Seed Quality and Seed-Borne Diseases of Cereal Crops

Seed generally refers to grain intended for planting, while grain is the term for sale into the marketplace as food, feed or fuel. Quality has different meanings, depending on whether it is grain being characterized for sale as food, feed or fuel, or for use as seed to plant. For example, marketplace quality characteristics include colour, shape, size, uniformity, and freedom from debris. These are grading factors for which the Canadian Grain Commission has designated allowable levels. Conversely, quality characteristics of seed intended for planting include germination, vigour, freedom from weed seeds, genetic purity and the level of seed-borne disease. This fact sheet will focus on the importance of seed-borne diseases in cereals.

Seed sample containing fusarium damaged kernels (FDK)

Planting cereal seed that is free of seed-borne pathogens is the primary means of limiting the introduction of pathogens, especially new pathogens, into a field. Planting infected seed may also result in widespread distribution of disease within the crop, and allows for an increased number of initial infection sites from which the disease can spread.

The consequence of planting infected seed depends on the pathogen in question. For those diseases that are primarily soil or residue-borne, planting infected seed is less important. The greatest concern is for those diseases where the pathogen is not commonly established in all soils, such as *Fusarium graminearum*.

Importance of Seed Testing

It is recommended to have seed tested at an accredited laboratory to assess the levels of seed-borne pathogens. Commercial seed testing laboratories can test cereal seed to determine the level of seed-borne *Fusarium* species, as well as true loose smut (*Ustilago nuda*). At this time, fusarium testing is only an "advisory test" as it is not recognized as an accredited test by the Canadian Food Inspection Agency. However, labs make an effort to follow standardized procedures for isolating and identifying *Fusarium* species.

Some labs may also provide comments on other pathogens isolated from seed, e.g. *Cochliobolus sativus*, *Pyrenophora* species., and *Septoria* species. Contact the seed testing lab for information on submitting samples for seed-borne disease testing and the pathogens they test for.

Testing for germination serves as an indicator for overall seed quality. Testing for vigour may also be of benefit as it can serve as an indicator for how seed would respond in less-than-ideal growing conditions.

Preferably, buy only certified seed that has documented good quality. Keep in mind that certified seed according to the *Seeds Act* (federal regulations) has to meet standards for germination, purity, and true loose smut, but not for *Fusarium* infection.

The motto is "buyer beware" when purchasing seed. Ask to see the lab certificate before purchasing seed.

What Does a Disease Test Mean?

Remember that the seed sample submitted to the lab is only a small representation of a larger seed lot and its value is dependent on how the sample was collected. Due to the statistical nature of such a small sample, it may not accurately quantify the disease infection. A zero per cent seed test does not necessarily guarantee the entire seed lot is free of disease. For example, in a seed lot with 0.2 per cent (one in 500) of seeds infected, there is a high probability that infection will not be detected in a 400-seed sample. Failure to detect infection does not mean there is anything wrong with the test; it is simply limited mathematically by the seed-lot size.

If using seed for feeding livestock and there is concern that FHB was a problem in the field, have seed tested for concentration of deoxynivalenol (DON) and other mycotoxins.

Cleaning Seed

Diseased seed is often shrunken or discoloured, but not always. *Fusarium*-infected seed may look healthy but still be carrying the fungus. Cleaners and colour sorters can be used to remove some diseased or damaged seed. If requested to do so, seed testing labs will clean seed to a standard level (based on screen size) before testing the lot for germination and disease. If the seed sample is very dirty, a disease test cannot be conducted without cleaning it first. There is usually an extra charge to the client for cleaning to a suitable level. Hence, it is important to talk to the lab to confirm expectations regarding cleaning.

Germination

It is recommended to have seed tested for germination to determine its suitability for planting. Seed reported as having a high level of "total *Fusarium* species infection" may still have high germination levels (> 90 per cent). This is likely an indication that the pathogen has only infected the seed coat or endosperm, not the embryo, so the severity of damage to the seed may be less. Germination can decrease in the bin over the winter, especially if the seed was immature, sprouted or otherwise damaged at harvest. It is a good investment to re-test seed for germination in the spring if quality was questionable in the fall. Increasing seeding rate will compensate for lower germination to a certain extent. However, if the reduced germination was a result of disease, an increased seeding rate will result in more disease inoculum in the field.

