Commercial Crop Production
Fruit and Nut Crops - Citrus

Integrated Citrus Disease Management

Profitable and sustainable citrus production relies on effective management of diseases and insects that transmit diseases. This is particularly important as exotic diseases such as citrus canker and citrus greening threaten the productivity of the citrus industry in Louisiana. To manage and prevent the spread of citrus diseases an integrated disease management program that incorporates early and accurate disease identification, cultural practices, fungicides and postharvest sanitation should be developed. An overview of citrus diseases commonly found on citrus in Louisiana and management tactics is provided in Table 1. A general seasonal fungicide spray schedule (Table 2) and a list of registered fungicides for disease management (Table 3) are also provided in this section.

Citrus Quarantines

Plant quarantines are established to prevent the introduction of economically important plant pathogens or insect pests into a region where it does not occur. The quarantine restricts movement of ***citrus trees, citrus nursery stock and citrus plant parts, including fruit,*** from parishes where plant diseases called citrus greening and citrus canker and the insect called Asian citrus psyllid have been confirmed. Quarantined areas in Louisiana are:

Citrus Greening – Jefferson, Orleans, Plaquemine, St. Bernard and Washington parishes.

Asian citrus psyllid (transmits citrus greening pathogen) – Jefferson, Orleans, Lafourche, Plaquemines, St. Bernard, St. Charles, St. James, St. Tammany, Tangipahoa and Terrebonne parishes.

Citrus canker – The current citrus canker quarantined areas include: the entire parishes of Jefferson, Lafourche, Orleans, Plaquemines, St. Bernard, St. Charles, St. James and St. John. Additionally, citrus canker has been detected in East Baton Rouge and Livingston parishes.

For more information on the diseases, the insect or the restrictions, contact the Louisiana Department of Agriculture and Forestry's Horticulture and Quarantine Programs office at 225-952-8100 or go to www.ldaf.la.gov. More information about citrus canker and citrus greening diseases can be obtained by calling the LSU AgCenter Plant Diagnostic Center at 225-578-4562.

For complete information on citrus diseases, consult Louisiana Home Citrus Production Guide, LSU AgCenter Publication 1234 (rev. 5/16).

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Table 1. Symptoms, source of inoculum and management of citrus diseases

Disease (Pathogen)	
Anthracnose (*Colletotrichum* spp.)	**Symptoms:** The disease can cause symptoms on both leaves and fruit. It produces light tan spots with dark purple margins on the leaves. Dry, firm decay of fruits occurs and the entire fruit rots during wet weather. **Source of Inoculum:** The lesions on the fruit and leaves produce spores that may disperse with water splashed from rain or irrigation. **Management:** Removal of infected fruits both from the ground and on the tree is crucial to reduce the fungal spores. Follow a fungicide spray program to manage Anthracnose (see below).
Brown rot (*Phytophthora* spp.)	**Symptoms:** Light brown, leathery-appearing spots develop on the fruit, particularly those low in the canopy or touching the ground. A whitish growth may develop under humid conditions. **Source of Inoculum:** The pathogen survives in the soil and is splashed onto low-hanging fruit. It can then be spread by rain splash or wind-driven rain. **Management:** Prune to remove low-hanging branches and fruit. Follow a fungicide spray program to manage *Phytophthora* root rot (see below).
Citrus canker *(Xanthomonas axonopodis* pv. *citri)*	**Symptoms:** Leaf lesions are raised on the upper and lower leaf surface. Lesions become corky and crater-like with raised margins, sunken centers, which are surrounded by a yellow halo. Fruit lesions vary in size (2-10 mm). Twigs and stem lesions resemble those on fruit. All citrus cultivars are susceptible to citrus canker. **Source of Inoculum:** The pathogen reproduces in lesions on leaves, stems and fruit. Bacteria ooze out of the lesions and are spread by wind-driven rain, overhead irrigation, flooding and human activities. Human movement of infected plant material is the primary means of spread over long distances. **Management:** The first line of defense against citrus canker is to prevent the movement of infected tissue from regions with known infections of citrus canker to disease free regions. Good sanitation practices and elimination of inoculum by removal and destruction of infected and exposed trees are recommended. Copper-based fungicides can be used to suppress disease.
Citrus greening or Huanglongbing (*Candidatus* Liberibacter *asiaticus*, *C.* L. *americanus*)	**Symptoms:** Symptoms differ according to citrus variety. The most common symptom is blotchy mottling (irregular pattern of indistinct light and dark areas) on both sides of the leaf. Leaf veins become raised and corky. Fruit are small and lopsided with internal discoloration (orange-brown staining). The disease causes uneven ripening of fruits and abortion of seeds in the fruit. Overall symptoms in the canopy are unevenly distributed. **Source of Inoculum:** The pathogen is transmitted by the Asian citrus psyllid. The disease is spread by moving infected plants and plant materials such as bud wood and even leaves. **Management:** Use clean bud wood, certified healthy trees, and only purchase trees from a certified nursery. Use good sanitation practices.
Citrus scab (*Elsinöe fawcettii*)	**Symptoms:** Citrus scab causes disease on a variety of citrus including grapefruit, lemon, satsuma and tangerine and on rootstocks of sour and trifoliate oranges. ***Sweet orange is not affected***. Citrus scab affects the fruit, leaves and young shoots of plants causing irregular, raised, corky, scabby, wart-like outgrowths. Severely scabbed leaves and fruit become misshapen and distorted. The rind of scabbed fruit is thick and puffy. **Source of Inoculum:** The fungus causing scab survives in old pustules on leaves and fruit. Spores are spread primarily by rain splash. **Management:** Follow a fungicide spray program.
Greasy spot (*Mycosphaerella citri*)	**Symptoms:** Yellow mottled lesions on upper leaf surface with a matching, slightly raised, pale orange to yellow-brown blister on the lower leaf surface. Affected areas later become dark brown to black with a greasy appearance. Black necrotic specks form on fruit. **Source of Inoculum:** Spores produced in previously infected decomposing fallen leaves during warm, wet periods of late spring and early summer. **Management:** Good sanitation practices and the use of a fungicide spray program.

