

Clubroot Management Plan

Developed by the Saskatchewan Clubroot Committee
Revised July 2024

Clubroot Overview

What is clubroot?

Clubroot is a soil-borne disease caused by a microorganism, *Plasmodiophora brassicae* (*P. brassicae*). Clubroot affects the roots of host plants, which include cruciferous field crops such as canola, mustard, camelina, oilseed radish and taramira and cruciferous vegetables such as arugula, broccoli, Brussels sprouts, cabbage, cauliflower, Chinese cabbage, kale, kohlrabi, radish, rutabaga and turnip. Cruciferous weeds (e.g., stinkweed, shepherd's purse, wild mustard) can also serve as hosts for the clubroot pathogen.



Clubroot infected canola root with intact clubroot galls.

What are the symptoms of clubroot?

Clubroot infection is easily identified by plant roots with a swollen or club-like appearance (clubroot galls). These swollen and deformed roots have a reduced ability to absorb water and nutrients, leading to stunting, wilting, yellowing, premature ripening and shriveling of seeds. The cause of these above-ground symptoms can be confirmed by digging up suspect plants to check roots for gall formation. Clubroot affects the yield and quality of several crops, described above, to a similar degree as other diseases affecting water and nutrient uptake and its impact depends on soil conditions and the growth stage of the crop when infection occurs. Early infection of seedlings tends to result in greater yield losses. Infection by the clubroot pathogen and disease development are favoured by warm soils, high soil moisture and low soil pH.

How does clubroot spread?

Infected roots will eventually disintegrate, releasing resting spores into the soil, which may then be transported by wind, water erosion, animals/manure, shoes/clothing, vehicles/tires, or field equipment. The clubroot pathogen, in the form of resting spores in the soil, can be moved any way that soil can be moved. Activities that move large volumes of soil (such as on agricultural or industrial field equipment) between areas or regions are considered to have the highest risk.

The pathogen population (spore numbers) in the soil will decline over time when non-host crops are grown, but a small proportion can survive in soil for up to 20 years.

Clubroot is primarily a soil-borne disease; it does not infect the seed but it may be found in soil attached to the seed (including seed potatoes) or other plant parts. If you are growing potatoes, source your seed potatoes from regions where clubroot has not been confirmed or suspected. Clubroot does not present any legal phytosanitary issues for trade.



Decomposing clubroot gall.

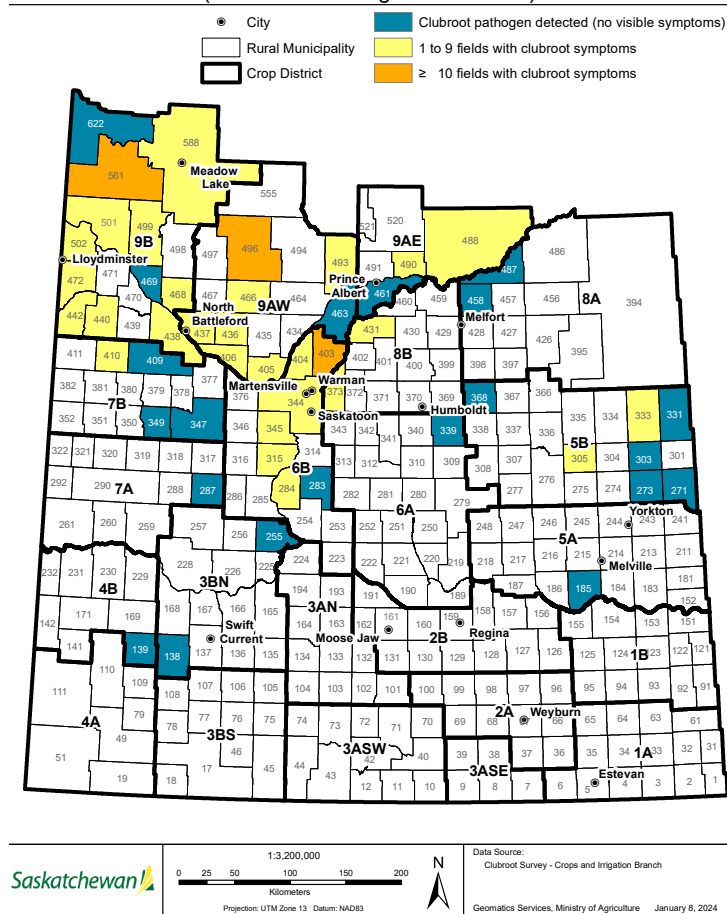
Where has clubroot been found in Saskatchewan?

