Tomato Leaf and Fruit Diseases and Disorders

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Several tomato diseases and disorders cause leaf spots and fruit rots. Typically, these diseases do not kill the plants, but they can lead to significant yield and quality losses. Many disease-causing microorganisms can survive in plant debris, on seed, or in the soil. Proper sanitation is one of the best ways to prevent or reduce losses. Gardeners should remove all tomato debris in the fall and avoid planting tomatoes in the same area year after year. This publication discusses some of the major leaf spot and fruit diseases and physiological disorders in Kansas. The first section describes fungal diseases, the second section describes bacterial diseases, and the third section describes physiological disorders.

Fungal Diseases

Septoria Leaf Spot and Early Blight

The fungal diseases Septoria leaf spot and early blight are two of the most common tomato diseases. Both diseases can occur anytime during the growing season, but they generally become more severe after blossom-set. These diseases result in the formation of leaf spots that typically develop first on the older leaves nearest the ground. During favorable conditions for disease development, these diseases can cause extensive defoliation, resulting in sunscalding of fruit and reduction in yield.

Septoria leaf spot and early blight have similarities, but they can be distinguished from one another in the field.

In Kansas, Septoria tends to be more common than early blight. Symptoms of Septoria leaf spot first appear as small, water-soaked spots on the lower leaves. Infection moves up the plant as the season progresses. The leaf spots (lesions) generally are smaller and more numerous than spots resulting from early blight. Eventually the center portion of the Septoria lesion turns light tan or gray, while the margin remains dark. Small black fruiting structures (pycnidia) of the fungus, readily visible with a 10X hand lens, form in the center portion of the lesion (Figure 1). Heavily infected leaves may scorch and wilt, giving the plant the appearance of a wilt disease.

Early blight causes irregular, brown leaf spots (lesions) that range in size up to ½ inch in diameter. The most important diagnostic feature of early blight is the formation of dark, concentric rings within the lesion, giving the spots a targetlike appearance (Figure 2). Often, several lesions coalesce, causing the leaf to turn yellow, dry up, and fall off the plant. Defoliation weakens the plant and exposes the fruit to sunscald injury. Although early blight is primarily a foliage disease, lesions may develop on both stems and fruit. Fruit lesions are tan to brown, leathery, and typically originate at the stem end of the fruit.

Figure 1. *Septoria leaf spot lesions often have small black specks (fungal spore-producing structures). Photo courtesy Wendy Johnson, Kansas State University.*

Figure 2. *Early blight lesions on tomato leaves usually have a target-like appearance. Photo courtesy Clemson University - USDA Cooperative Extension Slide Series, Bugwood.org.*

Cause

Septoria Leaf Spot: *Septoria lycopersici*

Early Blight: *Alternaria solani*

Both fungi survive the winter in plant debris, on seeds, or on weeds such as nightshade and horse nettle. In the spring and summer, spores of these fungi can be splashed or blown to tomato leaves. Relatively warm temperatures, abundant rainfall, and high relative humidity favor disease development.

Control

Sanitation measures in the fall reduce the amount of inoculum available for infection the following year. In the fall, deep plow tomato plots to bury tomato debris, or remove and destroy dead plants. Avoid planting tomatoes in the same area of the garden year after

year. Clean seed and healthy transplants in the spring help control the disease. To reduce humidity and leaf wetness, avoid overhead irrigation. To improve airflow, use staking and appropriate plant spacing. To prevent rain splash, use mulch. Avoid composting diseased plant material.

Start with the cultural practices described above. However, there are control materials available. For best results, begin applications as soon as the symptoms become apparent.

Homeowners can refer to Table 1. Commercial growers should consult the *Midwest Vegetable Production Guide for Commercial Growers*; a management guide published every year. Contact your local K-State Research and Extension Office or the K-State Plant Diagnostic Lab for ordering information.

