

Commercial Crop Production

Small Fruits - Strawberry

Integrated Strawberry Disease Management

Strawberries are among the most challenging horticultural crops to grow in the South because of high levels of soilborne pathogens. Chemical use, from preplant to harvest, is a critical component in maintaining crop yield and producing high-quality fruit. Traditionally, disease management in strawberries has relied on the establishment of a clean crop planted into methyl bromide-fumigated soil. With the phase-out of methyl bromide, the use of alternative, more sustainable management strategies is necessary. (For fumigant information see the [Southeast Regional Strawberry Integrated Management Guide](#).)

Rotate your planting site. Rotating where strawberries are planted is an important part of avoiding soilborne disease problems. This is especially important in the absence of fumigation. Try not to plant strawberries in a particular site more than once every three to four years.

Start with clean plants. Purchase plants from a reputable source. Many disease-causing agents can be brought in on plants, and clean plants are especially important for avoiding anthracnose crown rot (caused by *Colletotrichum gloeosporioides*), Phytophthora crown rot and virus problems.

Minimize plant stress during establishment. Overhead irrigation is recommended during the first one to two weeks after planting bare-root plants. It may also be helpful to provide some overhead water during the first several days after planting plug plants. Drip irrigation can be used after this time.

Correctly diagnose problems. Contact your local extension agent or the LSU AgCenter Plant Diagnostic Center for assistance, if needed. The [Strawberry Diagnostic Key](#) may also be helpful.

Use crop protectants. Prior to using chemicals, have the disease confirmed by a crop specialist. Once the disease has been confirmed, select a labeled product that has been shown to be effective in reducing disease (see Tables 1 and 3), and apply the product at the correct stage of plant development (Table 2). Chemicals with proven efficacy against a pathogen will not reduce disease if applied at the wrong time. Always rotate between products with different modes of action (in different FRAC groups; see Table 3) to prevent the development of fungicide resistance in the pathogen (disease-causing agent). If a pathogen becomes resistant to a product, the product will no longer be effective. Tests of fungal isolates from Louisiana and other states have shown that the gray mold fruit rot pathogen (*Botrytis cinerea*) is likely to be resistant to common fungicides in several FRAC groups and that the anthracnose fruit rot pathogen (*Colletotrichum* sp.) is likely to be resistant to FRAC 11 fungicides. More information is given in the respective sections. Although some details about chemical application are given in Table 3, always see the label for complete instructions.

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Table 1. Diseases and nematodes of strawberry.

