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Some Common Diseases of Pepper in Florida

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Pepper is an important commercial vegetable crop in Florida. During the months of November through May, the country is dependent on Florida for its supply of fresh peppers. Sweet bell pepper is produced in the highest quantity; however, recent years have seen increased plantings of "specialty" items such as jalapenos and pimientos.

Production of pepper in our state is often severely limited by one or more disease problems. This fact sheet describes the symptoms of several commonly observed diseases and provides recommendations for control. Since pesticide registrations and varieties change frequently, consult the Cooperative Extension Service for current, specific pesticide recommendations.

Bacterial Spot

Bacterial Spot, caused by *Xanthomonas campestris pv. vesicatoria,* is the most common and serious foliar disease problem facing Florida pepper growers. It is especially destructive when the weather is warm and there are frequent episodes of wind-driven rain. In southern Florida, we have observed the most serious outbreaks in the months of August through November.

All plant parts above ground are susceptible. In leaves, the first symptoms are watersoaked spots on the lower leaf surface. These occur within 3-4 days of infection. In another 2-3 days, the lesions become tan to brown, greasy spots on the upper leaf surface. These leaf spots sometimes are the center for a spreading yellowing of leaves. The lobed or angular lesions often are aggregated, possibly as a result of the transport of a number of bacteria to a leaf by one rain drop. Leaf spots may expand and coalesce to form large areas of yellow and brown tissue with a characteristic, greasy appearance (Fig. 1). Meanwhile on the lower leaf surface, the spots remain watersoaked and greasy, with the development of brown areas, especially in the lesion centers (Fig. 2). In some cases, leaf margins become scorched, probably as a result of invasion of hydathodes by the bacteria. Infected leaves often drop prematurely, even when only moderate damage from bacterial spot is incurred.

Lesions in fruit appear initially as small, raised pimples that are slightly lighter green than the normal fruit color. They enlarge and turn brown to black and appear as raised warts or scabs (Fig. 3). Under humid conditions, other microbes may enter the fruit at the bacterial spot lesions and cause massive fruit decay.

An integrated approach, which uses several tactics in concert, is needed to manage this disease. Bacterial spot is most severe when night temperatures are above 65°F, but the bacteria can be active below that temperature. While all

pepper varieties are susceptible to one or more races of the bacterium, differences in degree of susceptibility exist. There is some evidence that the pathogen can be transmitted in pepper seed. Pepper and tomato volunteers should be destroyed well before the next cropping season. Transplants should be certified as disease-free. Overhead irrigation should be avoided whenever possible. Workers and farm equipment should be kept out of fields when fields are wet. This organism is readily spread through fields when contact is made with wet foliage. Avoid unnecessary use of magnesium as foliar or soil applications. Limited control may be obtained with copper sprays. However, the effectiveness of copper bactericides is limited, because of the widespread occurrence in Florida of copper tolerance among strains of *X campestris pv. vesicatoria.*

Phytophthora Blight

Phytophthora blight, caused by the fungus *Phytophthora capsici,* has caused major losses the last few years, especially in the fall crop. All root and shoot tissue of pepper can be infected by *P. capsici.* The first symptom noted, in many cases, is a general wilting of pepper plants (Fig. 4). The wilt, however, occurs only after the development of lesions at any point on the stem. The stem lesions start as dark green, watersoaked spots or streaks, that later become dark brown (Fig. 5). Wilting is seen above lesions that girdle side shoots or the main stem.

Fruit infection is common. The fungus usually first grows through the fruit stalk. Fruits are then invaded with the development of a soft, mushy rot. The white growth of the fungus is often evident on the surface of lesions. Fruits eventually shrivel up but remain on the plant for considerable periods of time.

P. capsici is a so-called water mold. Other watermold fungi include *P. infestans* that causes late blight of tomato and potato and *Pythium* spp. which cause damping-off in many crops. *P. capsici* forms lemon-shaped spores (sporangia) among the mass of white fungal growth that can subsequently produce many, smaller zoospores that are motile in water. These can be seen by growers, agents, scouts, and others with access to a reasonably good compound microscope. Special resting spores with thick walls, called oospores, are formed which enable the fungus to survive long periods of adverse conditions.

The fungus has been reported to survive in seed as well as in soil as oospores. The lemon-shaped spores produced by the actively growing fungus are readily spread by splashing rain. However, unlike many water molds, they can also be spread by the wind. *P. capsici* can be active during moist conditions from 46 to 91°F. Optimum temperatures for fungal activity range from 68-86°F. Heavy rains during warm periods favor development of this disease.

