Environmental Health
Santé de l'environnement

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Fusarium Head Blight of Cereals in Atlantic Canada

Fusarium head blight (FHB) is a common fungal disease of small grain cereals in Canada. It is caused primarily by *Fusarium graminearum.* *F. graminearum* is found on a wide range of hosts, including wheat, barley, oat, corn, rye and grasses. FHB occurs on all cereals common to the Atlantic Region, but is most obvious in spring wheat. The occurrence of FHB is dependant on presence of the pathogen and favourable environmental conditions from the flowering stage onwards. Depending on cereal type, effects of FHB include yield losses, shriveled and light weight kernels, and mycotoxin contamination. Infections of crown and roots by *Fusarium* species can also occur.

Agriculture and Agri-Food Canada scientists across Canada are conducting research on *Fusarium* biology and crop production strategies to develop reduced risk technologies and best management practices for fusarium head blight in cereals. Emphasis is on gaining a better understanding of the pathogen and how it behaves in the environment. A priority of breeding programs in the department is the development of resistant cultivars with economic potential. Research on other FHB control strategies are also being assessed and refined.

SYMPTOMS:

Wheat:

- Symptoms are very evident in the field as a premature bleaching of part or all of the head (Figure 1) .
- Initial symptoms often start at the centre of the head, and then progress up and downwards.
- Disease development and spread can be very rapid and the entire head may be diseased.
- Pink to salmon-orange colouration may develop on infected spikelets, particularly during prolonged wet periods.
- Small, dark fungal fruiting bodies may develop late in the season (Figure 2).
- Mature grain may be shriveled, light weight, chalky white or occasionally pink in colour. (referred to as tombstone or fusarium damaged kernels (FDK)) (Figures 3 and 5),
- FDK are often more heavily contaminated with mycotoxins.

Barley:

- Symptoms are not as apparent as in wheat.
- Infected spikelets may darken and be confined to just a few spikelet groups on individual heads (Figure 4).
- Infected areas may demonstrate the pink to orange colouration, as commonly seen in wheat.
- Harvested infected grain may be darkened, pink, or with black fungal bodies on the exterior (Figure 5).
- Seed size is not as severely affected as in wheat.
- Care must be exercised to avoid confusion with other diseases that can occur on heads, and which have similar symptoms (ie. net blotch and spot blotch).

Figure 1. Fusarium head blight (FHB) on spring wheat.

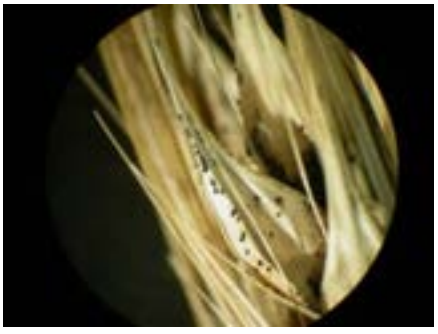

Figure 2: Black fungal fruiting bodies associated with FHB, on barley.

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Oats:

- Field symptoms are often not clearly evident, and can be confused with other diseases.
- Pink to salmon-orange colouration may develop on infected spikelets, particularly during prolonged wet periods.
- As with barley, infected grain may be darkened with a pink colouration (Figure 5).
- Seed size is not as severely affected as in wheat.

Figure 3: Fusarium damaged kernels (FDK) of wheat; left - health seed, centre - FDK tombstone kernels, right - FDK with pink colouration

DISEASE CYCLE: The fungus causing FHB persists and multiplies on infected crop residue of cereals, grasses and other crop and non-crop plants within and surrounding the field. Spores of *Fusarium* are windblown or splashed onto the heads. Small grain cereals are susceptible from flowering (head emergence) through to mid dough, and possibly later depending on weather conditions. The most favorable conditions for infection are 48 - 72 hours of high humidity and temperatures of 24-30°C. Longer periods of high humidity combined with cooler temperatures can also result in infection. Early infections may produce air-borne spores which can further spread the disease.

The severity of FHB will vary between fields and years and depends on climatic conditions, appropriate plant growth stage and presence of the pathogen. Early infection will result in greater FHB. A very susceptible cultivar and abundant inoculum at flowering combined with favourable weather conditions will result in the highest severity of FHB and mycotoxin contamination.

MYCOTOXINS: One of the major problems associated with FHB is the production of toxic substances, called mycotoxins. The most common of these is deoxynivalenol (DON, vomitoxin), although other mycotoxins can also be present. Mycotoxins can adversely affect animals, including feed refusal, vomiting, poor weight gain or immunosuppression. The amount of mycotoxins will vary depending on timing of initial infection, environmental conditions, cereal species and cultivar resistance. The guidelines for amount of DON in feed that may cause adverse effects varies with animal species, from 1 part per million (ppm) for swine to 5 ppm for cattle and poultry.

