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Bacterial Canker of Tomato

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Bacterial canker of tomato is caused by the pathogen *Clavibacter michiganense* pathovar *michiganese* and is one of the most destructive diseases found in tomato growing regions of the world.

Although erratic in time of appearance, it can be devastating when it occurs. In addition to fruit spotting and stem cankering, the pathogen causes vascular wilting and premature death of the entire plant, often resulting in high yield loss.

It was first discovered in 1909 by Erwin F. Smith on tomatoes growing in a greenhouse in Grand Rapids and was called for many years "The Grand Rapids Disease". The current common name of this pathogen is bacterial canker. Other names used to describe bacterial canker include bird's-eye spot, stem rot and stem canker. Birds eye spot describes the small, white, raised lesions that appear on the fruit.

Major losses due to this pathogen have been occurring since the 1930's. In the 1930's, the disease became epidemic in Ohio greenhouses and severely curtailed commercial production. It has also been a major problem in other parts of the U.S. For example, it was discovered in 1958 in North Carolina and by 1962, growers in that state were nearly forced out of tomato production. That year, they reported 70-80% losses in their tomato fields.

Bacterial canker has been a serious problem over the years in most of the tomato-growing areas of the world. Other members of the Solanaceous family have been shown to be affected by the pathogen, but tomato is considered to be the primary host. This pathogen has been of particular concern during the last two years to tomato growing areas in Michigan, Ohio, Indiana, Iowa and Kansas. The disease has also occurred widely in Ontario, the major tomato growing region of Canada. In 1985, it caused serious losses in Michigan and is now a major concern to many of Michigan's tomato growers.

Symptoms

Bacterial canker of tomato causes a variety of symptoms on tomato plants. These symptoms depend upon the age of the plant when infected, the mode of infection and various environmental factors. Perhaps the most obvious symptom of bacterial canker is the wilting phase. When plants are infected at a young age, they can wilt and die rather rapidly. However, wilting of mature tomato plants is a slow, gradual process. Because other diseases of tomato cause wilting symptoms, wilt is not a diagnostic symptom of bacterial canker. Wilting, however, is a primary symptom of bacterial canker.

In early stages of wilt, the oldest leaves hang downward, while the leaflets themselves curl upward. It is interesting to note that very often only half the plant wilts while the other half remains healthy looking. Sometimes, the leaflets wilt on one half of the petiole while the other leaflets remain turgid and healthy.

The name canker arises from the scars or the sunken lesions that occur on the stems. This usually takes place after the wilting symptoms can be seen, however. There can be necrosis of leaf tissue especially around the margins of the leaves. This is called the "firing stage" of the disease.

The two most distinctive symptoms of bacterial canker are the fruit lesions, called "birds-eye lesions," and the vascular discoloration at the juncture between the stem and the petiole. The fruit symptoms usually occur through external infection of the tomato fruit. The lesions start as small, white dots. As they get larger, the center of the spots die and turn dark, giving a "birds-eye" effect. Plants infected with bacterial canker do not always show these fruit lesions, but their presence is a very specific symptom of bacterial canker.

The vascular necrosis can be seen when the petiole is removed, revealing the vascular system of the plant. A slight browning or discoloration should be evident. If the stem is cut and squeezed, a yellowish exudate might be observed. Ultimately, the internal tissue of the stem, called the pith, can dry out and cavities are formed within this tissue. This takes place in long stretches of the stem tissue or may be locally specific to certain areas of the plant; however, it is not observed in the roots.

It is difficult to diagnose bacterial canker based upon any one symptom (except birds-eye lesions). However, when two or more of these symptoms appear in a plant, they are very likely the result of bacterial canker infection and identification should be made through isolation of the organism. Symptoms expressed on younger plants are usually more severe than those on newly infected older plants. Transplants diseased with bacterial canker can die after transplanting usually from rapid wilting. Mature plants can sometimes survive infection and produce fruit. Therefore, it is difficult to make a prognosis on any particular field unless a history of the infection is known.

