Preharvest Development and Control of Fungal and Bacterial Pathogens

Pamela D Roberts

Southwest Florida Research and Education Center

IFAS/University of Florida

September 22, 2015

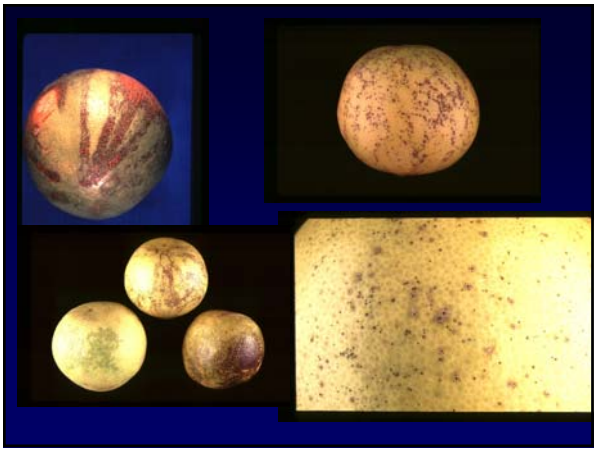
Diseases of Citrus

- Melanose
- Greasy Spot
- Citrus Canker
- Citrus Black Spot

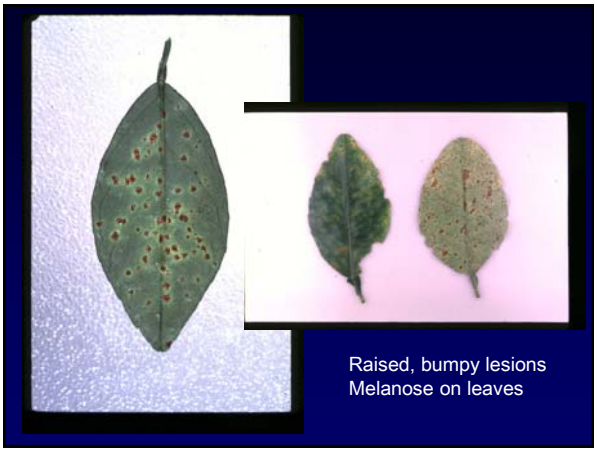
  - Symptoms
  - Causal agent (=pathogen)
  - Life Cycle
  - Environmental conditions
  - Management

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



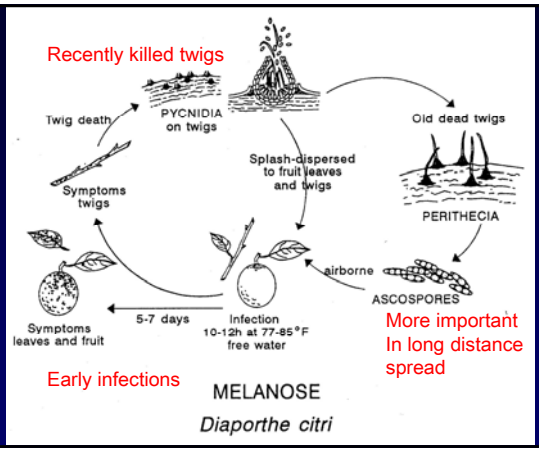
Melanose grapefruit



Raised, bumpy lesions
Melanose on leaves

Melanose

- 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

- For fresh market: must protect fruit from diameter of 1/4 to 1/2 inch until 2.5-3 inches
- Copper applied at 3-week intervals from approx. mid-April to July
- Non-copper may be used at any time but may be used in June to avoid damage to fruit from hot weather/copper reaction and used as first greasy spot spray

Melanose: Registered Fungicides http://edis.ifas.ufl.edu/cg019

copper fungicide	M1	Use label rate.
Abound	11 azoxystrobin	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.
Gem 500SC	11 trifloxystrobin	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.
Headline SC	11 pyraclostrobin	12–15 fl. oz. Do not apply more than 54 fl. oz. (0.88 lb. a.i.)/acre/season for all uses.
Pristine	11/7 pyraclostrobin boscalid	16–18.5 oz. Do not apply more than 74 oz./acre/season for all uses.
Quadris Top	11/3 azoxystrobin difenoconazole	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.

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', 'Hamlins' tangelos, and lemons. Early oranges more so than late oranges

Greasy spot on fruit

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

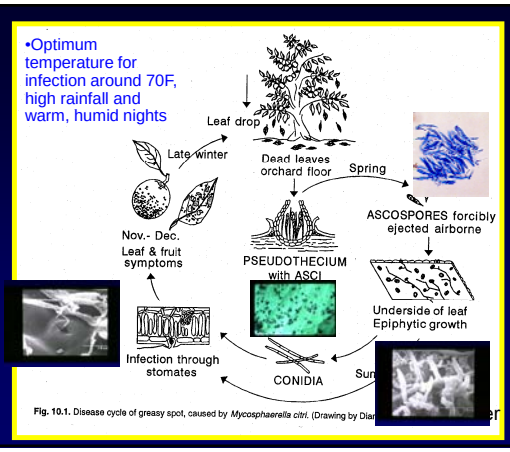


Fig. 10.1. Disease cycle of greasy spot, caused by *Mycosphaerella citri*. (Drawing by Dian

