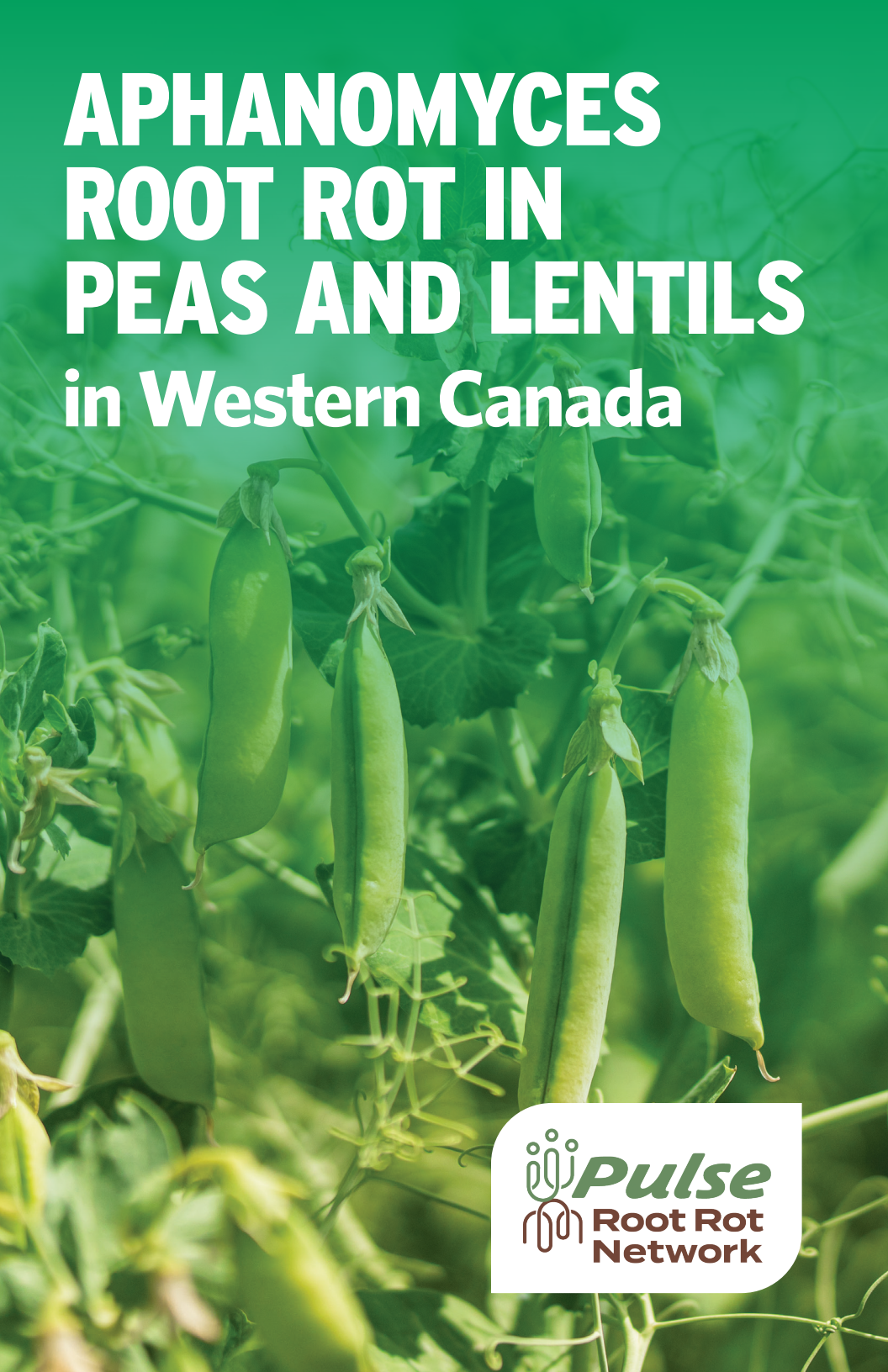
APHANOMYCES ROOT ROT IN PEAS AND LENTILS

in Western Canada



Pulse Root Rot Network

Root Rots

Root rot in peas and lentils is caused by a complex of diseases that affect the belowground portion of the developing plant, leading to poor-performing pulse crops. The organisms that cause the disease are seed- or soil-borne and can infect the plant at any stage of development. Unfortunately, once root rot has set in, there is nothing that can be done. Understanding the disease, identifying the risks for root rot infection, and thorough planning for prevention are the only current options.

