Prairie Crop Disease Monitoring Network
Cereal Leaf Spot Assessment Protocols
Summer 2024

1. General

During June and July, crop scouting for leaf spot diseases in cereals is critical for assessing risk and gauging the need for and timing of an in-crop fungicide application. However, late season crop scouting is also important as it can be used to assess the prevalence, severity and impact of these disease issues. Where unsprayed check strips or areas have been left in the field late season assessments can be used to assess the impact and benefit of spraying in relation to leaf spot management and crop productivity.

The main leaf spot diseases in wheat include:

1. Tan spot caused by the fungus *Pyrenophora tritici-repentis*;
2. Speckled leaf blotch aka septoria tritici blotch caused by the fungus *Zymoseptoria tritici* aka *Septoria tritici* aka *Mycosphaerella graminicola*;
3. Parastagonospora leaf and glume aka septoria nodorum leaf and glume blotch caused by the fungus *Parastagonospora nodorum* aka *Stagonospora*/*Septoria nodorum*;
4. Spot blotch caused by the fungus *Bipolaris sorokiniana* aka *Cochliobolus sativus*. It can be found in the Prairie region, but it tends to be more of a minor issue for wheat crops.

In barley, the main leaf spots include:

1. Scald caused by the fungus *Rhynchosporium secalis* aka *Rhynchosporium commune*. Scald tends to be more of a cooler region disease affecting barley mainly in the cooler moister regions of Alberta;
2. Net-form net blotch caused by the fungus *Pyrenophora teres* f. *teres*;
3. Spot-form net blotch caused by the fungus *Pyrenophora teres* f. *maculans*;
4. Spot blotch caused by the fungus *Bipolaris sorokiniana* aka *Cochliobolus sativus*.

2. Timing

It is critical to assess end-of-season leaf spot levels at the correct growth stage. Assessment of leaf diseases becomes very difficult if plants have started to ripen. Table 1 outlines the recommended stage to assess end-of-season cereal leaf spot levels. For cereal leaf spots the late milk-early dough stage is ideal to assess the final level of disease. The focus should be on the key leaves for grain filling and yield. For wheat this is the flag leaf and penultimate leaf, while for barley it is the penultimate leaf (2nd leaf from the head) and the 3rd leaf from the head (Figure 1). If the growth stage is at or approaching the early dough stage, the penultimate leaf in wheat

and the 3rd leaf from the head in barley may have already started to senesce. If this is the case, then the focus should be on the flag leaf in wheat, and the penultimate (2nd leaf from the head) in barley.

Table 1. Growth stage information for collection of leaf samples.

Growth stage for collection/assessment	Description of growth stage
Late milk to early dough stage. Depending on the seeding date this stage will typically occur towards late July or in early August. If the upper canopy leaves (flag, penultimate, etc.) have started to turn colour and ripen off it is too late for sampling.)	When a kernel is squeezed during this growth stage a white milky fluid is produced from the kernel and towards the end of the milk stage the embryo of the barley kernel is fully formed. The early dough stage occurs when a milky fluid can no longer be squeezed from the barley kernel, and the internal kernel material is starting to have a meal or dough-like consistency

3. Leaf sample assessment and/or collection

When assessing late season cereal leaf spot disease levels, one should look at a representative sample of leaves throughout the field. For example, **a minimum of 4-6 sites** should be looked at in a quarter section field; with 20-50 leaves assessed at each site. Half or full section fields will require more sites. If the field is quite variable then separate assessments in specific areas may be needed, e.g. lodged versus non-lodged. Assessments can also be made in sprayed versus unsprayed areas to determine the usefulness and benefit of in-crop fungicide applications. Leaving unsprayed checks, even small areas, can be quite useful to assess the impact of in-crop fungicide applications.

There are a variety of recommended patterns that one can follow for the assessment of cereal leaf spot diseases. One of the most common ones to follow is a "w-shaped" pattern in a field starting from one side and moving towards the opposite side of the field (Figure 2a). Along this "w-shaped" pattern one can collect and/or assess leaves at several points along the "w-shaped" path. Ideally you should avoid the headlands of the field as these areas may have somewhat different crop development due to double seeding and fertilization, compaction, or impacts due to tree lines along the field edges. Individual sites along the "w-shaped path can be spaced according to the purposes of the assessments. If it is just to get a general idea of leaf spot levels then the total length of the path should be at least 400-500 feet long with approximately 50-100 feet between sampling points (Figure 2a). In contrast, if one is interested in a more thorough assessment over the entire field, then more sampling points and time may be needed. Here the "w-shaped" pattern should cover most of the field going north to south and east to west (Figure 2b). If your field has an unusual shape due to water courses and/or bodies, etc. then modify your sampling

pattern accordingly (Figure 2c). At each sampling point, randomly assess 20-50 leaves for leaf spot level.

An alternative pattern that can be used to get a general idea of leaf spot levels is to follow a "diamond-shaped" path starting past the field head lands (Figure 3). The main reason for a "diamond-shaped" path is ensure that you exit the field at the same location where you entered the field. This will help to shorten the time it takes to sample a field and avoid any unnecessary walking. Along each "diamond-shaped" path randomly assess 20-50 leaves at a minimum of 4-6 locations. Make sure the total sampling path is at least 400-500 feet in length. If you are interested in a more thorough assessment for the entire field, the size of the "diamond-shaped" pattern can be increased to cover a larger area.

When evaluating leaf spot levels it is important to ensure that leaves are assessed at random. Unfortunately, there is a natural tendency to gravitate and focus on leaves with symptoms. Try to avoid this by assessing/collecting leaves at random along the sampling path. One way to do this is when you reach a sampling point you can pick a cereal head at random and then assess the flag leaf (wheat) or flag leaf – 1 (barley) from that plant (Figure 1). Assessments can be done in the field and recorded using a small notepad and pencil or alternatively recorded onto a smart phone using a note app or a mini spreadsheet app. Make sure to label the assessments according to date, growth stage, field, and sampling point. Moreover, it may be a good idea to draw a small map to show the approximate areas where the sampling was performed. One can also use a GPS mapping app to identify the sampling point and this GPS value can be noted or copied and recorded electronically.