Anthracnose

Anthracnose is a frequent problem in the latter part of the growing season on ripening tomato fruit. The disease results in a fruit rot that reduces the quality and yield of tomatoes. Symptoms of anthracnose appear first as small, circular, slightly sunken lesions on the surface of ripening fruits. The spots quickly enlarge, become bruiselike depressions, and develop a water-soaked appearance directly beneath the skin (epidermis) of the fruit. Black, concentric rings form in the center of the lesions. The rings consist of numerous small fruiting structures (acervuli) of the disease-causing fungus (Figure 3).

During humid weather, masses of buff-colored fungal spores (conidia) are extruded from the fruiting structure. Several lesions coalesce, causing extensive decay of the fruit. Eventually, secondary microorganisms invade the lesions and cause a complete rotting of the fruit.

Cause

Anthracnose is caused by several fungal species in the genus *Colletotrichum*, including *C. coccodes, C. dematium*, and *C. gloeosporioides.*

The fungus can survive in infected plant debris and in the soil. During rainy weather, fungal spores are splashed onto the fruit. Most infection takes place on ripe or overripe fruit. Green fruit also can be infected, although symptoms do not develop until the tomatoes begin to mature. Disease development is favored by frequent rainfall temperatures around 80 degrees Fahrenheit.

Control

Several cultural practices help reduce the incidence of anthracnose. Mulching around the tomato plants prevents splashing of spores from the soil onto the fruits. Staking tomatoes increases air movement and decreases the likelihood of favorable environmental conditions for infection. Avoid overhead watering and remove infected or rotting fruits from the plant.

Start with the cultural practices described above. However, there are control materials available.

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Figure 3. *Anthracnose causes circular, sunken areas on ripening fruit which later support numerous fungal spore-producing structures (black specks). Photo courtesy Clemson University - USDA Cooperative Extension Slide Series, Bugwood.org*

Table 1. *Homeowner fungicides labeled for Septoria leaf spot, early blight and anthracnose of tomato.*

Active ingredient	Example products*	Notes
Bacillus subtilis *(biological control organism)*	Serenade Garden Disease Control	The bacterial species Bacillus subtilis has had efficacy in trials for some fungi, but not in others. Little data available for tomato diseases.
chlorothalonil	Fertilome Broad Spectrum Fungicide, Ortho Garden Disease Control, Garden Tech Daconil Fungicide Concentrate	In trials with commercial formulations of chlorothalonil, fungicides have reduced disease compared to untreated controls.
copper	Natural Guard Copper Soap Liquid Fungicide	Performance of copper materials has been good in several trials for Septoria and early blight, but poor in several others.
maneb	Hi-Yield Maneb Garden Fungicide	In trials with commercial formulations of a related material called mancozeb, fungicides have reduced disease compared to untreated controls.

** Labels change frequently, and it is the responsibility of the user to follow all label instructions.*

K-STATE Research and Extension

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BACTERIAL DISEASES

Bacterial Speck and Spot

In average Kansas summers, bacterial speck and bacterial spot of tomato are not common, but they can cause serious damage during wet growing seasons. On tomatoes, both diseases result in spot formation on the leaves and fruit. Heavy infection can cause defoliation, but the main effect of these diseases is the reduction of fruit quality.

Leaf symptoms of bacterial speck and bacterial spot are similar. Both diseases cause small (⅛ to ¼ inch) black lesions on leaves. These spots usually are surrounded by a yellow halo. The lesions of bacterial *spot* tend to have a greasy appearance; those of bacterial *speck* do not. The two diseases are more easily distinguished by symptoms on the fruit. Bacterial *spot* results in small, black, slightly raised, water-soaked spots. These spots may enlarge to ¼ inch in diameter and become very rough and cracked. Bacterial *speck* lesions also are slightly raised, but typically are much smaller (1⁄16 inch) than those of bacterial spot. Bacterial speck lesions do not crack or become scaly as in bacterial spot (Figures 4 and 5).

