Agricultural Extension Service
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STRAWBERRY DISEASES IN TENNESSEE

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A number of diseases affect the fruit, leaves, roots and crowns of strawberries. This publication provides information on the most important strawberry diseases in Tennessee. Reference is made to two systems of strawberry production in Tennessee. The **matted-row system** is a perennial system in which the plants are allowed to spread, and the planting is maintained for several years. **Plasticulture** is a term often used to refer to an annual system of production in which planting takes place in plastic-mulched rows in the fall, and the plants are destroyed the following summer, after harvest is completed.

Cultural control practices are provided in this publication. For chemical recommendations, backyard growers are referred to Extension PB 1622, *Disease and Insect Control in Home Fruit Plantings*. Commercial growers are referred to Extension PB 1187, *Commercial Small Fruit Spray Schedules*. Both publications are available at no charge at your county Extension office.

Fruit Diseases

Diseases of the fruit are very important because they cause a direct loss of the harvested product. One of the diseases, anthracnose, also affects many other parts of the strawberry plant.

Anthracnose is a very destructive disease that can affect almost any part of the strawberry plant. Several species of the fungus *Colletotrichum* can cause strawberry anthracnose, but the predominant species is *C. acutatum*. In matted-row plantings, anthracnose can cause bed-fill problems during runner production in the summer, while fruit rot can affect either type of strawberry planting.

Anthracnose fruit rot is characterized by circular, slightly sunken, tan to brown spots (Figure 1) that usually turn black but may remain tan. Under humid conditions, the center of the spot can become covered with orange or salmon-colored spore masses. The spots enlarge until the entire berry rots and shrivels. Green berries also can be infected, producing small, hard, deformed fruit with a dark brown lesion. If warm, humid weather occurs during the bloom period, flowers and their stems may become infected, and entire flower clusters may die (Figure 2). Calyx (cap) infections result in dark, dry caps (Figure 3).

Figure 1. Circular-shaped lesions typical of anthracnose fruit rot (left) and irregular-shaped lesions typical of gray mold (right).

Figure 2. Death of blossom cluster caused by anthracnose fungus.

Figure 3. "Brown cap" condition caused by the anthracnose fungus. Other disease organisms can also cause this condition.

On stolons (runner stems) and petioles (leaf stems), anthracnose lesions are dark, firm, sunken and dry (Figure 4). The lesions can quickly girdle and kill stolons and young runner plants. Small anthracnose lesions on stems can be confused with lesions of other diseases.

In infected matted-row plantings, established plants become debilitated, showing lack of growth, dead older leaves and little runner production (Figure 5). The root system is usually dark and decayed. The

Figure 4. Anthracnose lesions on stolon.

Figure 5. Dead older leaves and lack of growth typical of plants with anthracnose.

Figure 6. Sliced crown showing reddish-brown discoloration on the left and upper side, caused by the anthracnose fungus. Healthy crown tissue is flesh-colored.

fungus can enter the crown, causing the plants to quickly wilt and die. A lengthwise cut through the crown reveals a reddish-brown, firm rot (Figure 6).

Anthracnose is favored by hot, rainy weather. In most years, symptoms are difficult to find prior to the harvest period. However, severe fruit rot can occur despite a lack of stem symptoms, if the weather is favorable. The fungal spores are dispersed by splashing rain. Infected transplants often serve as the source of the disease in a planting. The fungus can survive one winter in plant debris, and can also survive in alternate hosts.

Anthracnose problems can be avoided by using certified disease-free transplants and by using resistant varieties (Table 1). If a planting is known to have anthracnose, follow a weekly fungicide spray program. In most years, adequate control is obtained by beginning the spray program at or just before the beginning of harvest. To protect against the occasional early outbreak, a spray program that includes fungicides effective against both anthracnose and gray mold should be initiated at early bloom. In matted-row plantings, control of anthracnose on susceptible varieties during the summer is difficult, because of the number of sprays required. Do not sprinkler-irrigate infected plants, if possible.