Symptoms, Sources of Inoculum, and Management
Angular (Bacterial) Leaf Spot (<i>Xanthomonas fragariae</i>) Symptoms: First visible as tiny, water-soaked spots on the lower leaf surface that enlarge into angular lesions delimited by leaf veins. Lesions appear translucent when held up to the light. Bacterial ooze may be found on lesions on lower leaf surfaces. Source of Inoculum: The bacterium survives in infected leaf debris or is introduced on infected planting material. Bacterial cells are spread primarily by rain splashing and wind-driven rain. Disease develops most under cool, wet conditions. Management: Use disease-free transplants. Spray with copper bactericide or the plant defense activator Actigard, if needed.
Anthraxnose Crown Rot (<i>Colletotrichum</i> spp.) Symptoms: Plants wilt suddenly and die during warm weather. Crowns have a reddish discoloration extending into the center. Black lesions occur on leaf petioles or runners. Disease development is inhibited by cool weather. Source of Inoculum: The fungus is often introduced on infected planting material and survives on infected plant parts. Fungal spores are spread by rain splashing and wind-driven rain. Management: Use disease-free transplants. Dip plants in a fungicide prior to planting if problems with the plant source are identified. Remove infected plants and treat surrounding plants with fungicides.
Anthraxnose Fruit Rot (<i>Colletotrichum acutatum</i>) Symptoms: Buds, flowers, sepals and/or flower stems (pedicels and peduncles) often turn brown. Spots on fruit are light brown to black and often begin with a water-soaked appearance and then become firm and sunken. Orange to pink spores can develop when weather is humid. Plant stunting and/or death and petiole lesions may be seen before flower blight or fruit rot occur. Source of Inoculum: The fungus is often introduced on infected planting material and survives on infected plant parts. Fungal spores can be spread by rain splashing, wind-driven rain, workers and equipment. Management: Use disease-free transplants. Do not use an excessive amount of nitrogen fertilizer. If the presence of <i>C. acutatum</i> has been confirmed, begin fungicide applications for fruit rot at bloom. Resistance to the FRAC group 11 fungicides has been found in the pathogen in some instances; three-quarters of 51 samples from Louisiana tested in 2016 were found to be resistant. Captan, thiram, Switch, and propiconazole are still expected to be effective for managing anthracnose fruit rot.
Botrytis Fruit Rot (Gray Mold) and Crown Rot (<i>Botrytis cinerea</i>) Symptoms: This fungus attacks flowers, flower parts, fruit and leaves. On the fruit, this disease causes a rot that is at first light brown and soft (not “leaky”). As the berry rots, it becomes covered with a grayish, powdery growth, and in the final stages of rot, it becomes tough and firm in texture. Crown rot can be a problem in the winter when early blossoms are killed by frost and a warm period follows. Source of Inoculum: The fungus survives in the decaying tissues of strawberries and many other plants. Fungal spores are wind-dispersed. Management: Removing dying and dead leaves shortly before plants flower may be helpful. If applying fungicides, begin while flowers are in bloom; most infections that eventually affect fruit are initiated through flowers. Harvest fruit frequently, removing infected and other unmarketable fruit from the field. Fungicide resistance in <i>Botrytis cinerea</i> is a major concern. Resistance has been documented in one or more locations to many of the fungicides previously effective for managing gray mold. In tests of the fungus from five Louisiana strawberry fields in 2019, all isolates were resistant to thiophanate-methyl and pyraclostrobin, and most were resistant to fenhexamid. Some resistance to penthiopyrad, fluopyram, and boscalid were observed, but resistance to isofetamid was not found, even though it is in the same FRAC group as the former three. Two fields had some level of resistance to at least one of the active ingredients in Switch (cyprodinil and fludioxonil). Captan, thiram, isofetamid (Kenja), polyoxin D salts (Ph-D/OSO 5%SC), and Switch (in most cases) appear to remain effective options for gray mold. Be sure to rotate among modes of action (FRAC groups). For chemical management of crown rot, choose among captan, Switch and iprodione.

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Symptoms, Sources of Inoculum, and Management
Common Leaf Spot (False Rust, Bird's Eye Spot) (<i>Mycosphaerella fragariae</i>) Symptoms: The spots are at first less than 1/8 inch in diameter and purplish-red. Spots enlarge to about 3/16 inch. They have white or gray centers with purplish borders. Source of Inoculum: The fungus survives from year to year on infected plant parts. Management: Spray with fungicides if needed. While many fungicides are effective on this disease, consider using myclobutanil, a combination of thiophanate-methyl and captan, or captan alone, unless another fungicide is needed for another purpose.
Leaf Blight (<i>Phomopsis obscurans</i> or <i>Dendrophoma obscurans</i>) Symptoms: First appears as large, circular, reddish-purple spots that become zonate with age (i.e., they have a dark brown center surrounded by a lighter brown area with a purplish border). Mature spots may be circular, oval or V-shaped. Source of Inoculum: The fungus lives from year to year primarily on infected plant tissue. Management: Use disease-free transplants. Spray with fungicides if needed. While many fungicides are effective on this disease, consider using myclobutanil, a combination of thiophanate-methyl and captan, or captan alone, unless another fungicide is needed for another purpose.
Leaf Blotch (<i>Gnomonia</i> sp. or <i>Zythia</i> sp.) Symptoms: First appears as purplish to brownish blotches on young leaves. Later appears as large, light brown spots on older leaves. Also causes spots on the stem end of fruit. Source of Inoculum: The fungus lives from year to year primarily on infected plant tissue. Management: Spray with fungicides if needed. While many fungicides may be effective on this disease, consider using myclobutanil, a combination of thiophanate-methyl and captan, or captan alone, unless another fungicide is needed for another purpose.
Leaf Scorch (<i>Diplocarpon earlianum</i>) Symptoms: The disease first appears on upper leaf surfaces as small purplish spots that enlarge rapidly into irregular purplish blotches from 1/16 inch to 3/16 inch in diameter. The spots may become numerous and coalesce. In severe cases, the edges of the leaflets curl upward and the tissue dies, giving the plant a scorched appearance. Source of Inoculum: The fungus survives from year to year on infected leaves. Management: Use disease-free transplants. Rotate strawberry fields, if possible. Spray with fungicides if needed. While many fungicides may be effective on this disease, consider using myclobutanil, a combination of thiophanate-methyl and captan, or captan alone, unless another fungicide is needed for another purpose.
Powdery Mildew (<i>Sphaerotheca macularis</i> f. sp. <i>fragariae</i>) Symptoms: A white powdery growth is present on the undersurface of infected leaves and on fruit. Infected leaves have a tendency to roll up. Source of Inoculum: The fungus persists from year to year on infected strawberries and other wild hosts. Usually a problem in the spring and early summer months. Management: Many varieties are resistant to this disease. It is more likely to be a problem in strawberries grown under cover (e.g., high tunnels). Spray with fungicides if needed.
Phytophthora Crown Rot (<i>Phytophthora</i> spp.) Symptoms: Youngest leaves often wilt first followed by the collapse of the entire plant. Crowns exhibit extensive brown discoloration that extends from the crown downward or from an infected stolon. Source of Inoculum: Oospores that survive in the soil or on infected transplants. Spreads primarily in water. Management: Use disease-free transplants, improve drainage and avoid low spots. Dip transplants in suitable fungicide prior to planting if problems with the plant source are identified. Remove infected plants and treat surrounding plants with fungicide. Do not use an excessive amount of nitrogen fertilizer.

