Black Rot of Crucifers

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Cause and Symptoms

Black rot is a plant disease caused by the bacterium, *Xanthomonas campestris* pv. *campestris.* Cabbage, broccoli, cauliflower, kale, kohlrabi, Brussels sprouts, rutabaga, turnip, collards, radish, mustard, water cress, and other plants in the cabbage family are susceptible. Vegetables other than crucifers (cabbage family) are not susceptible. Cruciferous weeds such as wild radish (Indian mustard), pepper grass (Virginia pepperweed), and shepherds purse are susceptible. The bacterium which causes black rot is less than 1 / 10,000 of an inch long. It may enter the plant through mechanical injury points occurring during the pulling and setting of transplants, transport of plants, or the growing of plants in the transplant bed or field. Wounds made to the root system during transplanting are ideal portals of entry. Mechanical injury from insect feeding also provides portals of entry for the black rot bacterium. However, insects have not been shown to be as important in the overall spread of black rot as are other methods.

Black rot bacteria may also enter plants through natural plant openings above and below the soil surface. Above-ground openings in the plant include hydathodes present at the edge of leaves, and stomates distributed over the lower and upper leaf surfaces. Entry of bacteria through stomates may occur when plants have been subjected to heavy rains or irrigation. Recently, a more virulent strain of the black rot bacterium has occurred in Florida and apparently it is more apt than the "common strain," to enter plants through stomates, particularly in transplants. Another natural portal of entry is through a normal root system. Higher plants develop prolific root systems by producing new roots that originate in older roots. During this process tissue breaks develop in the older roots which offer portals of entry for bacteria. This portal of entry is most significant if the soil is saturated with water from rain, irrigation, or flooding.

After black rot bacteria enter the plant, symptoms of disease can occur near the original point of entry or throughout the plant because the bacterium moves systemically. Optimum temperatures for growth of the bacterium are 80-86°F. However, it can grow from 40°-97°F. After plants are infected, marginal leaf lesions can be found within 8-12 days. After infection occurs, temperatures from 68°-82°F are ideal for expression of symptoms. It may take up to 43 days for symptoms to appear on leaves after infection has occurred. Sometimes plants that are infected during the seeding stage may not develop symptoms until flowering time. This, of course, is important in seed production as this bacterium is carried in the seed.

The bacterium causing black rot can survive in cruciferous debris that has not been thoroughly decomposed. It is unlikely that the bacterium can survive in soil free of cruciferous debris.

Symptoms of black rot are variable but are highly diagnostic. Marginal leaf yellowing, often in a wedge shape, is a common early symptom (Figs. 1, 2, 3). Within the yellowed areas tissue may become necrotic and leaf veins become darkened, usually black (Fig. 4). Sometimes wedge-shaped areas are not present; instead a diffuse yellowing of the leaves is present, but, darkening or blackening of the veins is almost always present (Fig. 4, 5). In some cases elongated wedge-shaped areas on leaves occur. From seed, leaf, or root infections, the bacterium can spread throughout the plant. Not only will leaf veins become darkened but, vascular tissue within the stem will also darken (Figs. 6 & 7). Advanced symptoms include increased leaf yellowing, leaf necrosis, and wilting of leaves.

As indicated earlier, most secondary infection in the field occurs through the hydathodes located at leaf margins. Wedge-shaped lesions are often prevalent with this type of infection. However, the more virulent strain mentioned earlier which enters through stomates may cause numerous, dark, somewhat circular, leaf spots (Fig. 5) in addition to common symptoms.

Control

The control of black rot is essential for the efficient production of cruciferous crops. Energy and money expended to produce a crop early and mid season only to be negated by crop destruction because of black rot prior to harvest has not been a rare occurrence in crucifers in Florida. Black rot can be controlled by utilizing a comprehensive control program. Using some techniques that you feel comfortable with and not others because they appear "not worth messing with" can result in disaster. The following control measures, if employed as an intensive program, will reduce black rot:

1) Rotate transplant beds and fields. Unless thorough decomposition of cruciferous debris occurs, black rot bacteria will survive from one year to the next. Where rotation can be used, it is good insurance against black rot.