Vigour

Some labs provide vigour testing, but there is still some debate about the best testing protocol and how to interpret results. Vigour is a measure of germination when seed is placed in less-than-ideal growing conditions, such as low temperatures. Some believe that a vigour test is a valuable indicator of seed performance as it mimics natural field conditions. The smaller the gap between per cent germination and per cent vigour, the more sound the seed is believed to be. If there is a significant discrepancy between these two values, it is important to determine why the vigour was reduced, e.g. mechanical damage, a high proportion of green seed, herbicide damage, etc. Knowing the cause of the problem will help in the decision to plant the seed, or to source another seed lot with acceptable vigour.

The Value of Fungicide Seed Treatments

Fungicide seed treatments protect seed viability and inhibit the invasion of fungal pathogens causing seed rot and seedling blight. Seed treatments work to protect the seed in two ways: (1) controlling fungal pathogens present either on the seed surface or carried internally in the seed; and (2) controlling fungal pathogens present in the soil or sporulating on organic matter in the soil.

Treating seed ensures that the crop gets off to a good start. But keep in mind that seed treatments will not "cure" a poor seed lot that has high proportions of dead, damaged or infested seed.

The degree of control with seed treatment depends on: (1) fungicide active ingredients, (2) rate, (3) seed- and soil-borne pathogens present, (4) environmental conditions, and (5) application coverage. The latter point cannot be overlooked-full coverage of the product over the seed coat is essential to ensure protection and is especially important for fungicides with contact activity. The application equipment must be carefully calibrated to ensure proper mixing of the seed and chemical to provide adequate coverage. The rate of application listed on the product label must be adhered to, as over-treatment may injure seed, and under-treatment may not provide adequate disease control.

Seed treatments may have either systemic or contact mode of actions. Systemic products are required to control pathogens that are present in the embryo, i.e. true loose smut, whereas contact or protectant products are suitable for other seed-borne and soil-borne pathogens.

The seed treatment is diluted quite quickly within the plant once the seed germinates and is actively growing. Some treatments will protect a young seedling against early leaf disease or root rot infection, but in most cases, seed treatments are no longer effective after the seedling emergence stage.

Guidelines for Tolerance Levels for Planting

There are no research-based recommendations for "safe" infection levels in cereals. This decision depends on a variety of factors affecting risk and is ultimately the farmer's decision. Such factors include:

- The cost and availability of disease-free seed with good germination.
- The cost and availability of registered seed treatments.
- The weather conditions and disease pressure typical of that region/soil climatic zone.
- The class of cereal and/or variety.
- The type of disease pathogen.
- Plans for infield scouting; availability and application of foliar fungicides.

Despite the above variables, guidelines have been developed to provide cereal producers some assistance when making decisions about seed-borne diseases. These are based mostly on knowledge of the biology of the different diseases. However, because of the biological, agronomic, environmental and economic variables mentioned, these guidelines should be treated as rules-of-thumb.

Seed-borne fusarium in wheat and barley

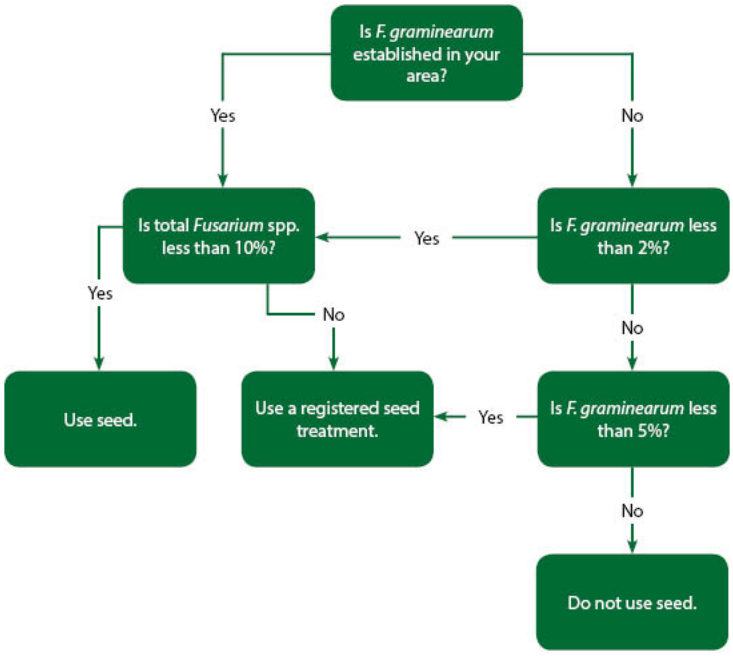
Pathogens: *Fusarium* species including *F. graminearum*, *F. acuminatum, F. avenaceum, F. culmorum, F. equiseti, F. poae*, F. sporotrichioides**

Guidelines:

In areas where *F. graminearum* is **not yet established**, stricter thresholds should be followed. In these areas, seed with greater than 5% *F. graminearum* should not be used.