In Saskatchewan, the Ministry of Agriculture monitors commercial canola fields for clubroot symptoms and or the presence of the clubroot pathogen through the clubroot monitoring program. The presence of the clubroot pathogen can be detected through DNA-based soil testing, which may allow for the detection of the pathogen before visible symptoms appear in the field. Formal confirmation of the disease in Saskatchewan requires visible symptoms on the roots of infected plants.

The clubroot pathogen was first detected through the ministry's canola disease survey in 2008, when one soil sample collected from a commercial canola field in west-central Saskatchewan tested positive for the clubroot pathogen. The clubroot pathogen was detected in a second field in west-central Saskatchewan in 2012. In both cases, there were no visible symptoms of clubroot in the field.

In 2011, clubroot symptoms were identified in two private canola industry research sites located in north-central Saskatchewan.

Clubroot Distribution in Saskatchewan (cumulative testing 2008 to 2023)



To date, visible symptoms of clubroot have been identified in 82 commercial canola fields in Saskatchewan. In addition, the clubroot pathogen has been detected at low levels using DNA-based testing in at least one field in 20 rural municipalities (RMs) where visible symptoms of clubroot have not yet been confirmed.

All findings of clubroot and the clubroot pathogen from 2008 to 2023 have been used to develop the [Saskatchewan clubroot distribution map](#). This map provides a regional assessment of clubroot risk. Producers and groups working on agricultural land should consider the following questions when using the Saskatchewan clubroot distribution map to assess clubroot risk:

- Have visible symptoms of clubroot been confirmed in the RM?
- Has the clubroot pathogen been detected in the RM?
- Have either visible symptoms of clubroot or the clubroot pathogen been detected within the crop district or in close proximity to the RM?

If the answer to any of these questions is yes, that field or area should be considered to have an increased risk of clubroot. In response to this increased risk, implementing proactive clubroot management and prevention strategies is encouraged.

Best Practices for Prevention and Management

1. Extend your crop rotation.

Aim for a four-year rotation (three-year break between host crops), even when clubroot-resistant varieties are used. A minimum of a three-year rotation (two-year break between host crops including clubroot-resistant varieties) should be followed. Longer crop rotations are encouraged for fields with high disease severity and high pathogen levels (resting spore concentrations) and for those wishing to further reduce the impact of clubroot.

- Crop rotation will not prevent the introduction of the clubroot pathogen to fields that are free of the pathogen, but it will restrict clubroot development by limiting the increase of clubroot pathogen population (resting spores) in the field, maintaining the effectiveness of clubroot-resistant varieties while also alleviating the impact of other plant pathogens.

2. Use clubroot-resistant varieties, whether or not clubroot has been identified on your farm or within your community.

- Resistance to clubroot does not mean full immunity to the disease. Tight rotations of resistant varieties may lead to an increase in the levels of and spread of new clubroot pathogen pathotypes that the variety has no resistance to, thus breaking down the effectiveness of the variety's resistance to clubroot. To prevent this from happening, clubroot varieties should be grown in extended rotations with a minimum of two years between host crops.

3. Control canola volunteers and brassica weeds, such as wild mustard, stinkweed and shepherd's purse, throughout the crop rotation. Controlling susceptible volunteers and weeds in non-host crops will help to ensure reducing soil spore loads.

