

## Bacterial Spot of Tomato and Pepper<sup>1</sup>

Xiaoan Sun<sup>2</sup>, Misty C. Nielsen<sup>2</sup> and John W. Miller<sup>3</sup>

**INTRODUCTION:** Bacterial spot, caused by a group of xanthomonads (*Xanthomonas* spp.), is a serious disease on tomato and pepper worldwide. It can be destructive to tomato and pepper seedlings and can result in total crop loss in warm and humid areas due to persistence of the causal bacterium and weather conditions favorable to the disease. Repeated chemical application for control of the disease is very costly. Severe damage on enlarging fruit makes them unmarketable due to poor quality (Kucharek 2000; Pohronezny and Volin 1979; Ritchie 2000). Four distinct phenotypic groups of pathogenic bacteria (A, B, C and D) have been determined to cause the disease (Jones and Stall 1998; Jones *et al.* 2000), of which three genomic species are proposed: *Xanthomonas vesicatoria* (ex Doidge 1920) Vauterin, Hoste, Kersters & Swings 1995 (B group); *X. axonopodis* pv. *vesicatoria* (ex Doidge 1920) Vauterin, Hoste, Kersters & Swings 1995 (A and C group); and 'X. *gardneri*' (D group). Although each group has its own geographic distribution around the world, they cause nearly identical symptoms on host plants. Bacterial spot is of great concern to transplant growers because many states that receive tomato seedlings from Florida require these transplants to be free of the disease.

**SYMPTOMS:** Symptoms can be found on all aboveground parts of tomato and pepper plants. Initially, spots appear as small, water-soaked, light to dark green areas on the young infected leaves (Figs. 1-2). On tomato, individual lesions on leaves develop rapidly to a size of about 0.2 cm (0.1 in.) in diameter and appear to be black and greasy. Lesions on pepper may enlarge rapidly to a size of 0.25 to 0.5 cm (0.1-0.2 in.) in diameter and become tan and brownish-red. Lesions on both hosts are with or without a yellowish halo and generally irregular, while leaf spots caused by phytopathogenic fungi or chemical injuries are usually round. When leaf spots are numerous, surrounding tissue often turns brown and the whole leaf will die. Under very wet weather conditions, spots may grow together, producing large black necrotic areas on the leaf. Lesions on stems and petioles are slightly more elongated than leaf spots (Fig. 1). On peppers, defoliation occurs more commonly on heavily infected leaves, while infected tomato leaves remain on the plant and the whole diseased plant appears to be scorched.

Fruit spots first appear as small pale green raised areas surrounded by water-soaked borders, which eventually become brownish, slightly larger in diameter (0.32 cm [0.125 in.]), raised and scabby (Fig. 3). Although spots remain small and do not penetrate very deeply into fruit, large numbers of these spots will lower the quality of the fruit. Various secondary fungi and other bacteria may colonize collapsed lesions and cause fruit rot. On peppers, lesions may form on fruit, including the pedicel, but the major crop loss results from shedding of blossoms and immature fruit. Fruit that remain on the diseased plants are usually non-marketable because of poor quality, misshapen appearance and blemishes caused by the infection and sunscald that result from defoliation.

Tomato bacterial speck, caused by *Pseudomonas syringae* pv. *tomato* (Okabe 1933) Young, Dye & Wilkie 1978, has symptoms similar to those of bacterial spot on tomato. However, symptoms produced by the two causal bacteria are slightly different and therefore can be distinguished by a seasoned plant pathologist in the field, although a more accurate determination should be made in a diagnostic laboratory.