2) Do not locate field beds or greenhouse transplant sites within 1/4 mile of production fields or gardens with cruciferous crops.

3) Raise transplant beds above the surrounding area or trench the periphery to provide for drainage of excess rainfall. Flooding of the seedbed area can result in widespread infection.

4) Eliminate wild cruciferous weeds near the transplant production areas and production fields.

5) Destroy, upon appearance, volunteer cruciferous plants growing near the transplant production areas and field.

6) Preplant fumigation of field transplant beds with a multipurpose chemical such as methyl bromide/chloropicrin, or Vapam will be helpful. This should be considered a must if transplant beds are not rotated. Not only will some control of black rot occur, but root rots, stem rots, nematodes, and weeds will also be reduced. At the time of fumigation the soil should be well tilled and slightly moist. Old plant debris should be well decomposed.

7) Purchase seed that is certified disease free.

8) If seed has not been hot water treated, it is essential that you carry out this treatment. One infected seed in 10,000 can result in a serious epidemic if weather conditions are favorable for development. Seed of cabbage, Brussels sprouts, and collards should be soaked at 122°F

for 30-35 minutes. Seed of broccoli, cauliflower, kale, kohlrabi, rutabaga, and turnips should be soaked at 122°F for 20 minutes. Heat treatment will also control black leg, another seedborne disease. Use only hot water treated seed.

9) Ask transplant growers for documented reports of seedbed certification, protection measures, inspections, seed treatments, and seed assays.

10) Plant several smaller transplant sites rather than fewer large transplant sites. With smaller transplant sites, individual seed lots from different sources can and must be isolated from each other. Then, if one seed lot has black rot, you can destroy plants in that lot in order to prevent spread to the remainder of your plants. Seed of foreign origin has often carried black rot. Domestic seed also carries black rot, but in the past, it has been to a much lesser degree than foreign seed.

11) Inspect transplants each day for black rot. If black rot appears on a plant**, immediately remove and destroy that plant as well as those surrounding it for a distance of 3-5 feet. If black rot continues to develop in plants from that lot of seed, destroy the entire planting from that lot of seed as soon as possible, before the disease is spread to other lots.** Transplanting infected plants with black rot or transplanting healthy-appearing plants in a lot known to have black rot, can be disastrous in the field and usually is a waste of time and effort.

12) Irrigate from well water. It is less likely to carry disease organisms than water from other sources.

13) Do not top or mow transplants to toughen them; rather, reduce water and fertilizer prior to pulling.

14) Do not wet down transplants prior to transplanting or dip plants to wash soil from roots. Moisture and handling are ideal for black rot spread. Cruciferous plants can tolerate wilting at transplanting.

15) Decontaminate plant boxes after each use by dipping or thoroughly cleaning them with a bleach solution. Boxes should be dry before reusing.

16) Before using equipment or tools where crucifers are grown, thoroughly clean them of all soil and preferably decontaminate them using steam or germicidal sprays.

17) Destroy left over plants at the transplant site as soon as possible.

18) Plow down cruciferous fields immediately after harvest to initiate plant tissue decomposition as soon as possible.

19) Do not handle or work with plants in the transplant site or field while they are wet.

20) Boom sprayers are less apt to spread black rot compared to airblast sprayers.

21) Consider the use of direct seeding of crucifers in the field. This minimizes handling and exposure areas and reduces the chance of black rot spread, compared to transplanting.

22) Implement a total control program. Failure to implement a total control program can result in severe losses because of a large number of ways in which the black rot bacteria can be introduced or spread. A total program is well worth the effort.

Figure 1. Black rot in cauliflower.

Figure 2. Black rot in broccoli.

Figure 3. Black rot in cabbage.

Figure 4. Wedge-shape lesion with black veins.

Figure 5. Black veins and leaf spots of black rot in young Brussels sprouts.

Figure 6. Inner stem vascular browning of collards.

Figure 7. Inner stem vascular browning of non-decayed cabbage stem in soil.