does it Work?
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Fruit Yield and Quality Evaluation

- Maury Boyd’s Orange Hammock grove (Felda)
  - Planted Nov 1991 – Feb 1992

- ‘Hamlin’ on Swingle
  - Harvested Dec 2008, January 2010

- ‘Valencia’ on Carrizo
  - Harvested April 2009, March 2010

- First HLB finds late 2005
Methods

• 10 HLB and 10 healthy trees harvested (Hamlin & Valencia)
• Fruit sized, counted and weighed
• 1 sack of small fruit and 1 sack of “average size” fruit sampled from each tree
  – °Brix, acid, ratio and color
• Yield per tree – pieces of fruit and total weight
Hamlin Dec 2008

![Graph showing the number of fruit per tree and fruit weight per tree for two categories: HLB and Healthy.](image-url)
## Hamlin Juice Analysis

### December 2008 Hamlin juice quality parameters

<table>
<thead>
<tr>
<th></th>
<th>°Brix</th>
<th>Acid</th>
<th>Ratio</th>
<th>Color</th>
<th>Juice Yield (ml/fruit)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HLB</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>9.25</td>
<td>0.95</td>
<td>9.87</td>
<td>34.38</td>
<td>29.45 d</td>
</tr>
<tr>
<td>Average</td>
<td>10.98</td>
<td>0.70</td>
<td>15.65</td>
<td>35.47</td>
<td>75.49 b</td>
</tr>
<tr>
<td><strong>Healthy</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>10.37</td>
<td>0.67</td>
<td>15.73</td>
<td>36.11</td>
<td>47.05 c</td>
</tr>
<tr>
<td>Average</td>
<td>9.58</td>
<td>0.64</td>
<td>14.97</td>
<td>36.32</td>
<td>92.75 a</td>
</tr>
</tbody>
</table>

### January 2010 Hamlin juice quality parameters

<table>
<thead>
<tr>
<th></th>
<th>°Brix</th>
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<th>Ratio</th>
<th>Color</th>
<th>Juice Yield (ml/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HLB</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>11.27</td>
<td>0.57</td>
<td>19.88</td>
<td>35.44 ab</td>
<td>336.1 b</td>
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<tr>
<td>Average</td>
<td>10.88</td>
<td>0.57</td>
<td>19.13</td>
<td>35.13 b</td>
<td>368.0 a</td>
</tr>
<tr>
<td><strong>Healthy</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>11.54</td>
<td>0.54</td>
<td>21.60</td>
<td>35.63 a</td>
<td>382.6 a</td>
</tr>
<tr>
<td>Average</td>
<td>11.27</td>
<td>0.52</td>
<td>21.65</td>
<td>35.55 ab</td>
<td>387.5 a</td>
</tr>
</tbody>
</table>
Valencia April 2009

Graph 1: Number of fruit per tree (HLB vs Healthy)

Graph 2: Fruit weight per tree (HLB vs Healthy)
Valencia March 2010

![Graphs showing the number of fruit per tree and fruit weight per tree by diameter for HLB and Healthy citrus trees.](image)
## Valencia Juice Analysis

### 2009 Valencia juice quality parameters

<table>
<thead>
<tr>
<th></th>
<th>°Brix</th>
<th>Acid</th>
<th>Ratio</th>
<th>Color</th>
<th>Juice Yield (ml/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HLB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>10.76 b</td>
<td>1.06 a</td>
<td>10.42 b</td>
<td>38.43 c</td>
<td>595.4</td>
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<tr>
<td>Average</td>
<td>12.66 a</td>
<td>0.81 bc</td>
<td>15.76 a</td>
<td>39.02 bc</td>
<td>640.6</td>
</tr>
<tr>
<td>Healthy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>13.57 a</td>
<td>0.92 b</td>
<td>14.86 a</td>
<td>39.76 ab</td>
<td>618.7</td>
</tr>
<tr>
<td>Average</td>
<td>12.74 a</td>
<td>0.77 c</td>
<td>16.66 a</td>
<td>39.81 a</td>
<td>636.9</td>
</tr>
</tbody>
</table>

Fruit from healthy tree

Fruit from HLB tree
Average total tree yield (lbs) for Hamlin and Valencia trees harvested in two successive seasons.

<table>
<thead>
<tr>
<th></th>
<th>Hamlin</th>
<th>Valencia</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dec 2008</td>
<td>Jan 2010</td>
</tr>
<tr>
<td>Healthy</td>
<td>478.4</td>
<td>153.66</td>
</tr>
<tr>
<td>HLB</td>
<td>300.8</td>
<td>65.3</td>
</tr>
</tbody>
</table>
But won’t the symptomatic fruit ruin our juice?

• Assume a grove with moderate yield of 400 boxes/acre (3600 lbs) with 50% HLB infection
  – 1800 lbs of symptomatic fruit
• But only a portion of each tree is really symptomatic – say 50%
  – 900 lbs of symptomatic fruit
• A lot of symptomatic fruit fall off the tree before harvest – say 25%
  – 675 lbs of symptomatic fruit
• Harvesters don’t pick the small fruit – eliminates 75%
  – 170 lbs symptomatic fruit (9.5%)
• Grading could eliminate virtually all of the remaining fruit, but let’s say 50%
  – 85 lbs or 4.7%
Conclusions

- HLB infected trees have more smaller fruit
- Only small, symptomatic fruit show quality changes
  - Similar to immature fruit
- Foliar nutrition program does not appear to prevent or correct small fruit symptom, but...
  - These trees have been symptomatic for 4 years!!!
  - What would their yield and fruit quality be today without a foliar nutrition program?
  - The program appears to significantly slow disease development within a tree
- Yields can be maintained with a nutritional program, but can product quality be maintained?
Acknowledgements

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