Citrus Canker and Phytophthora Management

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SWFREC, Immokalee FL

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Outline

- Citrus Canker
  - Canker and early season fruit drop
  - Field trial results (Drs. Graham and Johnson)
  - How sprays of Streptomycin and Oxytetracycline for HLB affect canker management

- Canker treatment and timing
  - Copper model
  - Development of new management tools

- Phytophthora Management
  - Citrus diseases caused by Phytophthora
  - Cultural control and management
  - Interaction with HLB
Citrus Canker

• Caused by Gram-negative bacterium *Xanthomonas citri subsp. citri*

• The disease spreads by rain splash combined with wind and worsens by tropical storms and hurricanes

• Infects young leaves, fruit and stems

• Symptoms begin as small water-soaked lesions that develop over 2 weeks

• Large yellow halos develop on leaves and fruit

• Lesions are corky and erumpent

• Fruit most susceptible between 1 cm and ~4 cm diameter

• Disease results in premature fruit drop reducing yield
Life Cycle of Citrus Canker

Wind-blown rain carries inoculum to uninfected plants.

Hedging, pruning, or other activities that cause injury create wounds for infection and/or transmit the bacteria mechanically.

Wounds open mesophyll tissues to direct infection.

Lesions are erumpent and consist of hyperplastic cells surrounding a sunken center of dead collapsed cells. A ring or chlorotic halo of cells often surrounds the lesion.

Further rain causes water splash of inoculum that is disseminated by wind.

Wind-driven rain can cause water congestion of tissues, form a column of water between the plant surface and the mesophyll through the stomata, and promote stomatal infections.

Infections can form on foliage, fruit, and young stems.

Rain, irrigation, or dew causes bacteria to ooze out of lesions and onto plant the surface.

Gottwald et al, 2002
Fruit susceptibility to canker

- Early bloom may affect timing of susceptible fruit size
- Fruit most susceptible from 1 cm diameter until fruit reach ~4 cm diameter
- Rains in April, May or June promote early season infection
- The rind is susceptible throughout the entire period of fruit growth
- Rind becomes much more resistant when fruit > 4 cm diameter
Cu sprays at 21 day interval protect fruit beginning at 1 cm:
Spray volume and tractor speed important for fruit coverage
Why 21 day interval?

- Copper residue is significantly reduced by rain washing
- Copper does not move once dried
- Copper residue is cracked by fruit growth

As the fruit grows, copper must be reapplied to continually cover the fruit as it becomes larger
Field Trials

- Drs. Graham and Johnson conducted these trials

- Evaluate copper sprays in relation to early season rains for control of fruit infection and drop in young fruiting Hamlin trees
  - Trial in a south central Florida citrus grove

- Compare soluble and fixed copper formulations for efficacy

- 2011 through 2015
In 2011, 9 sprays began 15 April (too late) ended 27 Sept in an attempt to reduce impact of the early epidemic
Early Season Fruit Drop

- In 2011 Hamlin: early rain events and miss-timed Cu sprays resulted in 50% fruit drop

Sebring Rainfall
March-May 2011

<table>
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<tr>
<th>Date</th>
<th>Rainfall (inches)</th>
<th>Total rainfall</th>
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<tbody>
<tr>
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<td>May 31</td>
<td>1.8</td>
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Weather data from the UF/IFAS Citrus Research Station, maintained by the USDA National Agricultural Library.
2012: First rain event in late-April after sprays begun

### Fruit canker 2012

- **Canker lesion incidence (%)**
  - **Treatment**
    - Kocide 2000 4.0
    - Kocide 3000 3.0
    - Nordox 75WG 1.33
    - Champ 30WP 3.0
    - Quimetal CO 2.0
    - Badger X2 2.68
    - Americop 40 DF 2.5
    - Magna-Bon 50
    - UTC 1
    - UTC 2

### Fruit drop 2012

- **No. canker fruit drop**
  - **Treatment**
    - Kocide 2000 4.0
    - Kocide 3000 3.0
    - Nordox 75WG 1.33
    - Champ 30WP 3.0
    - Quimetal CO 2.0
    - Badger X2 2.68
    - Americop 40 DF 2.5
2014: Rain was below average when fruit was at the most susceptible size

Fruit canker 2014

Fruit drop 2014
2015: Rain higher than normal in April when fruit were at the most susceptible stage

Fruit canker 2015

Fruit drop 2015
Early season canker induced fruit drop due to April rains, not due to inoculum carry over from previous season
Conclusions

- Timing of sprays before rains in late March and early April is critical for protecting fruit from 1 cm diameter (3/8 in.)

