PP152

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Alternaria Brown Spot[1]

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Alternaria brown spot, caused by *Alternaria alternata*, first appeared in Florida citrus groves about 35 years ago and has been a serious problem on tangerines and tangelos in recent years. The disease was first reported in Australia in 1903 on Emperor mandarins. It is a mystery how the disease arrived in Florida but it may have developed locally from other *Alternaria* species or it may have been imported from other locations. To date, Alternaria brown spot has been reported in South Africa, Turkey, Israel, Iran, Spain, Italy, Greece, Brazil, Argentina, Peru and Colombia. The disease likely occurs in other countries that grow susceptible varieties.

In Florida, Alternaria brown spot was originally observed on Dancy tangerines. The disease can severely affect Minneola, Orlando, Nova and Lee tangelos and also attack Murcotts as well as Sunburst tangerines. Minneolas are the most susceptible cultivar of the tangerine hybrids and control is the most difficult. This disease does not affect oranges, but may cause some spotting on grapefruit if they are adjacent to heavily infested tangerines or tangelos.

Figure 1. Alternaria brown spot lesions on Minneola tangelo leaves with yellow halos and lesions that follow the veins.

Symptoms

Alternaria brown spot attacks young fruit, leaves and twigs, producing brown-to-black lesions surrounded by a yellow halo (Figs. 1, 2). The halo is caused by a fungal toxin which rapidly kills citrus tissue. Leaf lesions are generally circular but will often have a tail, following the leaf vein which gives the lesions an eye-spot appearance. The necrosis extends along the veins as the toxin spreads in

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vascular tissues. On young leaves, lesions can appear as early as 36-48 hours after infection. Lesions enlarge as leaves mature and can vary in size from 1-10 mm (0.04-0.4 inches) and will be larger if the infection occurred earlier in the season (Fig. 2). Cultivar susceptibility is also a factor that determines ultimate lesion size. A less susceptible cultivar than Minneola, like Dancy tangerine, will have smaller lesions (Fig. 3). If Alternaria brown spot is severe, the leaves may drop and entire shoots can wilt and die.

Figure 2. Alternaria brown spot lesions on a twig and young leaves. The infection occurred early in the season leading to very large lesions that will likely defoliate this twig.

Figure 3. Alternaria brown spot lesions on a susceptible cultivar, Dancy tangerine.

Severe fruit infections, especially shortly after petal fall, result in the drop of young fruitlets. Remaining fruit can have lesions that vary in size from dots to large pock marks on the peel. Young lesions form a corky protuberance that is able to be dislodged as the fruit matures, leaving a light tan pock mark (Figs. 4, 5). On occasion, *A. alternata* is able to penetrate the citrus rind and cause localized necrosis, but this is relatively rare. Fruit are susceptible to Alternaria brown spot for 4 months after petal fall. Even when the fruit are no longer susceptible, some fruit may fall as the result of earlier infections, especially if they are near the fruit stem.

Figure 4. Alternaria brown spot lesions with the typical corky protuberances on Minneola tangelo.

Figure 5. Light tan pock marks on the peel from where the corky protuberances of Alternaria brown spot lesions have been dislodged.

Tangerines and tangerine hybrids are affected by one strain, or pathotype, of *A. alternata*. A separate pathotype of *A. alternata* only attacks rough lemon and Rangpur lime. *Alternaria* leaf spot of rough lemon was seen commonly in Florida on rough lemon root sprouts (Fig. 6) in old groves. The specificity of both diseases is due to separate, well characterized, host specific toxins. A third disease, black rot of fruit, a postharvest disease, is also caused by *A. alternata*. Black rot isolates, however, do not have a host specific toxin or cause Alternaria brown spot on tangerines or rough lemon leaf spot. Many *Alternaria* isolates can cause black rot and therefore this disease is not considered to be caused by a specific pathotype.

Figure 6. Alternaria leaf spot of rough lemon caused by a separate pathotype of *Alternaria alternata*.