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Root-knot Nematodes (*Meloidogyne* spp.)

Symptoms: Affected plants are stunted, unthrifty, nonproductive and often pale green in color. Galls or knots on the roots are rather small. Numerous secondary roots may develop at the small swellings. Frequently, blackened, rotten roots are associated with root-knot problems.

Source of Inoculum: Root-knot nematodes live from year to year in the soil and on the roots of strawberry plants and many weeds. Root-knot nematodes are more severe in light soil types.

Management: Sample soil for nematodes and fumigate soil if needed. See recommendations in the Nematode Control section of this guide and in the [Southeast Regional Strawberry Integrated Management Guide](#).

Summer Dwarf or Bud Nematodes (*Aphelenchoides besseyi*)

Symptoms: Affected plants are severely stunted during the summer and early fall. Older leaflets usually are darker green with a greasy appearance. Young leaflets are reduced in size, usually crinkled and somewhat elongated, with shorter petioles. Margins of leaflets may curl upward in the young leaflets and downward in the older leaflets.

Source of Inoculum: Bud nematodes live from year to year on infected daughter plants and in the soil.

Management: Fumigate fields where the disease has occurred. Obtain clean plants. There is no satisfactory treatment to eradicate these nematodes from infected plants.

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Table 2. Seasonal fungicide spray schedule for strawberries.

Season	Pesticide Application Timing	Diseases
Preplanting	Preplanting fungicide dip ¹	Anthrachnose Crown Rot Phytophthora Crown Rot
Postplanting until prebloom	Early postplanting	Anthrachnose Crown Rot Phytophthora Crown Rot Powdery Mildew
Postplanting until prebloom	Warm periods following frost	Botrytis Crown Rot
Postplanting until prebloom	New growth	Leaf Spots (bacterial and fungal) Phytophthora Crown Rot Powdery Mildew
Bloom until harvest	Every 7 to 10 days or according to label	Gray Mold Anthrachnose Fruit Rot Leaf Spots (bacterial and fungal) Phytophthora Crown Rot Powdery Mildew

¹If it is known that plants from a particular source have a problem with one of the root or crown rot diseases, bare-root strawberry plants may be dipped in a fungicide suspension prior to planting to provide early season control. Prior to dipping, the plants should be washed with potable water to remove adhering soil.

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Table 3. Pesticide efficacy¹ and use.

