SPOTLIGHT ON BARLEY DISEASES

Strategies to mitigate the severity of barley diseases
Disease management strategies

Research and on-farm experience has demonstrated some strategies which may either prevent or mitigate the severity of most barley diseases. As there is no one solution which will prevent all diseases, a combination of several strategies is required to provide protection from diseases.

Seed quality: Undamaged, good quality, pathogen-free seeds or seed with low pathogen levels with good germination and vigour is important for disease management as it can help to avoid early season diseases and stand establishment issues. Seed treatment with registered fungicides also helps limit seed-borne diseases especially at early growth stages promoting good plant stands.

Variety: Varieties with the best resistance packages for the most common diseases should be grown if they meet desirable market characteristics. It is also important to rotate barley varieties as research has shown that growing a different variety each year, even without crop rotation, could reduce disease severity and improve yield. Breeders and plant pathologists may be able to indicate varieties with different resistance genes. Rotating varieties each year may reduce the possibility of pathogens adapting and overcoming resistance. Variety mixtures in grains or intercropping with compatible cereals have been shown to reduce the severity of foliar diseases, producing higher yields in years when disease severity is high.

Fertility: A good fertility program which meets the micro- and macronutrient requirements will promote vigorous growth, increasing tolerance to diseases. While good fertility does not guarantee a disease-free crop, crops with good nutrients and better vigor are more likely to better tolerate diseases. Studies on the relationship between nutrient concentration in plant tissue and diseases have shown that while higher concentrations of one nutrient may decrease the severity of one disease, it may also increase the incidence of other diseases or exhibit the opposite effect under different environmental conditions.
Information and resources: Accurate identification of diseases and their causal agents are important to effectively manage any disease. All available information should be sought by producers from agronomists and local extension agents. Provincial Departments of Agriculture often host websites which can be a source of information for farmers and agronomists, providing extension materials on plant diseases and how to control them. Some provincial crop commissions have developed forecasting sites which could help producers predict the possibility of certain diseases occurring. For example, the Alberta Wheat Commission, in collaboration with provincial specialists, have developed a fusarium head blight forecasting site which informs producers when weather conditions are favourable and fusarium risk is high helping producers to determine if fungicides are warranted for crop protection.

Crop rotation: Crop rotation is one of many practices which reduce diseases in barley, as non-host crops break the life cycles of many barley pathogens. Rotating barley with a crop that is a non-host to barley diseases may reduce disease incidence and severity. As some key barley diseases develop primarily from infested crop residues, barley crops separated by at least a two-year break with non-host crops will reduce the severity of diseases as this allows sufficient time for breakdown of infected residues.

Crop residue management: Infected barley residues on fields may serve as a source of inoculum for the next barley crop. It has been shown that leaf disease severity was 2.5 times higher in barley grown on barley residue compared to barley grown on canola or pea residues. Reduction or complete destruction of residue has been proposed as a means of eliminating potential sources of inoculum that may initiate some diseases. However, studies in Western Canada show that conservation tillage has not resulted in an increase in disease compared to conventional tillage. Key risk factors are tight rotations, susceptible varieties and weather conditions regardless of the tillage system used. Burning residues as means of destroying inoculum to manage leaf disease has been shown to be ineffective besides its negative impact on soil quality.
Netted and spotted forms of net blotch

Two forms of net blotch disease, the net form, caused by *Pyrenophora teres* f. *teres*, and the spot form, caused by *P. teres* f. *maculata*, are barley diseases which can result in both yield and quality losses. The causal agents for both diseases are seed-borne. Net form net blotch can be seed-transmitted resulting in brown spots appearing on seedling leaves. However, in western Canada the most important source of both types of net blotch are infested residues from previous barley crops. Spores produced from infested residues or leaf symptoms will initially result in small brown spots. In the net form these eventually expand into long, narrow, brown lesions with occasional dark brown lines across the lesions, producing a net-like pattern. In contrast, the spot form remains as oval or circular lesions on infected leaves. If the lesions of either type of net blotch merge, they are capable of killing entire leaves.

