UF IFAS Extension UNIVERSITY of FLORIDA

PP-182

2019–2020 Florida Citrus Production Guide: Citrus Canker[1]

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Citrus canker is a leaf-, fruit-, and stem-blemishing disease that affects most citrus. Severe infections can cause significant fruit drop. It is caused by the bacterium *Xanthomonas citri* subsp. *citri*. Grapefruit, Mexican lime, and some early oranges are highly susceptible to canker. Lemons, limes, and Navel, Pineapple, and Hamlin oranges are moderately susceptible to canker. Mid-season oranges, Valencias, tangors, tangelos, and other tangerine hybrids are less susceptible, and tangerines are the least susceptible.

Symptoms. Young lesions are raised on both leaf surfaces, particularly on the lower leaf surface. The pustules later become corky and crater-like with raised margins and sunken centers and are surrounded by a yellow halo. Fruit lesions vary in size because the rind is susceptible for a long time, and more than one infection cycle can occur on fruit. Twig and stem infections resemble those on fruit. The lesions are raised with a corky appearance and can support long-term survival of the bacterium. Older lesions may darken when they become colonized by saprophytic fungi such as *Colletotrichum* spp.

Major citrus canker outbreaks generally occur when new shoots emerge or when fruit are in the early stages of development, especially if a major rainfall event occurs during this critical time. Frequent rainfall in warm weather, especially storms, contributes to disease development. Citrus canker is a cosmetic disease, but when conditions are highly favorable for infection, it causes defoliation, shoot dieback, and fruit drop. Leaf susceptibility is complicated by the citrus leafminer. The galleries caused by leafminer larvae do not heal quickly and increase leaf susceptibility. Leaves then have highly susceptible wounds for long periods of time where the bacterium can infect the leaf. Lesion number and individual lesion size increase greatly and magnify the inoculum pressure in a grove compared to citrus canker without leafminer.

Biology. The bacterium reproduces in lesions on leaves, stems, and fruit. When there is free moisture on the lesions, the bacteria ooze out and can spread to new growth and other trees. Wind-driven rain is the main means of movement, and wind speeds >18 mph aid in the penetration of bacteria through the stomatal pores or wounds made by thorns, insects, and blowing sand. Tissues become resistant to infection as they mature, except when exposed to extreme windblown rain such as in a hurricane. Almost all leaf and stem infections occur within the first 6 weeks after growth initiation unless there is a leafminer infestation or tropical-storm-force winds. The most critical period for fruit infection is when the fruit are between 0.5–1.5 inches in diameter for grapefruit and 0.25–1.25 inches in diameter

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for oranges. In this stage, the stomates on the fruit surface are opening, and fruit are particularly susceptible to bacterial penetration. After petal fall, fruit remain susceptible during the first 60 to 90 days for oranges or tangerines and 120 days for grapefruit. Infection after this time can result in the formation of small, inconspicuous pustules.

Most spread of the bacterium by wind and rain is over short distances, such as within trees or to neighboring trees. Canker is more severe on the side of the tree exposed to wind-driven rain. Spread over longer distances, up to miles, can occur during heavy winds, severe tropical storms, hurricanes, and tornadoes. Long-distance spread occurs more commonly with the movement of diseased plant material such as budwood, rootstock seedlings, budded trees, or less commonly, fruit and leaves. Workers can carry bacteria from one location to another on hands, clothes, and equipment. Grove equipment can spread the bacteria within and among plantings, especially when trees are wet.

Management

The Citrus Health Response Plan (CHRP) does not require removal of affected trees. Thus, growers should use their best judgment in management of citrus canker. The entire state of Florida is under quarantine, and fruit movement is subject to specific regulations depending on market destination.

Canker losses can be severe under Florida conditions and can be difficult to control on grapefruit and the most susceptible early-season orange varieties. Areas that are currently canker-free should be protected to the extent possible.