4. Minimize the movement of contaminated or potentially-contaminated soil to non-contaminated regions by:

- Restricting entry of vehicles, machinery or industrial equipment into fields unless they have been properly sanitized. Ask questions about where the equipment is from and what sanitation measures have been used before the equipment left the infested area, dealer or auction site (prior to entering the field or farm).
- Cleaning steps may include: removal of crop debris and soil, washing of equipment with a powerwasher using hot water or steam and misting with a bleach solution (two per cent sodium hypochlorite solution) for 20 to 30 minutes, followed by an optional additional rinse with water.
 - Sodium hypochlorite is the active ingredient in bleach that is used as a disinfectant for clubroot.
 - Bleach products range in the concentration of sodium hypochlorite and typically contain between approximately four and eight per cent. As a result, different dilutions will be needed for different bleach products to create a two per cent sodium hypochlorite disinfectant solution. For example, Clorox disinfecting bleach contains six per cent sodium hypochlorite. To make 750 mL of a two per cent sodium hypochlorite, you would need to add 250 mL of the Clorox disinfecting bleach and 500 mL of water.
 - The concentration of sodium hypochlorite will decrease during storage. Purchase bleach in small quantities and use it relatively quickly (within a few months). If you are storing bleach, store it in a cool, dry location.
 - Organic matter will inactivate the sodium hypochlorite. If using a two per cent sodium hypochlorite solution to disinfect foot wear or other equipment, refresh the solution frequently or as it becomes dirty to maintain a two per cent solution.
 - The level of sanitation used should be representative of the risk associated with the particular activity.

- Consider creating a separate exit as far as possible from the field entrance to reduce the movement of the pathogen out of an infected field. If possible, create the exit on higher ground to further reduce the amount of soil leaving the field. Testing the new exit to ensure that clubroot or the clubroot pathogen is not present is also a good idea.
 - Consider restricting unwanted vehicles entering your field by posting “no trespassing” and “no hunting” signs.
 - Use direct seeding, zero-tillage and other soil conservation practices to reduce erosion.
 - Resting spores can be moved in soil transported by wind or water erosion. Reducing the amount of tillage will reduce the spread of the organism within the field and to other fields.
 - Clubroot spores can be found in soil particles on seed and may survive livestock digestion. Avoid use of seed or seed potatoes with earth tag, straw, hay, silage and/or manure from infested or potentially infested areas. The risk of spreading clubroot through contaminated plant material or manure is much lower than through transporting contaminated soil on field equipment and vehicles.
5. **Scout crops**, including both susceptible and resistant varieties, regularly and carefully. Early detection is important for clubroot management. Symptoms can be quite severe below ground while remaining healthy above ground. As a result, randomly pulling plants at the field entrance is suggested, even if the plants look healthy.
 - Scouting should include a full plant assessment at field entrances, low areas or areas with above-ground symptoms including wilting (will be more apparent in hot weather), stunting, yellowing and premature ripening. Plants should be dug and pulled up and the roots examined for the presence of clubroot galls.
 - Field entrances and approaches are likely to be contaminated with the clubroot pathogen first. Therefore, symptoms will often appear there first.
 6. If the clubroot infestation is only near the current field access or a limited area of the field, consider seeding that area to a perennial grass and **create a new access point** as far as possible from the contaminated area. This will allow time for the pathogen levels to decrease while also minimizing the movement of contaminated soil on equipment and via wind or water erosion.
 7. Seed canola early. Early crop establishment has been shown to reduce the effects of clubroot if it is present in a field.

Precautions to take when conducting research

To minimize the risk of accidental release of *P. brassicae*, appropriate containment guidelines should be followed when conducting research involving *P. brassicae* in greenhouses, growth cabinets or laboratories. Because clubroot is not widespread in Saskatchewan, this particular kind of field plot research should not be conducted in the province. Preventative measures should also be followed when conducting disease surveys in Saskatchewan.

Contact the Saskatchewan Clubroot Committee Chair (contact information below) for a copy of the current recommendations for managing risks associated with clubroot research in Saskatchewan.

