VEGETABLE CROPS

CORNELL COOPERATIVE EXTENSION

Bacterial Diseases of Tomato

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Bacterial diseases of tomatoes can be some of the most serious and destructive diseases affecting both field- and greenhouse-grown crops. Under moist field conditions they can cause localized epidemics affecting young developing fruit; in the greenhouse total crop losses can occur. The three bacterial diseases discussed here are bacterial canker, bacterial speck, and bacterial spot. The third disease can also cause serious damage of peppers.

Bacterial Canker

Bacterial canker is caused by *Corynebacterium michiganense* pv. *michiganense*. Although usually sporadic in its occurrence, it is so destructive in nature that vigilance must be exercised in the selection and handling of seed stocks, the preparation and management of greenhouse soil beds or bags, and the selection and preparation of ground for field production. Bacterial canker is a vascular (systemic) and parenchymatal (superficial) disease with a wide array of symptoms resulting in loss of photosynthetic area, wilting and premature death, and the production of unmarketable fruit. Early recognition of the disease, especially in greenhouse crops, is essential if the disease is to be contained. The organism is seedborne and can survive for short periods in soil, greenhouse structures, and equipment and for longer periods in plant debris.

Symptoms

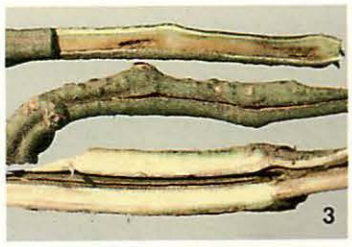
Plants at any stage of growth are susceptible. Infected seedlings may be quickly killed, or they may produce weak, stunted plants, or if conditions are unfavorable for disease development, infected seedlings may develop into apparently healthy plants that fail to show disease symptoms until they are set in the field. In New York the disease may not be observed until after the plants begin to blossom. The early symptoms of the disease are wilting, curling of leaflets, and browning of leaves, often only on one side of the plant. As the leaves die, the petioles remain green and firmly attached to the stem. A cut through the stem shows yellowish brown discoloration of the vascular element.

Symptoms can be divided into two types: *superficial* symptoms resulting from bacterial colonization of the *surface* tissues and *systemic* symptoms resulting from bacterial invasion of the *vascular* tissue. Necrotic leaf lesions (fig. 1) up to 1/4 inch in diameter appear on the upper leaf surface of mature leaves, and in other cases circular, slightly raised white spots about 1/16 inch in diameter appear. Similar spots may also be noted on stems and petioles. Superficial symptoms on fruit may be observed at any age, but are usually seen first on green fruit 1/2-2 inches in diameter. White spots 1/8 inch in diameter develop on the most-exposed parts of the fruit (fig. 2). The spots have a dark brown center, which becomes raised, and are surrounded by a distinct white halo; they have been termed "bird's-eye spots." Sometimes the spots lose the white halo and become necrotic, and may merge with others.

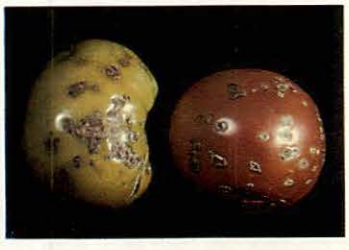
As plants mature, symptoms may be noted on leaves, stems, and inside fruits. Areas of leaves above the second or third truss may show dull green and water-soaked areas, which later appear desiccated and become necrotic. Wilting progresses until the entire leaflet dies. Close examination of stems reveals open cankers, from which the disease receives its name (fig. 3). Splitting of the stem lengthwise reveals reddish brown discoloration. The pith becomes granular to mealy and filled with cavities. Young green fruit cut in half often show discolored vascular bundles in surrounding tissue. Bacteria can occur on the seed coat as well as within the embryo. Seedborne inoculum may serve as one source of the bacterium.

Control

Bacterial canker is one of the most difficult tomato diseases to control. First, there is the problem of detecting infected plants, due to the wide variability of symptom expression. Second, the highly infectious nature of the disease, the number of sources of inoculum, and the absence of effective chemicals for treatment mean that sanitation and preventive measures must be enforced.



We acknowledge photos 5, 6, and 7 provided by A. F. Sherf.

(1) Use only certified, disease-free seed from canker-free plants. Never save seed from a source known to have had bacterial canker. If it is necessary to use noncertified seed or seed of unknown origin, make sure the seed has been extracted by the standard acetic acid extraction method or by the fermentation process. Make sure seed has not been prepared by centrifuge extraction, which can lead to high levels of seed contamination. Although the acid or fermentation treatment will eliminate seed coat contamination, it does not completely control embryonic infection. We do not recommend that growers save their own seed. However, if this is necessary for special reasons, see the section entitled "Tomato Seed Extraction and Treatment."