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Disease (Pathogen)	
Melanose (*Diaporthe citri*)	**Symptoms:** Melanose is caused by a fungal pathogen that attacks leaves, shoots and fruit, causing numerous dark brown dots or spots to develop. These spots are sunken at first but later become raised, so area has a rough, sandpaper feel. The spots may be irregularly scattered on the surface of the fruit or they can run in streaks (tear stains). Melanose infections occur only on the young, tender growth, and fruit become resistant as they age. The fungus also infects ripe fruit after harvest, causing stem-end rot. **Source of Inoculum:** The fungus colonizes and survives in dead twigs. Fungal spores are spread primarily by rain splashing and wind-driven rain, although windborne spores also may be produced. **Management:** Prune out and burn dead wood, which eliminates much of the inoculum. Follow a fungicide spray program. Control of melanose will help to reduce fruit loss from stem-end rot.
Penicillium decays (Green, blue and Whisker molds) (*Penicillium* spp.)	**Symptoms:** The pathogen enters the fruit through wounds in the rind. Decay appears as a softened, water-soaked area that is easily punctured by pressure. Later, white mycelium appears on the surface of the fruit, and a mass of powdery olive-green (green mold) or blue spores (blue mold) are produced. **Source of Inoculum:** These fungi are common saprophytes in citrus groves. They also survive on contaminated packing equipment resulting in postharvest decay. **Management:** Prevent fruit injury at harvest. Sanitize postharvest equipment and storage areas. Follow a fungicide spray program.
Phytophthora root rot, Foot rot and Gummosis (*Phytophthora* spp.)	**Symptoms:** The cortex of infected roots is soft, discolored and sloughs off easily. Growth of and fruit production by infected trees are greatly reduced. Cracked lesions on the bark exude a gummy sap. The spread of lesions around the tree trunk can cause girdling and tree death. *Phytophthora* root rot symptoms progress more rapidly in the presence of the citrus root weevil. **Source of Inoculum:** The pathogen survives in the soil and moves in running or splashing water. **Management:** Use resistant rootstock, improve drainage and manage irrigation. Follow a fungicide spray program.
Postbloom fruit drop (PFD) (*Colletotrichum acutatum*)	**Symptoms:** The fungus produces necrotic reddish-brown spots on the petals. The entire flower cluster becomes dark brown to orange and the petals dry. Infected young fruits exhibit yellow discoloration and abscise (drop off). The calyx and the floral disc stay intact and are called buttons. **Source of Inoculum:** The fungus survives on the surface of leaves, twigs and buttons. Fungal spores are splash-dispersed from infected by rains to healthy flowers by rains. **Management:** Avoid overhead irrigation during blooming period to reduce leaf wetness period. Follow a fungicide spray program.
Sooty mold (*Capnodium* spp.)	**Symptoms:** The fungi that cause sooty mold are not plant pathogens. They do not penetrate plant tissue and only grow superficially on the honeydew excretions of aphids, mealy bugs, scale insects and white flies. Sooty mold causes an overall decline in plant health because it prevents sunlight from reaching the leaves and hence photosynthesis is reduced. Fruit covered with sooty mold are smaller, do not color well and have an unattractive (dirty) appearance. **Management:** Control honeydew-producing insects. Wash off with soapy water or loosen and protect using dormant oils.
Sour rot (*Geotrichum candidum*)	**Symptoms:** Lesions appear as soft, water-soaked spots on fruit at points where an injury has occurred and may increase to involve the entire fruit. White fungal growth develops on the surface of the infected fruit. A strong sour odor is present. **Source of Inoculum:** This fungus is a common saprophyte in citrus soils. The pathogen is windborne or splash-borne on soil particles and penetrates the fruit through wounds caused by insects or mechanical means. The pathogen can survive on contaminated packing equipment resulting in postharvest decay. **Management:** Prevent fruit injury during harvesting. Prevent fruit from coming in contact with the soil. Sanitize postharvest equipment daily. Do not reuse packing boxes.
Sweet orange scab (*Elsinöe australis*)	**Symptoms:** Sweet orange scab causes disease on cultivars of sweet orange, satsuma, tangerine, grapefruit and lemon as well as sour orange and trifoliate orange rootstocks. Sweet orange scab affects fruit, leaves and young shoots causing irregular, slightly raised, corky, scabby growths. **Source of Inoculum:** The fungus causing sweet orange scab survives in old pustules on leaves and fruit. Spores are spread primarily by rain splash. **Management:** Follow a fungicide spray program.

