

# Clubroot of Crucifers

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Most cultivated crops that belong to the crucifer family are susceptible to clubroot, a disease caused by the soil-borne fungus *Plasmodiophora brassicae*. Cabbage, cauliflower, broccoli, radish, turnip, mustard and rape are all susceptible to the disease, which gets its name from the severely misshapen or club-shaped roots caused by the fungus.

## Symptoms

Infected plants have yellowish, sickly leaves or green leaves that wilt on hot days (Fig. 1). Young plants may die and older ones fail to produce marketable heads. Roots of such plants are much enlarged and malformed (Fig. 2). The malformations vary in size from very small swellings on smaller roots to large, club-shaped masses that later turn black, decay and produce disagreeable odors. Clubroot galls can usually be distinguished from galls caused by the root knot nematode by their more spindle-shaped or oblong form. Root knot galls are usually more spherical and are generally not as large as clubroot galls.



Fig. 1. Clubroot-infested field showing stunted and discolored plants.  
(Photo by M. A. Hansen)



Fig. 2. Cabbage root system showing distortion typical of clubroot.  
(Photo by R. C. Lambe)

## Disease Cycle

*Plasmodiophora brassicae* gains entrance through root hairs and injured roots. After causing the roots to grow in an abnormally enlarged fashion, the fungus transforms into a mass of spores that are released into the soil upon decay of the host tissue. Spores of the fungus are spread in infested soil or water. The organism can remain viable in the soil for a period of 7-10 years. Spores are not carried on or in the seed.

Wet, cool, and acid soils are favorable for the development of clubroot. The optimum temperature for germination of spores and for disease development is 64°-77°F (18°-25°C). Infection can occur, however, when temperatures are as low as 54°F (12°C), or as high as 81°F (27°C).

## Control

### Cultural Control

- The most important step in control is to locate the plant bed in an area where diseased cabbage has not

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been grown and where infested soil cannot wash over it.

- Do not use any clubrooted seedlings as transplants.
- The application of lime to an infested seed bed will reduce the severity of root galling. If cabbage is to be planted in a field known to be infested with clubroot, lime the soil to pH 7-7.2 at least six weeks prior to planting. Hydrated lime appears to be more effective in reducing the severity of clubroot than ground limestone. The correct amount of lime to use can be determined by a soil test. Note that infected, symptomless plants that are transplanted to acid soil will develop symptoms of the disease.
- Eradicate weeds belonging to the mustard family.
- Provide and maintain well drained soil.
- To reduce the risk of clubroot occurrence in fields that have not had the disease, grow crucifers on the same soil no more than once every 3-4 years.
- In fields where the disease has occurred, rotate cruciferous crops with unrelated crops for a period of 7-10 years. Each time cabbage is planted in the rotation, hydrated lime should be applied.
- Avoid transporting infested soil on shoes or equipment.

## Chemical Control

- PCNB (e.g. Terraclor 75% WP) can be applied in transplant water at a rate of 6 lbs. per 100 gallons of water. Approximately 1/3 pint should be applied per plant. This treatment is not registered for use on turnips, collards and kale.

## Resistance

- The occurrence of many races of the fungus has made development of resistant cultivars of crucifers difficult. No resistant cultivars of cabbage are available. Cruciferous plants are divided roughly into the following four classes according to their susceptibility to clubroot:
  - **Most Susceptible:** cabbage, Chinese cabbage, brussels sprouts.
  - **Moderately Susceptible:** rape, black mustard, some turnip and radish varieties.
  - **Very Resistant:** winter cress, horse-radish, shepherd's purse, garden cress, and some radishes.

Refer to the current *Virginia Pest Management Guide for Home Grounds and Animals* (VCE Publication 456-018), <http://www.ext.vt.edu/pubs/pmg/>, for details on the proper use of pesticides.

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