ALABAMA A&M AND AUBURN UNIVERSITIES

ALABAMA COOPERATIVE Extension SYSTEM

Wilt Diseases of Tomatoes

ANR-0797

Wilt diseases of tomatoes can be caused by fungal, bacterial, viral, and nematode pathogens, as well as by abiotic factors. Determining which agent is responsible can be vital for prescribing the proper management strategies. This publication discusses the common wilt diseases afflicting tomatoes in Alabama and the organisms and conditions that are responsible for their development. The publication describes the external and internal symptoms produced on the host by each pathogen; provides information on the disease life cycle and environmental conditions that favor disease development; and also provides diagnostic techniques that can be used to make in-the-field diagnosis of each disease described.

Fusarium Wilt

Fusarium wilt, caused by the soil-borne fungus *Fusarium oxysporum,* initially causes a yellowing and wilting of lower leaves on infected plants. Symptoms can be seen on a single branch, or on several branches on one side of the plant, or on all the lower branches. The yellowing and wilting progress up the plant as the fungus spreads within its host (figure 1). Yellowed, wilted leaves often dry up and drop prematurely. Eventually the entire plant wilts and dies early, producing few, if any, fruit.

Plants infected with Fusarium wilt will have a brown discoloration of the vascular system, which can be used as an aid in diagnosis. When the epidermis and cortical tissue (bark) on a section of the main stem, slightly above the soil line, is cut and pealed back, a distinct brown discoloration of the vascular tissue is evident (figure 2). The discoloration can extend from the roots up the stem through the branches and into the petioles of the plant.

Figure 1. Plant infested with Fusarium wilt.

Figure 2. Vascular discoloration of Fusarium wilt.

Fusarium usually enters its host through feeder roots and subsequently multiplies and colonizes the food and water conducting vessels of the plant. The disease is most severe when air and soil temperatures are between 78 degrees and 90 degrees F and is more likely to occur in poorly drained soil. Infection may occur at any time during the life of the plant. The fungus can persist in most soils indefinitely, because of its ability to colonize the roots of a number of weeds and its ability to produce resistant spore structures. At least three physiological races of the fungus have been reported; races 1 and 2 are known to occur in Alabama.

Control of Fusarium wilt begins by planting only certified, disease-free seed and transplants in fertile, well-drained soil. In infested soil, grow only tomato varieties that are highly resistant to the fungus. Infested soil can be disinfected with a suitable soil fumigant or through soil solarization (see Extension publications ANR-0030, "Nematode Control in the Home Garden"; ANR-0500, *Alabama Pest Management Handbook*; and ANR-0713, "Soil Solarization for the Control of Nematodes and Soil-borne Diseases"). Crop rotation (growing tomatoes in the same area no more than once every 4 years) will reduce the disease inoculum level in the soil.

Verticillium Wilt

Symptoms of Verticillium wilt, caused by the soilborne fungus Verticillium albo-atrum, may be confused with those of Fusarium wilt. The two fungal wilts cause similar field symptoms and cannot be distinguished except by growing the fungus in the laboratory. Verticillium, unlike Fusarium, also attacks brambles, eggplant, okra, pepper, potato, strawberries, and 300 or more other herbaceous and woody plants. The Verticillium fungus thrives best in cool, moist soil (60 degrees to 75 degrees F) and therefore is not as common as Fusarium in Alabama. Control measures for Verticillium wilt are the same as those for Fusarium wilt.

Southern Blight

Southern blight, also known as white mold and stem rot, is caused by the soil-borne fungus *Sclerotium rolfsii*. The disease is a common problem on vegetables, especially tomatoes, as well as most other broadleaf crops such as peanut and soybean. Plants of any age can be attacked if environmental conditions are suitable. Development of southern blight is favored by moist conditions and high temperatures (more than 85 degrees F).

