The fungi never rest

By Megan Dewdney

This season, like last season, fruit drop has been a common complaint in the Florida citrus industry. The cold front in late November has contributed to this by stimulating some ethylene production, and that has been enough to start the abscission process. As of early December, the odd flush patterns of 2012–2013 have yet to occur, but it is very hard to predict the future over the next couple of months. Fungal diseases are a particular problem for fresh fruit producers, but they also affect tree health and fruit drop in processed oranges. The fruit forecast has already been reduced from the original predictions for this season, but hopefully will not continue to fall. Foliar diseases directly contribute to fruit drop, so it is important to consider them when planning your disease and pest management regimens.

GREASY SPOT

Greasy spot, caused by *Mycosphaerella citri*, is a disease that affects all Florida citrus and is a concern for both 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 there were many greasy spot symptoms on the leaves 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.

Greasy spot

Major ascospore ejections occur from late April to June, but conditions are not always favorable for infection at that time. Even though peak ascospore ejections are over, there are still many ascospores in the air able to cause infection from June through July, when conditions are most favorable. During the summer, *M. citri* is in its epiphytic (on the surface of the leaves) 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 whether the climate has been cool or warm. Symptoms develop most rapidly when it is warm. Severe outbreaks of greasy spot can cause major defoliation on nontreated trees, which can lead to small 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 (greater than 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; that is most problematic for fresh fruit production. Copper is best applied on moderately warm days without any additives, including 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, but control of rind blotch is inconsistent.

If phytotoxicity is of particular concern, strobilurin fungicides Abound (azoxystrobin), Gem (trifloxystrobin) and Headline (pyraclostrobin) are effective control options, as are Enable (fenbuconazole) and mixtures of strobilurins and other ingredients — Pristine (pyraclostrobin and boscalid) or Quadris Top (azoxystrobin and difenoconazole). 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 issues, since they share a mode of action (Table 1).

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

[a]*Mode of action class from the Fungicide Resistance Action Committee (FRAC) Code List 2013*

MELANOSE

The fungus that causes melanose, *Diaporthe citri*, rapidly colonizes and sporulates on small twigs (less than 0.25 inch, 5 mm) that die from freeze damage and other causes including huanglongbing (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 the dead twigs 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. Melanose severity may gradually increase overall as more groves become afflicted by HLB and greater canopy die back occurs, but conversely there may not be much flush or fruit on such trees to be infected. Only time will tell.

Melanose

Only 10 to 12 hours of leaf wetness are needed for infection if temperatures are between 70°F and 80°F (21°C and 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 infections to continue infections.

Copper is 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 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 mixtures give good control, but should never be used more than twice in a row because of possible development of fungicide resistance (Table 1, page 6). One caveat is that strobilurins also do not have as long of a residual activity as copper.


Alternaria

ALTERNARIA BROWN SPOT (ABS)

Alternaria alternata is always a 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 when the humidity changes or there is more than 0.1 inch (2.5 mm) of rain and can land on susceptible tissues. 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°F to 80°F (23°C to 27°C), but *Alternaria* can infect at any temperature between 63°F and 90°F (17°C and 32°C).

Strobilurin resistance of *A. alternata* populations was first reported in Florida in 2008. Since that time, we conducted a survey of tangerine blocks throughout the state and found that 58 percent of the isolates were resistant to strobilurin fungicides. The first groves to report 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 is a topic that should concern anyone growing tangerines and tangerine hybrids as it greatly limits control options.

Since resistant isolates are commonly found, I am now advising ABS to 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, page 6). 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 in your program.

BLACK SPOT

Black spot is concentrated in Collier and Hendry counties and the area affected continues to expand, but a 2012 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, the primary inoculum, ascospores, is formed in the leaf litter under the trees and is spread by wind. Additional inoculum, conidia, is formed on dead twigs and in certain symptom types, and is spread by rain splash similarly to melanose. The main period of fruit infection is from May to September; however, fungicide 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. At this time, products for black spot control are restricted to the strobilurin fungicides (Abound, Gem and Headline) and copper (Table 1, page 6). Monthly applications


Black spot

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. Strobilurins are recommended where phytotoxicity is a concern or where there was severe disease the previous season. In processing oranges where cosmetic damage is less of a concern, strobilurins may be most efficacious 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 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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