Protecting Canker-Free Areas

Decontamination

Where canker is absent, decontamination protocols are still in place and should be followed. With wide-spread canker around the state, the likelihood of further spread is greater than ever. In moving equipment and personnel from grove to grove, every effort should be made to make sure that plant material is not moved inadvertently and that all equipment has been thoroughly decontaminated. Decontamination is especially important in harvesting operations, hedging and topping, and in any other practices involving extensive contact with foliage. Obviously, when equipment is moved from blocks where canker is endemic to other infected blocks, decontamination serves little purpose.

Tree Removal

If canker is detected in areas previously free of the disease, removal and burning of trees on site may slow the establishment of the disease. For tree removal to be effective, canker has to be localized and limited to a small number of trees. Tree removal is not likely to be effective if canker is already present within a mile of the grove because it can spread with the wind and rain; therefore, tree removal is no longer a viable option in most of Florida.

Defoliation and Pruning

There are currently no registered defoliants, but it is possible to defoliate trees using high concentrations of legal copper or fertilizer products. However, no rates or spray volumes have been established for this practice, and results can vary dramatically based on spray application method, tree age, water relations, huanglongbing status, and environmental conditions at time of application. For the same rate and application method, results can vary from incomplete defoliation to severe dieback of brown wood. Severe pruning or buckhorning with strict sanitation procedures for removal and disposal of the infected plant materials provides similar results to chemical defoliation. Defoliation may be useful in areas surrounding foci of infected trees that have been removed. These trees may appear healthy but are likely to harbor undetected canker lesions. Defoliation can reduce this inoculum. Defoliation or pruning should only be attempted during dry times of the year and in conjunction with an intense inspection program. A strong flush of highly susceptible leaves will follow and is likely to become infected from residual inoculum in the tree or nearby infested groves. Following defoliation or pruning, the new growth flush should be treated with either copper sprays once the growth is half expanded or a Blockade drench at flush initiation to protect it from new infections.

Endemic Canker

In most of Florida where canker is endemic, the primary means of control are: 1) plant windbreaks, 2) protect fruit and leaves with copper or Blockade and copper applications, and 3) control leafminer populations.

Windbreaks

Windbreaks are highly effective to reduce canker spread, but more importantly, they reduce the severity of the infection in endemic situations. When canker lesions are wetted, millions of bacteria ooze onto the leaf surface. While the bacterium can drip down to lower leaves and fruit, the vast majority of the infection occurs by wind-blown rains that spread the bacteria throughout a tree and to neighboring

trees. Winds above 18 to 20 mph are needed to force bacteria into stomates on leaves and fruit; in so doing, bacteria can bypass copper barriers.

Windbreaks reduce wind speed for a distance of five to ten times the height of the windbreak. For example, a 30 ft tall windbreak will exert an effect for about 150 to 300 ft. To be effective for canker control, windbreaks do not need to be dense. All that is required is to reduce wind speed to < 20 mph. The need for windbreaks and the distance between rows will depend on the destination of the fruit, fresh or processed, and cultivar susceptibility. Fresh-market grapefruit in Florida is best with a windbreak that surrounds each 5- to 10-acre block. The tree species *Corymbia torelliana* has proved to function well in grapefruit blocks because the tree retains its leaves and branches all the way to the ground, reducing wind penetration through the lower canopy. Replacement of windbreak trees that fail to thrive or have been killed by lightning is recommended to prevent breaches that allow for local wind penetration and incursions of the bacteria. In many groves with less-susceptible citrus cultivars, a windbreak down the row about every 300 ft may be sufficient. In situations where some protection exists and tolerant varieties are grown for processing, windbreaks are unnecessary. Additionally, not topping outside rows of citrus can also serve as a viable, harvestable windbreak. Currently, the recommendation is that growers plant windbreaks along fence lines, ditches, around wetlands, or wherever they can plant without removing citrus trees. If it becomes obvious that more windbreak protection is needed, rows of citrus or end trees can be removed to accommodate more windbreaks.

For more information on selection of plant species and design, see the CREC Web site (http://www.crec.ifas.ufl.edu/extension/ windbreaks/).

Copper Sprays

Over the last 30 years, IFAS has evaluated dozens of products for canker control. Products such as antibiotics (compounds that induce resistance in plants) and disinfectants provide limited canker control, but no material has proven more effective than copper products.