Clubroot surveillance and testing

The best time to scout for clubroot is later in the growing season, around late July or August, since clubroot symptoms take approximately six to eight weeks to develop. The best places to scout for clubroot include the field entrance, low spots, high-traffic areas, natural water runs or areas with premature ripening. When possible, mark or record the specific sample spot so it can be monitored for changes over time. Recording the GPS coordinates by dropping a pin on a map on your phone is a handy option.

DNA-based testing (at an approved laboratory) can be used to detect the clubroot pathogen in soil collected from the field. It is important to note that the occurrence of the clubroot pathogen can be variable throughout a field. Therefore, a negative DNA test only reflects that the pathogen could not be detected in the area sampled. A false negative can occur when the pathogen levels are lower than the detection limit of the test, or when the pathogen is absent in the area where the soil is collected but present in another area of the field. To reduce the likelihood of a false negative, it is important to collect soil from the areas of highest clubroot risk in the field.

This method of testing can provide early detection of the clubroot pathogen at levels lower than those required for obvious disease symptoms to develop under field conditions. Soil samples can be submitted for DNA-based testing at an approved laboratory to detect the clubroot pathogen at low levels. Soil samples should be collected later in the season (just before or after harvest) or in the spring following a canola crop, but soil should be dried after collection.

When sampling or scouting for clubroot, do not drive into the field or field entrance, but park on the road. Follow sanitation procedures if visiting more than one field. Dispose of or clean and disinfect footwear and tools that come in contact with the soil. Keep records for all fields visited.

In fields that have been confirmed to have clubroot, sampling can be expanded in intervals of 150 metres from the field entrance or other location of the initial finding, in order to determine the extent of infestation.

Plant sampling and field scouting procedure

1. **Collect 20 plants at each of five sites** in the field, for a total of 100 plants and observe for disease symptoms. Each of these five sites needs to be at least 20 metres from each other and at least 20 metres from the field edge.
2. **Monitoring for clubroot should be focused on areas of high clubroot risk** in the field. These include field entrances, high traffic areas, low spots, areas with low pH and natural water runs.
3. If patches of premature ripening are observed, particularly in field entrances or corners, dig or pull up plants, shake off excess soil and **inspect roots for the presence of galls**. If clubroot is suspected, cut off stems and collect root samples.

Air-dry root samples in double paper bags or freeze the samples in a double Ziploc bag (samples must remain frozen if this option is chosen) and send them to the Ministry of Agriculture's Crop Protection Laboratory at 1610 Park St, Regina, SK, S4N 2G1. You may mail, courier or drop off samples in person. If the visual diagnosis is positive, root samples will be forwarded to an accredited laboratory on behalf of the municipality or the person who submitted the samples.

Soil sampling procedure

1. Soil samples should be comprised of a mixture of small scoops (approximately one quarter to one third of a cup each) of soil taken at each of five sites visited in one field. To reduce the risk of false negatives, take clubroot soil samples from areas of high clubroot risk in the field. Keep each of these five sites at least 20 metres from each other and at least 20 metres from the field edge.
2. Clear away residue from the soil surface and take samples from the rooting zone (five to 10 cm deep) as explained above, (total approximately two cups from all five sites combined).
3. Air-dry soil samples in paper boxes and send them to an approved laboratory for DNA testing.

For a list of laboratories providing clubroot testing, please visit clubroot.ca (click on Identify Clubroot) or contact the Crop Protection Laboratory in Regina. More information on clubroot soil testing can be found in the "Clubroot soil sampling on the Prairies" and "Interpreting a clubroot soil test" factsheets on saskatchewan.ca/agriculture.

Saskatchewan Ministry of Agriculture

- Co-ordinate efforts to monitor crops in the province for clubroot.
- Compile and distribute the Saskatchewan Clubroot Management Plan.
- Extend clubroot education to the agriculture industry and the general public, as well as provide information to the oil and gas industries, environmental companies, landscaping companies, equipment dealers and auction companies and custom applicators, seeders and harvesters.
- Assist growers in the development of a clubroot management plan for their farm.