Disease Cycle

The asexual spores of the fungus are thick walled, multicellular, and pigmented and thus tolerate adverse conditions like dry weather (Fig. 7). They are produced on leaves 10 days after symptoms appear, primarily on old lesions on mature leaves. Spore production continues up to 50 days after infection. In addition, spores are produced in lower numbers on fruit and twigs remaining on the tree as well as on leaf litter. When there is no susceptible tissue available, such as over the winter, the fungus survives on mature leaves, twigs and fruit. Spore production is greatest at relative humidities above 85%. Spores are air-borne and release into the air is triggered by rainfall or by a sharp change in relative humidity. Once the spores are released, they are moved by wind to susceptible tissue where they are able to infect. When temperatures are favorable (68-83°F (20-29°C)), the length of the wetting period required for infection is about 8-10 hours. When temperatures drop below 17°C or above 32°C (63° and 90°F, respectively), the fungus requires extended leaf wetness durations (>24 hrs) to cause significant infections. On highly susceptible cultivars, it has been shown that as little as 6 hours of leaf wetness can result in infections. Most of the infections probably follow rains, but dew can be sufficient for an infection event. For example, in Israel and Spain, little rain occurs after petal fall, but they can still have significant infection as the result of heavy dews.

Figure 7. Asexual spores (conidia) of *Alternaria alternata*. They are pigmented, multicellular, thick-walled spores that are able to survive adverse conditions for extended periods of time.

Disease Management

Fungicides are the primary means of controlling Alternaria brown spot. However, there are many cultural management practices which are helpful to reduce disease severity.

When new groves of susceptible varieties are planted, they should be established with disease-free nursery stock. With the new nursery regulations, trees grown in greenhouses without overhead irrigation should be free of *Alternaria*. Planting with disease-free nursery trees helps prevent Alternaria brown spot because even though spores are air-borne, they tend not to travel long distances so plantings of healthy trees remain so for long periods. If *Alternaria* is present from the outset, the disease builds to high populations during the vigorous vegetative growth on young trees and subsequently is difficult to control on fruit. When establishing new groves, it is best to locate susceptible varieties in higher areas where air drainage and ventilation is good so that leaves dry more rapidly. Minneola tangelo groves in low, wet areas have conditions so favorable for disease that Alternaria brown spot may be virtually uncontrollable. Less vigorous rootstocks such as Cleopatra mandarin should be selected rather than vigorous ones like Carrizo citrange so that there is less susceptible tissue to be infected. Highly susceptible cultivars such as Minneola should be planted at a wider spacing than oranges to promote rapid drying of the canopy and make the disease more manageable.

In existing plantings, it is important not to promote excessive vegetative growth. Overwatering and excessive nitrogen fertilization should be avoided. Frequent light hedging should be done, rather than less frequent severe hedging. The best time to hedge, in terms of Alternaria brown spot control, is late March.

For products currently registered for control of Alternaria brown spot see the Florida Citrus Pest Management Guide: http://www.crec.ifas.ufl.edu/extension/pest/index.htm. Fungicides protect expanding young leaves for only a very short period, and except for the spring flush which is uniform, it is not feasible to control Alternaria brown spot on leaves. Thus, disease managment recommendations are aimed primarily at keeping the fruit from being blemished. The number of fungicide applications needed for control varies greatly with the susceptibility of the cultivar and the severity of the infestation. In the worst cases, the first spray should be applied when the new flush is 1/4-1/2 of full expansion to prevent buildup of *Alternaria* on the spring flush. The second application should be made at petal fall. Thereafter, applications may need to be made as often as every 10 days to achieve good control on fruit and foliage. For more precise application timing see the Alter-Rater (http://edis.ifas.ufl.edu/CH183), a weather-based predictive model. During dry periods which often occur in April and early May, spray intervals can be increased. Likewise, less susceptible varieties or less severely affected groves do not need such intense spray programs. Groves of susceptible varieties should be monitored frequently to determine the current disease status. The use of strobilurin fungicides should be limited for resistance management. **There should be no more than 2 consecutive applications of any strobilurin and no more than 4 applications of strobilurins within a year for any disease. There should also be strict adherence to the maximum use rate per acre.** Strobilurin-resistant populations of *A. alternata* have been found in isolated Florida groves. Once a population becomes resistant to strobilurin fungicides, it does not become sensitive again and an important tool for control is permanently lost. When applications of copper fungicides are applied more frequently than every 3 weeks, rates can be reduced to as little as one pound of metallic copper per acre. Spraying can be discontinued in late June since fruit usually becomes resistant to *Alternaria* in July when fruit growth slows. It is not economical to try to control the disease on late summer flushes of growth.