Risk factors for net blotch include the use of untreated seed infested with the net form of net blotch, infested residue from previous barley crops, and moist, warm weather. Net blotch can be controlled using different methods. Planting resistant varieties will reduce the risk of infection. Minimizing infested residues from previous crops with at least two years of non-host crops between barley crops will greatly reduce the risk. In fields where barley hasn't been grown for a long period of time use of clean seed and seed treatment with a fungicide will reduce chances of infection that may arise from infected seed. If the risk of net blotch is high as the crop moves from stem elongation to flag leaf emergence and beyond applying in-crop fungicides can significantly limit the impact of net blotch.

Scald

Scald of barley, which is caused by the fungus *Rhynchosporium secalis*, can result in yield losses of 10 to 40 per cent and losses of nearly 100 per cent if susceptible barley cultivars are grown continuously. The fungus is carried on infected crop residue and seed. Crop residues are the most important disease source, especially when short rotations are used. Cool, wet weather favours the disease. Barley plants can be infected when rain splash carries the spores from infected residue in the field onto a barley plant. Infected plants
will develop water-soaked, greyish-green oval spots on the leaves, sheaths and glumes. These spots eventually expand into oval lesions, grey to tan coloured in the centre with dark brown margins. Lesions can merge, killing entire leaves. If infection does not appear until early to mid-August, losses will be minimal. However, if infection appears on the upper leaves and sheaths in early to mid-July, considerable yield losses can occur. Seed treatment with appropriate fungicide, planting resistant varieties, rotating barley varieties, using good quality seed with good germination and vigour, scouting the field for infection and in-crop fungicide application when necessary are measures which can protect barley fields.

**Fusarium Head Blight**

Fusarium Head Blight (FHB) is a devastating disease which infects barley heads, causing losses in yield and grain quality. Although several species of fusarium can cause FHB, *Fusarium graminearum* is the principal pathogen. The pathogen can survive the winter on infected cereal residue, on the seed or as infested residue in the soil. Fruiting structures on old infested residue typically emerge in spring and summer and produce wind-borne spores that can infect cereal and grass heads at flowering stage. The resulting symptoms are characterized by prematurely ripened portions of the head, with development of white or pinkish/orange fungal growth and masses of rain-splashed spores. Disease development is favoured by warm, moist weather. Seed-borne or soil-borne inoculum can infect plants at the early stages of growth causing seedling blight and crown and root rot.

FHB development resulting from *Fusarium graminearum* not only reduces yield in barley and other cereals, but significantly affects grain quality as it produces deoxynivalenol (DON), a mycotoxin which affects end-use quality and can make grains unsafe for human or animal consumption. Tolerance levels for DON in malting barley are very low, i.e. < 1 parts per million (ppm). However, for livestock feed a maximum of 1 ppm of DON is acceptable for swine, dairy cattle, and horses, while 5 ppm is the recommended limit for poultry, beef cattle, and sheep according to Agriculture and Agri-Food Canada.

Strategies to limit the impact of FHB include planting disease-free seed in areas where the pathogen isn’t typically found. In areas where the pathogen is established, using seed with low levels of infection can limit the impact on seed and seedling health. Also use fungicide seed treatment and apply a foliar fungicide at early flowering. To limit the effects of FHB, use resistant varieties and increase rotations to include non-host crops for at least two years between cereals. Increasing seeding rates to reduce tillering, which shortens flowering period and the potential infection period, and managing residues using good chopping and distribution of straw and chaff at harvest to encourage decomposition, may help to limit FHB.
Ergot
Ergot, caused by the fungus *Claviceps purpurea*, is a fungal disease which can affect barley, other cereals and grasses. The disease generally appears as dark, hardened bodies, called sclerotia, that replace grain in the head and can contaminate harvested grain. Although ergot causes only slight yield reductions, grain quality is significantly reduced due to the presence of toxic alkaloids in the sclerotia which are harmful to humans and livestock.