Assessments can be done while out in the field, or alternatively leaf samples can be collected by just removal of the leaf next to the stem. The sampled leaves for each sample site can be placed in labelled (date, growth stage, field location, site) envelopes wide enough to accommodate the length of the leaves. Try to keep the leaves as flat as possible. Once all leaves are collected and placed in the labelled envelopes they can be left in a clean dry room until you are ready to rate them. Ideally they should be rated within 1-2 days.

4. Assessment cereal leaf spot severity

Overall, the concern is in relation to the total amount of leaf spotting on individual upper canopy leaves. Differentiation of individual diseases may be difficult in the field and ultimately may require a laboratory diagnosis. For farmers and consultants assessment of total leaf disease level is sufficient. However, it may be useful to note the predominant disease issue that is present as this information can be used to select a variety with adequate levels of resistance in subsequent growing seasons.

Leaf spot assessments in cereals should focus on the severity of leaf disease, which is the extent or area of the leaf that is covered by leaf spot symptoms. For some disease issues assessment of the incidence of disease is sufficient, whereby one counts the number of plants or plant parts out that have symptoms and then calculates a percentage. For example, counting 100 plants, noting the number that are infected and the calculating a percentage of infected plants. However, the utility of assessing incidence for cereal leaf spots and rust is limited and instead the focus should be on severity aka the area that an individual leaf is affected by leaf diseases.

Fortunately, there are diagrammatic keys that can help to illustrate different leaf disease severities. These diagrams provide examples of low to moderate to severe leaf spot levels. Figures 4-8 illustrate diagrammatic keys for scald, spot-form net blotch and spot blotch and net-form net blotch in barley, tan spot/septoria in wheat, and stripe rust in wheat and barley, respectively. These keys can be used to assign a disease severity rating to each leaf you evaluate.

Once all leaves have been assigned a severity rating one can calculate an average value for the area of the field sampled or for the entire field, or for sprayed and non-sprayed areas. Rules of thumb have been developed to estimate potential yield losses. For barley the main focus is on the penultimate leaf aka the second leaf from the head. To estimate the extent of yield loss for a given severity of scald, multiply the average severity on the penultimate leaf by 0.4 to give % yield loss. Although not given by Cook and King (1984), likely a similar conversion factor can be used for both forms of net blotch and spot blotch. In some cases there may be more than one disease present and here the total leaf area affected by all leaf spot diseases can be assessed and used to estimate yield loss.

In wheat the main focus is on the flag leaf itself. To estimate the extent of yield loss for a given severity of septoria, the % yield loss is equivalent to the % leaf area affected by this disease (Cook and King 1984; King et al. 1983). Although not given by Cook and King (1984) or King et al. 1983), likely a similar conversion factor can be used for tan spot. It may be very difficult to differentiate tan spot and the septoria complex and here the total leaf area affected by all leaf spot diseases can be assessed and used to estimate yield losses.

Cook and King (1984) also provide information for yellow rust and brown rust in wheat and barley, respectively. The focus for wheat is the flag leaf, while the focus for barley is the penultimate leaf. For both crops the extent of yield loss for a given severity of brown rust (leaf rust) of barley or stripe rust (yellow rust) can be estimated by multiplying the average severity on the leaf of concern by 0.4 to give % yield loss. Currently, brown rust aka leaf rust is a limited problem for Prairie barley growers. However, the conversion factor for brown rust can be used to estimate barley yield losses due to stripe rust. Note that under extremely severe stripe rust epidemics and with a highly susceptible variety the extent of yield loss due to stripe rust may be well over 40%.

Please note that the conversion factors for % yield loss due to leaf spots or rusts in barley and wheat should be viewed as general rules of thumb and can be used to derive a rough estimate of potential yield losses.

References

Cook, R.J. and King, J.E. 1984. Losses caused by cereal diseases and the economics of fungicidal control, in Plant Diseases, Infection, Damage and Loss (eds R.K.S. Wood and G.J. Jellis), Blackwell, Oxford, 238 pp.

King, J.E. Jenkins, J.E.E., and Morgan, W.A. 1983. The estimation of yield losses in wheat from severity of infection by *Septoria* species. Plant Pathol. 32:239-249.