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

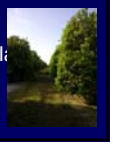
- Non-coppers can be applied any time but may be most useful in June to also control melanose and avoid damage to fruit that can occur with copper at that time a year
- Oil plus non-copper (strobilurins) may increase efficacy

Greasy Spot: Labeled Fungicides at http://edis.ifas.ufl.edu/cg018

Petroleum Oil 97+% (FC 435-66, FC 455-88, or 470 oil)	NR	5-10 gal. Do not apply when temperatures exceed 94°F. 470 weight oil has not been evaluated for effects on fruit coloring or ripening. These oils are more likely to be phytotoxic than lighter oils.
copper fungicide	M1	Use label rate.
copper fungicide + petroleum oil 97+% (FC 435-66, FC 455-88, or 470 oil)	M1 and NR	Use label rate + 5 gal. Do not apply when temperatures exceed 94°F. 470 weight oil has not been evaluated for effects on fruit coloring or ripening. These oils are more likely to be phytotoxic than lighter oils.
Abound Gem 500 SC, Headline SC	11 Azoxystrobin, trifloxystrobin, pyraclostrobin	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. Best applied with petroleum oil.
Enable 2F	3 Febuconazole	8 fl oz. Do not apply more than 3 times per year; no more than 24 fl oz. (0.38 lb a.i.)/acre. Minimum retreatment interval is 21 days.
Pristine	11/7 pyraclostrobin boscalid	16-18.5 oz. Do not apply more than 74 oz/acre/season for all uses.
Quadris Top	11/3 azoxystrobin difenoconazole	10-15.4 fl oz. Do not apply more than 61.5 fl oz/acre/season for all uses. Do not apply more than 0.5 lb ai/acre/season difenoconazole. Do not apply more than 1.5 lb ai/acre/season azoxystrobin.

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 l
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 Black Spot

- Optimum temperature for infection 70 to 90 F
- Ascospores
  - Develop from fungal fruiting bodies in decaying leaf litter
  - Ascospores are released during wetting events
    - Forcibly ejected and carried approximately 75 feet by wind
- Conidia
  - No special requirements for release from pycnidia
  - Reach susceptible tissue in rain splash or irrigation

Black spot disease cycle

Fall/Winter

Spring/Summer

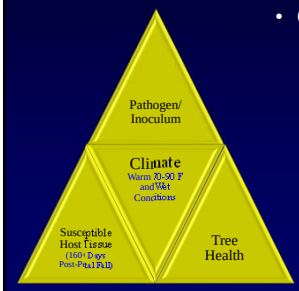
Leaf litter on grove floor
Decays and produces airborne ascospores

Spores land on fruit o

Pycnidium and conidia

Latent period (1-2 to 12 months)

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

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

Integrated management

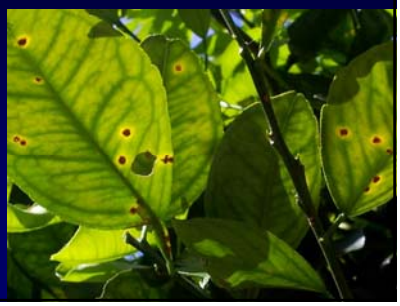
- Reduce/Manage leaf litter
- Fungicide applications
- Use copper model and others tools to aid application timing
- Maintain tree health and grove health

Citrus Canker

Citrus Canker Caused by the Bacteria

Xanthomonas citi subsp *citri*

Lesions are dark brown and often surrounded by a yellow ring or halo



Pathogen: *Xanthomonas citri subsp. citri*

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

Flagella (Tail): cell propels itself in water

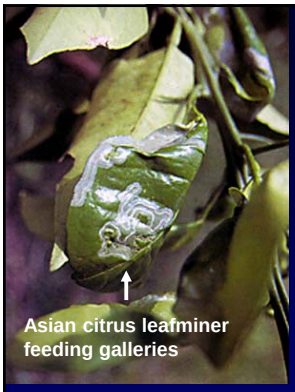
Citrus Canker Disease Cycle

- Spread by rain, wind, and tools

Gottwald et al., 2002

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)



Citrus leafminer, *Phyllocnistis citrella*

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 sachalinesis*
- Serenade formulations- *Bacillus subtilis* strain QST 713
- Double Nickel 55- *Bacillus amyloliquefaciens* strain D747
- Actinovate AG- *Streptomyces lydicus WYEC 108*
- Firewall 17WP – Streptomycin sulfate
- Imidacloprid (immature trees)
- Rendition- Hydrogen peroxide/Peroxyacetic acid

Disease Triangle