Copper products are quite effective for preventing fruit infection but much less effective for reducing leaf infection. Application of copper to young leaves protects against infection, but the protection is soon lost due to rapid expansion of the surface area. Also, copper has limited value in reducing disease spread. Fruit grows more slowly than leaves and is easier to protect. Oranges develop resistance in mid- to late July. Grapefruit remain moderately susceptible through full expansion in late September to mid-October. Infection through wounds can occur at any stage of fruit growth.

For oranges with endemic canker, most infections will occur from April to July. No more than five copper sprays applied at 21-day intervals are recommended for early processing oranges: one in early April (fruit at 0.25- to 0.5-inch stage), a second in late April, a third in mid-May, a fourth in early June, and a fifth in late June to early July when the fruit is about 1.5 inches diameter. Three applications at a 21-day interval should be sufficient for Valencias and midseason varieties, in mid-April (fruit at 0.25- to 0.5-inch stage), in early/mid-May, and late May/early June. Varieties of early oranges grown for higher color score (Early Gold, Westin, Ruby, Itaborai) and Navel are more susceptible than Hamlin. They may require additional sprays before April and beyond July. HLB results in early bloom, so first applications may need to be adjusted into late March. Consult the Citrus Copper Application Scheduler to ensure that copper residue levels are adequate for disease control. The 21-day interval is an approximate timing, but growth rate and rainfall can cause copper residues to decay faster or slower than otherwise expected. More details are available in EDIS PP289, .

Programs for fresh fruit are more complex, but many copper sprays are already used on these varieties. For fresh-market grapefruit, a low rate of copper should be added to the last spray of spring flush for scab. Subsequently, the copper spray program used for melanose control should also control canker, but additional applications will be required every 21 days when the fruit reach 0.5- to 0.75-inch size until fruit are fully grown in October. Copper may need to be added to applications of fungicides or petroleum oil. Use caution when mixing copper with oil, because it increases the phytotoxicity risk.

Most tangerines are fairly tolerant to canker. Copper programs used for Alternaria control should also protect against canker. Fallglo is less susceptible, and probably three sprays in April, May and June would suffice. Newly planted trees in canker-exposed settings are more susceptible because they produce leaf flushes more often, and the flush tissue represents a high proportion of the canopy volume. The recommendation for the more susceptible varieties (grapefruit and early oranges) is that the trees be sprayed every 3 to 4 weeks to coincide with vegetative flush cycles from spring though the fall. Sprays should be applied with a hoop sprayer that thoroughly covers the foliage on all sides of the canopy.

The rates of copper products depend on the length of protection expected and the weather. As little as 0.5 to 1.0 lb of metallic copper will protect spring flush growth or fruit during the dry spring season. However, in the rainy season, more than 1 lb of metallic copper may be required to protect fruit for 3-week periods.

To the extent possible, copper usage should be minimized since this metal accumulates in soil and may cause phytotoxicity to the fruit peel or create environmental concerns.

Leafminer Control

Leafminers do not spread canker, but damage from leafminer larval feeding galleries enables entry of the bacterium into leaves and greatly increases inoculum levels, making the disease difficult to control. Leafminers are not usually a problem on the spring flush, and no control is needed at that time. Leafminer control on the first summer flush can reduce disease pressure considerably. If properly timed, applications of petroleum oil, Agri-mek, Micromite, Spintor, or Assail will reduce damage by leafminer. Late summer flushes tend to be erratic, and effective control at that time is more difficult. (See EDIS publication CG098, *Citrus Leafminer*, or the section of this Guide on Citrus Leafminer.)

Activation of Systemic Acquired Resistance

SAR is a natural induction of resistance to disease, in this case canker, throughout the plant, and it can be chemically stimulated. The disease may occur or continue to develop before SAR can be naturally induced or take full effect. The SAR activator, Blockade (formerly Actigard) triggers the natural defense mechanism before the onset of disease but has no direct effect on the pathogen. High inoculum levels can overcome defense activation, so it is important to apply Blockade before weather and host flush conditions are favorable for infection at the beginning of each season. There are two methods of application, drench or chemigation, but drench was found to be more effective.

