



Black Rot of Crucifers

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IMPORTANCE

Black rot is a common and destructive disease that affects plants in the crucifer family (cole crops) at any growth stage. Black rot has also been referred to as bacterial blight, black stem, black vein, stem rot, or stump rot. While most commonly observed on cabbage (FIGURE 1), kale, cauliflower, and broccoli, other crucifers are also susceptible (see TABLE 1).

SYMPTOMS

Seedlings

Young seedlings are particularly susceptible to black rot. Initial infections on the cotyledons (seed leaves) may seem to disappear when these leaves fall off,

but the bacteria remain present in plants at low levels. Infections become systemic as the bacterium spreads through leaf veins. Close spacing and overhead watering of transplants worsen plant-to-plant spread. As disease progresses, plants become stunted and chlorotic (yellowed; FIGURE 2), and may drop leaves prematurely before eventually dying.

Mature plants

Initial symptoms appear as distinct, yellow V-shaped lesions along leaf margins, with the bottom of each "V" pointing inward (FIGURE 2). Lesions turn brown as they become necrotic (dead) (FIGURE 3), enlarging until entire leaves yellow, wilt, and fall from plants. Leaf veins in affected areas turn from green to dark-brown to black.

FIGURE 1. V-SHAPED LESIONS DEVELOPING ALONG LEAF MARGINS ARE CHARACTERISTIC SYMPTOMS OF BLACK ROT.



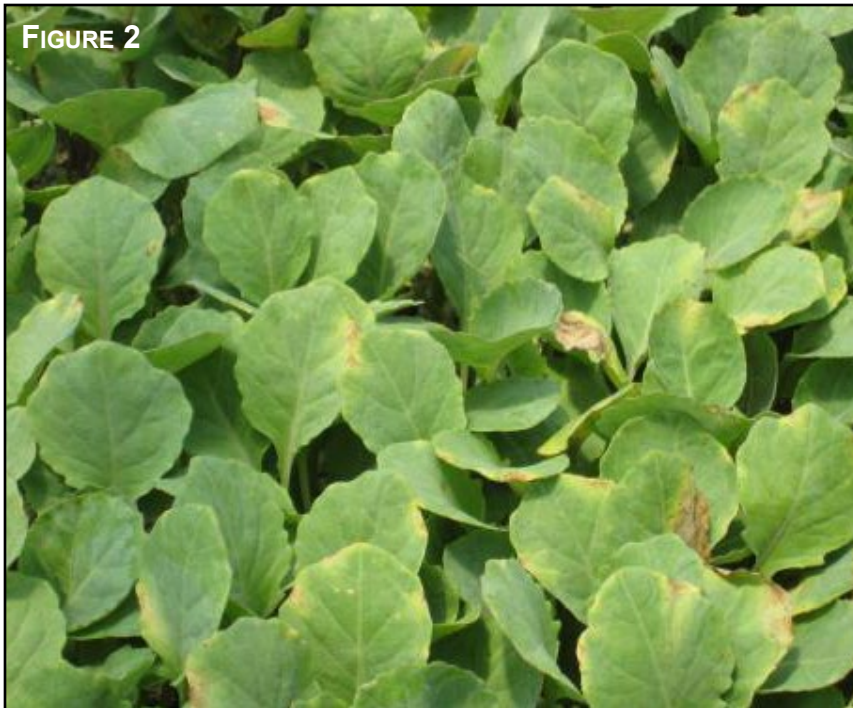


FIGURE 2



FIGURE 4



FIGURE 3

FIGURE 2. CABBAGE TRANSPLANT FOLIAGE BECOMES CHLOROTIC (YELLOW) ALONG LEAF MARGINS WHEN INFECTED WITH THE BLACK ROT BACTERIUM.

FIGURE 3. CHLOROTIC AND NECROTIC BLACK ROT LESIONS ADVANCE INWARD FROM LEAF MARGINS. NOTE ALSO THE BLACKENED VEINS ASSOCIATED WITH THESE SYMPTOMS.

FIGURE 4. VASCULAR TISSUE WITHIN STEMS BECOME DISCOLORED AS A RESULT OF INFECTION.

Black discoloration is evident in the vascular system when stems or heads are cut lengthwise (FIGURES 4 & 5). Soft-rotting bacteria often invade and colonize diseased tissues, resulting in a slimy, foul-smelling decay of stalks and/or heads (FIGURE 6).

Impact on yield

Black rot can cause a substantial loss of yield even when it does not kill the entire plant. Heads may remain small and quality may be poor. In addition, symptomatic harvested crops and secondary soft rots may further reduce quality and spread to healthy portions of the lot. This results in significantly shortened storage life and issues with overall marketability.

CAUSE & DISEASE DEVELOPMENT

Black rot is caused by the bacterium *Xanthomonas campestris* pv. *campestris*. The most common source of the pathogen is infested seed lots or infected transplants, but it can also survive from season to season in plant debris left in the field or garden. While the pathogen only infects crucifers (cole crops), a number of related weeds (see TABLE 2) are also hosts and can serve as reservoirs of inoculum.

Infection can occur through wounds or insect damage, but most common is entrance through natural openings, such as stomates (microscopic pores in leaf surfaces) and hydathodes (openings along the margins of plant leaves that form dew

droplets overnight). Spread within fields occurs via splashing rain, insects, wind-blown plant debris, or handling plants with infested tools or human hands. Warm (79°F to 95°F), humid or rainy weather favors infection and spread of black rot.

DISEASE MANAGEMENT

Cultural Practices

The following cultural practices can help minimize the risk of black rot introduction and carry-over.

Resistant varieties

- Plant cultivars that have high or partial resistance (tolerance) to black rot.

