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report on
PLANT
DISEASE

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BACTERIAL SPOT OF PEPPER AND TOMATO

Bacterial spot, caused by the bacterium *Xanthomonas campestris* subsp. *vesicatoria*, is the most common of all leaf and fruit diseases of sweet pepper in the Midwest. The disease is also frequently found on tomatoes in warm, rainy seasons with frequent or heavy dews. Fruit losses to peppers have approached 100 percent in some Illinois fields during warm, wet seasons, while losses in southern plant beds have been almost as high. Tomato fruit losses have been reported as much as 50 percent in fields. Besides pepper and tomato, the causal bacterium also infects black or deadly nightshade (*Solanum nigrum*) and groundcherry (*Physalis minima*).

Figure 1. Bacterial spot on pepper leaves.

SYMPTOMS

Distinct symptoms occur on pepper and tomato fruit, leaves, and seedlings and on pepper stems. Young leaves and fruit are more susceptible than older tissues.

Figure 2. Bacterial spot on pepper fruit.

Pepper

Infected plants in the seedbed have small, irregular, black spots, usually along the edges of the cotyledon leaves. Older plants develop small, circular, pale green, slightly raised spots (lesions) on the undersides of young leaves, with slight depressions on the corresponding upper surfaces. As the spots enlarge, they become straw-colored with dark brown margins.

The center of the lesion often dies and collapses. As a rule the spots do not merge. On older leaves of plants in the field, the lesions are usually dark green, water-soaked, not noticeably raised, and up to 1/8 or 1/4 inch in diameter. Later, these spots develop dead, pale yellow centers with dark brown borders (Figure 1). When numerous, the lesions remain dark brown with a paler brown center on the lower leaf surface. Spotted leaves may turn yellow and fall at any time during the season. When spots are numerous, entire leaves drop off while still green. Seedlings infected in the plant bed may lose all but their top leaves.

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Spots on pepper fruit are conspicuous, blisterlike, roughly circular, and up to 1/4 inch in diameter, with a cracked, roughened, or wartlike appearance (Figure 2). The spots are initially pale green but soon turn brown. During moist weather, various secondary, decay-producing bacteria and fungi enter through these lesions, causing the fruit to rot before or after harvest. Stem spots are small, raised, and up to 1/4 inch long. Eventually the cankers become roughened and light brown.

Tomato

Symptoms on young tomato plants are similar to those on peppers. Seedlings in seedbeds may be so severely spotted that the leaves turn yellow and drop. Leaf spots on older plants appear as small (1/8 inch), water-soaked, translucent lesions that later turn brownish black and may have a yellow halo (Figure 3). The lesions are somewhat irregular and appear "greasy" on the upper leaf surface with a translucent center and a black margin. The centers of the spots dry out and frequently tear. Spots are most numerous on the younger leaves. Only a few spots may cause a leaflet to turn yellow, wither, and drop prematurely. Lesions on the flower stems (pedicels) also cause the blossoms to blast and drop.

Figure 3. Bacterial spot lesions on the lower leaf surface of tomato. Note the yellow halo around each lesion (courtesy Dr. B.J. Jacobsen).

Spots on green fruit first appear as small, black, raised "pimples" surrounded by a narrow, water-soaked border (Figure 4, right). Somewhat older spots are black, slightly raised, superficial, and up to 1/3 inch in diameter, with lobed margins and water-soaked borders (halos). Later, the raised center sinks, forming a rough, brownish black crater (Figure 4, left). Fruit spots are usually superficial and do not penetrate to the seed cavity. The spots continue to enlarge until the fruit matures. Ripe fruit are not susceptible due to their high acidity. Spotting of the fruit and dropping of the flowers are the most serious phases of the disease in the Midwest.

DISEASE CYCLE

The *Xanthomonas* bacterium has survived at least 16.5 months and possibly for years on and within seed. Cotyledon leaves commonly become contaminated as they emerge from an infested seedcoat. Seedlings and adjacent transplants become infected by bacteria splashed or blown from nearby infected plants. Seedlings infected in the plant bed carry the spot bacterium to the field or garden and are sources of further infection.

In the southern states the causal bacterium also may overwinter on old infected pepper and tomato stems and roots on or above the soil surface, in association with wheat roots, and possibly on black nightshade and ground-cherry debris.

Figure 4. Bacterial spot lesions on two tomato fruits: (Left) older lesions; (Right) young lesions.

The bacterium apparently cannot overwinter in soil in the Midwest if all infected plant debris is absent, including seed of tomato or pepper fruit and weed reservoir hosts. **Contaminated seed and transplants are the most common source of primary infection in Illinois.**

Overhead irrigation, frequent, warm, driving rains, and long dew periods favor severe outbreaks of bacterial spot. Infection is favored by 100 percent relative humidity for periods of 24 hours or longer. The combination of wind and splashing rain, surface-drainage water, the movement of equipment, and the handling of wet plants all aid in spreading the bacteria throughout a field. Every plant in a field or garden can become infected from just a few isolated infected plants. The direction of spread within a field can often be correlated with the direction of prevailing winds.