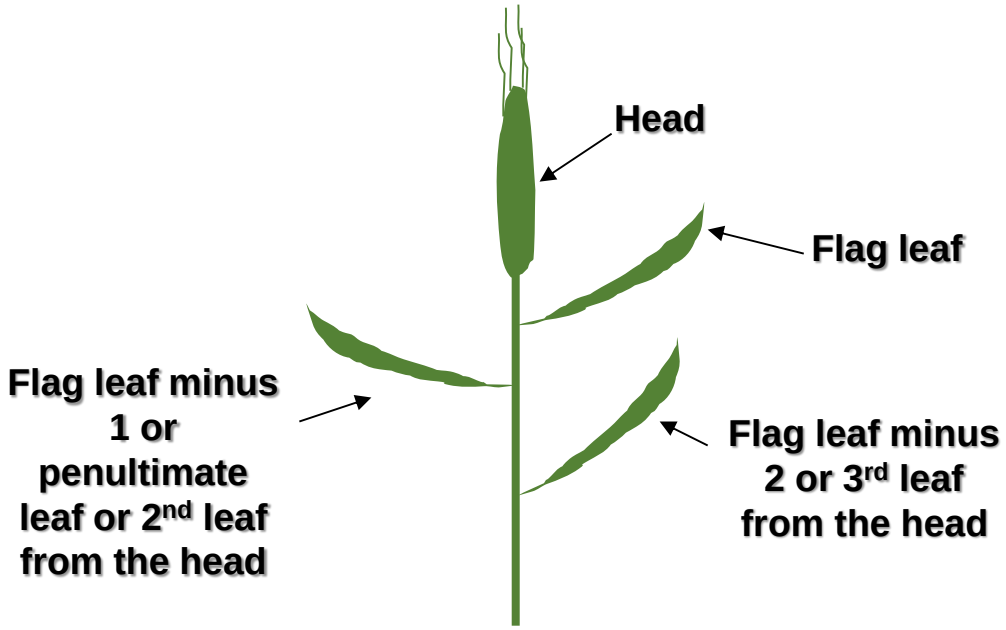


Figure 1. Position of the flag leaf, flag leaf – 1 (penultimate leaf), and flag leaf -2 on barley and wheat plants.

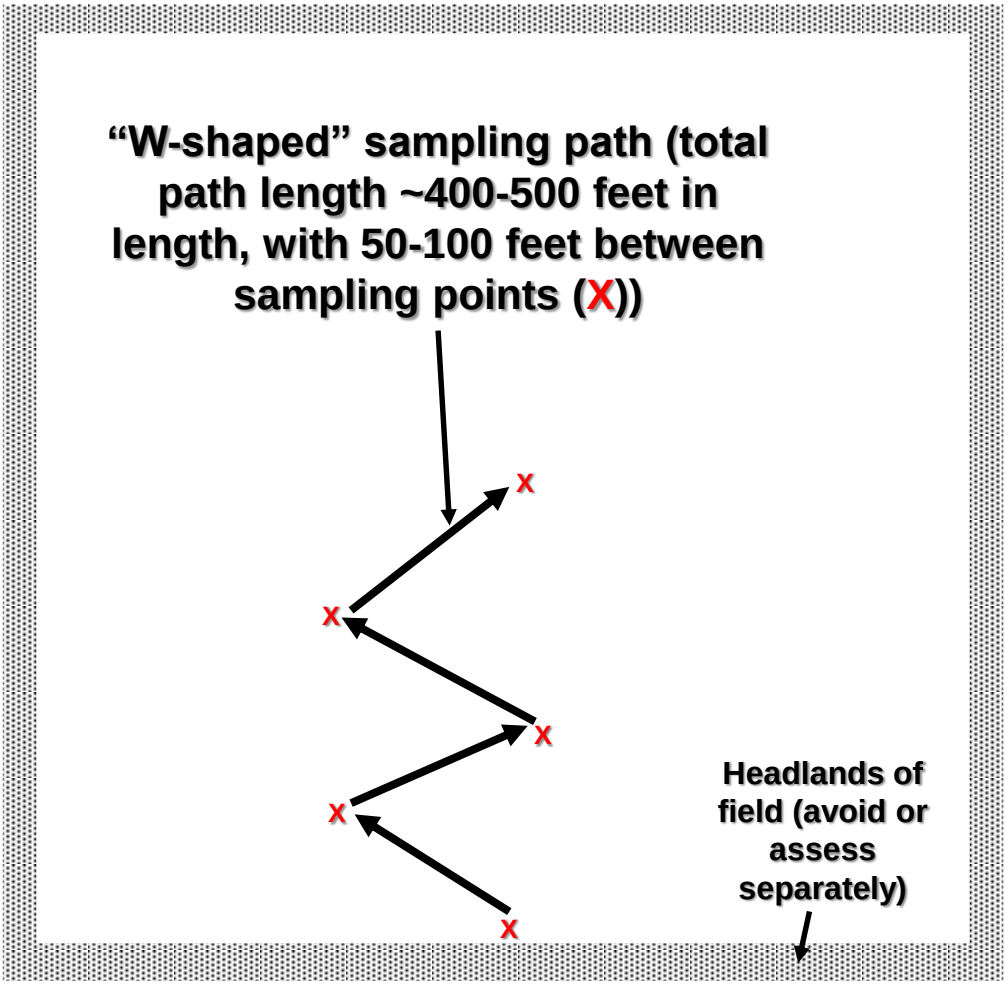


Figure 2a. Suggested "W-shaped" sampling pattern for a quick general assessment and/or collection of cereal leaves.