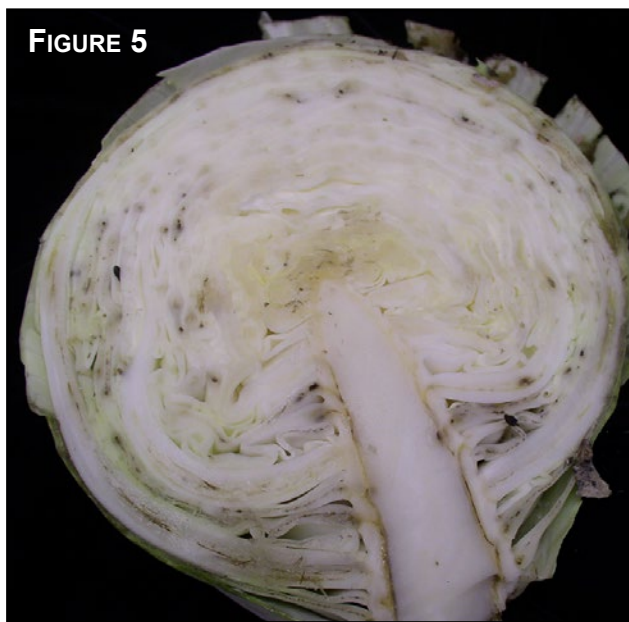


FIGURE 5

- Consult the latest version of *Commercial Vegetable Guide for Commercial Growers* (ID-36) for information on variety selection.

Disease-free planting material

- Use certified disease-free seed.
- Inspect transplants for disease symptoms prior to purchasing or planting them.
- Seed into trays that have slightly broader plant spacing (wider than tobacco trays) to ensure more effective air flow, better leaf drying, and healthier transplants.
- Remove and trash transplants that appear symptomatic.
- Hot water seed treatment is recommended for small-scale producers and seed savers. Refer to Appendix H (Disinfection and Treatment of Vegetable Seeds) in *Vegetable Production Guide for Commercial Growers* (ID-36) for seed treatment temperature and times.

Sanitation

- Use new or bleach-sanitized trays in transplant production.
- Avoid clipping transplants, which can worsen plant-to-plant spread of the black rot pathogen.

FIGURE 5. BLACKENING OF VEINS IS EVIDENT WHEN INFECTED CABBAGE HEADS ARE CUT.

FIGURE 6. SOFT ROTTING BACTERIA INVADE AND COLONIZE INFECTED PLANTS, RESULTING IN FURTHER DECAY AND LOSS OF HEADS. HOLES IN LEAVES ARE THE RESULT OF CATERPILLAR FEEDING.



FIGURE 6

- Do not purchase transplants that have been clipped.
- Do not handle plants or work in fields when plants are wet to reduce the risk of pathogen spread.
- Destroy crop residue by disking or deep-plowing soon after harvest.

Crop rotation

- Rotate crucifers with crops that are not susceptible to black rot.
- Do not plant cruciferous crops in the same field or garden area for 3 to 4 years.

Weed and Insect management

- Manage weeds, especially those in the crucifer family (see TABLE 2).
- Manage insects, especially caterpillar or chewing insect populations.

Chemical Management

The effectiveness of chemical control for black rot has been inconsistent in university trials over the years. It is important to keep cultural practices and sanitation at the forefront of any disease management program.

- The spread of black rot in fields may be slowed in some instances through applications of fixed coppers. These materials are inexpensive and are available to both commercial producers and residential gardeners.
- Refer to the University of Kentucky production guides listed below for products and rates.

TABLE 1. CRUCIFER CROPS COMMONLY AFFECTED BY BLACK ROT IN KENTUCKY.

Common Name	Scientific Name
Broccoli	<i>Brassica oleracea</i> var. <i>italica</i>
Brussels sprouts	<i>Brassica oleracea</i> var. <i>gemmifera</i>
Cabbage	<i>Brassica oleracea</i> var. <i>capitata</i>
Cauliflower	<i>Brassica oleracea</i> var. <i>botrytis</i>
Chinese cabbage	<i>Brassica rapa</i> var. <i>chinensis</i>
Collards	<i>Brassica oleracea</i> var. <i>viridis</i>
Kohlrabi	<i>Brassica oleracea</i> var. <i>viridis</i>
Mustard greens	<i>Brassica juncea</i>
Radish	<i>Raphanus sativus</i>
Rutabaga	<i>Brassica napus</i> var. <i>napobrassica</i>
Turnip	<i>Brassica rapa</i> var. <i>rapa</i>

TABLE 2. CRUCIFER WEEDS THAT CAN SERVE AS HOSTS TO THE BLACK ROT BACTERIUM.

Common Name	Scientific Name
Birdsraps mustard	<i>Brassica rapa</i>
Black mustard	<i>Brassica nigra</i>
Hairy whitetop	<i>Cardaria pubescens</i>
Hedge mustard	<i>Sisymbrium officinale</i>
Indian mustard	<i>Brassica juncea</i>
Shepherdspurse	<i>Capsella bursa-pastoris</i>
Shortpod mustard	<i>Hirshfeldia incana</i>
Swinecress	<i>Coronopus didymus</i>
Virginia pepperweed &	<i>Lepidium</i> spp.
Wild radish	<i>Raphanus raphanistrum</i>

ADDITIONAL RESOURCES

- Home Vegetable Gardening in Kentucky, ID-128 <http://www2.ca.uky.edu/agcomm/pubs/id/id128/id128.pdf>
- Vegetable Production Guide for Commercial Growers, ID-36 <http://www.ca.uky.edu/agc/pubs/id/id36/id36.pdf>

- Managing Black Rot of Cabbage and other Crucifer Crops in Organic Farming Systems <https://articles.extension.org/pages/29925/managing-black-rot-of-cabbage-and-other-crucifer-crops-in-organic-farming-systems>

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