

What is happening with the fungi?

By Megan Dewdney

As I write this in mid-January, trees are starting to flush, and in some cases, bloom already. The warm weather in January is stimulating early growth, although the predicted cooler weather should slow the trees down a little. If this warm weather continues, it may change when foliar fungal diseases occur.

The foliar fungal diseases are of special concern for the fresh fruit producers, but they also affect overall tree stress and fruit drop. Fruit drop has been a common occurrence this season and has reduced predicted fruit harvests. Foliar diseases can directly contribute to fruit drop and size, so it is important to give them a little thought in planning your disease and pest management regimens.

GREASY SPOT

Greasy spot, caused by *Mycosphaerella citri*, is a problem on all Florida citrus and is a concern for both processing and fresh market production.



Fungal greasy spot on leaves

Ascospores, the spores responsible for infection, are formed in the leaf litter beneath the trees from the previous season's leaf infections.

If greasy spot was problematic in the prior season, it is advisable to increase greasy spot control efforts this year, possibly by adding a fungicide application in August. Also, if there is substantial leaf drop in a block, an enhanced greasy spot program should be considered as the leaf litter will increase the inoculum for greasy spot.

Major ascospore ejections occur from late April to June, but conditions are not always favorable for infection at that time. Despite the fact that peak ascospore ejection has already occurred by June through July, there are still many ascospores in the air able to cause infection, and conditions are favorable. During the summer, *M. citri* grows epiphytically on the surface of plants and is most vulnerable to chemical control. Most infections do not occur until late summer and symptoms are most often seen from November to February, depending

on whether the climate has been cool or warm. Symptoms develop most rapidly when it has been warm, like this season. Severe outbreaks of greasy spot can cause major defoliation on untreated trees.

Copper is an effective and economical choice for greasy spot control, especially rind blotch,

Table 1. Fungicides with modes of action to aid rotation for resistance management

Fungicide	Mode of Action ^a
Abound	11
Copper	M1
Enable 2F	3
Gem 500 SC	11
Headline SC	11
Petroleum oil	--
Pristine	11 + 7
Quadris Top	11 + 3

^aMode of action class from the Fungicide Resistance Action Committee (FRAC) Code List 2012

particularly in groves with canker. However, if summer temperatures are high (> 94°F; 34°C) and the weather is dry, copper can cause phytotoxicity on the fruit. Application of copper with petroleum oils can also lead to rind defects during the summer months — most problematic for fresh fruit production. Therefore, copper is best applied on moderately warm days at 2 lb./acre or less without any additives, like petroleum oil.

On processing oranges where fruit blemishes are not as important, petroleum oils are a good alternative to copper, but control rind blotch inconsistently. If phytotoxicity is of particular concern, strobilurin fungicides [Abound (azoxystrobin), Gem (trifloxystrobin) and Headline (pyraclostrobin)], Enable (fenbuconazole) or Quadris Top (azoxystrobin and difenoconazole) are also effective control options. The strobilurins are most appropriate in late May to early June because they also control melanose. No more than one application of strobilurins alone or in a mixture should be made within a season to avoid selection for resistant strains of *M. citri*. Enable is especially effective for mid- to late-season control of rind blotch, but should not be followed by Quadris Top because they share a mode of action (Table 1).

MELANOSE

The fungus that causes melanose, *Diaporthe citri*, rapidly colonizes and sporulates on small twigs (< 0.25 inch; 5 mm) that die from freeze damage and other causes. The spores (or conidia) are formed inside flask-shaped pycnidia that can be seen with the naked eye or a hand lens on twig

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Fungal melanose on fruit

surfaces as small black bumps. More dead twigs allow the fungus to produce much more inoculum than if they were not present. It is impossible to remove all dead twigs, but twig removal will reduce disease pressure.

The fungus also infects live twigs, which produce inoculum after the twig dies. Normally, groves under 10 years old do not have much melanose since there are not many dead twigs in the canopy, but a freeze can allow the fungus to become established in young blocks sooner. Luckily, high inoculum levels do not carry over from one year to the next, so if there is no significant freeze event this year, melanose inoculum should be at normal levels. The conidia are spread by rain, but if there is no rain, the conidia remain as tendrils attached to pycnidia, able to infect when the rains resume. This can result in seemingly explosive infection events.

Melanose severity may gradually increase overall as more groves become afflicted by HLB and greater canopy dieback occurs, but conversely there may not be much flush on such trees to

be infected. Only time will tell.