Non-infested fields located near infested fields can remain clean if care is taken to prevent spread. Pickers should never move from an infested field to a non-infested field. There have been reports of success in checking spread by removing plants showing anthracnose fruit rot from the field. In this method, which is practical if the disease begins in a small area, all infected plants and surrounding plants are removed and destroyed.

Gray mold, caused by the fungus *Botrytis cinerea*, is the most common strawberry fruit rot. Losses can be high if persistent wet weather occurs during bloom or the fruiting season. The fuzzy brown to gray spore masses can develop on any injured or senescent tissue, but most economic losses result from fruit rots (Figure 7) and, sometimes, blossom blight. The fungus can also cause a crown rot. Fruit infections appear as light brown, rapidly expanding spots. They are irregular in shape, as opposed to the circular shape of anthracnose lesions (Figure 1).

Figure 7. Powdery gray Botrytis spore masses (gray mold) on fruit.

The gray mold fungus is readily airborne and commonly encountered. Winter carryover is greatest in fields in which there is a large amount of dead plant material, on which the fungus develops. Mild, wet, humid weather is most favorable for infection. Most infections of the fruit result from blossom infections that remain latent in the developing berry, becoming active and causing a rot when the fruit ripens.

Control of gray mold includes planting in a sunny location that provides good air movement and has good soil drainage. Mulching helps prevent contracting the fungus from the soil. Do not sprinkler irrigate, except for frost protection. Avoid applying nitrogen fertilizer in the spring, as this practice leads to soft berries and excessive leaf cover. A common practice in plasticulture systems is to remove winter-killed foliage from the field before bloom, to eliminate an important food base for the fungus. Pick fruit frequently and remove diseased fruit. Matted-row plantings should be properly renovated after harvest, narrowing the rows and removing diseased and dead plant parts. Certain varieties, such as Earliglow and Delmarvel, have resistance to gray mold.

Key times for applying protective fungicide sprays are during bloom. The period between early bloom (5 to 10 percent open blooms) and late bloom (90 percent of blooms having opened) is most critical. Sprays can be continued through harvest, observing the label restrictions of the fungicides.

Figure 8. Leather rot symptom on mature strawberry fruit.

Leather rot is a fruit rot caused by *Phytophthora cactorum*. In Tennessee, losses to leather rot are slight, except where drainage is poor or plant growth is excessive. Leather rot can present a marketing problem in that some infected berries appear normal, but have a sour odor and unpleasant taste. Processing such berries can produce bitter-tasting jams and jellies. Infected green berries become brown, while mature berries can be brown, lilac (Figure 8), or dark purple. A sparse, white mold may cover the surface of the berry (Figure 9). Initially soft, the rotted berry later becomes tough and leathery.

Avoid overhead irrigation, since the spores are spread by splashing or wind-blown water. Avoid over-fertilization, especially in the spring, and keep matted-row plantings properly thinned. Mulching aids control by preventing fruit contact with the soil, and preventing splashing of the spores onto the fruit. Certain fungicides are also helpful.

Figure 9. Leather rot symptoms on green fruit. Note sparse, white growth of the causal fungus.

Leaf Diseases

Leaf diseases commonly appear on strawberry plants. The three fungal diseases and one bacterial disease discussed below can cause significant damage on susceptible varieties if environmental conditions are conducive for their development. In such cases, enough leaf tissue can be destroyed that the plant is weakened, thus causing it to be more subject to winter injury. Additionally, the organisms that cause these diseases can infect berries, calyxes or berry stems, causing quality problems or even loss of fruit.

Fungal leaf diseases are controlled by planting certified, disease-free plants in a location exposed to all-day sun; the use of resistant varieties; avoidance of overhead irrigation, except for frost protection; and proper renovation (in matted-row plantings) that includes narrowing the rows and clipping excess foliage. Fungicide spray programs may be needed. Many of the fungicides used in the spring for prevention of gray mold are also effective against the fungal leaf diseases. There may be a need for fungicidal control in matted-row plantings in the summer and fall, and in plasticulture fields in the fall. These needs may be met on an as-needed basis. Unless a highly susceptible variety is planted, adequate control can be maintained by delaying the application until disease activity is observed.