Aphanomyces Root Rot

DNA testing conducted on root rots in Alberta, Manitoba, and Saskatchewan from 2014–2024 (see survey results on next page) shows that *Aphanomyces* is a common cause of root rots in pulse crops in the Prairies. *Aphanomyces* can infect at any time during the growing season and spores persist for many years in the soil, making it the most difficult cause of root rot to manage (and therefore the most serious among the root rot pathogens). While research is underway in Alberta, Manitoba and Saskatchewan, there is currently no reliable prevention or cure.

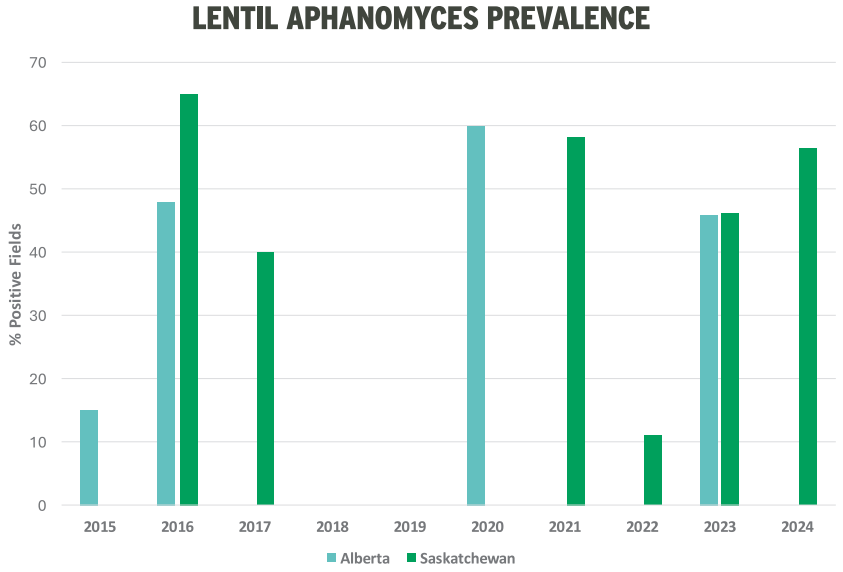
Aphanomyces root rot causes severe damage to the roots, causing infected plants to wilt and die prematurely. In wet years, high yield loss in peas has been observed under high *Aphanomyces* root rot infections.

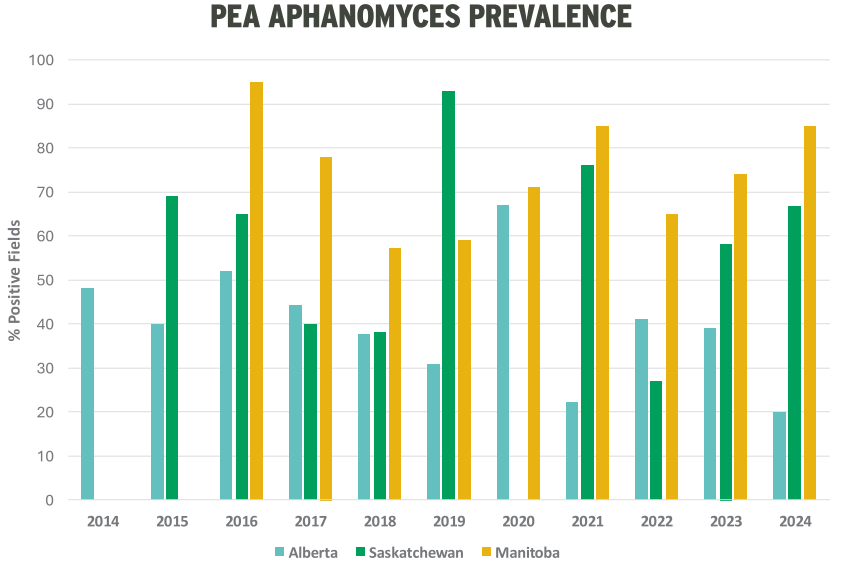
Aphanomyces root rot is caused by *Aphanomyces euteiches*, a highly specialized pathogen of legumes. While this pathogen has a number of legume host plants, peas and lentils are the most susceptible pulse crops to infection. Faba beans and sainfoin exhibit good partial (quantitative) resistance to *Aphanomyces*, and chickpeas are considered moderately resistant. Soybeans and fenugreek are both non-host crops to *A. euteiches*.

