Preharvest Development and Control of Fungal and Bacterial Pathogens

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Diseases of Citrus
- Melanose
- Greasy Spot
- Citrus Canker
- Citrus Black Spot

- Symptoms
- Causal agent (=pathogen)
- Life Cycle
- Environmental conditions
- Management

Melanose
- Symptoms are raised, reddish-brown lesions on fruit, stem, and leaves of citrus
- Lesions on fruit may coalesce to form Mudcake Melanose
- Tearstain pattern on fruit from water dispersal
- Fruit quality for fresh market reduced
- Fresh market grapefruit mainly but also oranges, tangerines, and lemons and other citrus

Melanose grapefruit

Raised, bumpy lesions
Melanose on leaves

Melanose

Melanose on leaves
Melanose

- Caused by fungus Diaporthe citri (anamorph=Phomopsis citri)
- Survives as a saprophyte
- Primary inoculum is produced on dead wood; not on living tissue
- Primary spores are dispersed by water and secondary spores are airborne

Environmental Conditions

- Temperature and rainfall during the first 12 weeks after petal fall affect disease severity
- Leaves must be expanding
- 10 to 12 hours of wet fruit at 77 F necessary for infection
- Wetness required increases as temperature decreases (18-24 hours at 59 F)
- Long period of wetness required for infection: i.e.: afternoon rains followed by dew and warm temperatures

Control of Melanose

- Scouting- Damage on fruit in previous season
- History of grove
- Not a concern for processed fruit
- Some circumstances such as heavy infections or severe freeze (more inoculum) may warrant extra control measures

Melanose: Registered Fungicides

<table>
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<tr>
<th>Copper fungicide</th>
<th>Use label rate.</th>
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<tbody>
<tr>
<td>Abound 11 azoxystrobin</td>
<td>12.0–15.5 fl. oz. Do not apply more than 92.3 fl. oz. (1.5 lb. a.i.)/acre/season for all uses.</td>
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<tr>
<td>Gem 500SC 11 trifloxystrobin</td>
<td>1.9–3.8 fl. oz. Do not apply more than 15.2 fl. oz./acre/season for all uses. Do not apply within 7 days of harvest.</td>
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<tr>
<td>Headline SC 11 pyraclostrobin</td>
<td>12–15 fl. oz. Do not apply more than 54 fl. oz. (0.88 lb. a.i.)/acre/season for all uses.</td>
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<tr>
<td>Pristine 11/7 pyraclostrobin boscalid</td>
<td>16–18.5 oz. Do not apply more than 74 oz./acre/season for all uses.</td>
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<tr>
<td>Quadris Top 11/3 azoxystrobin difenoconazole</td>
<td>15.4 fl. oz. Do not apply more than 61.5 fl. oz./acre/season for all uses. Do not apply more than 0.5 lb. a.i./acre/season difenoconazole. Do not apply more than 1.5 lb. a.i./acre/season azoxystrobin.</td>
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http://edis.ifas.ufl.edu/cg019
Greasy Spot and Rind Blotch/Pink Pitting

- Symptoms are yellow to dark brown lesions that occur first on the underside of mature leaves.
- Fruit symptoms are small necrotic spots which retain the surrounding green color.
- Causes defoliation, reduced yield and fruit size.
- Susceptible varieties: Grapefruit, 'Pineapple', 'Hamlin's' tangelos, and lemons. Early oranges more so than late oranges.

Greasy Spot and Rind Blotch or Pink Pitting

- Caused by the fungus *Mycosphaerella citri*.
- Relative humidity above 90% needed for ascospore germination.
- Major ascospore release from April to July.
- Infection occurs from June to October.

Greasy Spot and Rind Blotch

- Scouting.
- History of grove.
- Processing and fresh fruit.
- Assess disease severity by observing canopy density and premature leaf drop prior to emergence of spring flush.
- Decision to apply type of materials, application method, and timing is made at this time.