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Table 2. Seasonal fungicide spray schedule for citrus

Season	Fungicide Application Timing	Disease
Prebloom	Grapefruit Oranges Satsuma	Citrus scab Sweet orange scab Melanose
Early bloom	Grapefruit Oranges	Post-bloom fruit drop
Late bloom (petal fall)	All citrus	Citrus scab Melanose Postbloom fruit drop Sweet orange scab
Postbloom	All citrus	Anthracnose Citrus scab Melanose Sweet orange scab
June 15 to July 15	All citrus	Anthracnose Citrus scab Greasy spot Melanose Sweet orange scab
October 15 to November 15	All citrus	Anthracnose Brown rot
Soil treatment	All citrus	Phytophthora root rot

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Table 3. Recommended pesticides, rates and pesticide-use restrictions for citrus produced in the field[1]
The symbol [OG] *indicates a pesticide that has been listed by the Organic Materials Review Institute (OMRI) as approved for use in organic production.*

Disease (Pathogen)	Product Choices[2] and Product Mode of Action Group[3]		Rate[4]	PHI[5]	Maximum Use
Anthracnose (*Colletotrichum* spp.)	copper hydroxide				
	Champ WG	M	4-6.3 lb	0	25.2 lb
	Kocide 3000	M	1.8-3.5 lb	0	42 lb
	Kocide 2000	M	3-6 lb	0	36 lb
	copper hydroxide and copper oxychloride	M			
	Badge SC	M	3-7 pt	0	44.4 pt
	Badge X2[OG]		1.8-3.5 lb	0	12.6 lb Cu
	copper Sulfate	M			
	Cuprofix-Ultra Disperss	M	1.8-6 lb	0	31.5 lb
	Cuproxat		5-13 pt	0	62 pt
	cuprous oxide				
	Nordox	M	4-20 lb		
	Top Cop with Sulfur	M	4 qt/100 gal	0	
Brown rot (*Phytophthora* spp.)	Aliette	33	5 lb	30	20 lb
	copper hydroxide			0	
	Champ WG	M	4-6.3 lb	0	25.2 lb
	Kocide 3000	M	1.8-3.5 lb	0	42 lb
	Kocide 2000	M	3-6 lb		36 lb
	copper hydroxide and copper oxychloride			0	
	Badge SC	M	3-7 pt	0	44.4 pt
	Badge X2[OG]	M	1.8-3.5 lb		12.6 lb Cu
	copper Sulfate			0	
	Cuprofix-Ultra Disperss	M	1.8-6 lb	0	31.5 lb
	Cuproxat	M	5-13 pt		62 pt
	cuprous oxide				
	Nordox	M	4-20 lb		
	mefenoxam				
	Ridomil Gold SL	4	1-2 qt[6]		3 app
	Ultra Flourish	4	4-8 pt[6]		24 pt
	phosphorous acid			0	
	Helena Prophyt	33	4 pt	0	
	Phostrol	33	4.5 pt		
	Top Cop with Sulfur	M	4 qt/100 gal		
Citrus canker *(Xanthomonas axonopodis* pv. *citri)*	**Suppression only**				
	copper hydroxide				
	Champ WG	M	6.3 lb	0	25.2 lb
	Kocide 3000	M	1-2.5 lb	0	42 lb
	Kocide 2000	M	2-4 lb	0	36 lb
	copper hydroxide and copper oxychloride				
	Badge SC	M	2-11 pt	0	44.4 pt
	Badge X2[OG]	M	2-5 lb	0	12.6 lb Cu
	copper sulfate				
	Cuprofix-Ultra Disperss	M	1.3-8 lb	0	31.5 lb
	Cuproxat	M	3-15.5 pt	0	62.1 pt
	cuprous oxide				
	Nordox	M	12 lb	0	
Citrus scab (*Elsinöe fawcettii*)	Abound	11	12-15.5 fl oz	0	92.3 fl oz
	copper hydroxide				
	Champ WG	M	4-6.3 lb	0	25.2 lb
	Kocide 3000	M	1.8-5 lb	0	42 lb
	Kocide 2000	M	3-9 lb	0	36 lb
	copper hydroxide and copper oxychloride				