Susceptibility of dry beans and alfalfa to *Aphanomyces* root rot infection varies among the different varieties and market classes. Cicer milkvetch is also very susceptible to infection by *Aphanomyces*.

2014–2024 *Aphanomyces* Survey Results

Researchers in Alberta, Manitoba, and Saskatchewan have been conducting surveys to assess the presence of root rot and levels of severity.





Source: Syama Chatterton, Agriculture and Agri-Food Canada / Yong Min Kim, Agriculture and Agri-Food Canada

Risk Factors for Root Rot

Stress factors that delay germination, as well as slow emergence and growth of plants, contribute to an increased risk of root rot infection when the pathogen is present.

These include:

- Wet conditions
- Cool temperatures early in the season
- Shortened rotations
- Heavy-textured soils
- Soil compaction
- Nutrient deficiency
- Herbicide residues
- Low seed vigour

Key Facts

Plant roots and nitrogen-fixing bacteria need oxygen. When the soil is saturated, roots function poorly, and rhizobia activity is reduced, resulting in delayed, yellowing growth.

- Cool conditions slow seedling metabolism and root growth. This also slows mineralization of nitrogen from organic matter.
- Plants that are stressed or have low vigour are more susceptible to seedling diseases.
- Seed treatments are ineffective past the seedling stage and foliar fungicides will not work on root diseases.
- Root rots tend to be more severe under waterlogged conditions. However, root rots can occur even under ideal or drier moisture conditions.
- Crops can also appear yellow and stunted due to wet feet regardless of pathogen pressure.

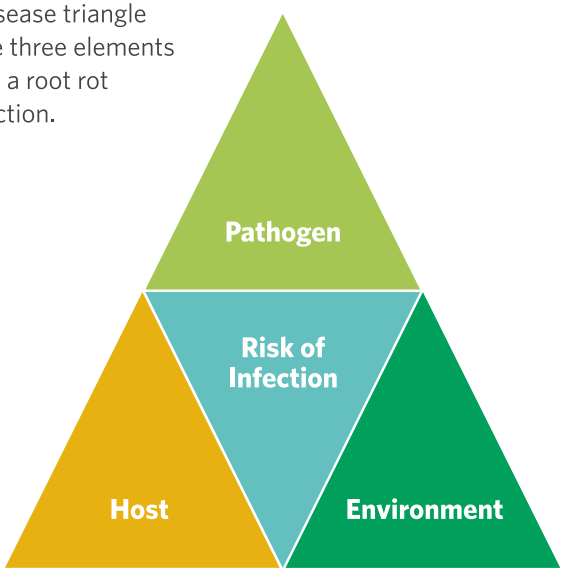
Heavy Disease Pressure

When a pathogen builds up in the soil due to conditions favourable for its development over consecutive seasons (such as waterlogging, warm temperatures, and tight rotations), the pathogen may continue to cause issues even when conditions return to “normal” or ideal for crop production.

More Than One Susceptible Host Crop

The root rot pathogen can infect various crops in the rotation or survive as a saprophyte (feeding on dead plant material) until the next susceptible crop is grown, and/or conditions are favourable for disease.

Right: The disease triangle illustrates the three elements necessary for a root rot complex infection.