Cause

Bacterial Speck *Pseudomonas syringae pv. tomato*
Bacterial Spot *Xanthomonas campestris pv. vesicatoria*

Both bacteria can survive the winter on plant debris or on other weedy hosts. The bacteria also can be introduced into a field on contaminated seed or infected transplants. Driving rain and mechanical injury to plants caused by hail and high winds increase the severity of these diseases. The development of bacterial speck is favored by relatively cool (65 to 75 degree Fahrenheit), wet conditions, while bacterial spot becomes more severe during periods of warmer temperatures (75 to 85 degree Fahrenheit), heavy rainfall, and high relative humidity.

Control

Control measures for the two diseases are similar. Removing plant debris in the fall, cultivation of weeds, rotation, and the use of clean (noninfested) seed and transplants reduces the severity of or prevents these diseases. To reduce humidity and leaf wetness, avoid overhead irrigation. Use staking and appropriate plant spacing to improve airflow. Use mulch to prevent rain splash. Do not work in the tomato planting when plants are wet.

Start with the cultural practices described above. There are several copper-based compounds available for homeowners, but chemical control of bacterial diseases is inconsistent. Bacteria have extremely fast reproductive times, and it is difficult to manage an epidemic once it is underway. If you use a chemical, read and follow all label instructions.

Commercial growers should consult the *Midwest Vegetable Production Guide for Commercial Growers*; a management guide published every year. Contact your local K-State Research and Extension Office or the K-State Plant Diagnostic Lab for ordering information.

Bacterial Canker

Bacterial canker, a third bacterial disease, can be a serious problem in commercial and small garden tomato plantings. This disease can cause lesions or cankers on any portion of the plant, including the fruit, or it can result in a general wilt or decline of the plant. Diseased tomatoes first exhibit yellowing and wilting of leaves on a portion of

Figure 4. *Bacterial speck causes tiny black lesions on fruit. Photo courtesy Christine Smart, Cornell University.*

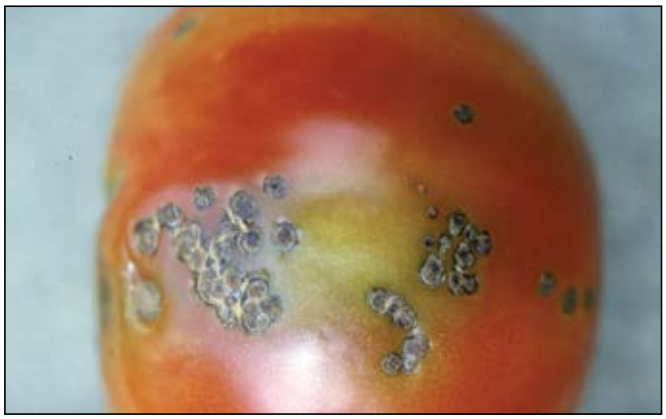

Figure 5. *Bacterial spot causes lesions up to ¼ inch that are often rough or cracked in appearance. Photo courtesy Mary Ann Hansen, Virginia Polytechnic Institute and State University, Bugwood.org.*

the plant. The leaves eventually become brittle and dry, and drop from the plant. Yellowish streaks may develop on leaf petioles, stems, and also internally in the water-conducting tissue of the main stem. Rotting in the stem may be visible when stems are cut (Figure 6). In addition, small circular depressed areas called cankers may form on the stem.

The most diagnostic feature of bacterial canker is the formation of fruit spots. These spots may be confused with those caused by bacterial speck or spot. However, fruit lesions caused by bacterial canker are bordered by a distinct white halo (Figure 7). These white halos may disappear as the fruit ripens.

Cause

Clavibacter michiganensis subsp. michiganensis

The bacterium can be introduced into fields on contaminated seed or on infected transplants. The bacterium also can survive in soil on infested plant material for at least 1 year. During the growing season, the small bacteria are dispersed by water (irrigation or rain) and infect plants through wounds or natural openings. Once inside the plant, the organism can invade the water-conducting tissue and be carried systemically throughout the plant.