Generally, the first above-ground symptoms are leaf yellowing and wilting of infected plants. The stem at the soil line often appears soft and sunken (cankered) and develops a brown to black discoloration both internally and externally. Under moist conditions, a white fungal growth can be seen

Figure 3. White fungal growth of southern blight.

Figure 4. Spherical sclerotia of southern blight.

on the lower stem near the soil surface (Figure 3); on fruit in contact with the soil; and on crop debris on the soil around the base of the plant. Spherical, light brown, mustard-seed size (1 to 2 mm) sclerotia often form in the mycelium (figure 4). Under dry conditions, fungal mycelium and sclerotia may not be visible. How ever, if southern blight is suspected, placing a section of the lower stem and a moistened paper towel in an enclosed plastic bag for 24 hours will stimulate formation of a white mat of fungal growth. This would be diagnostic for southern blight.

The fungus is spread as mycelium in infested organic matter or as sclerotia in infested soil. Infection usually takes place at the soil surface but may also occur below the soil line. The fungus may spread more than 3 feet through the soil and from plant to plant within a row. It is common to see five or six infected plants within a row killed. Sclerotia, produced on crop debris and dying plants, serve as inoculum for the next crop.

Control of southern blight is difficult to achieve when inoculum levels are high and environmental conditions favor its development. Rotations with crops such as corn, grain sorghum, and cotton will reduce disease. Rotations are most effective when tomatoes

Figure 5. Pith discoloration of bacterial wilt.

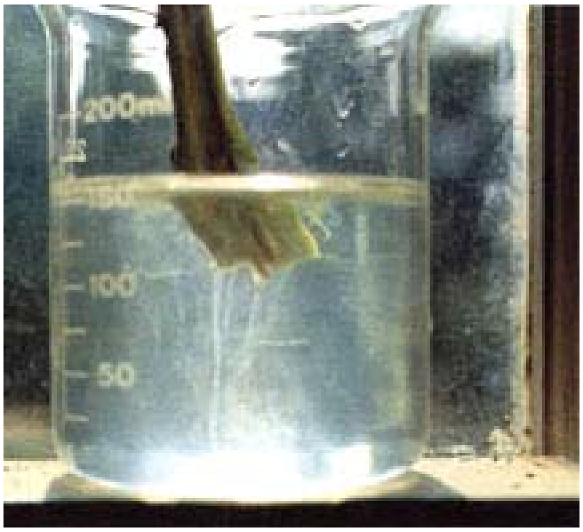

Figure 6. White, milky ooze of bacterial wilt.

or other susceptible crops are not planted in the same area more than once every 3 to 4 years.

Deep-plowing the soil to bury crop debris and the fungus will also help reduce inoculum. Wider plant spacing to improve air movement and roguing infected plants will aid in reducing disease development and spread within a field. Soil fumigation is effective in controlling southern blight but will not eradicate the pathogen from an infested field. The fungicide Terraclor can be used at transplanting, but its effectiveness is limited (see Extension publication ANR-0500, *Alabama Pest Management Handbook*).

Bacterial Wilt

Bacterial wilt is caused by the soil-borne bacterium *Pseuclomonas solanacearum*. A characteristic of this disease, which sets it apart from other wilt diseases, is that plants wilt and die rapidly without the presence of yellowing or spotting of the foliage. The disease can occur in newly cleared land as well as in areas where susceptible crops have not been grown previously. The bacterium often enters a field on infested transplants, equipment, or through drainage water. The pathogen can overwinter in soil.

Bacteria infect plants through the roots or stem, most often where tissue has been injured by cultivating, or by some other physical means such as nematodes. Bacteria invade the vascular tissue, apparently causing wilt by a gradual blocking of the water conducting vessels. The disease is most commonly found in low, wet areas of fields and is most active at temperatures above 75 degrees F.

