PP200

UF UNIVERSITY of FLORIDA
IFAS Extension

A Series on Diseases in the Florida Vegetable Garden: TOMATO [1]

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Many Floridians delight in maintaining a vegetable garden in their backyard. Others keep several pots of popular vegetables on patios or similar residential sites. Our long growing season and generally mild climate are ideal for the gardening enthusiast. Whats more, the health benefits of moderate gardening activity are well documented, and the supply of wholesome garden-fresh vegetables adds to our quality of life in the Sunshine State.

Sometimes pest problems interfere with our gardening pursuits. Some problems, such as weeds and certain insects, are relatively easy to identify as causing damage. However, another group of maladies, plant diseases, can cause serious damage and are underappreciated and not as well understood by many homeowners.

The majority of plant health problems categorized as plant diseases are caused by microorganisms. As the name implies, these are extremely tiny disease-causing agents that ordinarily require a microscope to be seen. The very minute size of these disease-causing pathogens accounts for the mystery that often surrounds their presence and impact in the garden.

The pathogenic microorganisms that attack garden vegetables, including tomato, can be classified into three major groups: fungi, bacteria, and viruses.

Fungi are seen (100-400x magnification) as threads (hyphae) that absorb food and water from their host (Fig. 1). Many of these fungi reproduce by forming thousands and thousands of spores that are readily blown about by even light winds. These spores can alight on your tomato plants and eventually cause disease. Some fungi have the capacity to survive very long periods of time (10 or more years) in soil in the absence of a host. Once tomatoes are planted in infested soil, these "resting" fungal structures can become viable again and attack plant roots, causing disease. The majority of tomato diseases you are likely to find in your home garden are caused by fungi.

Bacteria are even smaller than fungi (you need a 1000x magnification with a special light microscope to see them) (Fig. 2). They consist of only one cell and do not form the airborne spores that fungi do. Rather than being blown by the wind, bacteria are usually spread by splashing water, as in rainstorms or

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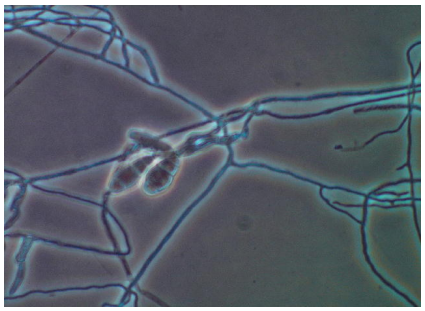

Figure 1. Microscopic threads (hyphae) and spores of a typical plant-pathogenic fungus.

overhead sprinkler irrigation. They can also be spread by gardeners who touch diseased plants and healthy plants in succession without thoroughly washing their hands in-between.

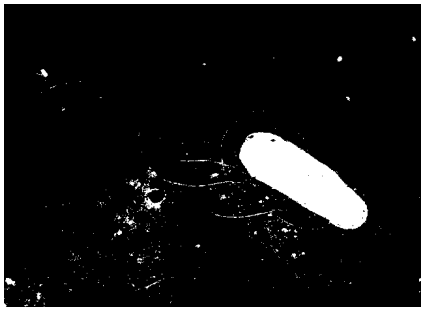

Figure 2. A bacterial cell. Credits: Photo courtesy of J. B. Jones

Viruses are most strange indeed (Fig. 3). They are not "organisms" in the sense of the fungi and bacteria. They are very large molecular structures consisting of a nucleic acid (DNA or RNA) wrapped in a protective coating of protein. Once inside tomato cells, they take over the host cellular machinery and use it to produce more viruses. Most of the important tomato viruses are transmitted to garden plants by insects such as aphids, whiteflies, or thrips.

Figure 3. Typical rod shaped virus as seen through a powerful electron microscope. Credits: Photo courtesy of Scott Adkins, USDA

The following diseases are a few of the ones, in our experience, that are most likely to appear on your garden tomatoes. This is not by any means an exhaustive list of tomato diseases, but the ones we feel occur most often in Florida home gardens. If you have a problem that you think might be a disease not covered in this publication, search the EDIS database or that of the Department of Plant Pathology web site of IFAS University of Florida for information on additional tomato diseases. Legal uses and effectiveness of plant disease control chemicals change with time. You are strongly advised to consult you local UF IFAS Cooperative Extension office for current disease management recommendations.