- Inoculum in form of infected leaves and stems from the previous season is always present in the spring

- Early fruit infection resulting in fruit drop depends on coincidence of late March-April rains with the most susceptible fruit stage (inoculum buildup on spring flush)

- In June-July, infections of fruit > 4 cm (1.5 in.) result in smaller lesions that do not induce premature drop
Streptomycin and Oxytetracycline Considerations

- Currently used only for HLB
  - No current label or declaration for citrus canker

- Have very short residual activity
  - Compounds need to be present when rain occurs

- Resistance development is likely
  - Rapid development in other foliar bacterial diseases

- Unlikely to provide the control you might hope for
  - Can’t spray with necessary frequency
  - Timing for HLB (leaf flush) does not match timing to protect fruit, but might lower leaf inoculum
How did Irma change canker incidence?

- Hurricane winds forced bacteria to past all barriers
  - Widespread mature leaf infection and stem lesions (even Valencia) occurred
  - Incidences were particularly bad in young blocks, especially if high canker inoculum was present in surrounding blocks

- Stem lesions are found on twigs with green bark
  - Quite visible still and advisable to prune out in young blocks while still dry
  - Will contribute years of inoculum; leaves only supply significant inoculum for a few months

- For non-bearing and young blocks, Actigard recommended
  - Copper does not control stem or leaf lesions
  - Will help to suppress inoculum
Citrus Canker Control

• Start with clean seedlings from well maintained nurseries
• Don’t move plant material from site to site, and decontaminate personnel and equipment
• Plant windbreaks around the grove
• Spray copper-based bactericides (or Actigard) on time during the new flush and before early season rains
• Aerial applications are not recommended due to poor penetration of canopy
Copper Facts

• High copper concentrations in the soil are toxic for citrus

• Applied as a **PROTECTANT** on citrus for foliar diseases
  • Must be present on plant before the pathogen!
  • Broad spectrum protectant and non-specific

• Copper residue is substantially reduced by rain washing

• Once dried, copper does not ‘expand’ with leaf or fruit tissue

• Copper can cause phytotoxicity when applied in hot weather (>94°F or >34°C) or in complex tank mixes
  • Phytotoxicity reduced when made into water insoluble salts
Timely Application of Copper

- Modern Web-based scheduler [vs Calendar-based (every 21 days)]
  - Incorporates rainfall data from Florida Automated Weather Network (FAWN)
  - Incorporates data on copper residue degradation
  - Incorporates fruit growth size

- Improves timing of copper sprays
- Reduces the environmental impact of copper
- Reduces management costs
- Warns when residue levels are lower than expected

- Available from AgroClimate and FAWN websites
CA

http://agroclimate.org/tools/citrus-copper-application-scheduler/

- Web-based
- User friendly
- Easier data input
- Mobile Version

http://agroclimate.org/tools/citrus-copper-application-scheduler/
Resources

Select:

Tools ➔

Climate Tools ➔

Citrus Copper Application Scheduler

https://fawn.ifas.ufl.edu/
Multiple new products under development

- Dr. Evan Johnson, UF CREC
- Dr. Swadesh Santra, UCF

- **Core-shell Copper**
  - Reduced copper, based on surface area

- **Fixed-Quat**
  - Quaternary ammonia immobilized to keep bactericidal activity and prevent phytotoxicity

- **Zinkicide**
  - Zinc-based nanomaterial using plant metabolizable ingredients

- Tested in Grapefruit trial (because of susceptibility)
2014 Grapefruit Canker Trial

- Equivalent efficacy to copper
  - Core-shell copper
  - Fixed-Quat

- Zinkicide control exceeded Cu and Cu/Zn
2015 Grapefruit Canker Trial

- Equivalent efficacy to copper
  - Core-shell copper
  - Fixed-Quat

- Zinkicide control matched commercial Cu/Zn at same rate Zn
Products under development - Conclusions

• Provide Copper equivalent or better efficacy

• Reduce metal or Cu applied to the field

• Provide rotation alternatives to Cu
  – Resistance management

• Licensing and Registration for commercial availability underway
  – Time to available product is difficult to predict
Summary

• Proper Copper applications on young fruit (3/8 to 1.5 inch) can reduce fruit drop from early season canker infections

• Copper must be applied before rain to be effective

• The copper application scheduler can help reduce unnecessary sprays and prevent gaps in coverage