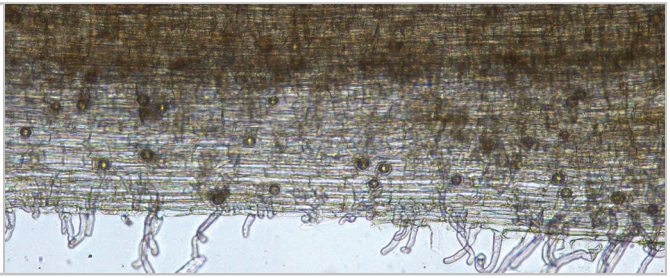
Right: Honey-brown discolouration of pea roots, characteristic of *Aphanomyces euteiches*. Other symptoms include yellowing and wilting of lower leaves, discolouration of roots (watery and honey-brown/caramel-coloured), poor lateral root growth with minimal root hairs, and pinching of the epicotyl that stops at the soil surface.

Source: Syama Chatterton, Agriculture and Agri-Food Canada

Symptoms & Crop Impact

Aphanomyces euteiches is classified as an oomycete, or water mould, and is not a true fungus. The resting spores, called oospores, are thick-walled and allow the pathogen to survive in the soil during harsh winter conditions.

Right: *Aphanomyces* oospores in pea.



Aphanomyces has been found to spread from the roots of a single infected plant to the roots of healthy neighbouring plants up to 18 cm away.

Roots of host plants infected with *Aphanomyces* root rot become soft and have a water-soaked, honey-brown or caramel-coloured appearance. Infections begin on the lateral roots, then spread to the main root, and eventually into the epicotyl, stopping where the green stem tissue begins. At this time, infected plants start to turn pale in colour and are especially noticeable beside healthy plants. Yellow areas in the crop may begin to appear, although distinct patches are not always visible, and healthy plants can be found right beside infected ones. As the season progresses and conditions remain favourable, the main root typically becomes colonized by other pathogens and turns dark brown to black.

The most severe symptoms and crop yellowing are seen when *Aphanomyces* is present alongside other pathogens, with *Fusarium* being the most common. Symptoms of *Aphanomyces* root rot are not always clear-cut because in most cases, a pathogen complex exists. It can be difficult to see the honey-brown root discolouration of *Aphanomyces* when *Fusarium* is also present. At advanced *Aphanomyces* root rot infection stages, only the vascular bundles remain, as the entire root system has decayed and plants are chlorotic, wilted, and will prematurely die.

Aphanomyces symptoms appear within 7–14 days after the first root infection, depending on soil moisture and temperature, and susceptible host plants can become infected at any growth stage. Even though root infections are favoured by wet conditions, the symptoms and yield impacts are most severe under warm, dry conditions after infection takes place.

Severe root rot caused by *Aphanomyces* impairs water and nutrient uptake in infected plants. Yield loss from *Aphanomyces* root rot can be difficult to assess

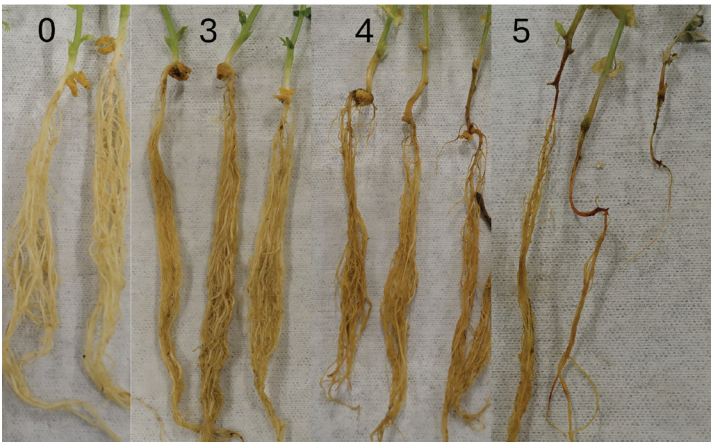
because of the numerous indirect effects it has on the crop and the timing of the initial infection.

Early-season infections cause plants to die prematurely, resulting in a direct and substantial yield loss. Later-season infections can delay crop maturity, thereby affecting harvest timing, and also weaken the plant stems, causing severe lodging and harvest challenges.