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Disease (Pathogen)	Product Choices[2] and Product Mode of Action Group[3]		Rate[4]	PHI[5]	Maximum Use
	Badge SC	M	3-11 pt	0	44.4 pt
	Badge X2[OG]	M	1.8-5 lb	0	12.6 lb Cu
	copper Sulfate				
	Cuprofix-Ultra Disperss	M	1.8-8 lb	0	31.5 lb
	Cuproxat	M	5-15.5 pt	0	62.1 pt
	Enable 2 F	3	8 fl oz	0	24 fl oz
	Gem 500 SC	11	1.9-3.8 fl oz	0	15.2 fl oz
	Headline and Headline SC	11	12-15 fl oz	0	54 fl oz
	Pristine	7, 11	16-18.5 oz	0	74 fl oz
	Quadris Top	11, 3	15.4 fl oz	0	61.5 fl oz
	Trilogy[OG]		1%		
Greasy spot (*Mycosphaerella citri*)	Abound	11	12-15.5 fl oz	0	92.3 fl oz
	Actinovate[OG]		3-12 oz		
	copper hydroxide				
	Champ WG	M	4-6.3 lb	0	25.2 lb
	Kocide 3000	M	0.8-2.5 lb	0	42 lb
	Kocide 2000	M	1.5-4.5 lb	0	36 lb
	copper hydroxide and copper oxychloride				
	Badge SC	M	1-5 pt	0	44.4 pt
	Badge X2[OG]	M	0.8-2.5 lb	0	12.6 lb Cu
	copper Sulfate				
	Cuprofix-Ultra Disperss	M	0.8-5 lb	0	31.5 lb
	Cuproxat	M	2-10 pt	0	62.1 pt
	Dormant Oils				
	Dormant Oil 435		5-10 gal		159 lb a.i.
	Suffoil		1-2 gal/100 gal		159 lb a.i.
	Tritek[OG]		1-2 gal/100 gal		159 lb a.i.
	Enable 2F	3	8 fl oz	0	24 fl oz
	Gem 500 SC	11	1.9-3.8 fl oz	0	15.2 fl oz
	Headline and Headline SC	11	12-15 fl oz	0	54 fl oz
	Pristine	7, 11	16-18.5 oz	0	74 fl oz
	propiconazole[7]				
	Amtide Propiconazole 41.8% EC	3	6-8 fl oz	1 yr	24 fl oz
	Banner MAX and MAX II	3	2-4 fl oz/100 gal	1 yr	5.4 gal
	Bumper ES and 41.8 EC	3	6-8 fl oz	1 yr	24 fl oz
	Fitness	3	6-8 fl oz	1 yr	24 fl oz
	Quadris Top	11, 3	10-15.4 fl oz	0	61.5 fl oz
	Quilt[7]	11, 3	20.5-27.5	1 yr	83.5 fl oz
	Trilogy[OG]		1%		