Product Choices²	Mode of Action Group(s)³	Angular Leaf Spot	Anthrachnose Crown Rot	Anthrachnose Fruit Rot	Botrytis Crown Rot	Botrytis Fruit Rot (Gray Mold)	Common Leaf Spot	Leaf Blight	Phytophthora Crown Rot a- Red Stele Root Rot	Powdery Mildew	Rate⁴	PHI⁵	Maximum Use⁶
acibenzolar-S-methyl (Actigard 50WG)	P01	P	-	-	-	-	-	-	-	-	0.5-0.75 oz	0	6 oz
aluminum tris (O-ethyl phosphonate; Aliette WDG) ⁷	P07	-	-	-	-	-	-	-	F	-	2.5-5.0 lb ⁸ (2.5 lb/100 gal for dip)	0.5	30 lb
azoxystrobin (Abound F, others)	11	-	G ^R	E ^R	-	F ^R	F	-	-	E ^R	6.0-15.5 fl oz (5-8 fl oz/100 gal for dip)	0	61.5 fl oz
azoxystrobin and difenoconazole (Quadris Top)	11, 3	-	G ^R	E ^R	-	F ^R	G	-	-	E ^R	12-14 fl oz	0	56 fl oz
azoxystrobin and propiconazole (Quilt Xcel)	11, 3	-	G ^R	E ^R	-	F ^R	-	-	-	E ^R	14 fl oz	0	56 fl oz
boscalid and pyraclostrobin (Pristine)	7, 11	-	G ^R	E ^R	-	G ^R	VG	VG	-	E ^R	18.5-23 oz	0	115 oz
captan (50 WP)	M04	-	G	G	F	G	F	F	-	-	3-6 lb	0	48 lb
captan (80 WDG)	M04	-	G	G	F	G	F	F	-	-	1.875-3.75 lb	0	30 lb
captan (38.75% FL, Captec 4L, Captan 4L)	M04	-	G	G	F	G	F	F	-	-	1.5-3.0 qt	0	24 qt
captan and fenhexamid (CaptEvote 68 WDG)	M04, 17	-	F	G	-	E ^R	G	F	-	-	3.5-5.25 lb ⁹	0	21 lb

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copper-containing products labeled for use on strawberries, including ones with basic copper sulfate, copper hydroxide, copper oxychloride, copper octanoate, copper sulfate pentahydrate, or cuprous oxide – some products OMRI listed	M01	P	-	-	-	-	P	-	-	-	see label	typically 0 – see label	see label
cyflufenamid (Torino)	U06	-	-	-	-	-	-	-	-	VG	3.4 oz	0	2 apps
cyprodinil and fludioxonil (Switch 62.5 WG)	9, 12	-	G	G	VG	E	F	F	-	-	11-14 oz (5-8 oz/100 gal for dip)	0	56 oz
fenhexamid (Elevate 50WDG)	17	-	-	-	-	ER	-	-	-	-	1.5 lb ⁹	0	6 lb
fluopyram and trifloxystrobin (Luna Sensation)	7, 11	-	G ^R	ER	-	ER	VG	VG	-	ER	4-7.6 fl oz (6-7.6 fl oz for gray mold; 7.6 fl oz for Rhizopus fruit rot and <i>Mycosphaerella</i> leaf spot)	0	27.1 fl oz
flutriafol (Rhyme)	3	-	-	-	-	-	-	-	-	ER	5 - 7 fl oz (7 fl oz for charcoal rot)	0	4 apps

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fluxapyroxad and pyraclostrobin (Merivon)	7, 11	-	G ^R	E ^R	-	E ^R	VG	VG	-	E ^R	see label (varies by disease)	0	3 apps
iprodione (Rovral 4, Meteor, Nevada 4F)	2	-	-	-	VG	G ^R	G	-	-	-	1.5-2 pt (2 pt/100 gal for dip)	Do not apply after first fruiting flower.	1 app
isofetamid (Kenja 400SC)	7	-	-	-	-	E ^R	-	-	-	G ^R	13.5-15.5 fl oz	0	54 fl oz
mefenoxam (Ridomil Gold SL)	4	-	-	-	-	-	-	-	VG	-	1 pt ¹⁰	0	3 pt
mefenoxam (Ultra Flourish)	4	-	-	-	-	-	-	-	VG	-	2 pt ¹¹	0	6 pt
metalaxyl (MetaStar 2E, Metalaxyl 2E)	4	-	-	-	-	-	-	-	VG	-	2 qt/treated ac	0	6 qt/treated ac
myclobutanil (Rally 40WSP)	3	-	-	-	-	-	VG	VG	-	E ^R	2.5-5 oz	0	30 oz
mono- and dibasic sodium, potassium, and ammonium phosphites (Phostrol)	P07	-	-	-	-	-	-	-	F	-	see label (varies by product and application method)	0	see label
mono- and di-potassium salts of phosphorus acid (Agri-Fos, Fosphite, Fungi-Phite, K-Phite 7 LP, others)	P07	-	-	-	-	-	-	-	F	-	2.5 – 5.0 pt (2.5 – 5.0 pt/100 gal for dip)	0	

