

Citrus black spot in Florida

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The fungal disease citrus black spot has been found in the Immokalee area in a small number of groves. The Division of Plant Industry (DPI) and the Citrus Health Response Program (CHRP) are conducting surveys to determine how many additional groves have been affected. A forensic team is attempting to discover how the pathogen may have arrived in Florida, but so far, no real clues have emerged. See www.doacs.state.fl.us/pi/enpp/pathology/citrus-black-spot.html for maps showing the locations of black spot finds as they are confirmed. If you feel that



Figure 1. Mild hard spot symptoms on Valencia fruit in Florida.

you have suspicious lesions on your fruit, please contact your local CHRP office to arrange for an inspection and collection of samples. Visit www.doacs.state.fl.us/pi/pec/pec-dist-map.html for CHRP contact information.

Black spot is a serious disease that has the potential to be economically damaging to both processing and fresh fruit. When the disease is not controlled in the grove, up to 80 percent of fruit has been reported to be affected. The disease impact comes in the form of blemished fruit and reduced yields from premature abscission of heavily infected fruit. The United States pres-

ently does not allow citrus to be imported from areas known to have this disease, and the movement of fruit into European markets is also restricted.

Currently, the USDA's Animal and Plant Health Inspection Service and other federal agencies are developing policies for intrastate, interstate and international trade of Florida citrus and will communicate these policies to growers via Florida Citrus Mutual. This is a complicated process involving trade negotiations with many countries, and great care is needed to make sure that all agreements are fair and biologically sound. The disease is currently found in many humid subtropical countries including Argentina, Australia, Brazil, China, South Africa, sub-Saharan Africa, Southeast Asia



Figure 2 (above). Moderate hard spot symptoms on Valencia in Florida. The small red lesions are early virulent spot.

Figure 3 (right). Classic hard spot symptoms from Florida.

Figure 4 (far right). Cracked spot on Valencia from Florida.



and southern South America. The disease has not been detected within Mediterranean countries.

As with many fungal pathogens, black spot has a sexual and asexual reproductive phase, and each stage has a different scientific name: *Guignardia citricarpa* is the sexual stage and *Phyllosticta citricarpa* is the asexual stage. Both names are used in documents referring to black spot.

DISEASE CYCLE

To aid disease management decisions, it is essential to have a basic understanding of the disease cycle. The sexual structures of the fungus, known as pseudothecia, are formed in decomposing leaf litter. Approximately 50 to 180 days from the time of leaf drop, the sexual structures mature and eject ascospores (sexual spores). Leaf drop can occur at various times during the season, but most leaves abscise in the spring. Intermittent wetting and drying appears to be essential for the maturation of the fungal structures in the fallen leaves, and rain, irrigation or even heavy dew can be sources of wetting.

The ascospores are ejected up to 0.5 inch (1.2 cm) above the litter surface, where they are dispersed by air to susceptible leaves, fruit and twigs. Optimal conditions for infection by *G. citricarpa* are temperatures between 70°F and 90°F (21°-32°C) and leaf wetness for 24 to 48 hours. In most regions where black spot is well established, ascospores are the primary inoculum. Conidia (asexual spores), produced in pycnidia (spore-forming structures), are produced on mature fruit, leaf litter and dead twigs. The conidia are dispersed over short distances by splashing water from one fruit to the next or from the leaf litter to low-hanging fruit and foliage. Infections on fruit from both spore types have a 4- to 6-month latent period before symptoms develop.

In South Africa and Australia, where many of the studies on the black spot disease cycle have been done, ascospores from leaf litter are almost exclusively responsible for new infections; so there is effectively only one disease cycle per year. Conidia are not important in South Africa and Australia because of the characteristics of these regions: 1) uniform flowering and fruiting because of cool temperatures during flower initiation and the use of drip irrigation; 2) rainfall is

limited to three months of the year.