Producers and Producer Groups

- Scout canola crops for clubroot symptoms and implement best management practices that adhere to the Saskatchewan Clubroot Management Plan.
- Producer groups including SaskCanola, the Saskatchewan Mustard Development Commission, the Saskatchewan Vegetable Growers Association and the Saskatchewan Seed Potato Growers' Association assist in educating Saskatchewan producers about clubroot prevention and management.
- Participate in voluntary soil testing program.
- The general locations of all clubroot confirmed fields (at rural municipality level only) are used to update the Saskatchewan Clubroot Distribution Map.
- Producers should clean and sanitize any used equipment that they wish to import into Saskatchewan, especially equipment from known clubroot infested regions.

Agricultural Retail Industry

- Help educate the Saskatchewan agriculture industry about clubroot and its management including the importance of clubroot resistant cultivars, rotation, and biosecurity.
- Take measures such as equipment cleaning to prevent the introduction of and minimize the spread of clubroot from infested areas.

Equipment Dealers, Auctioneers and Custom Applicators

- Help educate those purchasing equipment from infested areas (destined for Saskatchewan), as well as the custom application, seeding and harvesting industries about clubroot.
- Take measures such as equipment cleaning to prevent the introduction of and minimize the spread of clubroot from infested areas.

Oilfield, Gas, Road Construction and Other Companies Operating on Agricultural Land

- Help educate the Saskatchewan oil, gas and other field operators about clubroot.
- Take measures such as equipment cleaning to prevent the introduction of and minimize the spread of clubroot from infested areas.

Saskatchewan Clubroot Committee

- Provide a forum to represent the interests and views of Saskatchewan's agricultural research and production sectors, producer and other industry groups and municipal government regarding the management of clubroot.
- Provide consultation in the development of the Saskatchewan Clubroot Management Plan as well as evaluation and revision of the recommendations as required.
- Help educate the Saskatchewan agriculture, equipment, oil, gas and other industries about clubroot and the economic and agronomic impacts the disease poses.
- Be informed of the general location of all confirmed clubroot findings and will determine what extension materials should be developed to inform Saskatchewan producers of the clubroot situation in Saskatchewan.

Researchers and Funding Agencies

- Researchers should familiarize themselves with the recommendations for managing risks associated with clubroot research in Saskatchewan and use them to develop suitable measures for their unique research situation. Funding agencies should also be aware of these recommendations and may wish to consider the importance of containment protocols in research proposals when considering supporting clubroot projects in Saskatchewan. For a copy of these guidelines, contact Alireza Akhavan at 306-787-4671.

Saskatchewan Clubroot Committee

The Saskatchewan Clubroot Committee was developed as part of a provincial clubroot management plan to promote awareness and identify priorities for clubroot prevention and management. The membership includes representatives from the Saskatchewan Ministry of Agriculture, Saskatchewan Ministry of Environment, Saskatchewan Crop Insurance Corporation (SCIC), Saskatchewan Canola Development Commission (SaskCanola), Saskatchewan Wildlife Federation, SARM, Agricultural Producers Association of Saskatchewan (APAS), Canola Council of Canada, Agriculture and Agri-Food Canada (AAFC), Crown Corporations and industry organizations.

Regular communication with and representation to the Saskatchewan Clubroot Committee also includes Saskatchewan Ministry of Highways, Saskatchewan Ministry of Energy and Resources, Saskatchewan Auctioneers Association, Canadian Association of Agri-Retailers and private labs and agriculture companies. If you would like to participate in the Saskatchewan Clubroot Committee, please contact the Saskatchewan Clubroot Committee Chair.

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For more information:

- [Clubroot Scouting and Management Tips](#)
- [Interpreting a Clubroot Soil Test Results](#)
- [Crop Disease and Invasive Species Biosecurity Protocol](#)
- [Clubroot.ca \(Canola Council of Canada\)](#)