
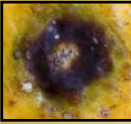




## Citrus Black Spot (*Guignardia citricarpa*): Identification, Biology and Control



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
## Fungal Disease

- ☞ Causal agent: *Guignardia citricarpa*
  - Asexual name: *Phyllosticta citricarpa*
- ☞ Hosts: Citrus species and hybrids
- ☞ Symptomatic: Sweet oranges, mandarins and tangerines, lemons
- ☞ Non-symptomatic: 'Tahiti' lime
  - Produces spores




## Black Spot

- ☞ Rind spots cause the economic damage
  - internal quality unaffected
- ☞ Reduces fruit value for the fresh market
- ☞ Restricts export of fresh fruit
  - mostly to European countries and U.S
- ☞ Causes premature fruit drop reducing yield
  - Especially on late harvested cultivars

## Symptoms Occur on Maturing Fruit

- ☞ Unusual to see hard spot more than 2 months before maturity
- ☞ Exposure to sunlight increases lesion number
  - Warm temps (~ 81F; 27C) also increase disease
- ☞ Symptoms generally occur on the 'sunny side of trees'



## Hard Spot

- ☞ The most characteristic symptom
  - If hard spot is found then likely some of the other symptoms will be as well
  - If scouting for disease concentrate on this symptom
- ☞ Small round sunken lesions with brick red-chocolate brown margin and tan center
  - Fungal structures often seen as slightly raised pencil-point dots
  - Can have green halo around lesion



## Hard Spot








## False Melanose

- ☞ Looks like melanose from a distance
  - Melanose is rough and is quite red
- ☞ False melanose is a large number of small slightly raised lesions with a smooth texture
  - Usually occurs in heavily infested groves
  - Can occur on green fruit
  - No fungal structures present
  - Can become hard spot later in season



## False Melanose vs. Melanose



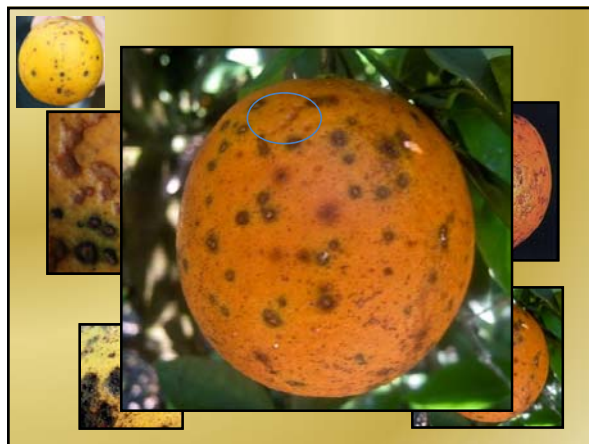
## Cracked Spot

- ☞ Reported to be interaction with rust mite damage
- ☞ Large, flat, dark brown lesions with raised cracks in their surface
  - Can become hard spot later in season
  - Occurs on green and mature fruit



## Virulent Spot

- ☞ Early symptoms small reddish irregularly shaped lesions.
  - Can develop into either virulent spot or hard spot
- ☞ Virulent spot is the expansion and/or fusion of many lesions covering most of fruit surface
  - Many fungal structures present
- ☞ Occurs only on mature fruit as well as post harvest in storage





## Leaf and Stem Symptoms

☞ Leaf symptoms are uncommon in groves with good control but present when little or no control under taken

- Lesions most commonly found on highly susceptible lemons
- Can be found on any cultivar

☞ Small reddish-brown lesions

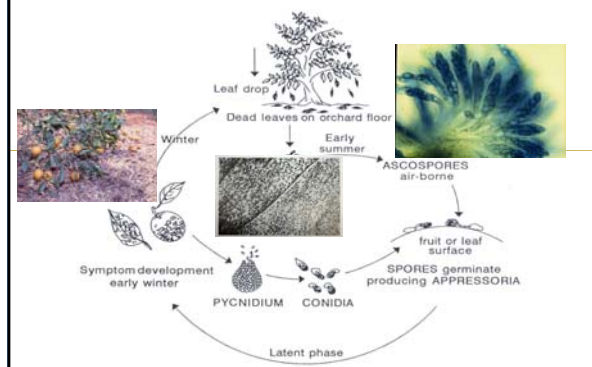
- Tan center forms as lesions age
- Old lesions have dark brown margin sometimes with large yellow halo



## Leaf and Stem Symptoms



## Black Spot Disease Cycle



## Disease Cycle Highlights

- ☞ Major source of inoculum: decomposing infected leaves on orchard floor (ascospores)
- ☞ Additional source of inoculum: lesions on infected fruits, leaves and branches (conidia)
- ☞ Means of spread: Wind (ascospores); Water splash (ascospores and conidia)



## Disease Cycle Highlights cont.

☞ Optimal conditions for infection:

- Temperatures 70-90 F (21 – 32 C)
- Wetting period 24 - 48h




☞ Symptom expression: 1 – 12 months

☞ Survival of the fungus: leaves, leaf litter branches, fruits and peduncles



## Cultural Controls

- ☞ Minimize trash when picking to avoid inadvertent movement of the fungus from one location to another
- ☞ Increase air flow in trees to reduce leaf wetness where possible
- ☞ Avoid cultivars with significant off-season bloom
- ☞ Purchase clean nursery trees
- ☞ Reduce leaf litter to reduce ascospore load



## Leaf Litter Reduction

- ☞ Work done with Greasy spot fungus *Mycosphaerella citri*
  - Primary disease causing spores also formed in leaf litter
  - Need to determine effect on *G. citricarpa*
- ☞ Found that litter/spores were reduced by 70-90% with urea (1 application), lime, ammonium sulfate and frequent irrigation
- ☞ Source of nitrogen important
  - nitrate little to no effect



## Fungicides

- ☞ Must work with fungicides registered for citrus in Florida
- ☞ Reported efficacy in other countries
- ☞ Copper – all formulations found to be equivalent
- ☞ Strobilurins (Abound, Gem and Headline)




## Black Spot Application Timing

Fruit is susceptible for 5-6 months post-petal fall



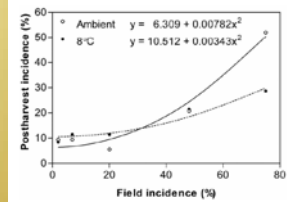
Continue applications at 1 month intervals

**Use strobilurins when concerned about copper phytotoxicity**




## Postharvest Treatments

- ☞ High temperatures and intense light promote symptoms (~ 81F; 27C)
  - Lemons from Argentina have been exposed to these conditions before export to USA
- ☞ Cool temperatures (46F; 8C) reduce disease in storage



Agostini et al, 2006




## Postharvest

Table 1. Incidence of postharvest symptoms of citrus black spot (CBS) on stored fruit that had received a preharvest CBS field control program versus none; a benomyl drench treatment immediately after harvest versus none, various packinghouse fungicide treatments, and that were stored at two temperatures\*

Factor	CBS incidence (%)				
	Murcott	Valencia (A)	Valencia (B)	Lemon (A)	Lemon (B)
Field treatment	1.3 <sup>a</sup>	7.0 <sup>b</sup>	-	6.8 <sup>b</sup>	-
No field treatment	10.7 <sup>a</sup>	41.7 <sup>a</sup>	-	41.4 <sup>a</sup>	-
P	<0.0001	<0.0001	-	<0.0001	-
Benomyl drench	5.9	24.3	13.0	24.3	-
No drench	6.1	25.2	11.0	25.0	-
P	0.79	0.09	0.64	0.54	-
°C	14.8	13.7 <sup>b</sup>	7.8 <sup>b</sup>	6.1 <sup>b</sup>	9.4 <sup>b</sup>
Ambient (15-23°C)	8.7 <sup>a</sup>	35.8 <sup>a</sup>	16.2 <sup>a</sup>	43.9 <sup>a</sup>	17.4 <sup>a</sup>
P	<0.0001	<0.0001	0.005	<0.0001	0.04
Postharvest fungicide					
Wax only	6.5	27.3	15.0	28.6	13.0
Fluorexonil	7.7	26.6	8.7	26.1	16.0
Pyrimethanil	5.1	21.2	14.7	23.8	12.6
Pyrimethanil + imazalil	5.5	24.9	13.1	22.4	15.0
Commercial <sup>†</sup>	5.3	23.9	8.9	22.0	10.7
P	0.97	0.53	0.23	0.13	0.83

\* All fruit were symptomless at harvest.  
<sup>a</sup> Mean separation within groups by Fisher's protected least significant difference, P ≤ 0.05.  
<sup>b</sup> Probability of P greater than that observed for effect within analysis of variance model.  
<sup>†</sup> Commercial = imazalil at 2,500 µg/ml, thiofanoxazole at 5,000 µg/ml, and 2,4-D at 500 µg/ml.

Agostini et al, 2006



## Conclusions of Study

- ☞ Better field control consistently lead to fewer postharvest affected fruit
- ☞ Storing fruit at low temperatures consistently lead to fewer symptomatic fruit
  - Once fruit in warm temperatures symptoms could appear
- ☞ Benomyl drenches were ineffective
- ☞ Fungicides dips and waxes were ineffective

Agostini et al, 2006





## Effects on Fungal Viability

☞ Tested humidity, fruit vs. peel, temperature and length of time in storage for effects on ability to isolate fungus

- Were able to isolate fungus after 40 days
- *G. citricarpa* was viable long after fruit not marketable
- No treatment had a significant effect

Agostini et al, 2006



# Questions?