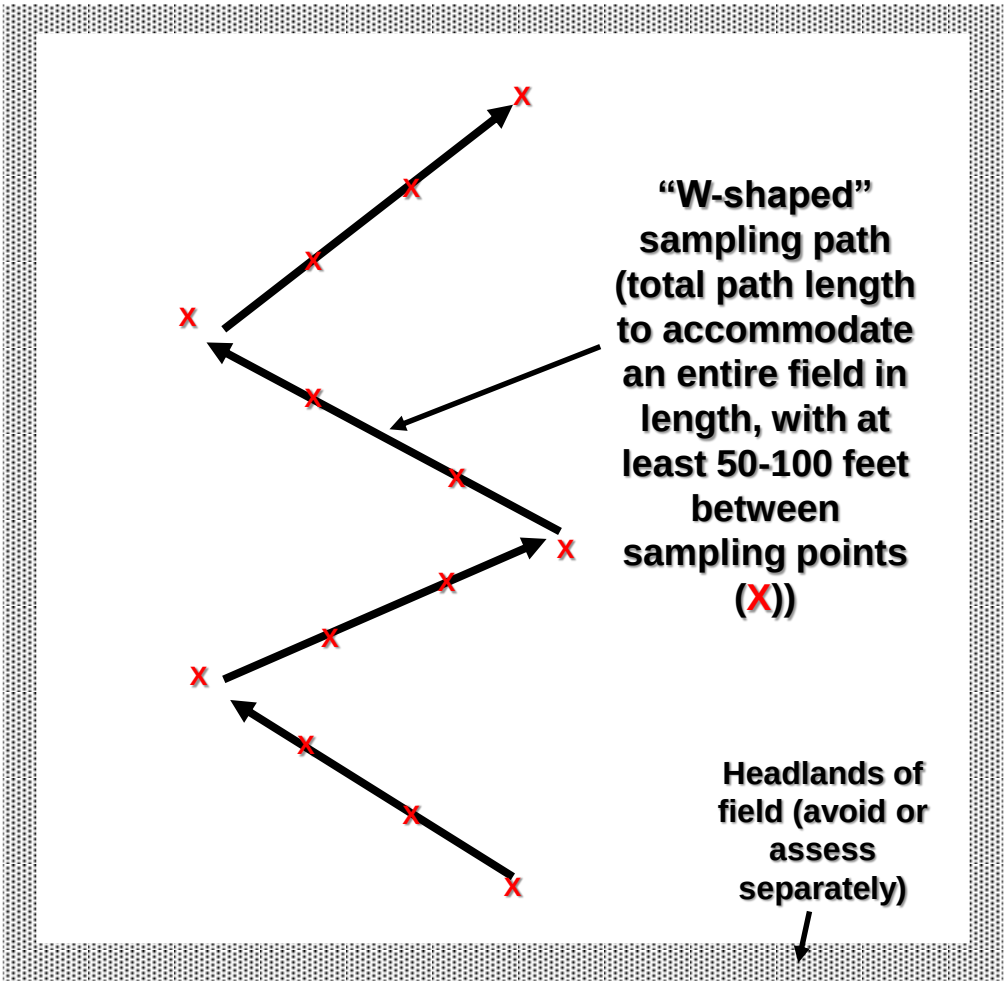


Figure 2b. Suggested "W-shaped" sampling pattern for more thorough entire field assessment and/or collection of cereal leaves.

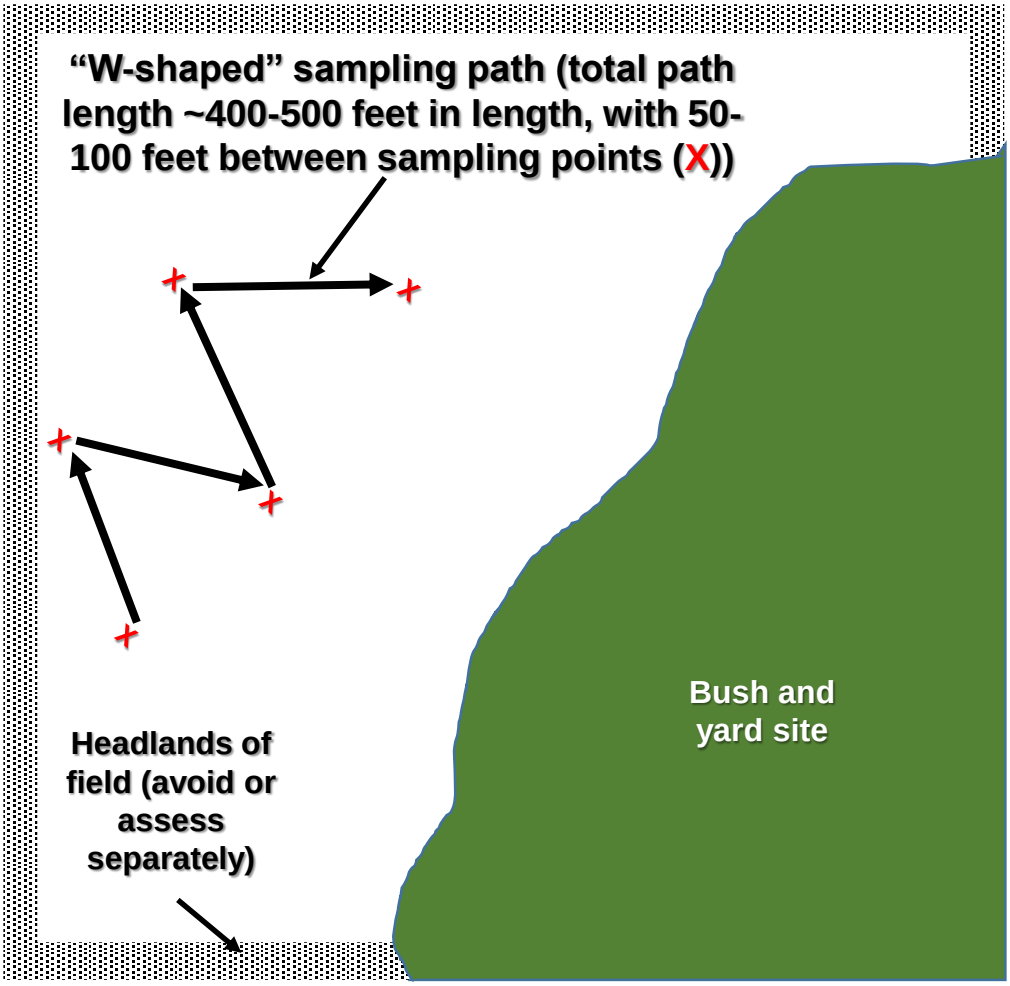


Figure 2c. Suggested "W-shaped" sampling pattern for a quick general assessment and/or collection of cereal leaves. Pattern modified to accommodate an irregularly shaped field.

