

Clubroot disease of oilseed rape and other brassica crops



SUMMARY

- **Clubroot is a serious disease of oilseed rape and horticultural brassicas**
- **It is of increasing importance in oilseed rape grown in short rotations**
- **Breakdown of resistance to the oilseed rape variety Mendel has been reported in the UK**
- **The threat from clubroot will increase if oilseed rape is grown more widely for biofuels**
- **Clubroot requires careful management by a combination of rotation, variety and liming**

Introduction

Clubroot is the most destructive disease of brassica crops worldwide, but it remains, one of the most difficult of diseases to control.

Clubroot can affect all brassica species including broccoli, Brussels sprouts, cabbage, cauliflower, swede, turnips, radish and oilseed rape (OSR). Cruciferous weeds, e.g. shepherd's purse and charlock, are also susceptible. It has even been found inside the roots of non-cruciferous species such as grasses, although it will not cause galls in these non-hosts. However, this raises the question whether it can ever truly be eradicated from an area once present.

It is an obligate pathogen, i.e. cannot be grown outside of a susceptible host. In a susceptible host, roots are infected by spores which gain entry to root hairs and then other root cells where the pathogen multiplies and causes the formation of tumours or galls on the roots (Fig. 1). These galls destroy the normal root architecture, such that water and nutrient uptake are severely inhibited, leading to yield loss. The galls are fleshy and easily decomposed after the crop matures, leading to release of pathogen resting spores into the soil. The resting spores have tough cell walls and can remain viable in soils for 20 years or more. The effects on the crop are worse in mid-summer when temperatures are high and under drought conditions.



Fig 1. Symptoms on calabrese roots

Clubroot is first seen in patches in the field, often associated with hollows where there is poor drainage and perhaps higher clay content to the soil. The disease is encouraged by high temperatures of 20 – 24 °C, high soil moisture and acid soil conditions of pH 6.5 and below. Swedish research on OSR showed that 10 – 20% of the crop affected gives 5 – 10% yield loss, whilst 100% of the crop affected gives 50% yield loss.

The disease has shown an alarming increase in OSR in the UK over the last two years, probably due to earlier drilling into warm, wet soils. This earlier drilling has been encouraged by warmer temperatures and higher rainfall over the last two years, indicative of our changing climate.

Disease management

Prevention

If you don't have clubroot on your farm, do everything possible to keep it that way. The disease is spread by moving contaminated soil containing resting spores from one area to another. If working in an infested field:

- As a minimum, scrape or knock soil from footwear, tools and other equipment. This includes nets and fleeces used for horticultural brassicas (it is not practical or necessary to wash these).
- Power wash machinery.
- Australian research has shown that the most effective biocides against resting spores are 70% ethanol or 70% methylated spirits. Clearly, these are impractical for most purposes except possibly for horticultural plug trays. Commonly used disinfectants such as Iodol FD (6%), Jet 5 (8%) and sodium hypochlorite (20%) are effective only if the resting spores remain in contact for a minimum of 20 mins. Resting spores can even survive autoclaving.
- Do not allow stock that have grazed on infested fields (horticultural stubbles, turnips) to graze on clean fields because resting spores can survive the digestive tract. Do not spread manure from animals fed on infested fields onto clean land.

Soil test

Arrange for a soil test for clubroot through your agricultural adviser and, if the pathogen is present, either do not grow a brassica or choose a resistant cultivar (see below).

Rotation

Swedish research in 1996 showed that clubroot has a half-life of 4 years and was undetectable after 17 years. Other reports claim that the resting spores can survive longer than 20 years. Continuous brassica production in an infested field will cause multiplication of inoculum via the release of millions of resting spores from rotting galls. Ideally, rotations between brassica crops should be 4 to 5 years, which may not be practicable, although 3 years is satisfactory. Cereals, peas and beans are good break crops. Growing a resistant cultivar such as Mendel is not a break (see below). Grass may not be a good break crop because the pathogen can infect and survive in the roots without galling, but there is insufficient evidence to recommend one way or the other for grass. Ensure that cruciferous weeds and volunteer OSR are controlled.