(2) Plant only certified disease-free transplants that have been produced under a vigorous inspection program. It is usually not possible to distinguish between infected or healthy seedlings at the time of transplanting.

(3) Once the disease is suspected or confirmed in a *greenhouse crop*, aids to pollination and high-volume, high-pressure pesticide spraying should stop. These restrictions will decrease the risk of spread, especially when superficial symptoms are present (fig. 4). Remove diseased plants as soon as they are detected by cutting the plants off at the ground line and placing them in a plastic bag for disposal. At least several "healthy" plants on either side of the infected plants should also be removed. If the area of diseased plants is limited, there is a good chance that the disease can be contained. Every effort must be made to isolate affected areas from the rest of the crop. Hands, shoes, tools, and crop-support wires should be disinfected. Hypochlorite, or laundry bleach, is not satisfactory as a greenhouse disinfectant. Quaternary ammonium compounds as used to disinfect potato storages are recommended. Refer to *Cornell Recommendations for Commercial Vegetable Production* for specifics. In the *field*, if bacterial canker becomes severe early in the season, fields should be plowed down to prevent spread to nearby healthy fields. If affected plants are found throughout the crop, not more than 100 plants per acre should be removed in an attempt to restrict spread. Pulling out more is rarely of benefit.

(4) Greenhouse seedbeds and soils must be sterilized to destroy the bacteria. Steam sterilization is preferred, but †methyl bromide is satisfactory if attention is paid to removing all debris. (Restricted-use pesticides are identified by a dagger, †.) In the field all plant debris must be plowed under, and affected areas should be rotated out of tomatoes for at least 3 years. Weeds belonging to the Solanaceae family should be destroyed.

(5) Fixed copper sprays may help in protecting healthy plants, particularly if only superficial symptoms are present.

Bacterial Speck

Bacterial speck is caused by *Pseudomonas syringae* pv. *tomato*. Although this disease has been known since the early 1930s, it did not result in serious losses until the winter tomato crop of 1977-78 in southern Florida and in 1978 in southern transplant fields and in northern production areas where some infected transplants were shipped inadvertently. Cool, moist environmental conditions contributed to the development of the disease, which has now established itself as a major production problem in northern producing states.

Symptoms

The *foliar* symptoms of speck consist of small (1/8-1/4 in.) black lesions, often with a discrete yellow halo (fig. 5). The lesions of bacterial spot are similar, but tend to have a greasy appearance, whereas those of speck do not. Speck seems to curl the leaves more severely than spot. Both diseases affect *flowers*. Lesions on *stems* and *petioles* cannot be distinguished. Bacterial speck and spot are more clearly differentiated by symptom development on the *fruit*. Bacterial speck lesions are slightly raised, but are generally much smaller (1/16 in.) than those of bacterial spot. Bacterial speck lesions are very superficial and do not crack or become scaly as in bacterial spot. (Compare figs. 5 and 8.)

Epidemiology

A better understanding of the epidemiology of bacterial speck is essential for developing control measures. The question may be asked why this disease, which has been around for many years, has now moved to the forefront of tomato production. Research from different sections of the country offers several explanations. Circumstantial evidence suggests that the recent introduction of the bacterial speck organism into transplant production fields in southern Georgia originated on commercial seed. If seeds are harvested by either the acetic acid extraction method or by the fermentation process, the threat of seedborne inoculum is greatly reduced. It is not known if the seed planted in Georgia was extracted by the more controversial centrifugation method.

A cool (below 70° F or 21° C) and moist (high relative humidity and prolonged period of free moisture) growing season in 1978 contributed to the outbreak of bacterial speck in southern transplants. Although these conditions are exceptional in the south, they represent typical growing conditions in the north, when young transplants are set out in spring. Research has shown that with appropriate temperature and leaf wetness plants harboring a low resident bacterial population can show symptoms within as few as 3-5 days. In most cases in the field, symptoms can be expected in 6-10 days. This is significant in light of the finding that the bacterial speck pathogen can survive shipment and spread disease in the field even though no disease symptoms were present on the plants during shipment or at planting time. Similarly, fruits that develop during cool, moist weather early in the season can be severely infected. Use of scanning electron microscopy has shown that bacteria can be associated with both glandular and nonglandular leaf hairs present on ovaries during anthesis (the period of flower expansion and stamen maturation) (fig. 9). After anthesis the leaf hairs are gradually lost, leaving openings in the young fruit epidermis. These sites may serve as areas for fruit infection. Uninjured fruit are most susceptible to infection from anthesis until the fruit reach 1 1/4 inches in diameter.