Fruiting structures produced from the sclerotia release spores that are carried by wind and deposited on barley heads. The spores germinate and the resulting fungal hyphae colonize the female reproductive parts of the cereal flowers. Eventually masses of a second spore type are produced from infected flower tissues resulting in secondary spread via rain-splash or insects. As the infection matures, the ergot fungus eventually produces black-coloured sclerotia, which are hard compact masses of hyphae that replace the seed. These sclerotia result in downgrading as they can contain toxic alkaloids which affect humans and livestock. Crop rotation with non-host broad leaf crops reduces inoculum levels as ergot sclerotia will decompose after 1-2 years in the soil. Controlling grassy weeds before they set seed can reduce ergot levels as weedy grasses serve as hosts. It is not clear whether burial of sclerotia as a result of tillage will have a beneficial effect, as subsequent tillage operations may bring the sclerotia back to the soil surface. Adequate soil copper availability, i.e. avoiding deficiencies, limits issues with pollen sterility and viability helping to reduce ergot infection. Pollen viability and sterility issues resulting from micronutrient deficiencies, late herbicide applications, or extreme hot or cold weather at heading leads to enhanced flower opening, making the plant prone to infection by wind-borne ergot spores.

Common Root Rot
Common root rot in barley, caused by the fungus *Cochliobolus sativus*, is an important pathogen of barley. Root rots can cause yield reductions of up to 10 per cent in addition to reduction in grain quality. The common root rot pathogen produces brown to black discolorations on the sub crown internode and root tissues of the cereal plant.

The disease is widespread, as fungal spores survive for several years in the soil. Although moisture favours infection of root tissues, the impact of root rot is
increased during dry, warm soil conditions as the diseased root system struggles to keep up with the plant’s water and nutrient demands. Over-application of nitrogen in dry conditions also increases the impact of the disease. Plants that are under nutritional stress, particularly phosphorus and potassium deficiency, are most vulnerable to infection.

Patchy plant emergence is often the first indicator of damage resulting from seed and seedling blight as a consequence or seed and soil-borne inoculum. The disease may not cause obvious aboveground symptoms, but scattered plants may ripen and die prematurely. Brown lesions usually appear on the crown area and on the roots. Occasionally, the aboveground parts of the plant display symptoms with the coleoptiles and lower leaf sheaves showing brown lesions. Diseased plants tend to be shorter and produce fewer stems and grains per head. Plants may also appear bleached and dead.

As with most diseases, rotation with non-host crops will reduce disease levels. Adequate fertilization which fosters vigorous seedling and root growth also increases crop resistance to the disease or at least improves the plants ability to tolerate root infections. Cultural practices such as minimum tillage and not seeding too deep are known to reduce the incidence of the disease.

**Spot Blotch**

Spot blotch, caused by *Cochliobolus sativus* the causal agent of root rot, is an important barley leaf disease common in the Eastern Canadian Prairie but is starting to move west. The disease is common in warmer areas where its development is favoured by humid conditions. Both barley head and grains are infected impacting germination, emergence, and growth and stand establishment. Under favorable conditions, this disease can cause significant reductions in both the yield and crop quality. Yield losses of up to 30% have been reported in susceptible Canadian varieties have been attributed to this disease. Malting quality is reduced by decreasing plumpness and staining the seed coat.

Spot blotch can best be controlled by growing resistant cultivars and through the application of a suitable fungicide at early stages of the disease. Field scouting around flag emergence and fungicide application when spots appeared on upper leaves has been found to reduce losses.


Ergot image courtesy of Noryne Rauchala, AAFC Lacombe. Stripe rust image courtesy of Dr. Kequan Xi, FCDC Lacombe. All other images courtesy of Dr. Kelly Turkington, AAFC Lacombe.
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