Drainage

Good soil drainage and aeration will reduce the pathogen, which needs moisture to spread. Growing horticultural brassicas on ridges such as those for growing potatoes has been shown to reduce clubroot in Australia.

Drilling date for OSR

Early sowing into warm, moist soils encourages disease; delayed drilling can help, but care is needed in northern regions with winter kill which may offset any advantages.

Liming and calcium supply for horticultural brassicas

Recent Defra research carried out by SAC and ADAS with calabrese has shown that the most effective control for mild to moderate levels of clubroot is the application of lime; although lime has been used for a long time, the type of lime and timing of application need careful consideration. Where disease is severe, nothing will help except a long rotation with a non-cruciferous crop.

Lime application decreases clubroot via the addition of calcium ions (Ca^{2+}) and raising soil pH. Both are essential for control – it is possible to raise pH without raising calcium and to raise calcium without raising pH, but these options are not effective.

The best products from the Defra experiments were calcium carbonate (ground limestone or sugarbeet waste lime, sold as Limex by British Sugar) and calcium oxide (quicklime). These products must be very finely powdered (Fig 2) so that they act quickly in the soil, although application of powders can create health and safety problems in windy conditions. Care is needed with the application and storage of calcium oxide as it heats rapidly when in contact with water. Granular calcium oxide was not effective in the trials.



Fig 2. Lime application to the soil is one of the most effective treatments for mild to moderate disease. Calcium carbonate (ground limestone or sugarbeet waste lime, marketed as Limex by British Sugar) and calcium oxide (quicklime) are suitable products but must be finely ground, in order to obtain a rapid release of Ca^{2+} and to raise pH, to achieve maximum effect.

If soils are acidic, the strategy should be to raise soil pH. If soils are already alkaline, as in many horticultural areas where lime is applied each year, the strategy should be to raise soil calcium levels. Aim for pH 7.5 and above and 8,000 to 10,000 mg/l available Ca²⁺ (by soil analysis): this can be achieved by adding 4-12 t/ha calcium carbonate as ground limestone or Limex, or 2-6 t/ha calcium oxide, depending on soil type and starting pH level (by soil analysis). Clay or organic soils will require higher application levels.

Apply lime as close as possible to planting the crop, ideally 0-7 days before the crop is planted, as evidence shows that a calcium and pH burst in the soil early in the crop's life gives the best results.

Trials in Australia and Scotland with banding lime into a 20 cm strip and worked 10 cm into the soil, with the crop in the middle of the strip, gave good results and reduced the amount of lime applied overall. Even soils with high starting pH's, eg, 7.5 in some Lincolnshire soils, require further applications of lime to achieve high calcium levels and to obtain the calcium burst at planting.

With horticultural brassicas it is cost-effective to apply lime to the whole crop. With OSR consider spot treating affected patches.

Calcium cyanamide: this product is marketed as the fertiliser Perlka, is widely used in horticultural brassicas particularly in the EU, and can be as effective as lime application. Perlka contains 20% N and 50% lime as calcium oxide, therefore reductions in nitrogen and lime applications can be made. It acts via a soil sterilant effect. It is an environmentally friendly product as it is broken down to harmless products by microbes. Defra trials on calabrese have shown good control in mild to moderate clubroot with a base dressing of 500 kg Perlka at planting, followed by 500 kg 14-21 days later, when using module transplants. Care is needed on drilled crops such as OSR as it can kill seedlings and needs to be applied in advance of drilling.

Liming and calcium supply for oilseed rape

New research will determine the practical application of these lime products to reduce clubroot in oilseed rape prior to sowing. Care should be taken at present since crop damage can occur if they are applied at the time of sowing.

Boron

Increasing the boron nutrition of the crop can help reduce clubroot but as boron is highly soluble and therefore easily leached, its effectiveness depends on regular application.

Pesticides

No pesticides are approved for use against clubroot in the EU. Some products approved for use in e.g. Australia, New Zealand and Japan have been tested experimentally in the UK and may lead to approval or off-label approval.

