

VEGETABLE CROPS



CORNELL COOPERATIVE EXTENSION

Black Rot of Crucifers

Margaret Tuttle McGrath

Department of Plant Pathology
Long Island Horticultural Research Laboratory

Black rot, caused by the bacterium *Xanthomonas campestris* pv. *campestris*, is considered the most serious disease of crucifer crops worldwide. This disease is also known as blight, black stem, black vein, stem rot, and stump rot. All crucifer crops are susceptible to black rot; radish and kale, however, are less easily infected. Plants that are not in the crucifer family are not susceptible. Yield can be affected in several ways: infected plants may die prematurely, heads may remain small, and quality may be reduced because of symptoms on the marketable part of the plant. Removing symptomatic leaves increases production costs. Soft rot may develop after black rot, further reducing quality and storage life.



Fig. 1.



Fig. 2.



Fig. 3.



Fig. 4.



Fig. 5.



Fig. 6.



Fig. 7.



Fig. 8.

Symptoms and Signs

Plants can be infected during any growth stage. Two types of symptoms occur depending on whether infection is systemic or local. Seedlings that are infected systemically become yellow, drop lower leaves, and may die (fig. 1). These symptoms can resemble nutritional problems. Leaves may be affected on only one side of a seedling. Dark spots and blackened veins sometimes develop on cotyledons. Plants infected systemically because of contaminated seed may not develop symptoms for many weeks (fig. 2). The classic symptom of black rot is caused by local infection that results when bacteria enter leaves through hydathodes, which are natural openings at leaf margins. The infected tissue is wilted and pale green initially (fig. 3), becomes yellow (fig. 4), then turns brown and dies. Affected areas are usually wedge- or V-shaped when bacteria enter leaves through hydathodes (fig. 4). These areas enlarge as the disease progresses, and severely affected leaves may drop off (fig. 5). Bacteria also can enter leaves through wounds, including those made by insects (fig. 6). The veins in infected leaves, stems, and roots sometimes become black because the bacteria produce an extracellular polysaccharide that plugs normal water flow (fig. 4, 7). Blackened veins can be seen in stems and leaf petioles by cutting crosswise (fig. 7). Cauliflower curds may become infected and turn brown (fig. 8), but this symptom is not diagnostic because soft rot bacteria cause similar symptoms.

Disease Cycle

The primary sources of bacteria for development of black rot in production fields are infested seed, infected transplants, and infected cruciferous weeds. Serious epidemics have occurred when only 0.03 percent of seed was infested. Cruciferous weeds known to be susceptible to black rot include birdsrape mustard (*Brassica rapa*), Indian mustard (*B. juncea*), black mustard (*B. nigra*), shortpod mustard (*Hirshfeldia incana*), Virginia pepperweed and other pepper grasses (*Lepidium* spp.), shepherdspurse (*Capsella bursa-pastoris*), radish (*Raphanus sativus*), wild radish (*R. raphanistrum*), hedge mustard (*Sisymbrium officinale*), swinecress (*Coronopus didymus*), and hairy whitetop (*Cardaria pubescens*). *X. campestris* can survive in infested crop debris until it is completely decomposed, and the bacteria can survive free-living in soil for about 40 to 60 days; however, these sources do not appear to be important for development of black rot in the northeastern United States.

Bacteria are spread within a crop primarily by wind-blown and splashing water and by workers, machinery, and occasionally insects. *X. campestris* can survive on leaf surfaces for several days until dispersed to hydathodes or wounds where infection can occur. Bacteria enter leaves through hydathodes when water exuded through these pores at the leaf margin during the night is drawn back into the plant in the morning. Bacteria can enter leaves in 8 to 10 hours, and wilt symptoms are visible as soon as 5 to 15 hours later. Wounds, including those made by insects feeding on leaves and by mechanical injury to roots during transplanting, also provide entry sites. Wounds on roots are most important when transplants are dipped in water or the soil becomes saturated. Flea beetles can transmit *X. campestris* but were found to be ineffective vectors in New York. Bacterial movement into plants through hydathodes is restricted in resistant varieties; consequently, there are fewer infection sites and/or the affected area is much smaller in resistant varieties than in susceptible varieties.

