Algal spot: What is old is new again

Megan M. Dewdney
Associate Professor of Plant Pathology and Extension Specialist
University of Florida, IFAS
Citrus Research and Education Center
Historical problem

- Most of the management information is from the late 1960s and early 1970s
- Not frequently seen in groves until recently
  - Has been minor on most cultivars except lemon and limes
- Usually disease could be managed with improved routine grove maintenance
  - Copper applications were recommended control agent
- Likely to intensify as problem with increased average temperatures
Associated with tree stress

- Among multiple hosts, algal spot more frequent and severe on stressed or declining trees
  - Only healthy plants able to form defensive structures?
- Reduced plant stress through cultural practices recommended
  - Optimal nutrition and irrigation
  - Thinning of canopies for improved air movement
- Disease and pest management for other problems to reduce stress
The responsible organism

- Part of a group known as Trentepohlialalgae
  - Known for bright colors such as orange, red, and yellow
  - Particularly prominent in low nutrient locations with strong light

- Green algae known as *Cephaleuros virescens*
  - Previously thought to be non-parasitic
  - Now confirmed to need a host to live and causes damage to host
  - Does not appear to get nutrients from trees directly
  - Does cause death of epidermal and palisade cells of leaves under ‘body’ of algae but not beyond
  - How it affects bark is unclear
Early infections difficult to detect

- Early infections do not contain the bright pigment
  - Not visible to naked eye
- Normally under the cuticle at early stages
  - Tricky to determine when infections occur
  - Not easily visible to naked eye
- Large areas of infection likely where multiple colonies overlap
Broad host range

- Has been observed on 287 plant species
  - Invaded stems on 80
- Selection of other economically important crops affected
  - Avocado
  - Blackberry
  - Blueberry
  - Grape
  - Common guava
  - Litchi nut
  - Magnolia
  - Mango
  - Timber trees

Willis and Flanders, UGA Extension

Avocado

Blackberry canes

U of Hawaii

Magnolia
Citrus tree symptoms

- Most consequential symptom type
- Lesions usually ½ inch diameter
  - Often coalesce up to covering most of a branch in sheath
- Occurs on branches, particularly scaffold limbs
- Most of the year, lesions subtle gray-green color
  - Difficult to spot but obvious bark texture difference is sometimes visible
  - Initial symptoms are thickened bark sections around lesions
- Lesions crack, bark falls off
  - Small pieces or shreds
If conditions favorable, scaffold limbs (2 inches) can be killed
  – Can also get limb stunting with chlorotic leaves and leaf drop

Lesions most visible when fruiting
  – Occurs between June to September

Colonies become orange-red to dark red with texture like velvet
  – Will often have donut appearance with gray center surrounded by red fruiting structures
Branch symptoms
Fruit and leaf symptoms

- Generally less severe than tree symptoms
- Fruit lesions are dark black and easily removed by brushing
  - Circular to irregularly shaped
  - Under magnification, highly branched
  - Mostly seen on over-ripe fruit still on the tree
- Raised leaf lesions occur on either side of leaf
  - Minor chlorosis around lesions
  - Will eventually flake off leaving depression
Fruit and leaf symptoms

Photos: T. Weeks and J.W. Miller
Life cycle

- Algal spot is a monocyclic disease
  - Only one cycle occurs per year
  - Usually in the rainy season
- Infection likely occurs via sporangia (asexual structures) in year 1
  - Unclear if gametes (sexual structures) are frequently involved
  - Subcuticular growth (thallus) and lesions form

Thallus structure with orange pigment

Brooks et al., 2015
Life cycle continued

- In year 2
  - Reproduction occurs during rainy season
  - Sporangia are definitely formed for asexual reproduction
    - Release motile zoospores with 4 flagella
    - These structures are highly pigmented and what we easily see
  - If gametangia are produced, occur before sporangia
    - Release motile gametes with 2 flagella

Brooks et al., 2015
Dispersal – How does it move?

- Wind is the main means of spread
  - Unique to the Trentepohliales
  - As structure holding the sporangia absorbs water, the cells straighten
- Can also spread with rain and moving water
  - Irrigation or pesticide applications could move among trees
- Insects
- Jarring or brushing of plants
  - Any activity that might involve agitating the canopy can assist spread
Trial in 2019

- First trial in decades
- Applications made with handgun
  - Ensured wood wetted until run-off
- Application timing was:
  1. Dormant spray - February 5\textsuperscript{th}
  2. Post-bloom - May 9\textsuperscript{th}
  3. When fruiting bodies visible - June 20\textsuperscript{th}
<table>
<thead>
<tr>
<th>Treatment</th>
<th>Active ingredient (% metallic Cu)</th>
<th>Rate/acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kocide 3000</td>
<td>Copper hydroxide (30%)</td>
<td>1.79 lbs (0.56 lb metallic Cu)</td>
</tr>
<tr>
<td>Kocide 3000</td>
<td>Copper hydroxide (30%)</td>
<td>2.23 lbs (0.67 lb metallic Cu)</td>
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<tr>
<td>Kocide 3000 + ProPhyt</td>
<td>Copper hydroxide (30%) + Potassium phosphite</td>
<td>1.79 lbs (0.56 lb metallic Cu + 0.5 gal)</td>
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<tr>
<td>ProPhyt</td>
<td>Potassium phosphite</td>
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<td>ProPhyt</td>
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<td>0.5 gal</td>
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<tr>
<td>ProPhyt</td>
<td>Potassium phosphite</td>
<td>1 gal</td>
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<tr>
<td>Orondis</td>
<td>Oxathiapiprolin</td>
<td>2.8 fl. oz.</td>
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<tr>
<td>Untreated control (UTC)</td>
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</table>
2019 Trial results

- Rating scale
  1 – 1-20%
  2 – 21-35%
  3 – 36-50%
  4 – 51-70%
  5 – 71-100%

Coverage of 12 inch section of branch
Conclusions

- Algal spot did not respond to applications of copper
  - Unlike the historical recommendations
- Best disease reduction from ProPhyt (phosphite) at 0.5 or 0.25 gal/acre
- The anti-phytophthora chemistry had no significant effect
  - Phytophthora is related to algae
- Looking at timing of applications in up-coming season to see if best time of year for management
- These only 1 year of data so needs confirmation
Interruption to 2020 trial and future work

- Main goal to determine best timing of phosphite applications
  - Only able to get one application on prior to shut down
  - Plan to redo next year

- Many questions about this disease remain
  - Only one species involved on citrus?
  - When is the exact timing of infection
    - Do practices one year, change outcome for the next
    - How does it enter citrus branches?
  - Is the sexual stage important in the life cycle
    - Could have implications for resistance to treatments
Acknowledgments

- Tracey Hobbs
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- Tonya Weeks

Please take the questionnaire at the end of the presentation