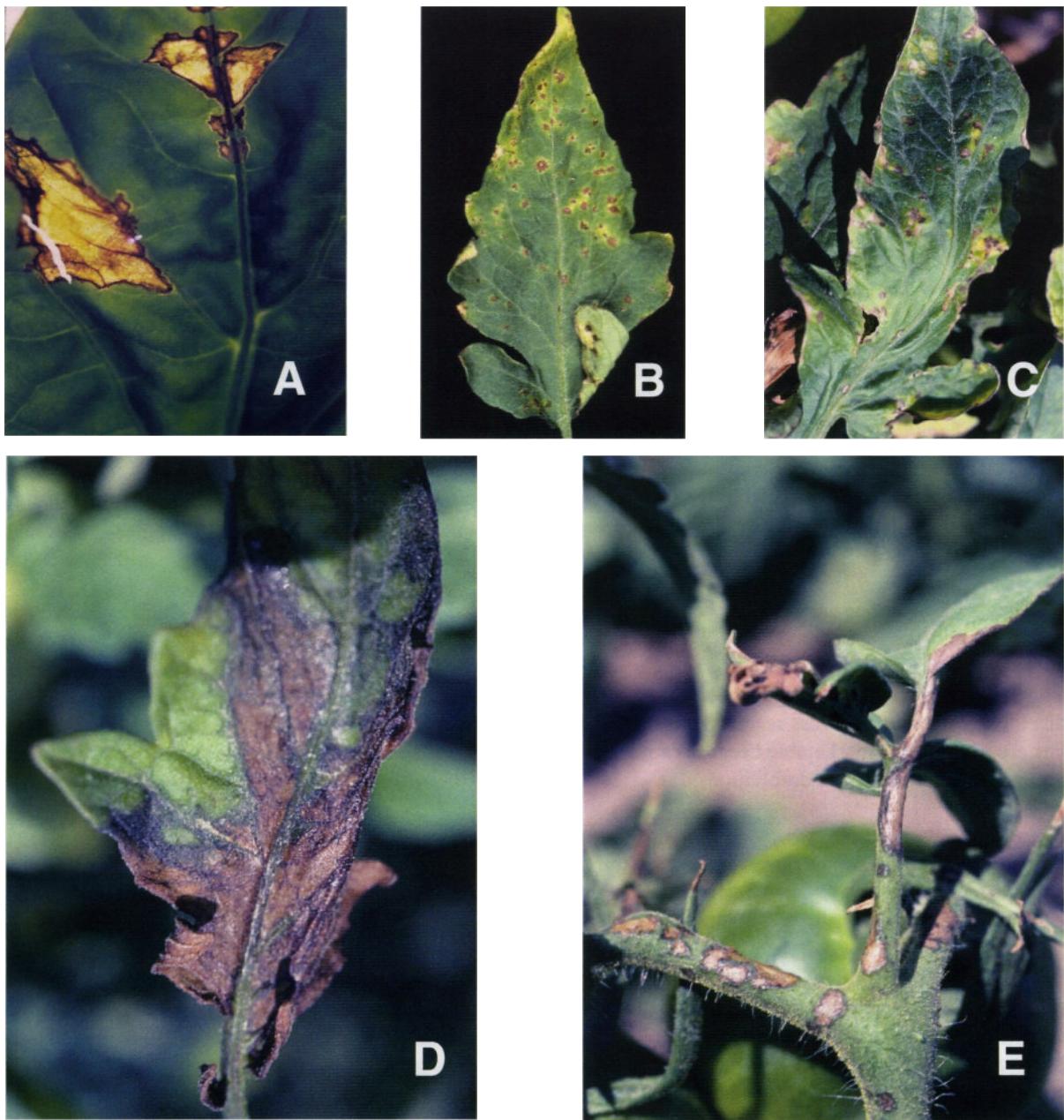
**DISEASE DEVELOPMENT:** The bacterial spot pathogen (Pohronezny and Volin 1979) may be carried as a contaminant on tomato and pepper seed. It is also capable of overwintering on plant debris in the soil and on volunteer host plants in abandoned fields. Because the bacteria have a limited survival period of days to weeks in the soil, contaminated seed is a common source of primary infection in nursery and home gardens. In commercial fields, volunteer host plants are the main source of initial inoculum because the bacterial pathogen survives in lesions on those plants.

The bacterium becomes active when the temperature reaches above 75°F. Moist weather and splattering rain are essential for dissemination of the bacteria. Transplant production environments are favorable for the bacterium because overhead sprinklers are commonly used. The wet and crowded plants are at high risk of infection.

