The fungi in my grove

PHOTO: University of Florida

By Megan Dewdney

In 2014, there was a resurgence of a disease that had been nearly forgotten. Post-bloom fruit drop (PFD) came back to Florida after a 15-year absence in many groves. While PFD caused severe damage in some groves, overall the disease did not cause the statewide damage that was seen in the 1990s. Diseases like PFD and Huanglongbing (HLB) are foremost in everyone's minds for good reason, but it is important not to forget the old fungal 'friends' that are there every year and, if ignored, can cause significant damage in their own ways.

GREASY SPOT

Greasy spot, caused by *Mycosphaerella citri*, is a disease that affects all Florida citrus and can cause problems for processing and fresh market production. Ascospores, the spores responsible for most of the infection, form in the leaf litter beneath the trees from the previous season's infections. If greasy spot symptoms were common in the canopy last year, it is advisable to increase control efforts this year, potentially adding an application in August. Also if there has been substantial leaf drop, an enhanced greasy spot program should be considered as the leaf litter will increase the inoculum for greasy spot. During the summer, *M. citri* is in its epiphytic (on the surface of the leaves) growth phase 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 temperatures. Symptoms develop most rapidly when it is warm. Severe greasy spot outbreaks can cause major defoliation on untreated trees, which can lead to small, marred fruit and fruit drop.

Copper remains an effective and economical choice for greasy spot control, especially for rind blotch and groves with canker. However, if summer temperatures are high (> 94°F; 34°C) and the weather is dry, copper phytotoxicity on the fruit can occur. Application of copper with petroleum oils can also lead to rind defects during the summer months — most problematic for fresh fruit production. Copper is best applied on moderately warm days without any additives, especially petroleum oil, at 2 lb/acre or less. On processing oranges, where fruit blemishes are not as important, petroleum oils are a good alternative to copper for controlling greasy spot on leaves. If

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phytotoxicity is of particular concern, strobilurin fungicides [Abound (azoxystrobin), Gem (trifloxystrobin), and Headline (pyraclostrobin)], Enable (fenbuconazole), Pristine (pyraclostrobin and boscalid) 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 of resistance management since 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, including HLB. The spores (or conidia) are formed inside flask-shaped pycnidia that can be seen with the naked eye as small black bumps on twig surfaces. Large numbers of 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 dead branch removal will reduce disease pressure. The fungus also infects live twigs, which produce inoculum after the twig dies. Normally, groves under 10 years old will 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 a significant freeze event does not occur, melanose inoculum should return to normal levels. The conidia are spread by rain but if it is dry, the conidia survive in tendrils attached to pycnidia, and are able to infect when the rains resume. This is the reason that melanose can seem explosive. Only 10 to 12 hours of leaf wetness are needed for infection if temperatures are between 70–80 °F (21–27 °C). However, melanose is not usually severe unless there are extended leaf wetness periods. If temperatures are cool, even longer leaf wetness periods of up to 24 hours are needed. No spores are produced from leaf and fruit lesions to continue infections.

Copper is still the most economical option for melanose control because of the long residual activity, but residues decline with fruit expansion and rainfall. The Citrus Copper Application Scheduler (http://www.agroclimate.org/tools/cudecay/) estimates the copper residue remaining on the fruit surface. The Scheduler assists the timing of copper applications for optimal coverage. If the Scheduler is not used, copper applications should be made every three weeks to both sides of the tree from early May on average until fruit become resistant in early July. This is especially important for grapefruit, which are the most susceptible to melanose. If copper is applied in early June, it can also serve as the first greasy spot application and as a canker application. In hot weather when copper phytotoxicity is problematic, strobilurin fungicides or the mixtures Quadris Top and Pristine give good control but should never be used more than twice in a row because of possible development of fungicide

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

Fungicide	Mode of Action[a]
Abound	11
Copper	M1
Enable 2F	3
Ferbam	M3
Gem 500 SC	11
Headline SC	11
Petroleum oil	--
Pristine	11 + 7
Quadris Top	11 + 3

[a]Mode of action class from the Fungicide Resistance Action Committee (FRAC) Code List 2014

A) Greasy spot, B) melanose, C) Alternaria brown spot and D) black spot.

resistance (Table 1, page 27). One caveat is that strobilurins do not have as long of a residual activity as copper, so applications will need to be more frequent than every 21 days.