Survival and Spread

It is well documented that the bacterial canker organism persists in soil for long periods of time. Several researchers in the 1930's and 40's re-isolated live bacteria from air-dried soil after 1½ years and 2½ years. It has been shown to survive on culture media for up to 5 years. The ability of the organism to overwinter in plant debris has been reported several times. Survival for 3 years on plants in soil has been noted in Europe. In the 1970's, Dr. J. Farley was able to recover the bacteria from buried infected tomato stems after 8 months in an Ohio tomato field.

The organism has been recovered from common Solanaceous weed hosts such as nightshade, jimsonweed and horsenettle. Since these weeds are common in the Midwest, it appears that bacterial canker could survive indefinitely in association with Solanaceous weed hosts. The bacterium has also been recovered from soil-covered stakes, cracks in the greenhouse floor and from water. The pathogen can also survive on the seed, externally and internally. This ability to survive in so many ways sets the stage for the means by which it is disseminated.

It is generally believed that dissemination has occurred worldwide through tomato seed. Infected seed leads to the production of diseased transplants. Often these transplants are symptomless at the time they are moved from the greenhouse or from the seedbed into the permanent planting site. It has been shown that the introduction of only a few infected plants can lead to a large number of diseased plants in the field if environmental conditions are favorable for disease development. Dissemination from infested soil, equipment and tools can occur readily.

There is general agreement that the organism can be spread by handling transplants and established plants. It has been shown to spread on the hands of workers and on pruning knives. Infection takes place through natural plant openings and wounds. Free moisture is critical for the bacterium to successfully invade the host tissue. Generally, disease spread occurs when the weather is wet and warm.

Control

Prevention is the most effective control of bacterial canker of tomato. There is no chemical control or known genetic resistance to this disease. Therefore, efforts should be directed toward preventing the introduction of this organism.

Two means by which the organism is commonly introduced into a field are by contaminated seeds and infected transplants. Sensitive assays are just becoming available to detect the organism in seedlots. We hope that seed companies in the future will assay their seedlots for the presence of the bacterial canker organism.

The only realistic recommendation we can make is to buy seed from reputable, well established seed companies. These companies are more apt to handle seed in such a manner that contamination by bacterial canker is reduced.

Growers should keep very careful records on each of the seedlots they use. That way, if a problem does occur it is easier to trace it back to the source. We recommend that the grower keep records on the variety, field location, soil type, cultivation practices, and any particular management practices used. Plants should be flagged in the field with variety, seedlot (if known) and planting date on the label.

Keep track of the management practices of the greenhouse in which the transplants are grown. If you purchase transplants from Georgia or seedlings from Florida, accept only certified transplants. Although these plants could be symptomless carriers, they have at least been checked visually for symptoms of bacterial canker. These practices will greatly reduce, but not eliminate, the introduction and spread of the bacterial canker organism by seed and transplants.

Sanitizing Equipment

Bacterial canker is a highly contagious disease and must be treated with maximum caution. If you are growing your own transplants, or they are being grown locally, be sure that maximum sanitation is used to insure a bacterial canker-free growing environment. In the greenhouse, sanitize all surfaces, equipment or tools that might come in contact with the plant, such as plant fillers, benches, plant containers, cutting knives and other associated greenhouse instruments.

A 10% Chlorox solution, plus a drop of liquid detergent, is sufficient to kill the pathogen on clean surfaces. Remember that Chlorox evaporates into the air or is tied up in organic matter in soil, so that after several hours there will be less than 10% Chlorox in the solution. Add additional Chlorox if the solution will be used for more than 2 hours.

It is best to use benches and tools that have a clean, smooth, non-porous surface because this type of surface is easiest to sanitize. Surface-treat benches and tools for at least two minutes. The greenhouse floor can be a source of the bacterium, particularly if there are weeds or plant debris present. The pathogen survives best in association with plant tissue. Elimination of the pathogen from the soil on the greenhouse floor is difficult so always proceed as though the organism is still residing there. Fumigation (with Vapam or other materials) will help to reduce the population of the pathogen but it may not eliminate it.