Research has reported reductions in both pod size and seed number, as well as decreased seed quality due to *Aphanomyces* root rot. A thin crop stand can also pose challenges for weed management, as weed competition can negatively impact yield, reduce harvestability, increase dockage at the elevator, and contribute to the weed seed bank in the soil.

High soil moisture caused by excessive rainfall, poor soil drainage, soil compaction, and/or heavy clay soils (35–40% clay content) will favour *Aphanomyces* root rot development, although it can occur in any soil type.

Aphanomyces Scale



Examples of the *Aphanomyces* root rot rating scale:

0 = No symptoms.

3 = Start to see discolouration of crown/epicotyl. 50–75% of the roots have browning.

4 = Honey-brown epicotyl/crown area. 100% of the roots are brown and the first leaves are dying off.

5 = Plant is dead. Decay and loss of all roots and usually only the vascular string remains. Honey-brown epicotyl/crown area.

Source for photos on pages 6 and 7: Syama Chatterton, Agriculture and Agri-Food Canada

Root Rot Diagnosis

An accurate diagnosis of root rot aids future crop management decisions. Results may reveal trends among varieties and management practices that affect the soil, other inputs, and stresses.

Information to Gather for Diagnosis and Discussions

FIELD HISTORY	Crop rotation, last year in pulses, number of susceptible crops (pea, lentil, dry bean, alfalfa) in rotation cycles.
HERBICIDE HISTORY	Herbicides that have been used throughout the current year as well as past years.
ENVIRONMENT	Moisture situation leading up to the problem including previous year(s).
SOIL INFORMATION	Texture, organic matter, pH, signs of compaction, flooding or water runs.
SEEDING INFORMATION	Variety, seeding date, seeding depth, seed treatments, inoculant, fertilizer amount and placement as applicable.
FIELD INFORMATION AND MAPS	Legal land location, map of good and bad areas, notes on topography and patterns in the field where symptoms are present and not present. Mark waterways, side hill seeps, heavier soil, etc.
PATTERNS IN FIELD	Note any patterns that may be visible. Patterns may relate to equipment such as misses, overlap areas, swath and chaff rows from harvest, and compacted areas. Note seeding and sprayer direction. Patterns may also relate to other factors such as field edges.
PHOTO AND SAMPLES	Good photos are critical. Aerial photos are great for identifying patterns. Collect plant and soil samples from both good and bad areas for analysis.

Send Samples to a Lab

Diagnostic laboratories can examine freshly-infected roots for spores, plate samples for fungal identification, or confirm disease using DNA testing. The following labs offer analysis for root rot pathogens:

A&L Canada Labs – London, ON 1-519-457-2575 alcanada.com
AFL Agriculture & Food Laboratory – Guelph, ON 1-519-767-6299 afl.uoguelph.ca
SGS BioVision Seed Labs – Sherwood Park, AB 1-800-952-5407 biovision.ca
Discovery Seed Labs Ltd. – Saskatoon, SK 1-306-249-4484 seedtesting.com
Quantum Genetix – Saskatoon, SK 1-306-956-2071 quantumgenetix.com
20/20 Seed Labs Inc. – Nisku, AB & Winnipeg, MB 1-877-420-2099 2020seedlabs.ca

Individual labs may differ in testing methods and sample requirements. Please check with the lab prior to sending samples.

Management of Root Rot

In the case of *Aphanomyces*, it is important not to grow a susceptible host for a minimum of six years. *Aphanomyces* can infect peas, lentils, dry beans, alfalfa, and possibly some of the native weedy legume species. Faba bean and chickpea varieties with partial resistance can be used to maintain pulse crops in rotation. Soybeans are another option for a nitrogen-fixing crop that is resistant to *Aphanomyces*.