Figure 10. Young (left) and older lesions of leaf blight (Phomopsis).

Leaf blight, caused by the fungus *Phomopsis obscurans*, is an important summertime disease because so few varieties have adequate resistance to it. Once considered to be a disease only of older or weakened leaves, leaf blight has become an important disease, aggressively attacking leaves of any age. Lesions begin as circular to elliptical, purple spots that can appear identical to those of common leaf spot or leaf scorch. The purple spots develop dark brown centers as they enlarge (Figure 10). Some infected leaves display large V-shaped lesions, with the widest part at the leaf edge. If the spots become numerous, large areas of the leaf become purple or red, and the leaf may die. The fungus can also cause dark lesions on stems and berry caps. On berries, infection can cause a soft, light pink lesion that develops a tough, tan-colored center (Figure 11).

Figure 11. Phomopsis soft rot of fruit.

Leaf blight prospers in hot, wet weather, usually not producing symptoms until late spring. Spores are produced in brown, speck-sized fruiting structures in lesions and are spread by splashing water to other

plant parts. The fungus overwinters in dead leaves and stems.


Figure 12. Common leaf spot symptoms on upper leaf surface.

Common leaf spot, caused by the fungus *Mycosphaerella fragariae*, is frequently encountered, but most of our commonly planted varieties have adequate tolerance to it. On highly susceptible varieties such as Idea, control practices are essential. Common leaf spot is characterized by small, 1/8-inch, circular leaf spots. These spots begin as purple to reddish purple lesions, developing distinctive tan to grayish white centers (Figure 12). Infections that occur on stem structures are similar to those on the leaves. The fungus can cause a "black seed" condition on the berries, and the tissue immediately surrounding a seed may become black.

Common leaf spot is more prevalent in cool, wet weather. Some spread can even be expected during mild periods of winter, especially under straw bed covers. Outbreaks are most severe in spring and fall. The fungus overwinters on infected leaves that survive the winter.


Figure 13. Leaf scorch symptoms on upper leaf surface.

Leaf scorch, caused by the fungus *Diplocarpon earliana*, is not as common in Tennessee as leaf blight or common leaf spot. Many of our varieties have adequate tolerance to leaf scorch under Tennessee conditions. Leaf scorch symptoms are very similar to the early stages of leaf blight or common leaf spot. Leaf spots are up to 1/4-inch in diameter and purple to red (Figure 13). The centers may become brown, but not white or gray as with common leaf spot. As with Phomopsis leaf blight, considerable scorching can occur, i.e., blighting and death of leaves. Reddish lesions may form on stem structures or calyxes.

Leaf scorch can be active during spring, summer or fall. Spores produced in lesions are spread mainly by splashing water. The fungus overwinters on infected leaves that survive the winter.

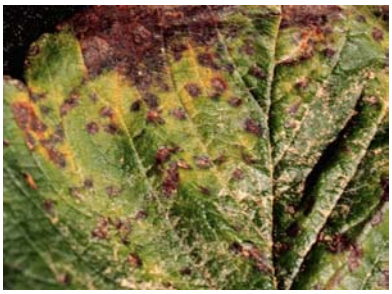
Figure 14. Angular leaf spot symptoms on upper leaf surface.

Angular leaf spot, caused by the bacterium *Xanthomonas fragariae*, became a problem in Tennessee strawberry production in the 1990s. It is seen more often in plasticulture than in matted-row production. Leaf lesions are reddish brown and often angular in shape, delimited by leaf veins (Figure 14). Under certain conditions, however, the spots are less angular and may resemble leaf blight or leaf scorch. The diagnostic symptom is the presence of dark green, water-soaked lesions on the underside of the leaf (Figure 15). These are recent infections and are translucent when the leaves are held up to a light. Calyxes and fruit stems can be infected, reducing marketability due to dry, brown calyxes. This aspect of angular leaf spot is, perhaps, its most damaging one.


Figure 15. Angular leaf spot symptoms on lower leaf surface. Note tiny, watersoaked lesions.