• Materials with new modes of action are under development to allow for future resistance management
Phytophthora Management

Topics:

- Citrus diseases caused by Phytophthora
- Cultural control and management
- Interaction with HLB
Phytophthora Diseases

- Foot rot of trunk and limbs
- Root Rot
- Brown Rot

Yield reduction estimate: 3-6% per year or approx. $20M in crop loss (pre HLB)
The Phytophthora species causing diseases in Florida citrus

- *Phytophthora nicotianae* (*parasitica*) common cause of foot rot and root rot

- *Phytophthora palmivora* causes brown rot of fruit, root rot in poorly drained soils with high water tables
Wet conditions favor root infection cycles

- Susceptibility of roots highest during very wet to very dry cycles
- Wetting and drying increases root exudation attracts zoospores
- HLB infected roots also produce more exudates that promotes infection
Phytophthora Foot Rot

• Kills bark
  – Blocks water and carbohydrate transport
• Can girdle tree
• Controlled with rootstock
  – see rootstock guide
• Avoid wounding and soil exposure of scion
• Graft union >6 inches above soil
Phytophthora Root Rot

- Impairs water and nutrient uptake
- Reduces CHOs allocated for next crop season
- If severe at planting, stunts tree growth
Phytophthora Root Rot Control

- Good drainage and irrigation
- Clean nursery material
- Monitor disease pressure (propagule count; Syngenta?)

Healthy | Damaged
Chemical Management of Phytophthora

• Based on history of Phytophthora in the grove; protect growing roots
  – details in FCPMG [http://www.crec.ifas.ufl.edu/extension/pest/]

• Phytophthora count >10-20 propagules/cm³ recommend rotation of fungicides:
  – Fosetyl-Al /phosphite after spring shoot flush

• If severe problem - Mefenoxam after spring-early summer rains begin

• Fosetyl-Al /phosphite after midsummer shoot flush

• Mefenoxam after fall shoot flushes

Remember root flushes follow shoot flushes!
Phytophthora Brown Rot

- Mainly damages early varieties

- Light brown leathery decay

- White fungal growth on surface under humid conditions

- Infected fruit have sharp, pungent odor

- Infection spreads in post harvest
Brown rot disease cycle

**P. nicotianae**
- Windblown rain spreads sporangia laterally
- Few sporangia on fruit surface splash to fruit above 3 ft.
- Decaying fallen fruit

**P. palmivora**
- Sporangia formed on fruit in trees splash to higher levels
- Immature fruit fall to ground due to herbicide operations
- Abundant sporangia formed on fruit surface splash >3 ft.
- Fallen fruit trap *P. palmivora* from soil

Infested soil splashes to low hanging fruit on skirt below 3 ft.

Round sporangia with swimming zoospores
Ellipsoid sporangia with swimming zoospores

Total: 642 words
Brown Rot Management

• Avoid fruit under tree to reduce inoculum (may not feasible with HLB)

• Raise tree skirts to increase air movement and promote drying of foliage

• Apply preventative sprays of phosphites or copper

• Time phosphite sprays in July (and October if fall rainy season is prolonged)
HLB-Phytophthora interaction

Based on 600+ samples statewide
Data courtesy of John Taylor, Syngenta Crop Protection
Statewide propagule counts have resurfaced in 2014 in response to increased root mass compared to 2013.

Based on 600+ samples statewide
Data courtesy of John Taylor, Syngenta Crop Protection
HLB reduces efficacy of Phytophthora management

**Root infection with Pn**

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**Fibrous root dry weight**

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Phytophthora control with HLB

• Start with root stresses that give the best return

• Monitor groves to look for a developing problem

• Decide which root flushes to protect
Phytophthora control with HLB

• Treat based on propagule count
  >20 propagules per cm³ of soil

• Time application for maximum effect
  • Management tools are less effective
  • Phytophthora damages root flushes
  • Treatments are protective – apply at/just before root flush
Target soil applications of fungicides to root flushes

Root Flushes and Seasonal Phytophthora Activity

- Spring Shoot Flush
- Shoot Flush
- Flowering/Fruit Set
- Root Flush
- Root Flush
- Shoot Flush
- Shoot Flush
- Fall Root Flush

Soil propagules (prop/cm³)

Month

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

0 10 20 30 40 50 60

root growth (g dry weight)

- No symptoms
- Symptoms
- Thinning
- Decline

UF IFAS Extension
UNIVERSITY OF FLORIDA
Thank You!
Any question?

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