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penthiopyrad (Fontelis) ¹²	7	-	F	F	-	ER	-	-	-	GR	16-24 fl oz	0	72 fl oz
polyoxin D zinc salt (Ph-D)	19	-	-	-	-	G	-	-	-	-	6.2 oz	0	6 apps
polyoxin D zinc salt (OSO 5%SC)	19	-	-	-	-	G	-	-	-	-	3.75 – 13.0 fl oz	0	78 fl oz
potassium phosphite (ProPhyt)	P07	-	-	-	-	-	-	-	F	-	2-4 pt (2 pt/100 gal for dip)	0	
propiconazole (Bumper 41.8 EC, Bumper 40.85 ES, Tilt, others)	3	-	F	G	-	-	G	-	-	VG ^R	4 fl oz	0	4 apps
propiconazole and thiophanate-methyl (Protocol)	3, I	-	GR	GR	GR	GR	G	G	-	GR	1.33 pt	I	5.3 pt
pyraclostrobin (Cabrio EG)	11	-	GR	ER	-	FR	F	-	-	ER	12-14 oz	0	70 oz
pyrimethanil (Scala SC)	9	-	-	-	-	GR	-	-	-	-	18 fl oz	I	54 fl oz
quinoxifen (Quintec)	13	-	-	-	-	-	-	-	-	E	4-6 fl oz	I	24 fl oz
sulfur ¹³ (Microfine & Yellow Jacket Wettable II; 90%)	M02	-	-	-	-	-	-	-	-	GR	3-50 lb	0	
sulfur ¹³ (Microthiol Disperss; 80%)	M02	-	-	-	-	-	-	-	-	GR	5-10 lb	0	

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tetraconazole (Mettler 125 ME)	3	-	-	-	-	-	-	-	-	FR	3-5 fl oz	0	4 apps
triflumizole (Procure 480SC, Trionic 4SC)	3	-	-	-	-	-	-	-	-	FR	4-8 fl oz	I	4 apps
thiophanate-methyl (Incognito 85 WDG)	I	-	GR	-	LR	LR	G	G	-	FR	0.6-0.8 lb	I	3.2 lb
thiophanate-methyl (Topsin M WSB, T-Methyl 70 WSB)	I	-	GR	-	LR	LR	G	G	-	FR	0.75-1 lb	I	4 lb
thiophanate-methyl (Topsin 4.5FL, others)	I	-	GR	-	LR	LR	G	G	-	FR	15-20 fl oz	I	80 fl oz
thiram (SC)	M03	-	F	G	F	G	F	F	-	-	2.6 qt	I	5 or 12 apps ¹⁴

¹Efficacy ratings: E = excellent, VG = very good, G = good, F = fair, P = poor. Actual performance may vary. A superscript "R" indicates that there is a possibility of resistance to the chemical and that the chemical will not be effective, or as effective as noted, if the pathogen is resistant to it. A "-" indicates that the chemical is not expected to be effective for managing the disease or that data is lacking. Ratings are based largely on the 2019 [Southeast Regional Strawberry Integrated Management Guide](#) of the Southern Region Small Fruit Consortium.

²Chemical name (trade name). Reference to commercial or trade names is made for the reader's convenience and with the understanding that no discrimination nor endorsement of a particular product is intended by LSU or the LSU AgCenter. In some cases, other brands are available.

³Mode of action groups are determined by the Fungicide Resistance Action Committee (FRAC).

⁴Rates are the amount of formulation (product) per acre unless otherwise indicated. Usually 100 gallons of water are required to give good coverage with boom sprayers.

⁵Postharvest interval (PHI) is the minimum number of days allowed between the last application and harvest.

⁶Maximum amount per acre per year or growing season. See labels for additional restrictions.

⁷Make sure to get the Aliette WDG that is labeled for use on strawberries. There is a product of the same name that is not labeled for strawberries.

⁸Do not apply more than 3.75 lb product per acre per application in Livingston or Rapides parishes.

⁹"When plastic mulch is used, do not apply within 16 feet...of naturally vegetated or aquatic areas."

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¹⁰Applications by ground (banded), drip or overhead chemigation.

¹¹Apply in banded sprays or drip irrigation.

¹²Do not apply to cvs. 'Clancy', 'Jewel', or 'L'Amour'.

¹³See labels for restrictions and recommendations regarding use at high temperatures and within given time periods before or after oil applications.

¹⁴Five applications per year of Thiram SC are allowed in locations west of the Mississippi River, and 12 applications per year are allowed east of the Mississippi River.

This section was updated by Dr. Mary Helen Ferguson in October 2019.