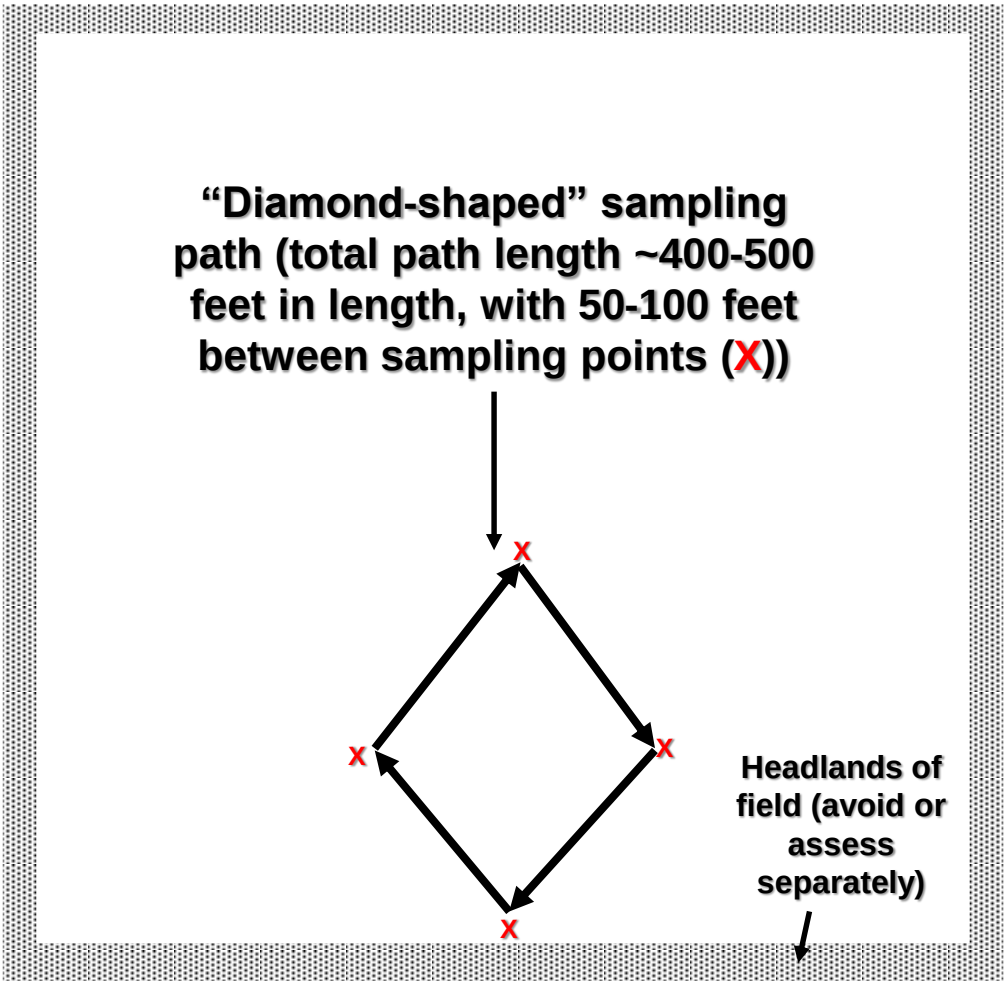


Figure 3. Suggested "diamond-shaped" sampling pattern for quick general assessment and/or collection of cereal leaves.