Peas and lentils fix their own nitrogen but until the nodules form, the crop relies on soil nitrogen. Starter nitrogen is not usually recommended with peas and lentils, as extra nitrogen can delay nodulation and maturity. However, under conditions where soils are low in nitrogen (less than 15 lb/ac in the top 12 inches) at the start of the season, an application of 10–20 lbs of nitrogen may be beneficial. As a rule, if soil tests indicate more than 20 lb/ac of nitrate nitrogen, then no additional nitrogen is needed. If below 15 lb/ac, then consider starter nitrogen.

Phosphorus is important for good root development and to support the nitrogen fixation process. Good phosphorus levels are important for early growth, especially under cool conditions associated with early seeding. Maximum safe rates of seed-placed phosphorus are 20–25 lb/ac for lentils and 15–20 lb/ac for peas based on a narrow opener (15% seedbed utilization) and good moisture conditions. If higher phosphorus rates are required, banding fertilizer away from the seed is the best strategy.

Right: A pea field infected with *Aphanomyces* root rot near Drumheller, AB. The importance of crop rotation is shown by the clear division down the centre of the field. Prior to being farmed as one field, the more diseased half on the left had been in pea production longer than the healthier half on the right.

Source: Syama Chatterton, Agriculture and Agri-Food Canada

CHOICES	OPTIONS FOR REDUCING RISK OF ROOT ROTS
Field Choice	• Lighter textured soils (sandier) with good drainage • No susceptible crops (pea, lentil, dry bean, alfalfa) for at least six years and up to eight+ years if *Aphanomyces* is positively identified • Manage or avoid compacted fields or areas
Soil Testing and Fertility	• Apply nutrients as needed • Starter nitrogen if soils <15 lb/ac available nitrogen in the top 12 inches • Phosphorus if seeding early into cool soils • Other nutrients as required • Know the safe rates of nutrients that can be safely applied
Seed Testing	• Plant good-quality seed • Apply seed treatments as warranted for seed-borne disease or if planting early into cool soils
Seeding Decisions	• Use appropriate inoculant and good application methods • Choose more resistant pulse crop options—faba bean, chickpea, or soybean (only for *Aphanomyces*) • Minimize seed damage and watch airspeed of seeder • Seed into warm, moist soil—the quicker the emergence, the more vigorous the seedlings
After Seeding	• Monitor crop for signs of stress • Follow herbicide labels—increased injury can occur when plants are stressed

Seed Treatments for Peas & Lentils

Root rot pathogens can be controlled to some extent through seed treatments. However, fungicidal effects will only last two to three weeks against early-season disease pressure. Making informed decisions before root rot symptoms appear is the best option. Once the seed is in the ground, it is important to monitor plant health by checking above and below-ground portions of the plant throughout the season. When determining the economic threshold for utilizing a seed treatment, consider conducting a soil test if the field has a disease history.

DISEASE (PATHOGEN)	SEED TREATMENTS
Pythium (seed rot and damping off) • Use seed treatment if field has a history of disease and/or seeding under cool/wet conditions	• Metalaxyl • Intego™ Solo (ethaboxam)
Aphanomyces	• Rancona Trio (ipconazole, carabthiin, metalaxyl) • Zeltera® Pulse (metalaxyl, inpyrfluxam, mandestrobin, exthaboxam) • Intego™ Solo (ethaboxam)

DISEASE (PATHOGEN)	SEED TREATMENTS
Root Rot Complex Including: *Botrytis*, *Fusarium*, *Pythium*, *Rhizoctonia solani* (Seed rot and seedling blight) • Use seed treatment if levels of *Botrytis* or *Fusarium* on the seed total 10% or more • Use seed treatment if the field has a history of disease and/or seeding under cool/wet conditions	• Agrox® FL (captan) • Apron® Advance (fludioxonil, metalaxyl, thiabendazole) • Apron® Maxx RTA (fludioxonil, metalaxyl) • CruiserMaxx® Pulses (thiamethoxam, fludioxonil, metalaxyl) • EverGol® E nergy (penflufen, prothioconazole, and metalaxyl) • Insure® Pulse (metalaxyl, fluxapyroxad, pyraclostrobin) • Rancona Trio (ipconazole, carabthiin, metalaxyl)• Trilex® EverGol® SHIELD (trifloxystrobin, metalaxyl, imidacloprid, penflufen) • Trilex® EverGol® (penflufen, trifloxystrobin, metalaxyl) • Vibrance® Maxx (fludioxonil, metalaxyl, sedaxane) • Vibrance® Total (thiabendazole, sedaxane, metalaxyl, fludioxonil, picarbutrazox) • Vitaflo® products (carbathiin, thiram) • Zeltera® Pulse (metalaxyl, inpyrfluxam, mandestrobin, ethaboxam)

Always refer to product labels before application. Review the most recent provincial Ministry of Agriculture's Guide to Crop Protection for more information on seed treatments.

