

# Black Rot of Crucifers<sup>1</sup>

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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, watercress, 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 for this bacterium. 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. In the late 1990s, a more virulent

strain of the black rot bacterium occurred in Florida, and this strain appears to be more apt than the “common strain” to enter plants through stomates.

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, and these breaks offer portals of entry for bacteria. This portal of entry is most significant if the soil is saturated with water, whether from rain, irrigation, or flooding.

After black rot bacteria enter the plant, disease symptoms 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 (27-30°C). However, the bacterium can grow from 40°-97°F (4-36°C). After plants are infected, marginal leaf lesions can be found within 8 -12 days. After infection occurs, temperatures from 68°-82°F (20-28°C) are ideal for symptom expression. 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 method of infection is significant since this bacterium is carried in the seed.

The bacterium causing black rot can survive in crucifer debris that has not been thoroughly decomposed. However,

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it is unlikely that the bacterium can survive in soil that is free of crucifer debris.

Symptoms of black rot are variable, but are highly diagnostic. Marginal leaf yellowing, often in a wedge shape, is a common early symptom. Within the yellowed areas, tissue may become necrotic and leaf veins become darkened, usually black. 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. 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. 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 and somewhat circular leaf spots in addition to common symptoms.

## Control

Control of black rot is essential for efficient production of crucifer 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, is not a rare occurrence in crucifer production in Florida. Black rot can be controlled by utilizing a comprehensive control program.

However, 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. (The numbering of this list does not indicate any ranking of management options.)

1. Rotate transplant beds and fields. Unless thorough decomposition of crucifer debris occurs, black rot bacteria will survive from one year to the next. Where rotation can be used, it is also good insurance against black rot.
2. Do not locate transplant beds within  $\frac{1}{4}$  mile of production fields or gardens with crucifer 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. For transplant houses, use raised beds.
4. Eliminate wild crucifer weeds near transplant beds and production fields.
5. Destroy, upon appearance, volunteer crucifer plants growing near the transplant bed and field.
6. Preplant fumigate transplant beds with a multipurpose chemical, such as Vapam. This practice 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 to 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 (50°C) for 30 - 35 minutes. Seed of broccoli, cauliflower, kale, kohlrabi, rutabaga, and turnips should be soaked at 122°F (50°C) for 20 minutes. Heat treatment will also control black leg, another seed-borne disease. *Only use seeds that have undergone hot-water treatment.*
9. Ask transplant growers for documented reports of seedbed certification, protection measures, inspections, seed treatments, and seed assays.
10. Plant several smaller transplant beds, rather than fewer large transplant beds. With smaller transplant beds, individual seed lots from different sources can and must be isolated from each other. Then, if one seed lot has black rot, 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. Cabbage seed of both domestic and foreign origin may contain the black rot pathogen. However, in the past, foreign seed has had a greater likelihood of infection.
11. Inspect transplants each day for black rot. If black rot appears on a plant, immediately remove and destroy that plant, as well as plants surrounding the infected plant 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 plants infected 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 apt 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. Crucifer plants can tolerate wilting at transplanting.
15. Decontaminate plant boxes and transplant trays 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 in a crucifer field or bed, thoroughly clean them of all soil and, preferably, decontaminate them using steam or germicidal sprays.
17. Destroy leftover plants in the transplant bed as soon as possible.
18. Plow down crucifer fields immediately after harvest to speed plant-tissue decomposition.
19. Do not handle or work with plants in the transplant bed 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 practice minimizes handling and exposure areas and reduces the chance of black rot spread, compared to transplanting.
22. Chemicals have limited impact on control, especially when applied after an infection has become severe. Coppers are not recommended and may cause black spotting on lower leaves.
23. Implement a total control program. Failure to implement a total control program can result in severe losses because of the large number of ways in which black rot bacteria can be introduced or spread. A total program is well worth the effort.