ALTERNARIA BROWN SPOT (ABS)

Alternaria alternata is a perennial problem on fresh market tangerines and tangerine hybrids, causing blemishes in addition to fruit and leaf drop with severe infections. Conidia are produced on infected leaves and twigs in the canopy, recently fallen leaves and last season's fruit remaining on the tree. Conidia become airborne when the humidity changes or there is more than 0.1 inch (2.5 mm) of rain. Leaf infection occurs in as little as four to six hours, but the disease is more severe with longer wetting periods. It takes longer to infect less susceptible cultivars like Sunburst. Optimum infection temperatures are 73–80 °F (23–27 °C), but *Alternaria* can infect at any temperature between 63–90 °F (17–32 °C).

Strobilurin resistance of *A. alternata* populations was first reported in Florida in 2008. We completed a survey of tangerine blocks throughout the state in 2012 and found that 58 percent of the isolates were resistant to strobilurin fungicides. Initially the groves reporting control failures had used the highest label rate of strobilurins many times per season and often without rotation. However, resistance has since been found in groves where label rates and rotation instructions were carefully followed. Fungicide resistance should concern anyone growing tangerines and tangerine hybrids because it greatly limits control options. Since resistant isolates are commonly found, I am now advising ABS be managed as if resistance were present. This would include incorporating the premixed fungicides Pristine and Quadris Top into your program instead of those containing only strobilurins. Both of these products contain alternate modes of action to strobilurins, but they are only available as mixtures with strobilurins, so they cannot be used in direct rotation (Table 1). These products should be rotated with copper products or ferbam. 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 for *any* use 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 in your program. Use of strobilurins to prevent fruit drop does count towards your seasonal limit. Remember, the label is the law.

BLACK SPOT

Black spot is concentrated in Collier and Hendry counties and the area affected continues to expand, but the find in Polk County should have everyone looking for symptoms in their groves. Most citrus cultivars and species are susceptible to the disease. Like greasy spot, the primary inoculums — ascospores — are formed in the leaf litter under the trees and are spread by wind. Additional inoculums — conidia — are formed on dead twigs and in certain symptom types are spread by rain splash similarly to melanose. The main period of fruit infection is from May to September; however, applications are advised in April if it 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. New fungicide recommendations were made in the 2015 Florida Citrus Pest Management guide. In addition to the strobilurins (Abound, Gem and Headline) and copper, Enable, Pristine, and Quadris Top are options for black spot management (Table 1). It is recommended to rotate modes of action as is presented in 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, especially Valencia, additional applications will be needed for black spot. Any of the other fungicides are recommended where phytotoxicity is a concern or where there was severe disease the previous season.

POST-BLOOM FRUIT DROP

Post-bloom fruit drop was a problem last spring, especially on Navel cultivars. The most susceptible cultivars are Valencia and Navel as well as Tahiti Lime. Hamlin, grapefruit and tangerines are less susceptible to the disease. The fungus, *Colletotrichum acutatum*, is stimulated to grow and produce spores by flower extracts, so off-season or long bloom periods favor the disease and make it more difficult to control. Many blocks have multiple bloom periods because of HLB, so applications should be concentrated on the bloom that you believe is most likely to provide your major crop. It is difficult to determine if PFD is going to be a major problem in the spring, but it is vital that growers inspect their flowers for the reddish, brown discoloration that is indicative of infection so that applications can be made as soon as possible, particularly if there are persistent calyxes from the previous year.

Currently there are few recommended fungicides. The strobilurins, tank mixed with Ferbam, are currently the best option (Table 1, page 27) but these products have very limited usages. Trials have not been done to test Pristine or Quadris Top so it is difficult to comment on efficacy. Copper is generally considered ineffective.

Further information on the control and biology of all of the fungal foliar diseases is available under the Extension tab of the Citrus Research and Education Center website, as well as in the Florida Citrus Pest Management Guide and EDIS (http://edis.ifas.ufl.edu/).

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