Greasy Spot and Rind Blotch

- Control is by one or two fungicide applications in early to mid-summer June to July. If severe or in South Florida, another application in August.
- Use citrus spray oil for tolerant varieties or when disease pressure is low.
- Use oil and copper or copper alone on susceptible varieties or when disease pressure is high.
Greasy Spot and Rind Blotch

- Non-coppers can be applied any time but may be most useful in June to also control melanose and avoid damage to fruit that can occur with copper at that time a year
- Oil plus non-copper (strobilurins) may increase efficacy

Citrus Black Spot

- Caused by the ascomycete fungi *Guignardia citricarpa* (teleomorph) and *Phyllosticta citricarpa* (anamorph)
- Susceptibility
  - All commercial citrus cultivars
  - Lemon is most susceptible; ‘Tahiti’ lime is asymptomatic
- Disease symptoms affect fruit rind and preclude the sale of fruit on the fresh market
- Can causes up to 80% fruit drop, especially on late maturing varieties

Fruit Symptoms

- Fruit lesions include hard-spot/shot hold spots, false melanoses/speckled blotch, freckle spot (early virulent spot), virulent spot and cracked spot.
- Leaf symptoms are rarely seen on sweet orange, but more common on lemons
**Citrus Canker**

*Caused by the Bacteria Xanthomonas citri subsp citri*

- Lesions are dark brown and often surrounded by a yellow ring or halo
- Canker lesions appear on both sides of leaves
- Raised, oily, water-soaked lesion surrounded by chlorotic halo

**Control & Management**

- **Cultural Practices**
  - Use of disease-free nursery stock-standard
  - Mulching of the grove
  - Reduce fallen leaves and late-hanging fruit
  - Increase air flow to decrease the time the leaves stay wet
  - *G. citricarpa* needs a long time of leaf wetness to germinate and infection

**Integrated management**

- Reduce/Manage leaf litter
- Fungicide applications
- Use copper model and others tools to aid application timing
- Maintain tree health and grove health

**Chemical Control**

- Chemical applications - timed to coincide with the critical infection period
- Ascospore release March-September
- Initiate sprays depending upon bloom, late spring (March/April/May)
- Sprays spaced at 1 month intervals until fruit becomes less susceptible at 5 to 6 months
- Labeled copper or QoI (strobilurin) fungicides
Lesions occur on the fruit and leaves, as well as on twigs.

Pathogen: *Xanthomonas citri* subsp. *citri*

- Bacteria
- Survives in wet/moist environment (on the surface or within plant tissues)
- Reproduce very quickly

Electron microscopy of a *Xanthomonas* bacterial cell

Flagella (Tail): cell propels itself in water

**Citrus Canker Disease Cycle**

- Spread by rain, wind, and tools

**Citrus Canker and Leafminer Interaction**

- The feeding galleries of the leafminer makes citrus tissue readily susceptible to infection because of wounding
- Wounds of leafminer damage affect the spread of canker lesions (not a typical round, oily lesion)

Leafminer feeding galleries

Asian citrus leafminer larva in mine

Asian citrus leafminer larva in mine

Leafminer feeding galleries

Asian citrus leafminer larva in mine

Citrus leafminer, *Phyllonectis citrella*

Adult moth of Asian citrus leafminer

Gottwald et al., 2002
Management
- Control Citrus Asian Psyllid
- Windbreaks
- Protection with copper

IFAS Copper Spray Recommendations for canker
Dewdney and Graham, 2014 Florida Citrus Pest Mgt Guide
- Early processing oranges: five copper sprays at 21 day intervals when fruit at 0.25 to 0.5 inch stage
- ‘Valencia’ and midseason: 3 applications at 21 days when fruit is the same size
- ‘Hamlin’ may need more application sprays
- Fresh Fruit program: sprays may be needed through entire season

Additional labeled materials for citrus canker
- Oxidate – hydrogen dioxide
- Regalia – extract of Reynoutria sachalinensis
- Serenade formulations – Bacillus subtilis strain QST 713
- Double Nickel 55 – Bacillus amyloliquefaciens strain D747
- Actinovate AG – Streptomyces lydicus WYEC 168
- Firewall 17WP – Streptomycin sulfate
- Imidacloprid (immature trees)
- Rendition – Hydrogen peroxide/Peroxyacetic acid

Disease Triangle
- Susceptible Host
- Environment
- Man