Infections occur through natural openings (stomates and hydathodes) on the leaves and stems, through abrasions and broken hairs (trichomes) caused by rubbing together of plant parts, or from windblown sand and insect punctures, through growth cracks in the fruit, or other surface wounds.

The optimum temperature for infection is between 75° and 86°F (24° to 30°C). Disease development is favored by temperatures that fluctuate between 68° and 95°F (20° to 35°C). Night temperatures of 75° to 82°F (23° to 27°C) favor disease development, while low night temperatures (61°F or 16°C) suppress disease development independent of daytime temperatures. High nitrogen levels increase the severity of bacterial spot. Symptoms can appear on tomato leaves about 6 days after inoculation and on pepper leaves 5 to 14 days after infection takes place.

Different strains, races, or pathotypes of the *Xanthomonas* organism can be distinguished according to host range and symptoms. Some isolates favor pepper, others favor tomato, while still others appear equally pathogenic on both pepper and tomato.

CONTROL

Once established in tomato and pepper seedbeds and production fields, bacterial spot is extremely difficult to control. The practices outlined below are all important in controlling the disease. The rate of disease spread in seedbeds and production fields and gardens can be reduced by avoiding overhead irrigation, handling plants, and working in and moving through fields and gardens when the plants are wet.

A. **If plants are started from seed** apply the following control measures:

1. Whenever possible, purchase **only** certified, disease-free pepper and tomato seed grown in a semiarid area of the Pacific Northwest.

2. Uncertified pepper and tomato seed may be freed of the bacterial spot organism, seedborne anthracnose, the *Rhizoctonia* damping-off fungus, and Phoma rot by a hot water soak. After the hot water treatment, when both pepper and tomato seed have been cooled and are thoroughly dry, dust the seed with a protectant fungicide to control seed rot and damping-off. Follow the manufacturer's directions as outlined on the container label.

3. Disinfest permanent seedbed soil with steam or a soil fumigant. Whenever possible, do not locate seedbeds on soil where bacterial spot has occurred within the past 2 years.

4. In plant beds apply streptomycin (200 parts per million) plus a fixed copper fungicide at about 2 pounds of active ingredient per acre. The sprays should start within 4 or 5 days of emergence and be continued at 4- or 5-day intervals using equipment that will provide 100 percent coverage of leaves and stems. When possible, spray when the plants are dry and will not receive overhead irrigation or rain for 24 hours. (Note: It is illegal to use streptomycin after transplant time).

B. **If transplants are purchased** apply the following control measures:

1. If you buy transplants from the south, be certain they come from fields certified as disease-free. **This is critical!**

2. Follow a 2- or 3-year rotation of pepper and tomato with other unrelated crops. Try to avoid small grains in the rotation since the causal bacterium may survive near the surface of wheat roots during the winter months. Also exclude weeds in the tomato-potato family such as black nightshade and groundcherries. If possible, tomato vines and pepper plants should be removed or chopped up and buried as soon as possible after harvest.

3. Fertilize based on a soil test report and recommendations of Midwest Vegetable Production Guide for Commercial Growers, available from ITCS, University of Illinois P345, 1917 S. Wright St., Champaign, IL 61820. Low fertility levels usually are associated with the most severe levels of disease. **Avoid** excessive ferility levels, especially before fruit set, as this can result in excessive foliage, low fruit set, and an increase in the severity of bacterial spot. Strive to maintain high balanced fertility.

4. Planting peppers in narrow strips between early-planted corn may help to reduce spread of bacterial spot during severe rain and wind storms.

5. After transplanting in the field or garden, apply fixed copper plus mancozeb sprays on a 5- to 7-day schedule following the manufacturer's directions on the container labels. Premix the fixed copper and mancozeb fungicides and start spraying 90 minutes after mixing. Continue the sprays at least until the first-formed fruit are 1/3 their final size. It is best to spray when plants are dry and just before rains are expected.

   Pathotypes of *Xanthomonas* differ in their sensitivity to copper. Bacterial spot control is improved by adding mancozeb to fixed-copper fungicides. The addition of mancozeb increases the amount of copper in solution. For more details on spraying to control bacterial spot and other diseases of pepper and tomato obtain a copy of Midwest Vegetable Production Guide for Commercial Growers.

6. Resistance to bacterial spot in both peppers and tomatoes appears promising and degrees of resistance occur in commercial varieties. Consult current seed catalogs and trade publications for resistant varieties.