Once plant material is introduced into the house, continue maximum sanitation procedures. Avoid plant contact with the floor of the greenhouse since roots of the affected tomato plants will grow into the greenhouse floor, and possibly pick up the pathogen. Cover the floor with a ground cover to break the contact roots might have with the soil on the floor of the greenhouse.

Water splashing is also an important method of dissemination in the greenhouse. In general, minimize contact with the plants as much as possible. People entering the greenhouse should sterilize their boots before walking through the greenhouse and wash their hands with soap before contacting plants. Greenhouse workers should be familiar with the symptoms of bacterial canker so that they can rogue out or call attention to suspect plants. However, symptoms generally don't appear under greenhouse conditions.

Field Sanitation

Sanitation efforts should continue once the plants are taken to the field. Use a 10% Chlorox solution to sanitize equipment that may come into contact with the plants—flat bed trucks, trailers or bulk boxes used to transfer the plants to the field, etc. Since it is difficult to properly sanitize rough surfaces, do not transfer plants to the field on anything but a smooth, non-porus surface. Pieces of equipment such as transplanters, cultivators, and tillers should be washed off with a good detergent and sprayed with a suction injector with 10% Chlorox. Sanitize equipment between fields and between seedlots. Stakes should be piled up on a wagon or cart and then fumigated (methyl bromide or Vapam can be used.)

Workers in the field should wear clean clothes and sanitize their boots and wash their hands between fields. They should avoid working in the field when it is wet or after a heavy dew. Plants should not be handled when wet. In general, workers should minimize handling plants whenever possible. Since the pathogen is known to survive in plant debris in the field, a three-year rotation is recommended. Solanaceous weeds, such as nightshade, horsenettle, and jimsonweed are potential hosts for the bacterial canker organisms. Make all efforts to control these weeds hosts in fields planted to tomato.

After Detection

These recommendations all deal with preventing the introduction of the organism, which, as previously stated, is the most successful way of controlling bacterial canker. However, it is likely that bacterial canker will reoccur in the Midwest. What can we do to minimize spread and severity? If canker is detected in the field early (in the first week or two after transplanting) and more than 25% of the plants are visibly affected, destroy these plants and consider using the field for another crop. If the field must be used for tomatoes, then replant with bacterial canker-free transplants. It is important that workers in the field be familiar with the symptoms of bacterial canker so they can monitor for the disease.

If symptoms are seen in the field and you are not positive that they are bacterial canker, remove an infected plant and take it to your local Cooperative Extension office where it can be forwarded to the MSU plant disease diagnostic clinic for confirmation of the organism. If possible, do this before planting suspect plants.

Remember that southern wilt caused by *Pseudomonas solanacearum* also will cause wilting in plants and it's difficult to visually distinguish this disease from bacterial canker on young transplants. Contact the transplant supplier immediately upon suspicion of canker in the field. If the disease is noticed later in the growing season, and only a small amount of infection appears to be present, it might be feasible to rogue out plants that appear infected. This is especially true for plants grown on stakes or for fresh market. Contaminated plants are clearly a source of spread of the organism onto healthy plants particularly during periods of irrigation or rainfall. When removing infected plants, avoid direct contact with the plants. Place a bag over the plants and remove them from the field without direct handling. It is not economical to rogue in a large, heavily infected field, particularly processing tomatoes.

Once a field is contaminated, do not move equipment or workers from the infested field to a clean site. Use maximum sanitation practices in dealing with an infested field. If possible, do all work in the infested field last.

When the growing season is over, the contaminated field should be rotated out of tomatoes for 3 years. Tilling this site frequently will break down the organic matter which helps reduce the survival of the canker organism in this site.

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