Disease development is favored by moderately high temperatures (75 to 85 degrees Fahrenheit) and wet, humid conditions.

Control

The most important means of controlling bacterial canker is using clean seed from a reputable firm and transplanting into disease-free soil. If you have an outbreak of bacterial canker, do not plant tomatoes or other crops in the tomato family (pepper, eggplant, potatoes) into that bed for at least 3 years. Avoid overhead irrigation, which spreads bacteria and allows infection to occur. Avoid working with plants under wet conditions. Sanitize tools such as pruning shears. Use mulch to prevent rain splash.

Start with the cultural practices described above. Copper materials are available but are generally not effective.

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Figure 6. *Bacterial canker can cause a rotting in the stem, visible as discoloration when the stem is cut. Photo courtesy Paul Bachi, University of Kentucky Research & Education Center, Bugwood.org.*

Figure 7. *Bacterial canker lesions on fruit usually have a white halo. Photo courtesy Mary Ann Hansen, Virginia Polytechnic Institute and State University, Bugwood.org.*

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PHYSIOLOGICAL DISORDERS

Blossom End Rot

Fruits develop a sunken, water-soaked lesion near the blossom end. The lesion expands rapidly, turns black, and results in a flattening of the end of the fruit (Figure 8). Secondary organisms frequently invade the lesions and cause a complete rotting of the fruit. The disorder commonly occurs during periods of hot, dry weather.

Figure 8. *Blossom end rot causes sunken, water soaked lesions that eventually turn black. Photo courtesy David B. Langston, University of Georgia, Bugwood.org.*

Cause: Physiological

Blossom end rot is a physiological disorder (not an infectious disease) resulting from a shortage of available calcium in rapidly developing fruit. This problem can occur even though the soil has an abundance of calcium. The disorder is associated with rapid plant growth and quick fluctuations in soil moisture. In Kansas, the disease is typically most severe during periods of hot daytime temperatures, low humidity, and windy conditions. The disease also is more serious when excess nitrogen fertilizer has been applied.

Control

Providing even and adequate soil moisture, especially during fruit set, can reduce the incidence of blossom end rot. More uniform soil moisture can be achieved by mulching and a balanced irrigation program. Avoid overfertilization of the plant with nitrogen, especially of the ammonia formulation. Select cultivars that are less prone to blossom end rot.

Leaf Roll

During mild spring weather, top growth is more vigorous than root growth. When drier summer weather occurs, the abundant foliage transpires water faster than the root system absorbs it. The plant compensates by rolling its leaves to reduce surface area (Fig. 9). The leaves may become thickened. The symptoms may occur after cultivation, heavy rains, or a sudden change in weather.

Figure 9. *Physiological leaf roll. Photo courtesy Ward Upham, KSU Horticulture*

Control

The condition is temporary and the plant will recover on its own. To prevent leaf roll, keep soil evenly moist (not too wet, not too dry) and avoid cultivation that damages roots.

Growth Cracks

Growth cracking occurs on tomato fruit that expand too quickly. It is most common on nearly ripe fruit, but it can occur on younger fruit. Cracks develop in concentric circles around the stem scar (Figure 10). They also can

Figure 10. *Concentric growth cracks. Photo courtesy Paul Bachi, University of Kentucky.*

occur as radial cracking that spreads in a starlike pattern from the stem scar toward the blossom end (Figure 11).

Cause: Physiological

Growth cracks occur when the fruit expands and stretches the epidermis (skin) beyond its capacity (Figure 10). Excessive moisture, fluctuations in temperature, and an overabundance of nitrogen can cause cracking. In addition, tomato fruits exposed to sunlight are more prone to cracking.

Control

Select cultivars less prone to cracking. Provide even water and balanced nutrition to avoid overly lush growth. Limit fruit exposure to sun through proper staking or trellising, and by managing foliar diseases.

Figure 11. *Radial growth cracks. Photo courtesy Meg Williamson, Clemson University.*

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