Resistant cultivars

Some resistant horticultural cultivars are available, eg, cauliflower 'Clapton' and white cabbage 'Kilaton', 'Kilaxy' and 'Tekila' (Fig 3). The resistant OSR cultivar 'Mendel' has been available to growers in the UK since 2003. All these cultivars are resistant to most common races of Pb; you may see some limited galling on the plants but these

are small and of no significance. However, there are reports of more serious disease in both clubroot resistant horticultural brassicas and in Mendel in the UK and mainland European crops. Most likely this is due to an increase in an aggressive race of Pb, in the case of Mendel, encouraged by close rotation with this cultivar on already infested land.



Fig 3. Resistant cultivars of some Brassicas are available. This is the resistant cauliflower cultivar Clapton (right) grown alongside the susceptible cultivar Fargo (left) on heavily infested land.

In order to protect this resistance into the future, it is important that resistant cultivars are integrated with other control measures. Grow resistant cultivars only where clubroot is a known problem, and widen the rotation such that a resistant brassica – including Mendel – is not grown on infested land more than 1 year in 4.

Testing soils for clubroot

Clubroot tests carried out at SAC Crop Clinic can help determine the presence and amount of clubroot in a field. The test takes six weeks to complete so it is important to sample fields in advance of sowing.

Time of sampling: Fields in which brassicas are to be sown or planted may be sampled at any time of the year, but samples are most conveniently taken when the soil is soft and any growing crop is small. As the test takes 6 weeks after setting up, fields must be sampled well in advance of sowing.

Sampling area: Five hectares agricultural brassicas (e.g. oilseed rape); 2 hectares or individual breaks for horticultural brassicas (e.g. calabrese).

Draw a map of the field and, if necessary, split it into 5 hectare blocks using features such as gates and trees as reference points. Sample each 5 hectare block separately. Gateways and wet hollows should be sampled separately as these areas are most likely to be heavily contaminated and could give a false clubroot rating to the main sampling area.

Sample size and pattern: Fifty cores should be taken from each sampling area to give a soil sample of 4.5 lb (2 Kg). The cores should be collected at regular intervals as the sampling area is traversed in a "W" or multi "W" pattern.

Sampling tools and sampling depth: A narrow bladed fern trowel or

auger should be used and the cores should be taken to a depth of 6-8” (15-20 cm). An auger will be essential where the soil is compacted. Remove excess soil from the sampling tools between different sampling sites.

All samples should be collected in heavy gauge polythene bags. Each bag should be tied as soon as it has been filled to prevent contamination. Label each bag separately giving the name of the farm and field or part-field.

Remember the validity of the clubroot test is determined primarily by the sampling procedure in the field.

Summary of management

Clubroot not present

Prevent infestation of clean land by

- Testing soil for clubroot infestation
- Avoiding transfer of contaminated soil
- Not grazing stock that have been on infested land

Clubroot present in horticultural brassicas

- Rotation: 1 in 5 best, 1 in 3 tolerable, 1 in 2 or continuous will increase problem
- Apply lime to raise soil pH to 7.5 and above and to raise calcium levels to 8,000 to 10,000 mg/l available Ca²⁺; apply lime overall for horticultural brassicas.
- Improve drainage
- Grow resistant cultivars but maintain rotation of 1 in 3-5 years
- Consider Perlka for horticultural brassicas

Clubroot present in oilseed rape

- Rotation: 1 in 5 best, 1 in 3 tolerable, 1 in 2 or continuous will increase problem
- Improve drainage
- Grow resistant cultivars but maintain rotation of 1 in 3-5 years
- Delay drilling date for OSR, but take care with winter establishment in Scotland
- Practical use of lime prior to oilseed rape sowing is being investigated

Author:

Simon Oxley

Senior Researcher

(Plant Pathology)

SAC

Kings Buildings

West Mains Road

Edinburgh

EH9 3JG

Phone 0131 535 4094

Fax 0131 535 4144

simon.oxley@sac.ac.uk