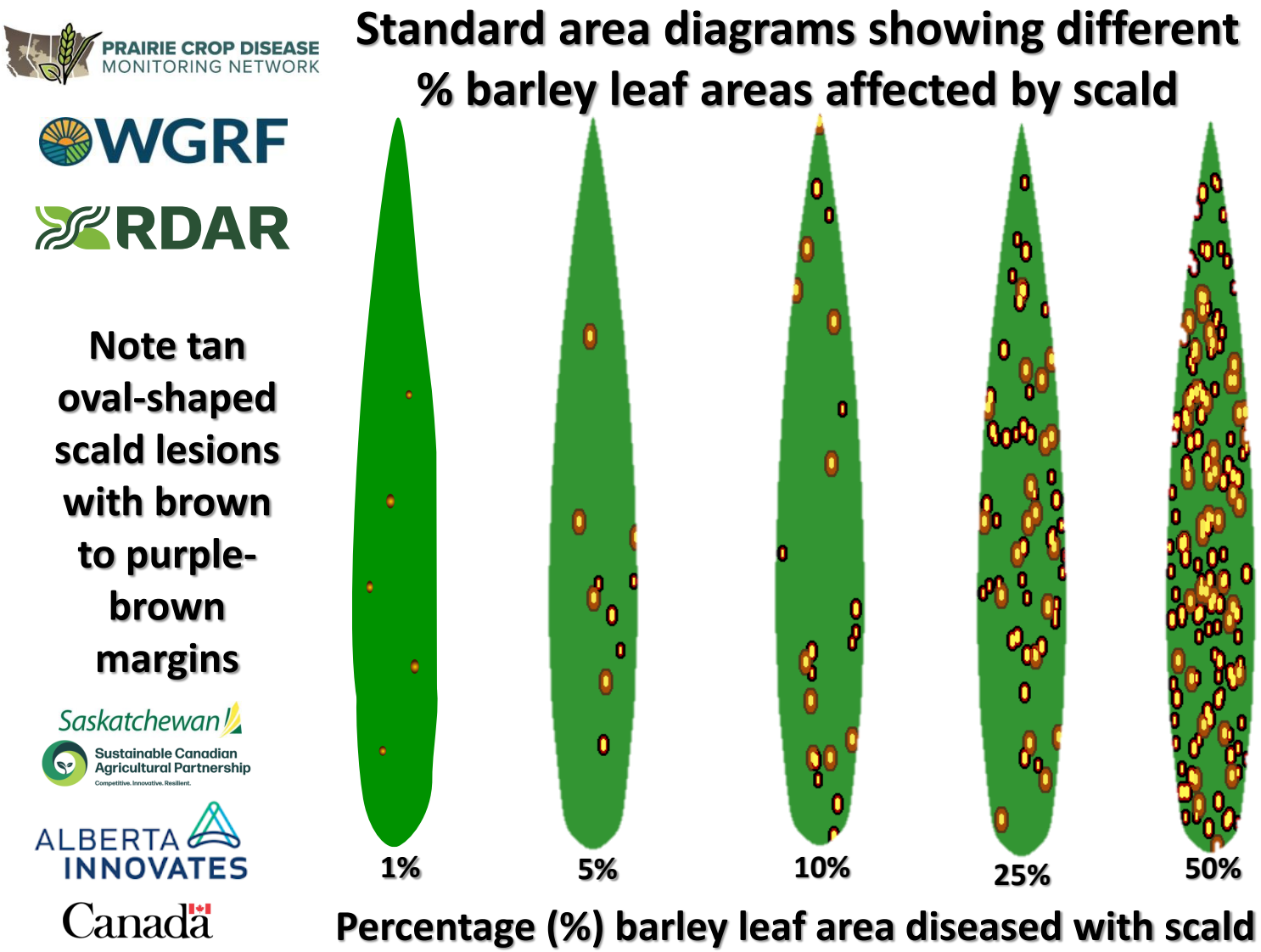


Figure 4. Standard area diagram for low to severe levels of scald of barley.

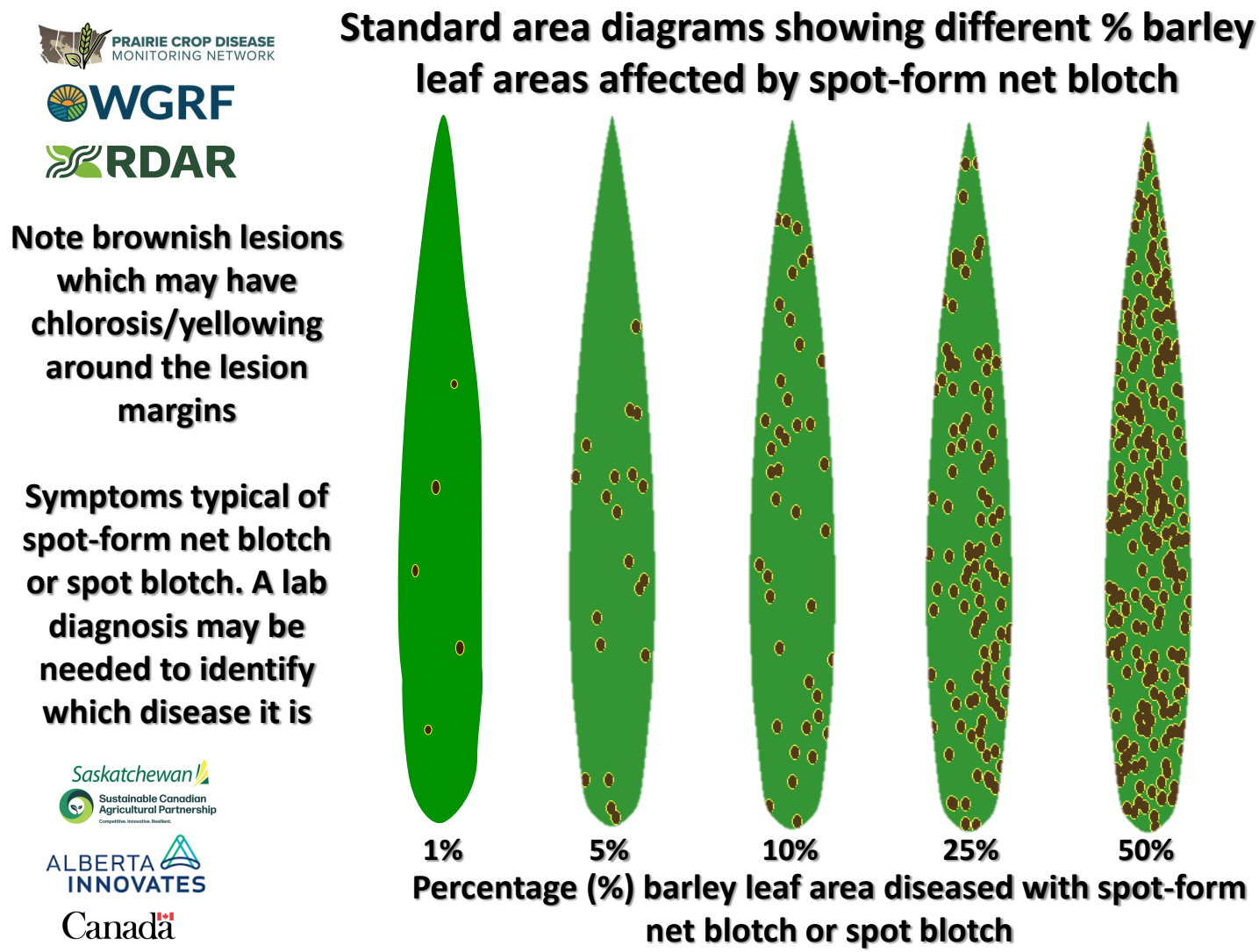


Figure 5. Standard area diagram for low to severe levels of spot-form net blotch or spot blotch of barley.