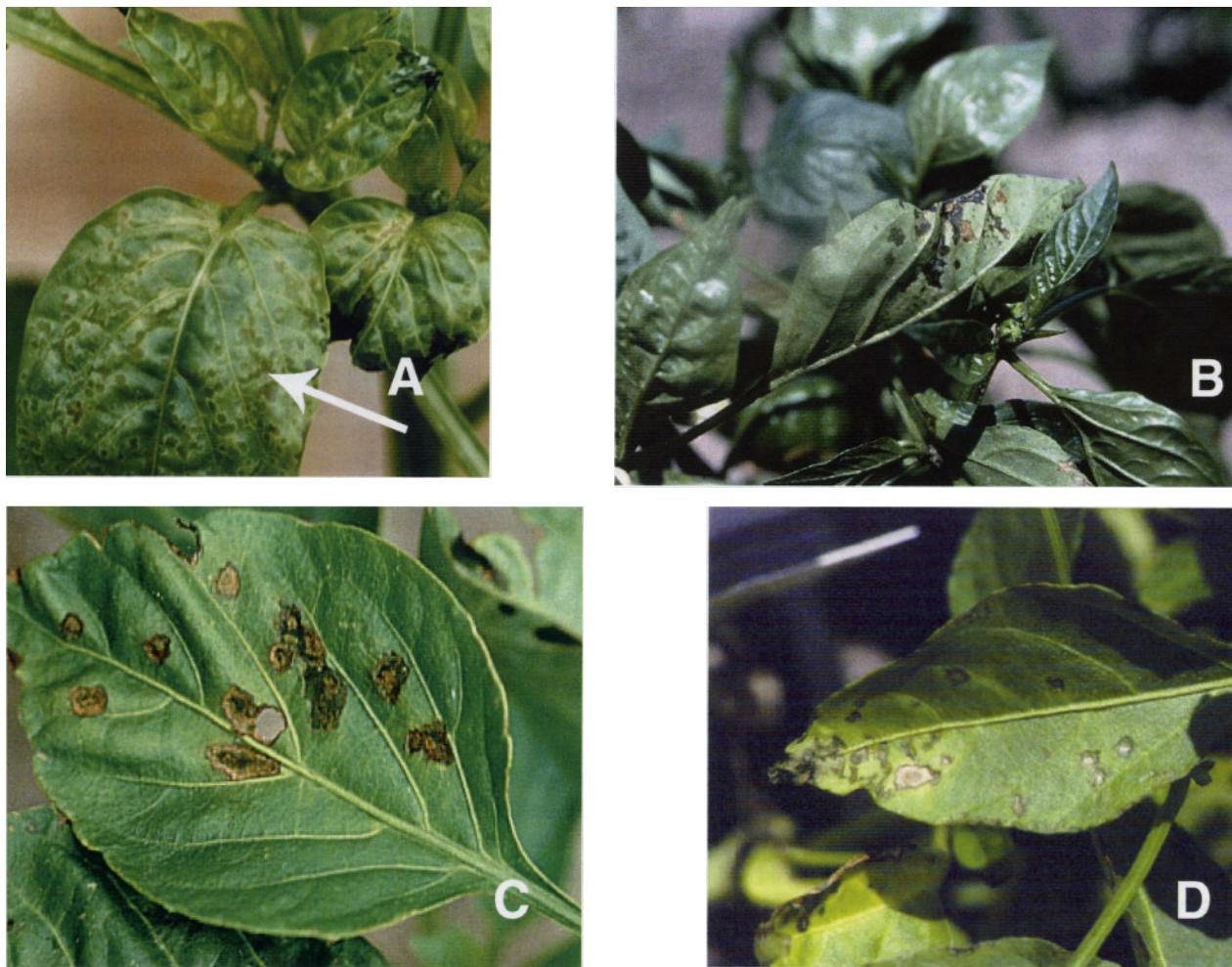
1 Contribution No. 733, Bureau of Entomology, Nematology and Plant Pathology - Plant Pathology Section.

2 Plant Pathologist and 3 Plant Pathologist (emeritus), FDACS, Division of Plant Industry, P. O. Box 147100, Gainesville, Florida 32614-7100.

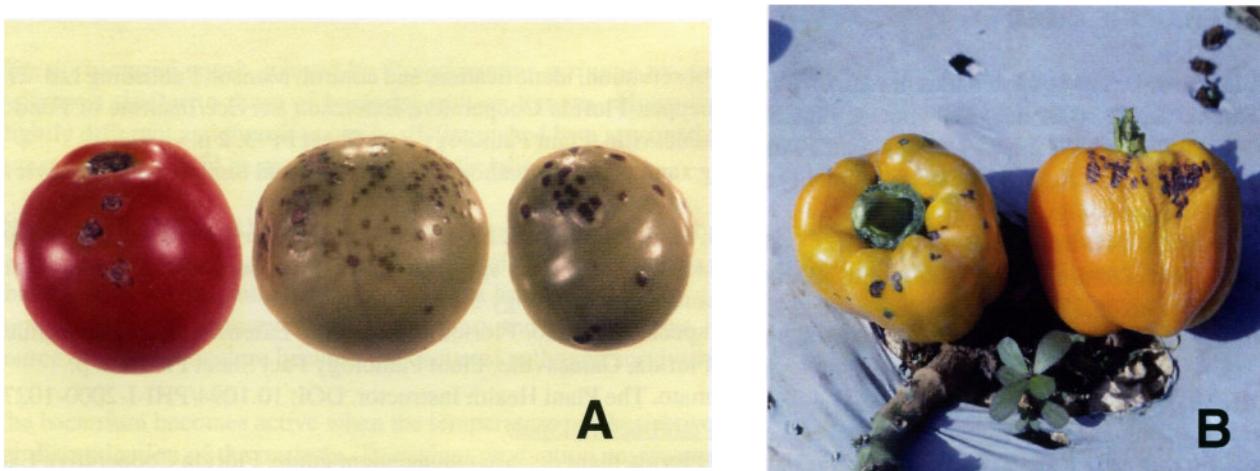
Bacteria enter through stomata on the leaf surfaces and through wounds on the leaves and fruit caused by abrasion from sand particles and/or wind. Prolonged periods of high relative humidity favor infection and disease development. In a 24-hr period, the bacteria can multiply rapidly and produce millions of cells. Symptom development is delayed when relative humidity remains low for several days after infection. Although bacterial spot is a disease of warm, humid regions, it can develop in arid but well irrigated regions. Bacteria may be spread in water droplets when high-pressure sprayers are used. Use of surfactants in sprays aid ingress of the bacterium into leaves.



