

## Cabbage club root (283)

### Common Name

Club root

### Scientific Name

*Plasmodiophora brassicae*. It is not a fungus; it is in a separate kingdom called Protista, and is in a group known as *rhizaria*. There are many club root strains.

### Distribution

Asia, Africa (restricted), North, South and Central America, the Caribbean (restricted), Europe, Oceania. It is recorded from Papua New Guinea (highlands), and Samoa.

### Hosts

All members of the cabbage family (Brassicaceae) are susceptible, including brassica weeds (e.g., shepherd's purse). Some ornamentals are also hosts (e.g., wallflowers, stocks, aubretia). Chinese cabbage, head cabbage, broccoli, Brussels sprout and turnip are very susceptible, cauliflower is less susceptible.

### Symptoms & Life Cycle

The soilborne organism that causes the disease is in a group that contain single celled amoebae. The leaves of infected plants turn pale green to yellow (sometimes purplish), wilt, even when the soil is moist, and then rot (Photos 1&2). If infection occurs early, plants become stunted; if later, the heads do not develop to marketable size. Roots become swollen, distorted, and club-shaped - hence the name - and fine roots are few (Photo 3). The damage to the roots prevents the uptake of water. Later, the clubbed roots disintegrate as they are invaded by soft rot-causing bacteria. Plants may die.

Ideal conditions for the disease are (i) soils which are acid (i.e., below pH 7), (ii) soils with high moisture, (iii) temperatures of 20-25°C, and (iv) a host which is susceptible.

The life cycle starts when chemicals from roots of plants in the cabbage family trigger the germination of resting spores near the soil surface; these spores release smaller spores ('zoospores') that 'swim' in soil water, finding their way to the root hairs. Once there, they form a cell with many nuclei, called a 'plasmodium'. What happens next is not well known, but it is thought that more zoospores are formed in the roots causing the roots to produce the characteristic swellings - the galls, as well as infecting the roots of plants nearby. As the roots decay, resting spores form and are released into the soil, where they can remain viable for 10 or more years.

Spread of the disease occurs when spores are moved by water through the soil, and in surface runoff, and in soil on farm machinery and footwear. Over long distances, spread occurs in the roots of infected seedlings. Survival of the spores occurs in the soil and in crop debris.

### Impact

It is an important disease and can cause losses wherever it occurs, but most damaging in temperate regions and tropical highlands. Once soil is infested, it is very difficult to get rid of it as the thick walled spores last for many years. High annual crop losses are reported in Europe, USA, Japan, Taiwan and Australia. In Australia, losses of brassica crops are at least 10% annually.

The disease can build up to high levels over the years, sometimes resulting in total loss of the crop.

### Detection & inspection

Look for wilting plants with pale green/yellowish leaves. Look for the club or spindle shaped swollen roots, which are characteristic of the disease.



Photo 1. Cabbage plants wilting from infection by club root, *Plasmodiophora brassicae*.



Photo 2. Leaves yellow, wilt and rot due to club root, *Plasmodiophora brassicae*.



Photo 3. Galls on the roots typical of infection by club root, *Plasmodiophora brassicae*. Note the lack of fine roots.

## Management

### QUARANTINE

Once fields become infested with club root, it is extremely difficult to eradicate and expensive to manage. Where it is not yet present, every effort should be made to keep it out. Where it is already present, but not widely distributed, controlling its further spread is also important.

### CULTURAL CONTROL

#### Before planting:

- Always use plants produced under official certification schemes if available.
- If club root is present in a field, apply hydrated lime (Ca(OH)<sub>2</sub>) to the soil to raise the pH to 7.1-7.2. The amount to apply is 500-1500 kg per ha, depending on the type and pH of the soil. Note, too, that potato scab is made worse if planted after crucifers in land where lime has been added (**see Fact Sheet no. 293**). Get advice from government services.
- Apply boron to the soil (in addition to the lime) as borax at 20kg/ha, because raising the pH of coarse textured soils can lead to boron deficiency. (If possible, obtain advice from government services.)
- Follow good nursery practices (if you are raising your own seedlings):
  - Clean seedling trays by dipping them in household bleach (1 part bleach to 9 parts water) for 15-20 minutes, rinse and dry.
  - Raise nursery plants in soil-less potting mix, or pasteurised soil mixes.
  - Keep nursery areas at distance from fields where cabbage (and other brassica) crops are grown.
- Improve field drainage; for example, make raised beds.
- Plough fields deeply to bury debris infested with spores.

#### During growth:

- Carefully clean machinery, wheelbarrows, tools, and footwear of soil to prevent the introduction of club root to disease-free fields. Make sure the equipment is cleaned again after use if the field is suspected of having club root.
- Weed, especially those in the cabbage family.
- Avoid overwatering.

#### After harvest:

- Practice crop rotation so that there is a 3-year gap (preferably 5-7 years) between susceptible brassicas grown on the same land.
- Do not compost infected plants, and do not use manure from animals that have been fed debris remaining after harvest.

### RESISTANT VARIETIES

There are varieties of Chinese cabbage, head cabbage, Brussels sprout and cauliflower, with resistance to club root; check to see if they are available locally. The presence of many strains makes breeding very difficult, and for some crops resistance break down occurs quickly.

### CHEMICAL CONTROL

There are no chemicals available to smallholders for the control of this disease.

AUTHOR Grahame Jackson

Information from *Diseases of vegetable crops in Australia* (2010). Editors, Denis Persley, et al. CSIRO Publishing; and CABI (2019) *Plasmodiophora brassicae* (club root). Crop Protection Compendium. (<https://www.cabi.org/cpc/datasheet/41865>); and Lancaster R (2018) Managing clubroot in vegetable brassica crops. Agriculture and Food. Department of Primary Industries and Regional Development. (<https://www.agric.wa.gov.au/broccoli/managing-clubroot-vegetable-brassica-crops>). and from Grabowski MA (undated) Department of Plant Pathology, NC State University. (<https://projects.ncsu.edu/cals/course/pp728/Plasmodiophora/Plasmodiophora.html>). Photos 1&3 Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org.

Produced with support from the Australian Centre for International Agricultural Research under project PC/2010/090: *Strengthening integrated crop management research in the Pacific Islands in support of sustainable intensification of high-value crop production*, implemented by the University of Queensland and the Secretariat of the Pacific Community.

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