Another important factor in the epidemiology of bacterial speck is the survival of the organisms in either soil or host debris and on native weeds. In California the leaves and roots of several weed and crop species maintained resident populations of bacterial speck pathogen. In Michigan survival of the bacterium in buried tomato leaf tissue at various soil depths suggested that overwinter diseased tissue was another source of primary inoculum.

Control

(1) Use disease-free, hot water-treated seed.

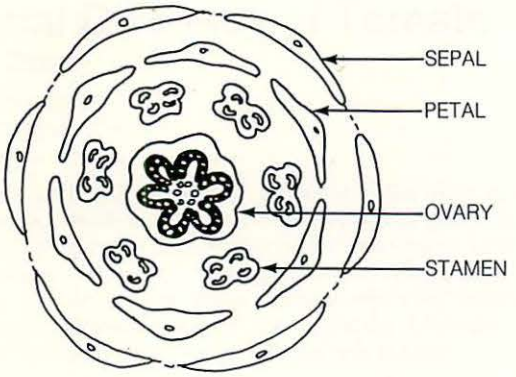
(2) If using southern grown transplants, strive to obtain disease-free transplants that have been produced with a good protective spray program (mancozeb plus fixed copper, with streptomycin as a replacement bactericide for copper in later sprayings if weather conditions favor speck development). *Note: Streptomycin can only be used on tomato plants before transplanting.*

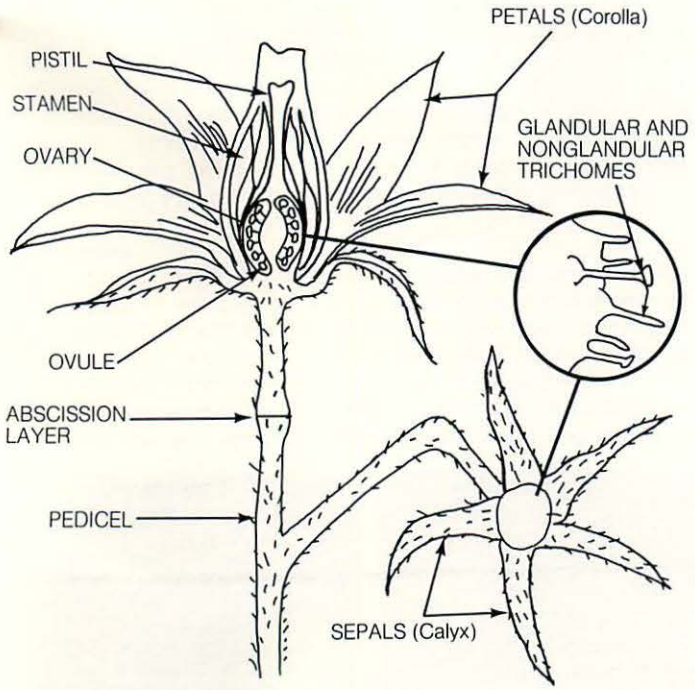
(3) Practice crop rotation because of the carryover of inoculum in plant debris and weeds.

(4) Follow good weed control and sanitation programs before establishing the current season crop.

(5) Practice a preventive copper + mancozeb spray program (see *Cornell Recommendations for Commercial Vegetable Production* for specifics) from anthesis until the first-formed fruit are

Figure 9. Anatomical details of a complete tomato flower and fleshy fruit (berry)





1/3 their final size. After that point, the greatest risk of bacterial speck is passed; copper can be dropped from the program, and the full labeled rate of fungicide should be used to control foliar blights, especially early blight.

(6) Resistance for bacterial speck has been identified in three tomato species and will be added to commercial varieties.

Bacterial Spot

Bacterial spot is caused by *Xanthomonas campestris* pv. *vesicatoria*. It is periodically a severe disease of tomatoes and sweet peppers in New York. Because bacterial spot and speck produce similar symptoms, they are often misdiagnosed.

Symptoms

Infected *leaves* show small, irregular, dark lesions (fig. 6), which can coalesce and cause the leaves to develop a general yellowing. Both spot and speck can occur on *stems* and *petioles* where they are indistinguishable. *Flower* infection with bacterial spot can be quite serious with pedicel (fig. 9) infection causing early blossom drop. The two diseases are most readily distinguished on the basis of *fruit* symptoms. In the case of bacterial spot on green fruit, small water-soaked spots are first noticed (fig. 7). These spots become slightly raised and enlarge up to 1/8 to 1/4 inch in diameter (fig. 8). The center becomes irregular, brown, slightly sunken, with a rough, scabby surface. Although ripe fruit are not susceptible, lesions are very obvious if fruit were infected when green.