**Fig. 1.** Leaf symptoms on tomato. A: necrotic and collapsed lesions; B: smaller necrotic spots surrounded by a yellowish halo; C: enlarged spots with obvious necrotic tissue that may fall out in the center of the lesion; D: merged small lesions forming a large lesion; E: elongated lesions formed on stems  
(Photography credit: Division of Plant Industry)



**Fig. 2.** Leaf symptoms on pepper. A: water-soaked young lesions; B: enlarged lesions with water-soaked appearance; C: necrotic tissues falling off from the center of the spots; D: merged lesions (Photography credit: D. Ritchie, North Carolina State University, used with permission).



**Fig. 3.** Fruit symptoms. A : on tomato; B: on pepper (Fig. 3A Photography credit: D. Ritchie, North Carolina State University, used with permission; Fig. 3B Photography credit: Dr. Thomas Kucharek, University of Florida, used with permission).

**HOST RANGE:** The bacteria infect all varieties of tomato and pepper. Although the causal bacteria have been isolated from various nightshades and other plants (Jones and Stall 1998), they cause no natural infections on those plants, but a hypersensitive reaction when those plants are artificially inoculated.

**DISEASE MANAGEMENT:** A successful bacterial spot management program follows general bacterial disease management guidelines. Start with pathogen-free soil and seeds. Transmission of the pathogen through contaminated seeds is very limited in commercial field, but very likely in backyard gardens because lower quality seed enters the retail seed packet trade. The causal bacteria have been detected very often in the seeds sold in retail stores and garden centers. Fields severely infested by the disease for the last several years should not be used for seedbeds or to grow tomatoes or peppers. Previously contaminated soil, flats, frames and tools should be disinfested. Permanent seedbeds should be treated with steam to kill the pathogen. Use disease-free transplants to eliminate initial inoculum in the commercial field. Volunteer host plants should be eradicated since they serve as a major inoculum source. Use herbicide during off-season to remove weeds and the small and usually unnoticeable volunteer host plants. Rotation of tomato and pepper with other crops is strongly recommended at least for three years once the disease is found. Avoid overhead irrigation and do not work around or on the plants in wet weather.

Seeds can be disinfested with a 0.6-percent sulfuric or hydrochloric acid solution (3/4 ounce acid per gallon of water). Place 1 pound of seeds in a cloth bag and immerse in 1 gallon of acid solution for 24 hours. Keep the solution agitated and at a temperature of 75°F.

No currently available bactericides are curative to bacterial cells when they reside and multiply inside the plant. Initial or subsequent infections may be prevented through chemical control. During the growing season, a series of copper-based chemicals are commercially available and commonly used to reduce disease incidence. Antibiotics such as streptomycin are used in seedbeds only. On pepper, spraying at interval of 7-10 days begins when two true leaves emerge till seedlings are pulled. On tomato, the applications start with the first true leaf. During the growing season, sprays of a mixture of 4 lbs basic copper plus 1 ½ lbs Maneb®, Dithane M-45®, or Manzate 200® in 100 gal water may be used to suppress the disease (Simone and Mullin 2000). If the disease is prevalent during periods of rainy weather, sprays should begin 4-5 days after emergence and continue on a 5-to-7 day schedule, but it is impractical to use chemicals when wind-driven rains are prevalent. All directions, precautions and restrictions that are listed on the chemical label should always be followed. Severely infected plant parts in the backyard gardens can be pulled up and burned prior to chemical application to reduce bacterial population size.

**SURVEY AND DETECTION:** Bacterial spot can infect all parts of the tomato and pepper plant above ground. Scattered spots with halos on foliage of the young seedlings are the first sign of infections. Pay attention to the scorched appearance of crops in the field and on individual plants: look for twisted, necrotic and irregular spots. Defoliation may occur on pepper, but rarely on tomato. Loss of blossoms on both tomato and pepper may be noticed. The causal bacterium can infect tomato and pepper plants at any stage of growth and development.

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