To identify bacterial wilt, cut and peal back a section of the epidermis and cortical tissue (bark) just above the soil line. The center of the stem (pith) will, in early stages, appear water soaked; later, the pith will turn brown and sometimes become hollow (Figure 5). The discoloration of the pith distinguishes this disease from Fusarium and Verticillium wilt. Another relatively easy diagnostic technique is to cut a portion of the affected stem and place in it a clear glass container filled with water. The appearance of a white, milky ooze streaming out of the cut end of the discolored vascular tissue is diagnostic for this disease (figure 6).

Bacterial wilt attacks members of the Solanaceous plant family, which includes peppers, potatoes, and eggplant, making crop rotation an effective method of control. Growing susceptible crops in the same area no more than once every 4 years will reduce inoculum in the soil. Soil fumigation should be considered in heavily infested fields. Roguing of wilted plants and the soil surrounding their roots can reduce spread of the disease and may be a viable control alternative in home garden situations. Soil solarization is another alternative for control of bacterial wilt (see Extension publication ANR-0713, "Soil Solarization for the Control of Nematodes and Soil-borne Diseases").

Bacterial Canker

Bacterial canker, caused by *Clavibacter michiganensis* subs. *michiganensis*, is a recurrent and serious problem on tomatoes. Bacteria survive from season to season in infested crop debris, on wooden stakes and other equipment, as well as in other Solanaceous hosts such as black and perennial nightshade and ground cherry. The fungus is commonly introduced into a field on infected transplants or seed. Its spread within the field occurs through wounds during irrigation or by splashing rain.

Weeks may pass between the time of infection and the development of symptoms. Vascular infections cause wilting, chlorosis, and eventual death of the plant. If the stem is cut open longitudinally, a yellow to reddish-brown discoloration may be observed in the vascular tissue. In later stages, canker

Figure 7. Bacterial canker lesions on stem.

Figure 8. Bird's eye spot of bacterial canker.

lesions may develop on the stem, petioles, and underside of the foliage (figure 7). Superficial foliar infections cause necrosis of the foliage, usually from the leaf margins inward, which can advance until the entire leaf and petiole dies. Early infection of the fruit can result in development of "bird's-eye" spots, which are characteristically white, necrotic lesions about inch in diameter that soon develop dark centers surrounded by a white halo (figure 8).

A control program for bacterial canker requires the planting of certified disease-free material in fields that have not grown tomatoes for at least 2 years, preferably longer, or that have been fumigated. Roguing infected plants immediately after detection will reduce the amount of disease inoculum in the field. Spraying a combination of copper and mancozeb at the first sign of disease and continuing at 7- to 10-day intervals can reduce disease spread (see Extension publication ANR-0500, *Alabama Pest Management Handbook*). Avoid field work when the plants are wet. Also, working areas that are known to be infested last will cut down on spread of the pathogen. Disinfecting equipment (stakes, posts, wire) in a 10 percent bleach solution prior to storage, especially if canker has been a problem, and burying plant debris and controlling Solanaceous weeds will reduce the overwintering potential of the disease.

Tomato Pith Necrosis

Figure 9. Hollowed, chambered pith of pith necrosis.

Tomato pith necrosis, caused by the soil-borne bacterium *Pseudomonas corrugata*, is a disease sometimes confused with bacterial canker. The bacterium is considered a weak pathogen on tomatoes growing too rapidly. Affected plants are randomly scattered in the field. Initial symptoms include yellowing of young leaves, which may progress into yellowing and wilting of the top part of the plant. Black streaking may be apparent on the main stem, which often splits. When the stem is cut open longitudinally the center of the stem (pith) will be hollow and often has a chambered (ladder-like) appearance (Figure 9). Profuse development of adventitious roots can be associated with the affected pith areas and the stem may appear swollen. Plants affected with pith necrosis do not exhibit the marginal necrosis of leaflets nor the bird's-eye spotting of the fruit characteristic of bacterial canker. Plants may die if the lower stem is affected, however, the disease usually does not progress, and plants will outgrow the condition.

High nitrogen fertilization, cool night temperatures, high relative humidity, and plastic mulches all increase incidence and severity of pith necrosis. The disease frequently occurs when the first fruit set is close to mature green. Control requires avoiding excessive nitrogen rates.