This disease is not easy to control. Use of soil fumigation to reduce soil populations of the pathogen helps. Plastic mulch can reduce actual contact of soil populations of the pathogen with plants. Plant only on well-drained soil. Fungicides may provide some control.

Wet Rot (Choanephora Blight)

Wet rot or Choanephora blight has become increasingly more common and more severe in recent years. As early fall plantings of pepper continue to increase, we may expect to see more damage from this disease.

The causal agent is the fungus *Choanephora cucurbitarum.* This fungus is ordinarily thought of as a "weak" pathogen; it colonizes dead or dying tissue before it actively invades living pepper tissue. Most of the time, it seems to start in senescing flower petals. Once established, entire flowers are overgrown, resulting in a brown to black mass of soft tissue. Flower stalks, buds, and leaves may subsequently be invaded (Fig. 6). Spore production can occur

between 77-86°F. Diagnosis of wet rot in the field is based on the appearance of a silvery mass of fungus growth topped with a black ball made of great numbers of spores. The growth looks like whiskers growing out of the affected pepper tissue. More information on the diagnosis and control of wet rot can be found in the Extension Plant Pathology Fact Sheet No. 11, Wet Rot of Vegetable Crops.

Cercospora Leaf Spot

Cercospora leaf spot, sometimes known as frogeye leaf spot, is common in northern Florida during the summer. It is rare in production areas south of Orlando. Symptoms may occur in leaves, stems, petioles, and fruit stalks. However, the leaf lesions are very distinctive and allow one to readily recognize the disease in the field. Spots are circular to oval, with light tan centers and dark red borders (Fig. 7). Under conditions of high moisture, the fungus *Cercospora capsici* may be observed growing in the middle of the spot, especially if a good hand lens is used. Under a microscope, one can observe many long, thin, colorless, multicelled spores, characteristic of Cercospora fungi.

The fungus can survive in northern Florida on crop debris. The spores are readily transmitted via wind. The disease is usually most severe during warm, wet weather.

Prompt destruction of abandoned pepper crops and crop rotation are non-chemical methods of control. Fungicides can control the disease.

Southern Blight (White Mold)

Pepper is included in the wide host range of the southern blight fungus, *Sclerotium rolfsii*. This disease has been more of a problem in the northern part of the state. The major symptom is a rapid wilting of plants (Fig. 8). Internal and external lower stem tissue is infected and discolored by this fungus. The disease can be definitively diagnosed by finding small, mustard seed-sized resting structures called sclerotia at the base of stems. Sclerotia will begin as white structures and later darken to shades of orange to dark brown. Southern blight is favored by high temperatures (80-95°F).

Control is achieved by crop rotation with nonsusceptible crops such as grasses. However, because the sclerotia are so resistant to adverse conditions, long rotations of several years are best. Care must be taken not to transmit sclerotia within or between fields on farm equipment or shoes of workers. Sclerotia may also be transmitted in runoff from rain or irrigation. Turning soil with a moldboard plow rather than disking prior to planting is preferred. Some control may be obtained from the use of broad-spectrum soil fumigants. These are usually applied when the full-bed, plastic mulch system is used for the production of pepper. Readers can see Plant Pathology fact sheet No. 4 for more information on southern blight.

Blossom End Rot

Blossom end rot is an abiotic problem; that is, a living microorganism does not initiate this disease. Damage is confined to the fruit. Symptoms begin as watersoaked spots at the blossom end or side wall of the fruit. Damaged areas expand and become sunken, tan to brown in color, and dry, with a papery or leathery feel. Quite commonly, the affected fruit areas become covered with saprophytic fungi, which appear as black, feltlike growth on the fruit (Fig. 9). It is important to know that these dark-colored fungi are not the cause of blossom end rot, but merely colonize damaged fruit tissue. This disorder is directly related to calcium deficiency in developing fruit. A low calcium level in fruit can be the direct result of insufficient calcium in the soil. It may also be an indirect result of competition from high levels of ions such as magnesium. Severe fluctuations in the water status of plants (as when drought-stress occurs among plants) accentuate calcium deficiency in fruit. Control is based on proper calcium nutrition

of the crop and optimum irrigation scheduling.

Tobacco Mosaic Virus

Tobacco mosaic virus (TMV) is one of the oldest known virus pathogens affecting pepper. TMV has not been a major problem in peppers in Florida. Many strains of the virus exist, and symptoms of the disease vary depending on the particular strain of virus and cultivar of pepper. TMV is active over a broad range of temperatures, light regimes, and nutrient situations.

Symptoms of TMV infection are more or less typical of those associated with virus infections of a great number of crops. Leaves are mottled and distorted (Fig. 10). Plants are often stunted. Fruits may also be distorted in shape and show mottling. Systemic symptoms occur in many strain/cultivar combinations. In these cases, plants may wilt, exhibit extensive yellowing, and die.