Ten to 12 hours of leaf wetness, not unusual in Florida, are needed for infection if temperatures are between 70°F to 80°F (21°C to 27°C). However, melanose is not usually severe unless there are extended leaf wetness periods. Up to 24 hours of leaf wetness are needed if temperatures are cooler. No spores are produced on

leaves or fruit.

Copper is the most economical option for melanose control because of its long residual activity, but residues decline with fruit expansion and rainfall. The Citrus Copper Application Scheduler (<http://www.agroclimate.org/tools/cudecay/>) is used to estimate the copper residue remaining on the fruit surface to assist copper reapplication decisions for maximized protection.

Grapefruit are most susceptible to melanose, and copper applications should be made every three weeks from early-May until fruit become resistant, usually in early July. If copper is applied in early June, it can also serve as the first greasy spot application and as a canker application.

If there is concern about copper phytotoxicity in hot weather, strobilurin fungicides or mixtures give good control, but should never be used more than twice in a row for melanose because of possible development of fungicide resistance (Table 1). One caveat is that strobilurins do not have as long a residual activity as copper.

ALTERNARIA BROWN SPOT

Alternaria alternata is a perpetual problem on fresh market tangerines and tangerine hybrids, causing blemishes in addition to fruit and leaf drop with severe infections. Infected leaves and twigs in the canopy, recently fallen leaves and last season's fruit remaining on the tree produce conidia. Conidia become airborne and can land on susceptible tissues when the humidity changes or there is more than 0.1 inch (2.5mm) of rain. Leaf infection occurs in as little as four to six hours, but the disease is more severe with longer wetting periods. Optimum infection temperatures are 73°F to 80°F (23°C to 27°C), but infection can occur between



Fungal alternaria on Murcott

63°F to 90°F (17°C to 32°C).

Strobilurin resistance of *A. alternata* populations was first reported in Florida in 2008. Since that time, we have done a survey of tangerine blocks throughout the state and found that 64 percent of the isolates tested were resistant to strobilurin fungicides. The first few groves to report control failures had a history of using the highest label rate of strobilurins many times a season, often without rotation. However, new cases of resistance have been found in groves where label rates and rotation instructions were followed carefully.

Fungicide resistance is an issue that should concern anyone producing tangerines and tangerine hybrids as it

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severely limits control options. Considering how common resistant isolates have become, I am now advising that alternaria brown spot be managed as if resistance were present. This would include incorporating the premix fungicides Pristine and Quadris Top into your program instead of strobilurins alone. Both of these products contain alternative modes of action to strobilurins but they are only available as mixtures with strobilurins, so they cannot be used in rotation (Table 1). These products should be rotated with copper products.

While current strobilurin use recommendations will not prevent resistance, they will slow the development. Thus, it is important to restrict strobilurin use to the label limit and never use strobilurin-containing products more than three times per year and never apply strobilurin-containing products more than twice in a row. The new modes of action are also vulnerable to resistance development, so it is advisable to include both premixes, described above, in your program.

BLACK SPOT

Black spot is concentrated in Collier and Hendry counties, but the re-



Fungal black spot on fruit

cent small find in Polk County should keep all producers looking for symptoms in their groves. Most citrus cultivars and species are susceptible to the disease. Like greasy spot, ascospores — the main inoculum — are formed in the leaf litter under the trees and are spread by wind. Conidia, which can also infect fruit, are formed on dead twigs and in certain symptom types on fruit, and are spread by rain splash. The main period of infection is from May to September; however, fungicide applications are advised in April if the season is wet. Black spot infection also requires long wetting periods of at

least 18 hours, but with the heavy dews that occur in Florida, such prolonged periods are not unusual.

At this time, products for black spot control are restricted to the strobilurin fungicides and copper (Table 1). Monthly applications should begin in early May. If canker is problematic in a grove, the copper applications used for canker control will also control black spot. However, in most processing oranges, additional applications will be needed for black spot. Strobilurins are recommended where phytotoxicity is a concern for fresh fruit or where there was severe disease the previous season. In processing oranges where cosmetic damage is less of a concern, strobilurins may be best applied in the early spring and then rotated with copper.

Further information on the control and biology of all of the fungal foliar diseases is available on the CREC website, as well as in the Florida Citrus Pest Management Guide and EDIS (<http://edis.ifas.ufl.edu/>).

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