Tomato Spotted Wilt Virus (TSWV)

Tomato spotted wilt is caused by a virus that is usually spread by thrips. Tomato plants infected with spotted wilt become stunted and often die. Initially, leaves in the terminal part of the plant stop growing, become distorted, and turn pale green. In young leaves, veins thicken and turn purple, causing the

Figure 10. Bronzed, purpled leaves of tomato spotted

Figure 11. Tomato spotted wilt-infected fruit.

leaves to appear bronze (Figure 10). Necrotic spots, or ring spots, are frequently present on infected leaves and stems often have purplish-brown streaks. Fruit, infected with the virus, may exhibit numerous ringspots and blotches and may become distorted if infected when immature (figure 11).

Currently, there is no effective way to control tomato spotted wilt. Control of TSWV-infected weeds adjacent to the field, where the virus can overwinter, should reduce the source of infection. Applying systemic insecticides to the soil at planting can slow the initial spread of the virus into the field. Applying foliar insecticides later in the season will help reduce the build-up of thrips within the field. Spraying weeds bordering the field with insecticides along with the tomato field will also suppress the thrips population and the spread of the virus. Roguing out infected plants as soon as symptoms appear will also reduce spread of the disease.

Figure 12. Root galls of root-knot nematodes.

Root-Knot Nematodes

Root-knot nematode, *Meloidogyne* spp., can attack tomatoes as well as more than 2,000 other species of plants. Nearly forty species have been described and physiological races exist among many of them. When root-knot nematode populations are high, tomato plants often are stunted and yellowish (nitrogen deficiency symptoms) and may wilt during dry weather or during the hottest part of the day. Detecting root-knot nematodes in the field is easily done by examining the roots of symptomatic plants. The nematode causes knots or galls to develop on both large and small roots; knots range in size from the head of a pin to an inch in diameter (Figure 12).

Root-knot nematodes have a wide host range that includes many cultivated crops as well as many weed species. The nematodes survive in the soil from year to year and become active as soil temperatures increase in the spring. The most effective control of root-knot nematodes is through the use of resistant varieties. Also rotations with grasses and clean fallowing during the off-season will reduce nematode populations. Soil fumigation is an effective means of reducing damaging population levels temporarily (one growing season). Soil solarization has been shown to be effective in reducing nematode populations when environmental conditions are favorable for its use (see Extension publications ANR-0030, “Nematode Control in the Home Garden”; ANR-0500, *Alabama Pest Management Handbook*; and ANR-0713, “Soil Solarization for the Control of Nematodes and Soilborne Diseases”).

Leaf Roll

Leaf roll of tomatoes is caused by unfavorable environmental factors. High temperatures, prolonged periods of wet soil conditions, and drought may promote symptom development. Leaf roll is characterized by the upward curling of leaflets on older leaves. At first, leaflets appear to be cupped; this may progress until the margins of the leaflets touch or even overlap each other. Rolled leaves may feel firm and leathery. Symptoms may affect up to 75 percent of the foliage, although plant growth and fruit production are not altered significantly. Symptoms are most common when plants have a heavy fruit set.

Controlling leaf roll is not a major concern since damage is minimal. Setting plants on well-drained soil and irrigating during periods of drought will help prevent the appearance of leaf roll. Leaf roll has been associated with varieties having a specific gene that favors this condition. Tobacco Mosaic Virus (TMV) can promote leaf roll symptoms on varieties containing this genetic makeup.

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Use pesticides **only** according to the directions on the label. Follow all directions, precautions, and restrictions that are listed. Do not use pesticides on plants that are not listed on the label.

The pesticide rates in this publication are recommended **only** if they are registered with the Environmental Protection Agency and the Alabama Department of Agriculture and Industries. If a registration is changed or cancelled, the rate listed here is no longer recommended. Before you apply any pesticide, check with your county Extension agent for the latest information.

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