TMV may be introduced into fields, in transplants, in crop debris, and on hands and clothing of workers, as well as on contaminated tools and machinery. Workers can get TMV-laden sap from infected plants on their hands and readily transmit the virus from plant to plant down the row. Some tobacco products used by workers can be a very important source of TMV.

TMV control centers on reduction of initial inoculum. Use of clean transplants and crop rotation are important. Cultural practices should be designed to minimize manipulation of plants. Workers should wash hands and tools with a phosphatic detergent (e.g., Spic n' Span) or milk after touching infected plants. There are differences in resistance to TMV among pepper varieties.

Aphid-transmitted viruses

Pepper mottle virus (PeMoV), potato virus Y (PVY), and tobacco etch virus (TEV) are aphid-transmitted viruses that have caused serious problems throughout Florida. Cucumber mosaic (CMV) is another aphid-transmitted virus. *It is very difficult to specifically diagnose which virus or viruses are in a plant based on field symptoms alone. Seek assistance from county agents, who can enlist the aid of plant disease clinic personnel in making a firm indentification.*

Symptoms can be similar for all these viruses. A mosaic pattern (blends of light and dark green to yellow areas) with distortion is common in leaves of plants infected with PeMoV, PVY, or TEV. The small leaves at the top of the plant may be crinkled. Plants may be stunted. Veins in leaves may be banded by a darker green than the background tissue (Fig. 11). Fruit mottling, distortion, and uneven ripening are not uncommon. PeMoV can cause mild (Fig. 12) or severe distortion of fruit and leaves. CMV-infected plants may show large yellow ringspots and oak-leaf patterns (Fig. 13).

All these viruses are transmitted by aphids in a "non-persistent" manner; i.e., the viruses are not taken up into the aphid, but remain on the outside of the insect's mouth parts. Transmission or acquisition of the virus by feeding is accomplished in seconds. Therefore, insecticides provide little control. Aphids lose the ability to effectively transmit these viruses by one hour after acquisition. The aphids acquire the virus by feeding on infected weed or crop plants. Disease occurrence parallels closely the fluctuations in aphid populations. Traditionally, these viral diseases have been worse in the cooler and drier months of the winter and early spring when aphids abound.

Numerous tactics have been identified to help manage these diseases. Source plants of these viruses include abandoned pepper crops and the weeds black nightshade and ground cherry. They should be identified and destroyed. Aluminum colored mulches have been shown to repel aphids. Repeated sprays of a light petroleum oil (JMS stylet oil) reduce infection by

interfering with acquisition and transmittance of the virus by the aphids.

Resistant varieties can be used. In southern Florida, earlier fall plantings tend to avoid peak aphid flights. However, such plantings are likely to incur more damage from bacterial spot. Growers are encouraged to purchase or produce certified disease-free transplants.

Tomato Spotted Wilt Virus (TSWV)

TSWV is spread primarily by thrips. Mechanical transmission is also possible. TSWV can kill plants or cause symptoms such as stunting, mosaics in leaves and fruit, or necrosis (browning) (Fig. 14). TSWV has caused severe damage in tobacco, tomato, and many other field, vegetable, fruit, and ornamental crop species. Considerable information about TSWV is available in Plant Pathology Circular 914. An intensive control program is necessary for reducing this severe disease.

Figure 1. Severe blighting of upper leaf surface associated with bacterial spot.

Figure 2. Greasy appearance of bacterial spot lesions in lower leaf surface.

Figure 3. Scabby appearence of bacterial spot lesions in pepper fruit.

Figure 4. Severe wilting associated with Phytophthora blight of pepper.

Figure 5. Advanced stage of Phytophthora blight showing extensive browning and collapse of stems. (photo courtesy of Ken Shuler).

Figure 6. Choanephora blight (wet rot) of pepper.

Figure 7. Cercospora leaf spot (frog eye spot). Note the characteristic dark red border around the light tan centers of the spots.

Figure 8. Wilted pepper plant with Southern blight (white mold).

Figure 9.Blossom end rot of pepper fruit. Note the dark colored secondary fungi growing in the damaged tissue.

Figure 10. Tobacco mosaic virus (TMV) infection in hot pepper.

Figure 11. Vein-banding symptom caused by an aphid-transmitted virus (potato virus Y).

Figure 12. Speckled leaf mottling associated with pepper mottle virus.

Figure 13. Ringspots and oakleaf pattern in pepper infected with cucumber mosaic virus.

Figure 14. Leaf distortion and necrosis (browning) caused by tomato spotted wilt virus.