Use scenarios for Blockade vary with age and size of trees.

New Plantings (0–3-year-old trees)

- Limits establishment of citrus canker during the nonbearing stage.
- Initiate treatments after planting when trees have overcome transplant shock and begun active growth. Continue through the entire nonbearing cycle.
- Use in conjunction with soil-applied neonicotinoid insecticides, which can also induce SAR. Blockade cannot replace a soil-applied neonicotinoid scheduled for Asian citrus psyllid management.
- Use in conjunction with other canker management tactics like windbreaks in highly susceptible grapefruit.
- Continue applications throughout the spring, summer, and fall at 60-day intervals.

Young Bearing Plantings (4–5-year-old trees)

- Limits development of lesions on foliage, thereby reducing potential for fruit infection.
- Initiate post-bloom but prior to conditions favorable for citrus canker.
- Use in conjunction with other canker management tactics. Do not reduce rates of other products.
- Continue throughout spring, summer, and fall at 45- to 60-day intervals, depending on tree size and planting density (Table 2).

Mature Bearing Plantings (6-year-old+ trees)

- Limits development of lesions on foliage, thereby reducing potential for fruit infection.
- Initiate post-bloom but prior to conditions favorable for citrus canker.
- Use in conjunction with other canker management tactics. Do not reduce rates of other products.
- Continue throughout summer season at 45- to 60-day intervals, depending on tree size and planting density (Table 2).

The rules and regulations regarding canker are changeable. For current information on disease status and regulations, see the website of the Florida Department of Agriculture and Consumer Services: https://www.freshfromflorida.com/Divisions-Offices/Plant-Industry/Agriculture-Industry/Citrus-Health-Response-Program or the UF/IFAS CREC website: https://crec.ifas.ufl.edu

Contact your Local UF/IFAS Extension agent (https://sfyl.ifas.ufl.edu/find-your-local-office/) for additional information, training materials, and programs.

Recommended Chemical Controls

READ THE LABEL.

See Table 1.

Rates for pesticides are given as the maximum amount required to treat mature citrus trees unless otherwise noted. To treat smaller trees with commercial application equipment including handguns, mix the per acre rate for mature trees in 125 gallons of water. Calibrate and arrange nozzles to deliver thorough distribution and treat as many acres as this volume of spray allows.

For applications of Blockade (drench or chemigation), use rates are expressed as the amount of Blockade per tree. Recommended drench water volume is 8 to 16 fl oz/tree.

Table 1. Recommended chemical controls for citrus canker.

Pesticide	FRAC MOA[1]	Mature Trees Rate/Acre[2]
Actigard 50WG	P01	See Table 2
copper fungicide	M01	Use label rate

[1] Mode of action class for citrus pesticides from the Fungicide Resistance Action Committee (FRAC) 2018. Refer to ENY624, *Pesticide Resistance Management*, in the 2019–2020 Florida Citrus Production Guide for more details.
[2] Lower rates can be used on smaller trees. Do not use less than the minimum label rate.

Table 2. Recommended rates and use patterns for Actigard 50WG/100 trees.

Number of Applications/Year[1]	Tree Age and Rate[2,4] (oz)/Application			
	< 1 year[3]	1–2 years	2–3 years	>3 years
4 or less	0.125–0.25	0.25–0.50	0.50–0.75	0.75–1.5
5 or more	0.125	0.25	0.50	0.75–1

[1] Minimum interval between applications is 30 days. If tree stunting, yellowing or other symptoms of possible phytotoxicity are observed, reduce the use rates in subsequent applications to the low end of the recommended rate range and increase the application interval to 60 days.
[2] Do not use more than 12.8 oz/A/year and no more than 3.2 oz/A/application.
[3] For newly planted trees, delay applications until trees become established and overcome transplant shock, and initiate treatment at 0.125 oz/100 trees.
[4] As tree size increases during the season, dosages should be adjusted toward the upper end of the recommended rate range.