In Brazil, conidia are more important for disease spread as they can infect young fruit on cultivars that have multiple or overlapping crops on the tree, such as Pera or Valencia oranges. Environmental conditions in Florida are most similar to those in Brazil, which suggests that conidia are potentially more important in the disease cycle. Only through experience can we be certain, but disease control in Florida will likely be more challenging than it is in South Africa and Australia.

CONTROL

In countries with the disease, black spot has been controlled most effectively through the use of fungicide applications during the summer months. Several of the fungicides recommended for control abroad are not labeled for use on Florida citrus. This leaves two control options: copper and the strobilurin fungicides (Abound®, Gem® and Headline®). An all-copper program appears to be effective at reducing disease incidence and severity in Brazil and may be adequate for many processing blocks that are not concerned with copper phytotoxicity to the rind (copper burn).

Applications should begin late April to early May and continue with monthly sprays until late August. If abundant rain is anticipated during April, applications should start early in the month. If a block is already on a canker-control program with copper applications every 21 days, this regimen should control black spot. If canker sprays are not needed in a fresh market block or phytotoxicity is a concern, it would be best to save strobilurin applications for the hottest months. In these cases, we suggest starting with a copper application, followed by a strobilurin, then copper, strobilurin and a final copper application.

Fungicide applications for other foliar fungal diseases earlier in the spring will be ineffective for black spot control because the spores are unlikely to be ejected until the rains of late April-early May when leaf decomposition has begun. Remember that a total of only four strobilurin applications are allowed per block per year for all disease problems. We also do not recommend back-to-back applications of strobilurins to discourage the development of pathogen resistance. Although there have been no reported

cases of black spot resistance to strobilurins in the literature, other countries have more fungicides with different modes of action to use as rotational products. We do not want to lose the strobilurin management tool from our disease control arsenal.

LEAF LITTER

The major period of leaf drop in Florida occurs from late January to March. Since black spot has a disease cycle similar to greasy spot (caused by *Mycosphaerella citri*), it is suspected that spore production by *Guignardia* will probably begin in late April and extend through mid- to late summer as it does with *Mycosphaerella*. Inoculum can be reduced if the leaf litter decomposes before spore production begins. Application of lime, shredding of leaf litter, or frequent light irrigation (approximately five times/week) will promote litter decomposition. The irrigation should be done with microsprinklers as drip emitters will not wet the grove floor enough to promote decomposition. Fertilization with urea, ammonium sulfate, or other fertilizers that generate ammonia delays decomposition, but inhibits spore production. In Brazil, mowers are designed to throw weed and ground cover residues from row middles under the canopy to cover leaf litter. This practice stimulates decomposition and provides a physical barrier to spore dispersal. Fungicide applications should reduce the leaf and fruit infection, and in combination with practices mentioned above for dealing with litter, could substantially reduce inoculum levels.

Because of the role leaf litter plays in the disease cycle, minimizing trash movement from one location to another is essential. The disease is normally asymptomatic on leaves, so it is very easy to inadvertently move inoculum from one block or grove to another. This is the rationale for the tarping regulations for fruit coming from the quarantine areas, but other equipment could also easily move trash from one area to another.

Movement of fresh fruit from areas with black spot is restricted to avoid introduction of the pathogen to new areas. However, since only asexual spores that are splash-dispersed are produced on affected fruit, the risk of introducing the pathogen into new areas with fruit is very low, especially after fruit have received commercial

packinghouse treatments (i.e., washing, waxing, fungicide application and grading).

Studies in Argentina showed that an effective black spot control program using fungicides during the growing season greatly reduced the disease in the field and also reduced latent infections in the fruit that could develop into visible symptoms after harvest. Cold storage of fruit at 46°F (8°C) delayed, but did not prevent, the develop-

ment of black spot symptoms. Application of fungicides shortly before or after harvest did not reduce subsequent disease development. Exposure of fruit to high light intensity accelerates the development of symptoms in the field and even after harvest.

Black spot will be another serious challenge for the Florida citrus industry. The disease is manageable, but will further increase production costs and cause uncertain problems with

shipment of fresh fruit.

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