When *F. graminearum* infection levels are between 2-5%, a registered seed treatment is recommended. Total *Fusarium* infection levels should also be taken into consideration.

In areas where *F. graminearum* is **already established**, seed treatment decisions can be made based on total *Fusarium* infection levels. Seed with up to 10% total *Fusarium* species infection should be safe to plant as long as other seed borne diseases are low and quality is good. Use of a seed treatment is advised if total *Fusarium* species is > 10% (see the decision tree below).



Seed rots, seedling blight and common root rot

Pathogens:

Cochliobolus sativus and *Fusarium* species.

Guidelines:

These are the same pathogens that can infect seed, but in this case are soil or residue-borne.
Seed treatments are effective at the seed and germination stages, but will only provide suppression of common root rot and *Fusarium* crown rot of older plants.

Black point / smudge

Pathogens:

Cochliobolus sativus, *Fusarium* species, *Alternaria alternata*, *Pyrenophora tritici-repentis*, *Stemphylium* and *Cladosporium* species.

Guidelines:

Seed testing labs do not routinely test for this disease. In the Prairies, infections are believed to occur mainly from soil-borne disease inoculum, not seed-borne inoculum, but more attention has been paid to the role of infected seed in recent years.
Although there are no guidelines for safe levels to plant, it is recommended not to use seed with a high level of infection, especially if the germination is low. If uncertain, use a seed treatment. Seed treatments will not provide protection against leaf spots or root rots later on in the growing season.

Net blotch of barley

Pathogen:

Pyrenophora teres

Guidelines:

Seed testing labs do not routinely test for this disease. The transmission from seed-to-seedling is not well understood but it is possible. Seed infected with high levels of *P. teres* should not be used, especially if the germination is reduced. Regardless, seed-borne disease inoculum is considered less significant than residue-borne inoculum in causing net blotch on above ground plant parts.

Scald of barley

Pathogen:

Rhynchosporium secalis

Guidelines:

Seed testing labs do not routinely test for this disease. The importance of seed-borne infection is not known, but is believed to be minor.

Septoria in wheat and barley

Pathogens:

Septoria tritici, *S. passerinii*, *Stagonospora nodorum*

Guidelines:

Seed testing labs do not routinely test for this disease. The pathogens are primarily residue-borne, but can also be seed-borne (especially S. nodorum). Shrivelled kernels may be carrying the fungus.
Although there are no guidelines for safe levels to plant, it is recommended to not use seed with a high level of infection, especially if the germination is low. If uncertain, use a seed treatment. Seed treatments will not provide protection against leaf spots and glume blotch developing later in the growing season.

Loose Smut (Synonyms: true loose smut, common loose smut)

Pathogens:

Ustilago nuda (barley) and *U. tritici* (wheat)

Guidelines:

There are legislated acceptable levels of seed-borne true loose smut for barley. The *Seeds Act* specifies a maximum of 2% true loose smut in No. 1 barley (unless the seed has been treated with a registered fungicide).

Seed labs routinely test for true loose smut in barley.

The loose smut pathogens are carried within the embryo of the seed and thus require a systemic seed treatment for control. The quality of the seed is not affected by loose smut. The smut pathogens are not soil- or residue-borne. It is also advised to select varieties with smut resistance.

Covered Smut in barley

Pathogen:

Ustilago hordei

Guidelines:

Primarily seed-borne, but not tested for at seed labs. Use resistant varieties and/or seed treatments.

False loose smut in barley

Pathogen:

Ustilago nigra

Guidelines:

Primarily seed-borne, but not tested for at seed labs. Use resistant varieties and/or seed treatments.

Common bunt or stinking smut in wheat

Pathogens:

Tilletia tritici, *T. laevis*

Guidelines:

Primarily seed-borne but not tested for at seed testing labs. Can be soil-borne, but more of an issue for winter wheat.

Bunted grain is noticeable at harvest, e.g. bunt balls mixed with grain, clouds of dust while combining, and/or strong fishy odour.

Use resistant varieties and/or seed treatments.

Ergot of barley, wheat, oat and rye

Pathogen: *Claviceps purpurea*

Guidelines:

Seed contamination is evident as hard, black sclerotia bodies mixed with the seed. Ergot bodies are also soil-borne.

Not tested for at seed testing labs. However, seed would be assessed at primary elevators and

For more information:

Contact the Agriculture Knowledge Centre at 1-866-457-2377