Epidemiology

The bacterial spot organism may be carried as a contaminant on tomato seed. This can occur during the seed extraction process. Refer to the section on "Tomato Seed Extraction and Treatment" for more details. Entry of bacteria into plants occurs through natural plant openings (stomata and hydathodes) or through wounds created by windblown soil, insects, or cultural practices. Water soaking of the leaves, as caused by high-pressure sprays, greatly enhances bacterial spot infection. Moist weather and splashing rains are favorable for dissemination of bacteria. Bacterial spot may be present on tomato transplants produced in southern states, especially when frequent rains occur in these areas before plants are pulled. Once bacterial spot is introduced into the field, it can be difficult to control. The bacterial spot pathogen can also persist on infected plant debris in the soil for at least 1 year.

Control

(1) Use disease-free seed that has been produced in western states or seed that has been hot water treated.

(2) Purchase only certified disease-free transplants.

(3) Rotate your tomato and pepper crops with nonhost crops.

(4) Spray plants with streptomycin before transplanting. After transplanting, apply a mixture of mancozeb plus copper before the occurrence of disease. Protection is most needed during early flowering and fruit setting periods.

Tomato Seed Extraction and Treatment

As was mentioned previously, we do not recommend that growers save their own tomato seeds. With more varieties available as hybrids rather than standard types, the desire to save seed is diminishing. Still, there may be exceptional cases where a grower may wish to maintain a standard specialized variety. Tomatoes (and peppers) are self-pollinated crops. The amount of outcrossing in tomato with neighboring plants is quite low, usually a fraction of 1 percent. (For pepper, natural outcrossing is greater because of wind and insect pollinations; therefore, greater isolation by distance

or use of natural barriers is required.) The main reason why seeds need to be properly extracted and treated is the potential contamination of bacterial canker, speck, and spot and tobacco mosaic virus (TMV).

Tomato Seed Extraction

The two methods of tomato seed extraction available are the fermentation process and acid extraction. For seed extraction by the fermentation process, thoroughly crush mature, disease-free fruit. Process the fruit with a tomato juicer and recombine *all* the juice, seed, and pulp into a suitable container (glass, plastic, or crockery) for fermenting. Fill the container half full and never add water as a substitute for tomato juice. Allow the fermenting process to continue at a temperature not over 70° F (21° C) for 96 hours. Stir the fermenting juices at least twice daily to submerge the pomace, which usually floats to the top. Separate the seeds from the pulp by repeatedly filling the container with water, stirring, and pouring off the water with flesh and skin fragments. Flush the seeds several times with jets of water to remove the fruit jelly that adheres to the seed. Spread the seed out on paper and allow them to dry for several days. The seed should then be treated with a fungicide seed-protectant (see *Cornell Recommends*).

Clean seed extracted by mechanical means without fermentation should be acid treated. Immediately treat the wet seeds with an 0.8% solution of acetic acid (1 oz. of 99% acid in enough water to make 1 gal) for 24 hours at or below 70° F (21° C). Use USP-grade acid, free from impurities. The seed can be treated loose or confined in a cheesecloth bag for easier handling. Make sure to stir the solution at intervals to ensure wetting all seeds and do not treat over a pound of seed in a gallon of acetic acid solution. Immediately after treatment, dry the seeds and treat with a seed protectant.

Although the fermentation process and acetic acid treatment result in some reduction in germination, this is usually negligible.

Hot Water Treatment

A hot water soak for vegetable seeds, including tomato, has long been recommended. Soak seeds at 122° F (50° C) for 25 minutes in a water bath with agitation to maintain uniform heat. A dairy or laboratory thermometer is recommended for accurate readings. Following treatment, plunge the hot seeds into cold water, thoroughly dry on newspaper, and then dust with a protective fungicide. Freshly harvested seeds withstand the heat treatment better than do one- or two-year-old seed, and treatment should be made as soon after harvest as possible. Hot water treatment will control seedborne bacteria, but will not eradicate TMV. Similarly, it will have no effect on bacteria borne in the embryo (bacterial canker) or TMV contained within the endosperm.

Other Treatments for Virus

No additional information is available for controlling internally borne bacteria for bacterial canker. Several other treatments are available for removal of seedborne TMV: soak seeds for 30 minutes in a 10% solution of household bleach (0.525% sodium hypochlorite, NaOCl); soak for 15 minutes in a 10% solution of trisodium phosphate (Na_3PO_4), often used to soften dried paint brushes; soak for 6 hours in 5% hydrochloric acid (HCl). A more-drastic treatment of using dry heat at 158° F (70° C) for a period of 4 days will inactivate internal virus, but even this treatment is not successful if the virus is in the seed endosperm. For this last treatment, seeds should not be treated within 3 months of harvesting, or germination will be affected.

Quantity discount available.
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