Bacterial spot

One of the most common diseases of tomato in Florida is bacterial spot, a disease caused by the bacterium *Xanthomonas campestris* pv. *vesicatoria*. It is especially common in warm, rainy weather. All plant parts are affected, but you are most likely to notice the spots (lesions) on the leaves. Dark brown leaf spots (lesions) appear as small (1/8 in. or so) wet-to-greasy areas on both upper and lower leaf surfaces (Fig. 4). There may or may not be yellow halos around these spots. These lesions may run together to form rather large, blighted areas on leaves. It is not unusual for affected leaves to drop off plants prematurely.

Figure 4. Typical bacterial spot symptoms on tomato leaves.

Fruit lesions occur less frequently than leaf lesions but are quite distinct. Fruit lesions often start as small brown-to-black spots with a light-colored halo. With time, the halos disappear and the fruit spots become larger, raised, and scabby appearing (Fig. 5). Infected fruit are unappealing, and many

home gardeners choose not to bring such fruit into the kitchen.

Figure 5. Bacterial spot on tomato fruit.

Bacterial spot of tomato, like most bacterial diseases, is difficult to control once introduced into a garden. Therefore, you are advised to do all you can to prevent the introduction of the pathogen when the garden is established. If you start your plants from seed, purchase the seed from a reputable seed company. This will increase the likelihood that you have seed free of spot-causing bacteria. If you purchase transplants at a retail nursery outlet, be sure to inspect plants carefully for symptoms of bacterial spot and avoid purchase of diseased transplants. Avoid overhead sprinkle irrigation as much as possible. Consider planting later in the fall in southern Florida in order to minimize production in the warmer, rainy season. Copper-containing fungicide (bactericide) plus mancozeb sprays that can be purchased at garden centers may provide some control of bacterial spot, particularly if the spray program is initiated before too many spots are present.

Target spot

Target spot is a fungus disease that has become more and more important over the years on commercial tomato farms in Florida. We have also noticed this disease in a few home gardens over the last several years, so it is one that homeowners should be aware. The causal fungus, *Corynespora cassiicola*, produces abundant spores that are readily dispersed on wind currents and may blow into gardens from remote locations.

On tomato leaves, the disease first appears as small brown spots with light-brown centers and darker-brown margins. There can be yellow halos around these spots. Especially in these early stages, target spot on the leaves is extremely difficult to differentiate from bacterial spot. Even experienced professionals can have difficulty telling these two diseases apart without laboratory tests. As the target spot disease develops, spots run together, and large blighted areas appear on leaves.

Fruit lesions caused by the target spot fungus are more distinct and easier to tell from bacterial spot than those on leaves. At first, fruit symptoms appear as small, slightly sunken flecks. As the disease progresses, lesions become darker and deeper. These lesions may overlap, resulting in large, pitted areas (Fig. 6). As fruit ripen, large sunken areas are evident, often with a gray or black growth of the fungus in the lesion center. Most home gardeners are reluctant to consume these damaged fruit.

Figure 6. Target spot on tomato fruit.

If target spot is a recurrent problem in your garden tomatoes, you might have to apply broad-spectrum fungicide every 7-10 days in order to protect plants. Consult with the UF IFAS Cooperative Extension Service for recommended fungicides. Gardens planted close to commercial tomato production fields may be more likely to come down with target spot.

Late blight

Late blight is one of the most famous diseases in the history of agriculture. The causal fungus, *Phytophthora infestans*, was responsible for a devastating epidemic on potatoes in Ireland in the 1840s that led to widespread famine and starvation. The huge migration of Irish to North America was in great part a response to the late blight impact on the most important crop in Ireland. Today, late blight is still a major concern to both potato and tomato growers on commercial farms in the US.

We occasionally see late blight on garden tomatoes in Florida. It is usually associated with relatively cool (e.g., daytime highs in the 60s and lower 70s) damp weather.

On tomato leaves, the symptoms initially consist of light brown to purplish spots that rapidly enlarge to larger, purplish, blighted areas (Fig. 7). Early in the morning and under wet conditions, you might see a white growth of the fungus on the lower leaf surface. Stems may become infected as well, with large purple to black sections that make stems look as if they were burned. On tomato fruit, mahogany to purple blotches appear, sometimes in a ring pattern (Fig. 8). Infected fruits often become overcome by a foul-smelling soft rot, as secondary bacteria follow the late blight infection.

Figure 7. Late blight symptoms on the lower leaf surface of tomato.

Figure 8. Late blight on tomato fruit.

To control late blight it is very important that you start with disease-free transplants. Space plants far enough apart in the garden so that plants will dry off quickly during the day. If late blight is a yearly problem in your garden, you might have to resort to periodical use of fungicide sprays.

