Reasons for inconsistent control of citrus canker

Jim Graham

Citrus Institute
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Avon Park
Canker Bacteria Dissemination
Copper film cannot protect entry points when the rain droplets exceed 18 mph.
Stomatal infections of grapefruit leaves and fruit
Site conditions that promote canker are wide open areas without natural windbreaks.
Canker control and resultant fruit drop in Hamlin oranges is difficult to manage due to wind exposure.
Effect of windbreaks on wind speed and canker incidence on grapefruit – 2014

Previous research has shown that wind speed influences infection with Xcc, and wind breaks may help reduce disease.

Wind speeds >18 mph increase infection of sweet oranges by Xcc.

Objective: Characterize wind speed and canker severity at different locations in blocks surrounded by Corymbia torelliana windbreaks (6-10 m tall).

Trials at two east coast grapefruit groves: Indian River Co., St. Lucie Co.
Effect of windbreaks on canker severity on grapefruit - collaboration with Clive Bock USDA-ARS

Foliage assessment scale:

0 = 0% leaves with any canker
1 = 1-15% leaves with any canker
2 = 16-30% leaves with any canker
3 = 31-50% leaves with any canker
4 = 51-75% leaves with any canker
5 = 76-100% leaves with any canker

On fruit percent area cankered estimated and number of lesions counted
Effect of distance from the windbreak on severity of canker on grapefruit

- Linear relationship between canker severity (no. of lesions/fruit) and distance from the windbreak
- Results confirm that the closer citrus trees are to windbreaks, the lower the incidence and severity of canker on fruit

**Estes grove**

- $y = 0.0713x + 28.206$
- $R^2 = 0.48$

**Scott grove**

- $y = 0.1188x + 27.726$
- $R^2 = 0.54$

Disease assessed October 2014
Promoting vigor in young trees: more susceptible to citrus leafminer (CLM) and fruit infection

- More flushes per tree canopy volume occur on younger fruiting trees
- Repeated vigorous and off-cycle flushes are highly vulnerable to CLM
- Infection of susceptible, wounded tissue promotes explosive increase in leaf inoculum
- Rapid build-up on leaves puts the developing fruit at risk for infection
- Leaf miner control is essential for canker control on younger trees
Contact with copper can control bacteria that exude from CLM-induced infections.
Cu sprays at 21 day interval protect **fruit** from 0.25 to 1.5-inch diameter: spray gallonage, tractor speed for coverage of fruit
Cu residue on fruit is depleted by 21 days due to fruit growth; unaffected by rainfall (Cu film is stable!)

<table>
<thead>
<tr>
<th>Days after application</th>
<th>Fruit Cu residue (µg/surface area)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.8</td>
</tr>
<tr>
<td>7</td>
<td>1.6</td>
</tr>
<tr>
<td>14</td>
<td>1.4</td>
</tr>
<tr>
<td>21</td>
<td>1.2</td>
</tr>
<tr>
<td>28</td>
<td>0.8</td>
</tr>
</tbody>
</table>

- High rainfall period
- Low rainfall period

![Graph showing Cu residue on fruit over time](image-url)
Hamlin with severe early season fruit infection and drop due to a missed copper spray and rain events in April-May 2011 (50% crop loss)

Valencias in same grove with no canker-induced drop

Hamlins
Early season canker induced fruit drop is due to April-May rains, not inoculum carry over from previous season.
## Formulations, rates of products for Ray grapefruit in 2013

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Manufacturer/supplier</th>
<th>Copper formulation</th>
<th>Metallic Cu (%)</th>
<th>Rate of Product (1b/ac)</th>
<th>Metallic Cu (lb/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kocide 2000</td>
<td>Dupont</td>
<td>hydroxide</td>
<td>35</td>
<td>4.0</td>
<td>1.6</td>
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<tr>
<td>Kocide 3000</td>
<td>Dupont</td>
<td>hydroxide</td>
<td>30</td>
<td>3.0</td>
<td>1.0</td>
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<tr>
<td>Nordox 75WG 1.33</td>
<td>Nordox</td>
<td>oxide</td>
<td>75</td>
<td>1.33</td>
<td>1.0</td>
</tr>
<tr>
<td>Nordox 75WG 1.0</td>
<td>Nordox</td>
<td>oxide</td>
<td>75</td>
<td>1.0</td>
<td>0.75</td>
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<tr>
<td>Champ 30WDG</td>
<td>Nufarm</td>
<td>hydroxide</td>
<td>30</td>
<td>3.0</td>
<td>0.9</td>
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<tr>
<td>Regalia (biologically based)</td>
<td>Marrone</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Untreated check (UTC)</td>
<td>---</td>
<td>--</td>
<td>--</td>
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<td>--</td>
</tr>
</tbody>
</table>
Cu formulations are equally effective at 21 day interval; biofungicide is less effective and more expensive.
Cu sprays reduce crop loss about 50%

Return on spray cost drops as trees form hedgerows
Interaction with HLB and its management

- HLB greatly disrupts cycles of flowering, fruit set and foliar flushing
- Canker is either suppressed or exacerbated depending on the inoculum present and horticultural management
- This past season, young trees were markedly reduced in foliar flush cycles in conjunction with a low number of significant rainfall events in April-May
- Inoculum failed to build up as expected based on experience prior to the prevalence of HLB
Enhancement of canker by foliar nutrition programs

- Grapefruit and Hamlins managed with an aggressive foliar nutritional program constantly flushed coincident with periodic rains
- These canker-conducive conditions rendered a well-timed, 21-day copper sprays almost completely ineffective
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