The bacterium overwinters on infected dead leaves and also enters plantings on infected transplants. Plant-to-plant movement is through splashing water and on the hands of workers. Development of angular leaf spot is favored by moderate to cool daytime temperatures, cool nighttime temperatures and high humidity. Overhead irrigation for frost control enhances the disease, since water and near-freezing temperatures favor infection.

Angular leaf spot is difficult to control with chemical sprays, so avoidance is the best means of control. Disease-free planting stock is key, but this disease can be present in symptomless plants. Avoid overhead irrigation, except for frost protection. Infested fields should not be worked when plants are wet, and work healthy fields first to avoid spread.

Foliar sprays of fixed copper products provide some control of the leaf spot phase of angular leaf spot, but have not proved satisfactory for control of calyx infections. Repeated use of copper can cause

phytotoxicity (leaf burn). The use of copper after berries begin to ripen can cause spotting on red berries.

Root and Crown Diseases

Red stele, caused by the fungus *Phytophthora fragariae*, is a serious threat to susceptible varieties. Most current varieties are resistant to red stele, but some susceptible varieties, such as Cardinal, are still planted commercially. Several varieties found in home gardens are susceptible. Affected plants are stunted, produce few runners and fruit, wilt when the weather becomes hot, and die. The disease usually appears first in poorly drained areas of the field, and is most apparent from spring through mid-summer. The most characteristic symptom is the reddish-brown discoloration of the central cylinder (stele) of otherwise white roots. The red stele symptoms in the roots are present only in the winter and spring. In later stages of the disease, roots die and turn black. Infected roots may lack branching, causing a "rat-tail" effect (Figure 16).

Figure 16. Red stele symptoms on roots. Note lack of branching.

The causal fungus can survive for many years in the absence of strawberries. If red stele-infested fields must be planted in strawberries, fumigate the soil with methyl bromide and use a resistant variety. Use certified disease-free transplants and select well-drained sites. Avoid moving infested soil to uninfested areas on farm implements. If you borrow equipment, clean off the soil thoroughly before using it. The proper use of appropriate fungicides combined with these cultural practices should aid in reducing losses to red stele.

Phytophthora crown rot, caused by the fungus *Phytophthora cactorum*, is increasing in importance. Like red stele, this disease is most likely found in poorly-drained areas of the field. Symptoms are most common between flowering and harvest when plants are under stress. It is first noticed as a wilting of the youngest leaves, and complete collapse occurs within days. The wilting may be one-sided, depending on the number of crowns infected. Brown areas resembling anthracnose crown rot occur in the interior of the crown (Figure 17). Crown tissue will disintegrate with time. Plants may survive but are usually stunted.

Figure 17. Sliced crown showing early stage of Phytophthora crown rot. Note brown discoloration in main crown and death of secondary crown at top.

For control practices, refer to red stele, above. No varieties suitable for production in Tennessee are known to be resistant to Phytophthora crown rot.

Verticillium wilt, caused by the soil-borne fungus *Verticillium albo-atrum*, does not occur frequently in Tennessee. Symptoms include death of older leaves, while the inner leaves remain green until the plant slowly dies. Control is accomplished primarily by the use of resistant varieties (Table 1) or by soil fumigation.

Table 1. Disease reactions of selected strawberry varieties.

Variety	Leaf Spot	Leaf Scorch	Leaf Blight	Anthracnose	Red Stele	Verticillium Wilt
Allstar	R	M	S	S	R	R
Cardinal	R	M	–	S	S	S
Chandler	M	–	S	S	S	--
Delmarvel	R	R	M	R	R	R
Earliglow	M	R	S	S	R	R
Idea	S	–	M	R	–	--
Latestar	M	R	–	–	R	R
Primetime	R	R	–	–	R	R
Redchief	M	M	S	S	R	R
Sweet Charlie	M	–	S	R	–	--

R = moderately resistant to highly resistant; M = moderately resistant to moderately susceptible; S = moderately susceptible to highly susceptible; – = unknown.

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