Tomato Spotted Wilt

Tomato spotted wilt (TSW) is a viral disease. It is transported from diseased to healthy plants by thrips, an insect that commonly feeds inside many different types of flowers, including the blossoms of tomato. The T*omato spotted wilt virus* (often abbreviated TSWV) has an incredibly wide host range, producing symptoms in at least 63 plants grown commercially in Florida. These include vegetables, field crops, and ornamentals. TSWV is of more concern in northern Florida, presumably because the thrips species and weed hosts that are best adapted to spread and survival of this virus are more abundant in the northern part of the state. However, it may occur in south Florida as well.

A wide range of symptoms can occur with TSWV. Small, light brown flecks first appear on leaves. These spots later turn brown (Fig. 9), followed by a general browning of leaves that die and appear drooped on stems. Brown to purple-brown streaks form on stems. Plants are often stunted, and with the droopy leaves, give one the impression that they are wilted. Green fruit show concentric rings of yellow or brown alternating with the background green color (Fig. 10). Striking brown rings occur on red-ripe fruit.

Figure 9. Leaf symptoms caused by TSWV.

Figure 10. Fruit symptoms caused by TSWV.

Vigilant weed control may reduce the incidence of TSW on your garden tomatoes but will not eliminate it. Control of the thrips with insecticides may help to reduce late infections (secondary cycle), but in controlled experiments, insecticides have not been all that successful. Ultraviolet (UV) reflective mulch (Fig. 11), as physical repellent, can reduce TSW incidence. UV-reflective mulches are available commercially in small packages for home owners.

Figure 11. Ultraviolet (UV) reflective mulch. Credits: Photo courtesy of Steve Olson

Tomato Yellow Leaf Curl Virus (TYLCV)

This virus was first introduced into Florida in Miami-Dade county in 1997. It has rapidly increased in commercial fields throughout Florida. We have personally observed it in gardens in Broward and Palm Beach counties. It could presumably be a problem anywhere a garden is grown in the state, especially in areas with significant commercial tomato production.

This virus is transmitted by a species of whitefly. Severe symptoms occur on tomato, especially when young plants are infected. These young, diseased plants are severely stunted. Leaf edges curl upward and appear mottled (i.e., show alternating areas of light and dark green) (Fig. 12). The tops of plants appear bushy. Often, fruit set is poor or non-existent.

Control of TYLCV is difficult. Again, it is important that TYLCV-free transplants be purchased and planted in gardens. An isolated, infected tomato plant or two can be removed and destroyed in an effort to eliminate sources of virus that might infect other tomatoes. A lengthly period of time between plantings in the garden will help break the cycle that can lead to repeated virus infection. For example, in

Figure 12. Extremely stunted tomato plant infected with *Tomato Yellow Leaf Curl Virus*.

southern Florida, it makes sense to have a tomato-free period in the garden for 3-4 months in the summer (tomatoes dont set fruit particularly well anyway during this time). Control of whiteflies might help.

Fusarium Wilt

Fusarium wilt was one of the first diseases known to affect tomato in Florida. As long ago as 1899, entire fields of tomatoes in our state were wiped out by *Fusarium oxysporum* f. sp. *lycopersici*. It can be an extremely difficult disease to control, in large part because it can survive indefinitely in the soil. Rather than primarily spreading by spores on wind currents, *F. o.* f.sp. *lycopersici* forms highly resistant structures that persist in the soil, are stimulated to develop when in the vicinity of tomato root systems, and attack plants through the roots. Once the fungus is inside the tomato plant, the water-conducting (vascular) system is colonized and becomes plugged, accounting for wilt symptoms.

As the name implies, progressive wilt is the predominant symptom. The wilt cannot be overcome by simply thoroughly watering the tomatoes. At first the wilt may be more evident during the warmest part of the day. However, the plants soon express a permanent wilt that is evident throughout a 24-hr period. In the early stages, infected plants show a characteristic “one-sided” wilt (i.e., wilting on only one side of the plant), which helps differentiate Fusarium wilt from other wilt diseases of tomato.

To confirm Fusarium wilt, make a vertical cut of the lower stem of suspect plants and examine the water-conducting tissue. This is a narrow column of solid-appearing tissue to the outside of the stem. If it is brown (Fig. 13), it could very well indicate Fusarium wilt.

Figure 13. Internal browning of water-conducting tissue in tomato stem of plant with Fusarium wilt.