PRAIRIE CROP DISEASE MONITORING NETWORK
WGRF
RDAR

Note brownish lesions which may have chlorosis/yellowing around the lesion margins

Symptoms typical of net-form net blotch, i.e. initially small brownish flecks/spots, which elongate and coalesce (join together)

Saskatchewan Sustainable Canadian Agricultural Partnership
ALBERTA INNOVATES
Canada

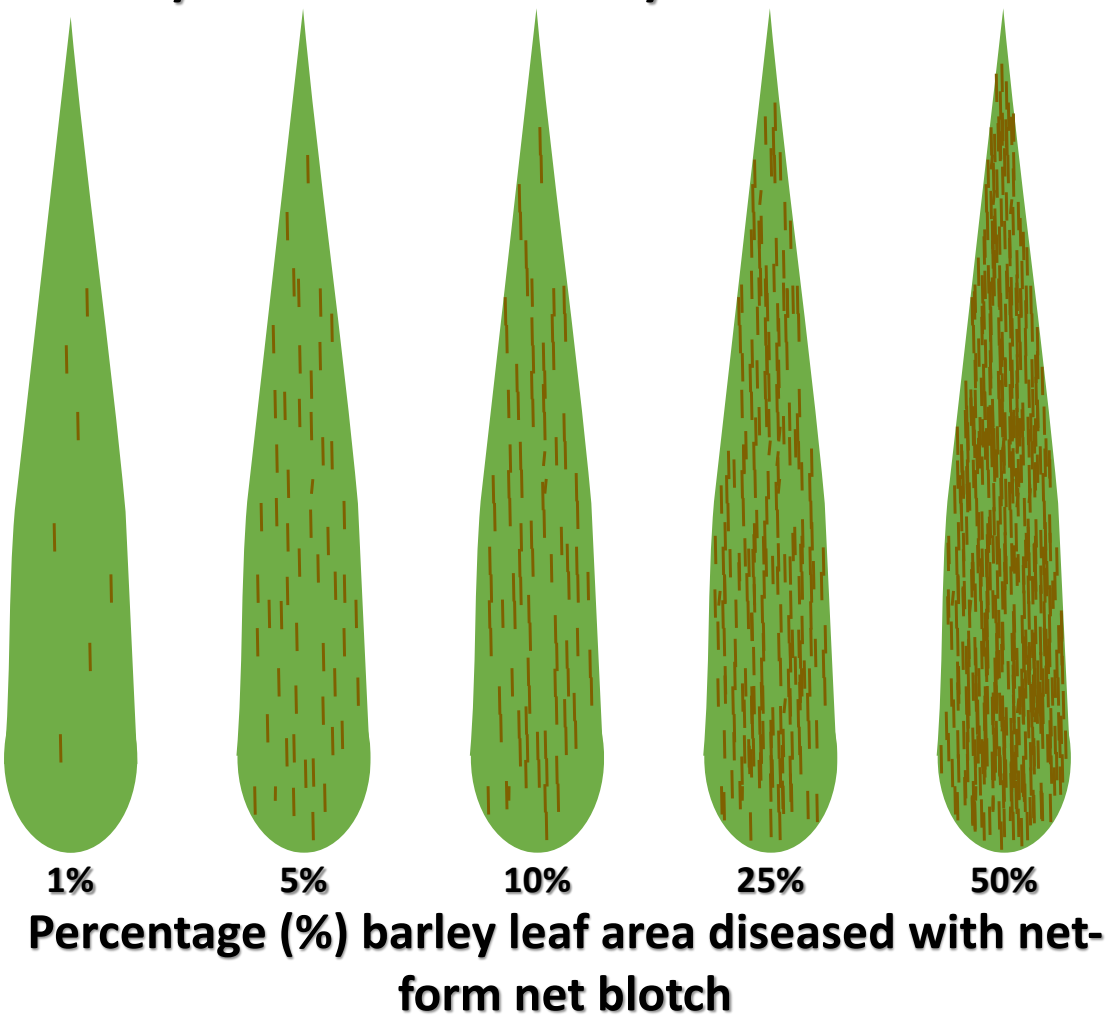


Figure 6. Standard area diagram for low to severe levels of net-form net blotch of barley.

Saskatchewan Sustainable Canadian Agricultural Partnership
ALBERTA INNOVATES
Canada