Warm, wet conditions favor black rot development and expression of symptoms. Rain and heavy fogs or dews and day temperatures of 75° to 95°F are most favorable. Under cool, wet conditions infection can occur without development of symptoms. Consequently, transplants grown at low temperatures may be infected but symptomless. The bacteria do not spread below 50°F or during dry weather.

Control

An integrated, comprehensive program is needed to manage black rot successfully:

1. Use resistant varieties. This management practice has been shown to be more effective than weekly applications of fixed copper or copper hydroxide beginning before development of symptoms. Resistant varieties have fewer infection sites and/or the affected area is much smaller compared with susceptible varieties.
2. Minimize chance of seed or transplants being infested.
 - a. Use seed or transplants certified to be free of *Xanthomonas campestris*.
 - b. Have seed tested before hot water treatment. The Georgia Department of Agriculture Seed Pathology Laboratory conducts black rot assays (1109 Experiment Street, Griffin, GA 30223-2797. Telephone 404-228-7234).
 - c. Have seed treated. For hot water treatment, place seed loosely in a cheesecloth sack, then immerse and soak in hot (122°F) water for 20 minutes (cauliflower and broccoli) or 25 to 30 minutes (cabbage and Brussels sprouts). Afterward, immerse seed in cold water then spread in a thin layer to dry. This will greatly reduce, but not always eliminate, bacteria in seeds, and it may reduce seed viability and seedling vigor. More effective and less damaging treatments are being developed. Treated seed should be retested.
 - d. Get from the transport grower documented reports of seedbed certification, protection practices, inspections, seed assays, and seed treatments.
 - e. Do not purchase transplants that have been clipped or "topped" by mowing because this can spread bacteria.
3. If seedlings are grown in a greenhouse, use new or sterilized flats and soilless mix.
4. Locate seedbeds away from production fields in an area where crucifers have not been grown for at least 2 years and air movement is good so that foliage dries quickly. Several small seedbeds are better than one large one, especially when several varieties or seed lots are grown.
5. Provide seedlings with optimal conditions of water, fertility, temperature, and light for growth.
6. Inspect seedlings routinely. If symptoms are found early, destroy seedlings in that area.
7. Do not clip transplants because they are oversized or to toughen them.
8. Foliage should be dry when seedlings are transplanted. Do not dip transplants in water. Crucifer plants can tolerate wilting during transplanting.
9. Incorporate leftover plants by plowing or discing seedbeds as soon as possible after transplanting.
10. Decontaminate plant boxes after use by dipping them in 10 percent bleach, rinsing, and drying.
11. Avoid planting in fields where crucifers have been grown the previous 2 years or where cruciferous weeds are numerous.
12. Select fields with good drainage and use raised beds.
13. If possible, direct seed production fields because bacteria can spread much more extensively among plants in seedbeds because of close plant spacing.

14. Separate successive plantings as well as direct-seeded and transplanted fields as much as possible. If this cannot be done, locate younger plantings and direct-seeded fields upwind from older plantings and transplanted fields.
15. Work in fields only when foliage is dry, especially if black rot is present. Thoroughly clean equipment used in fields with black rot before entering other fields.
16. Control insects and weeds, especially cruciferous weeds.
17. Do not irrigate early in the day when dew is present or so late in the day that foliage remains wet overnight.
18. For chemical control options, refer to the current *Cornell Pest Management Recommendations for Commercial Vegetable and Potato Production* for an updated list of available materials. Always follow label directions. Airblast sprayers are more likely to spread bacteria than are boom sprayers.
19. Plow or disc fields as soon after harvest as possible, especially if black rot has developed.

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