Control of Fusarium wilt for the home gardeners is primarily by use of varieties with resistance to the disease. Commercial farmers have used primarily *Fusarium*-resistant varieties and have had great success doing so. Unfortunately, home gardeners often plant "old" varieties or heirloom tomatoes that are not resistant to this pathogen. If *Fusarium* is a problem in your garden, try to purchase VFN tomato varieties. These letters stand for (in order) V*erticillium* (a wilt fungus similar to *Fusarium*) *Fusarium*, and nematodes (tiny worms in the soil that attack and damage roots). VFN tomato varieties are sensible choices for the high disease pressure we can experience in Florida. Gardens planted on residential properties that were developed from land with a past history of tomato farming, may be simply ill-suited for tomatoes. Homeowners with this situation may have to bring in topsoil free of *Fusarium* and use a raised-bed system to be successful. Of course, potted tomatoes that use a "clean" soil mix should be free of the *Fusarium* fungus.

Early Blight

Early blight is another fungus disease that damages leaves and fruit of tomato. Spores of the causal fungus, *Alternaria solani*, are blown on the wind, alight on leaves or other plant parts, and produce lesions.

On leaves symptoms begin as small, pencil-point-size, dark-brown to black spots. The spots enlarge up to a half-inch in diameter and usually have readily visible concentric rings that looks somewhat like a bulls-eye (Fig. 14). These leaf spots are distinctive enough to make early blight one of the easier tomato diseases to diagnose. Similar concentric rings are seen in lesions that develop on stems and fruit. When the fungus attacks young stems, complete girdling of the stems may occur with subsequent plant death. Fruit lesions are usually at the junction of the fruit and fruit stem or on the portions of the fruit nearer the stem and are conspicuously sunken.

Figure 14. Early blight on tomato leaves.

To control early blight, start with disease-free transplants and fertilize plants adequately. Inadequate nitrogen (N) levels, in particular, make tomatoes more susceptible to early blight. A persistent problem with early blight might reqire periodic sprays with an appropriate fungicide.

Bacterial Wilt

Bacterial wilt, caused by *Ralstonia solanacearum*, is a serious soilborne disease of many economically important crops, such as tomato, potato, tobacco, and geranium in the southeastern US. *R. solanacearum* is an extremely complex and diverse bacterial species that enables it to be pathogenic to several hundred plant species belonging to over 50 families.

Although diseased plants can be found scattered in the field, bacterial wilt usually occurs in foci associated with water accumulation in lower areas. The initial symptom in mature plants under natural conditions is wilting of upper leaves on hot days followed by recovery throughout the evening and early hours of the morning. The wilted leaves maintain a green color and do not fall as disease progresses. Under favorable conditions complete wilt will occur (Fig. 15). The vascular tissues in the lower stem of wilted plants show a dark brown discoloration. A cross section of the stem of a plant with bacterial wilt produces a white, milky strand (ooze) of bacterial cells in clear water (Fig. 16). This feature distinguishes the wilt caused by the bacterium

from that caused by fungal pathogens (e.g. Fusarium wilt).

Figure 15. Bacterial wilt symptoms on tomato.

Figure 16. Bacterial ooze due to *Ralstonia* infection. Credits: Photo credit, University of Georgia, Plant Pathology Extension)

Bacterial wilt of tomato is caused predominantly by race 1 of *R. solanacearum* in the southeast. These strains have a wide host range that guarantees a long-term survival of the pathogen in soil in the absence of the main susceptible crop. The pathogen can survive in the rhizosphere of nonhost plants, including weeds. Soil factors also influence the survival of the bacterium. For example, bacterial wilt is an important disease of tomato in Florida but it rarely occurs in calcareous soils with a high pH, which is the dominant soil type in Homestead. Moderate pH and moderate to high temperatures are associated with longer bacterial survival in soil.

Infested soil is the main source of inoculum. It is not rare to find bacterial wilt in the first crop in recently cleared land in tropical and subtropical regions. Disease-free areas can be infested through infected planting material (tomato transplants), contaminated irrigation or surface water, machinery, and with other cultural practices.

Bacterial wilt is very difficult to control after it is established in the field. No single measure totally prevents losses caused by the disease. The race 1 strains of *R. solanacearum* has been found to cause significant losses in tomato, especially in north Florida and other southeastern states. Cultural practices might reduce the disease incidence. Seedlings must be pathogen-free. It is essential that gardeners use irrigation water not contaminated with the pathogen. Pond water in north Florida was found contaminated with this pathogen. Gardens should not be over-irrigated because excess soil moisture favors disease build-up. Crop rotation with non-susceptible crops reduces soilborne populations of the bacterium. Shifting planting dates to cooler periods of the year can be effective to escape disease development. Soil amendments with inorganic and organic mixtures reduce wilt incidence in some locations. Bacterial wilt resistant tomato cultivars (Neptune and FL 7514) could be used to reduce the impact of this disease. FL 7514 is available commercially.