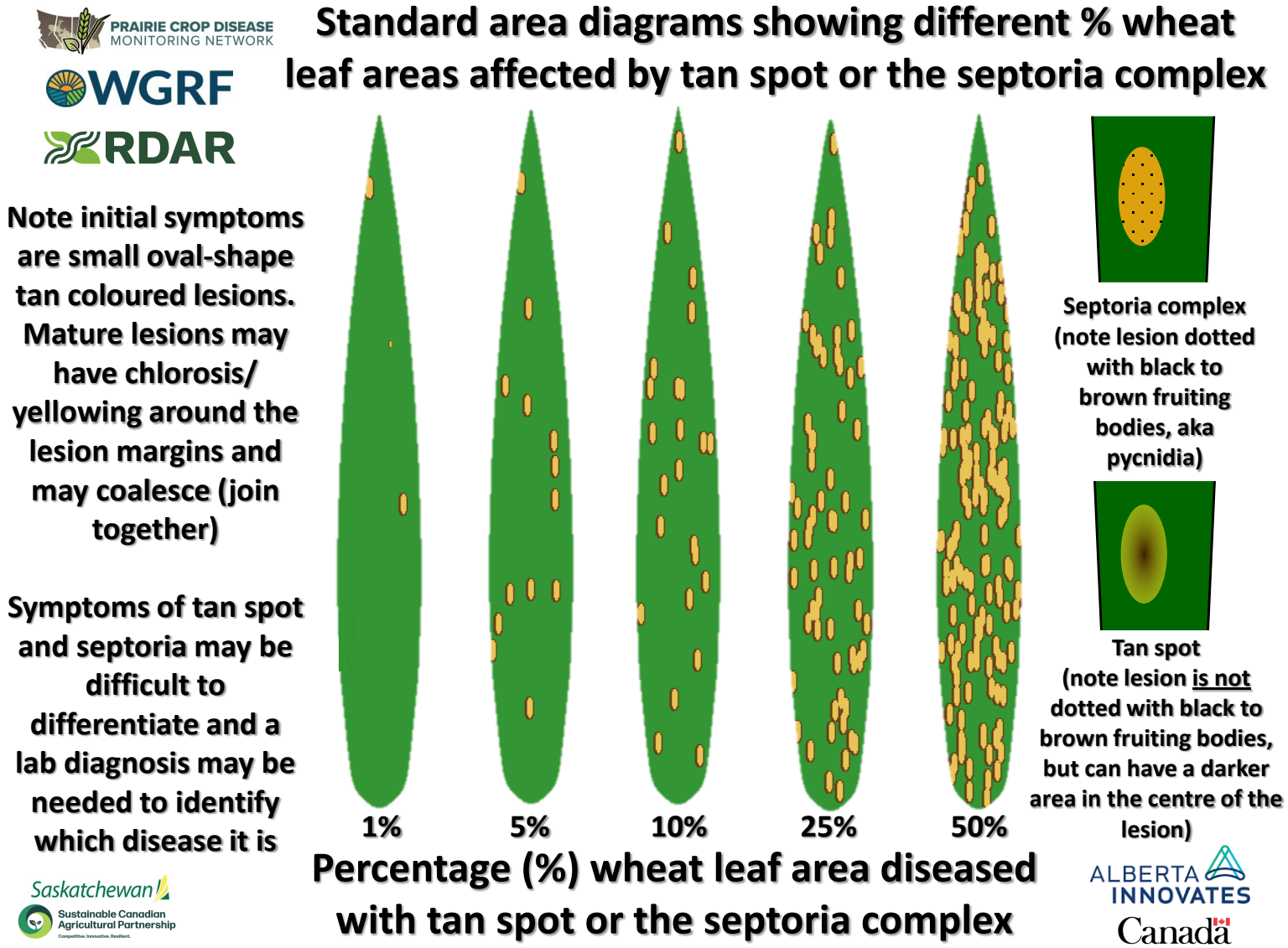


Figure 7. Standard area diagram for low to severe levels of tan spot and septoria of wheat.

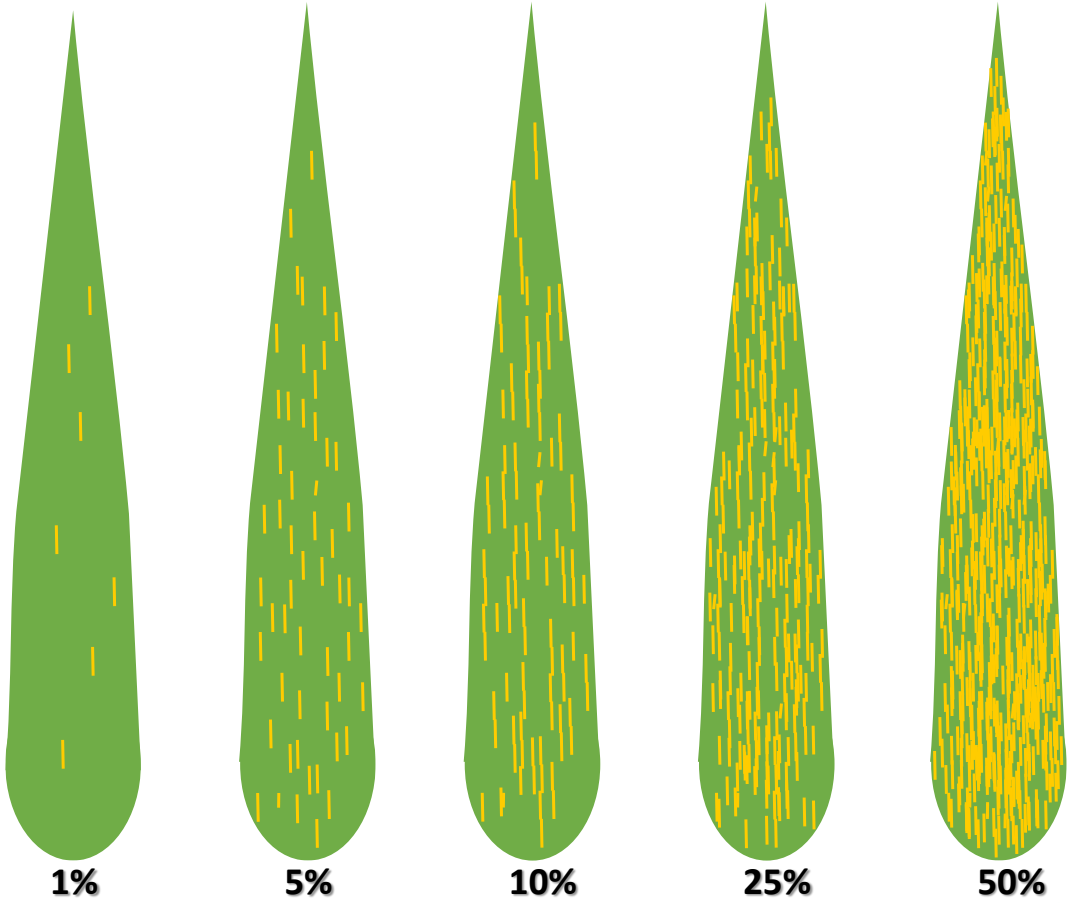
PRAIRIE CROP DISEASE MONITORING NETWORK
WGRF
RDAR

Note orangish-yellow stripe rust pustules which may have chlorosis/yellowing around the pustule margins

Initially small orangish-yellow pustules, which elongate and coalesce (join together)

Saskatchewan Sustainable Canadian Agricultural Partnership
Canada

Standard area diagrams showing different % wheat leaf areas affected stripe rust



Percentage (%) wheat leaf area diseased with stripe rust

ALBERTA INNOVATES

Saskatchewan Sustainable Canadian Agricultural Partnership

Figure 8. Standard area diagram for low to severe levels of stripe rust of wheat and barley.

ALBERTA INNOVATES
Canada

Prairie Crop Disease Monitoring Network (PCDMN)
Funders, 2023-2028