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Disease (Pathogen)	Product Choices[2] and Product Mode of Action Group[3]		Rate[4]	PHI[5]	Maximum Use
Melanose (*Diaporthe citri*)	Abound	11	12-15.5 fl oz	0	92.3 fl oz
	copper hydroxide				
	Champ WG	M	4-6.3 lb	0	25.2 lb
	Kocide 3000	M	1.8-5 lb	0	42 lb
	Kocide 2000	M	3-9 lb	0	36 lb
	copper hydroxide and copper oxychloride				
	Badge SC	M	3-11 pt	0	44.4 pt
	Badge X2[OG]	M	1.8-5 lb	0	12.6 lb Cu
	copper Sulfate				
	Cuprofix-Ultra Disperss	M	1.8-8 lb	0	31.5 lb
	Cuproxat	M	5-15.5 pt	0	62.1 pt
	Gem 500 SC	11	1.9-3.8 fl oz	0	15.2 fl oz
	Headline and Headline SC	11	12-15 fl oz	0	54 fl oz
	Pristine	7, 11	16-18.5 oz	0	74 fl oz
	Quadris Top	11, 3	15.4 fl oz	0	61.5 fl oz
Penicillium decays (Green, blue and Whisker molds) (*Penicillium* spp.)	Abound	11	12-15.5 fl oz	0	92.3 fl oz
	Fungi-Phite	33	2 qt/100 gal		
	Graduate A+	11, 12	32-64 fl oz/100 gal[8]		1 app
	Magnate 500 EC	3	12.5-18.7 fl oz/100 gal[8]		1 app
Phytophthora root rot, Foot rot and Gummosis (*Phytophthora* spp.)	Aliette	33	5 lb	30	20 lb
	copper hydroxide				
	Champ WG	M	1 lb/gal[9]	0	25.2 lb
	Kocide 3000	M	0.5 lb/qt[9]	0	42 lb
	Kocide 2000	M	0.8 lb/qt[9]	0	36 lb
	copper hydroxide and copper oxychloride				
	Badge SC	M	1 pt/qt[9]	0	44.4 pt
	Badge X2[OG]	M	0.5 lb/qt[9]	0	12.6 lb Cu
	copper Sulfate				
	Cuprofix-Ultra Disperss	M	0.5-1 lb/gal[9]	0	31.5 lb
	Cuproxat	M	1.2-2 pt/gal[9]	0	62.1 pt
	mefenoxam				
	Ridomil Gold GR	4	40-80 lb[6]		3 app
	Ridomil Gold SL	4	1-2 qt[6]		3 app
	Ultra Flourish	4	4-8 pt[6]		24 pt
	MetaStar 2 E	4	1-2 gal[6]		3 app
	phosphorous acid				
	Helena Prophyt	33	4 pt		
	Phostrol	33	4.5 pt		
	Fungi-Phite	33	2 qt/100 gal		
Post-bloom fruit drop (PFD) (*Colletotrichum acutatum*)	Abound	11	12-15.5 fl oz	0	92.3 fl oz
	Gem 500 SC	11	1.9-3.8 fl oz	0	15.2 fl oz
	Headline and Headline SC	11	12-15 fl oz	0	54 fl oz
	Quadris Top	11, 3	15.4 fl oz	0	61.5 fl oz
	Trilogy[OG]		1%		
Sour rot (*Geotrichum candidum*)	No fungicides are available to manage sour rot decay. Fruit injury prevention and good postharvest sanitation practices are recommended.				
Sooty mold (*Capnodium* spp.)	Dormant Oils				
	Dormant Oil 435		5-10 gal		159 lb a.i.
	Suffoil		1-2 gal/100 gal		159 lb a.i.
	Tritek[OG]		1-2 gal/100 gal		159 lb a.i.24 fl oz
	Enable 2 F		8 fl oz	0	
Sweet orange scab (*Elsinöe australis*)	Abound	11	12-15.5 fl oz	0	92.3 fl oz
	Quadris Top	11, 3	10-15.4 fl oz	0	61.5 fl oz

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[1]Fungcides and application rates apply to open field citrus production unless otherwise noted. Refer to product labels for registered cultivars, rates and restrictions for citrus grown in greenhouses or shade houses.
[2]Reference to commercial or trade names is made with the understanding that no discrimination is intended nor endorsement of a particular product by LSU or the LSU AgCenter is implied.
[3]Mode of action groups are determined by the Fungicide Resistance Action Committee (FRAC).
[4]Rates are the amount of formation per acre unless otherwise indicated. Usually 100 gallons of water are required to give good coverage with boom sprayers.
[5]Postharvest interval (PHI) is the minimum number of days allowed between the last application and harvest.
[6]Apply to soil beneath tree or through irrigation water. Refer to label for other application methods.
[7]**Do not apply to fruit-bearing trees.** Refer to label for additional restrictions and maximum amount of product allowed per acre per year.
[8]Postharvest drench. Dip for a minimum of 30 seconds and allow fruit to drain.
[9]Apply by painting the trunk of the tree from the soil surface to the lowest scaffold limbs.

Information in this section was last updated in December 2019 by Dr. R. Singh.