Aphanomyces at a Glance

- Excessive soil moisture and warm soil temperatures promote *Aphanomyces* root rot development in peas and lentils. Wet conditions from continued rainfall will result in significant root damage and yield loss. Soil compaction can contribute to the severity of *Aphanomyces* root rot by reducing air-filled pores and creating the high-moisture conditions favoured by *Aphanomyces euteiches*.

- *Fusarium* root rot often occurs in conjunction with *Aphanomyces* root rot and can mask *Aphanomyces* root rot symptoms. If root rot is observed, submit a soil and/or root sample for DNA testing to confirm if *A. euteiches* is present.

- Minimum six-year, and preferably eight-year, crop rotation for peas and lentils is recommended to reduce inoculum levels in the field. Control weedy host plants such as volunteer alfalfa, chickweed, and shepherd's purse that can serve as an alternate source of inoculum.

- Faba beans are the best pulse crop option and soybeans are also a good option for fields infested with *Aphanomyces*, providing they are suitable for the local growing environment. Chickpeas are considered moderately resistant and may develop low levels of infection, but could also be used as a rotational pulse crop option.

- Proper nutrient management can help promote the development of healthy plants and root systems to better withstand disease pressure and adverse environmental conditions. A proven nitrogen inoculant that is compatible with the seed treatment should be used at the recommended rate. Phosphorus is an energy source in the plant, supporting root formation and nitrogen fixation. Starter phosphorus is important for early plant growth, especially under the cool soil conditions associated with early seeding.

Visit RootRot.ca for more resources to help eliminate the risk of root rot in pulses.

Determine *Aphanomyces* Risk by Field

Try the *Aphanomyces* Risk Evaluation App (AREA), developed by the Agronomic Crop Imaging Lab in collaboration with the Interaction Lab, University of Saskatchewan (2023) with funding from SPG.

About the Pulse Root Rot Network

Root rot complex has become the leading production risk to pea and lentil acres in Western Canada. It consists of *Fusarium* spp., *Pythium, Rhizoctonia*, and the pathogen of most concern, *Aphanomyces euteiches. A. euteiches* was identified in Alberta and Saskatchewan in early 2010. Since their identification, root rot complex and *A. euteiches* have led to a rapid decline in pea and lentil acreage, forcing growers to rethink their production strategies.

In 2021, Canada's provincial pulse grower associations developed a National Pulse Research Strategy to identify priorities and coordinate pulse research nationwide. Controlling root rots in pea and lentil, particularly *Aphanomyces* and *Fusarium* spp., was identified as a top priority.

In 2022 the Root Rot Task Force (RRTF) was established, consisting of the three prairie pulse crop commissions, Saskatchewan Pulse Growers (SPG), Alberta Pulse Growers (APG), and Manitoba Pulse and Soybean Growers (MPSG), to coordinate provincial efforts to maintain profitable and sustainable pea and lentil production and eliminate the risk of *A. euteiches* and root rot complex. Since these three organizations are producer-led and farmers are at the forefront, their voices have become a priority.

The first initiative of the RRTF was to bring together researchers, agronomists, and industry from across Canada through participation in the first Root Rot Rodeo event. From this event, the Pulse Root Rot Network was established as a collaborative approach to root rot research and management focused on agronomy, breeding, and pathology in peas and lentils. Since the root rot rodeo, the RRTF has developed a strategic action plan to address root rots with a mission to eradicate the risk of root rots through a coordinated, collaborative effort across the pulse industry.

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