FHB symptoms indicate potential mycotoxin contamination. However, analysis of the grain is necessary to confirm the presence and amount. This is particularly relevant for barley where the level of infection is difficult to determine. Wheat is easily rated for FHB and should be suspected of mycotoxin contamination based on symptom expression. The higher the level of fusarium damaged kernels the higher the potential for high DON levels. The level of contamination should still be confirmed through chemical analysis: FHB symptoms and DON contamination can vary between fields. Sampling technique is critical and every effort must be made to ensure that a representative sample is sent for analysis. Levels of mycotoxins can vary substantially within a lot of grain or within a field.

Figure 4: Fusarium head blight (FHB) on barley

MANAGEMENT:

Seed treatment and quality seed: Seed treatments improve the stand and vigor of the crop, but will not protect against FHB. Quality seed that has been well cleaned to remove fusarium damaged kernels should also be considered. Fusarium damaged kernels often will not germinate or result in plants with poor vigor. Germination tests should be performed.

Residue Management: Practices which bury residue of contaminated crops can reduce the amount of *Fusarium* inoculum at the soil surface. Minimum tillage practices which reduce the size of the residue pieces or increase decomposition rates should be used to reduce inoculum potential. Residue of non-host crops may also be invaded (infected) by *Fusarium graminearum* and act as an inoculum source.

Crop Rotation: Crop rotation will not prevent FHB but can reduce its severity. Rotations that do not include host crops should be planted in the year preceeding the small grain crop. Cereal and corn rotations should be avoided. Corn can be a major inoculum source for *Fusarium*

causing root, stalk and ear rot. *Fusarium* can survive for several years on large pieces of corn residue.

Resistance: Extensive screening and development projects in breeding and pathology are underway across Canada, to develop cereal cultivars with improved resistance to FHB. No commercially available cultivars are totally resistant to FHB, however some show less symptoms and mycotoxin contamination. Cereal guides to cultivar selection, published in various forms in each Atlantic province, compare the tolerance level of many common cultivars, and are available from extension specialists. The ratings are based on the relative performance within each cereal type, and indicate relative performance where disease pressure is low to moderate. Each cultivar, even those with low FHB ratings, can still be seriously infected under high levels of *Fusarium* and prolonged environmental conditions which favour disease development and spread.

In barley, two row cultivars are generally less susceptible to FHB than six row cultivars. Visual symptoms are usually low in barley and can be confused with other diseases such as spot and net blotch. Spring wheat cultivars common to the region are similar in susceptibility. Testing of cereals continues in an effort to refine the expected level of resistance. A number of lines, currently in later stages of testing, indicate an improved level of resistance. However these lines will not be available for several years. Recent work indicates that FHB may be significant on oats, particularly with mycotoxin contamination.

Winter wheat in the Atlantic region has shown relatively low levels of FHB. This however is not related to resistance but reflects characteristics of the crop stage when conditions for FHB have been ideal. Winter wheat usually flowers before spring cereals and is normally past the critical stages when inoculum and environmental conditions are optimum for disease development. It is possible that future conditions will be optimum earlier in the season and winter wheat will be more seriously affected. Winter wheat has been seriously impacted by FHB in other parts of Canada. The 2003 Atlantic season did show that a delay in harvesting winter wheat can result in mycotoxin development, even in the absence of severe visual symptoms.

Planting Date: This is less of an issue in the Atlantic Region. Spreading seeding over a longer period of time could be an advantage if flowering is also spread over a longer period. This would reduce the risk of serious infection to the entire crop.

Foliar fungicide application: A fungicide spray program may reduce FHB damage, but will not provide total disease control. Work within the Atlantic Region and in other parts of North America indicates that reductions in FHB of 50 - 60% may be achieved through well timed fungicide applications. Producers should consult their cereal specialists for relative performance of available materials. The timing of applications is very exact, and specific protocols should be followed for optimum FHB reduction. These must be established well in advance of heading as once symptoms are visible in the field it is too late to apply a fungicide. As an example, one product that may soon become available in the Atlantic Region requires application within a few days of flowering and the use of a bi-direction nozzle to provide good head coverage at the critical time.

Harvest: Timely harvest can limit the risk from FHB. Grain left in the field longer than necessary may still be affected by the pathogen and result in yield reduction and increased levels of mycotoxin. Presence of Fusarium damaged kernels will also affect the grade. Appropriate combine settings to remove the light-weight Fusarium damaged kernels along with the chaff are recommended: this is particularly important with wheat. Not all damaged or mycotoxin contaminated kernels will be removed in this manner - healthy, plump kernels may still be contaminated. It is more difficult to clean barley and oats in this manner.

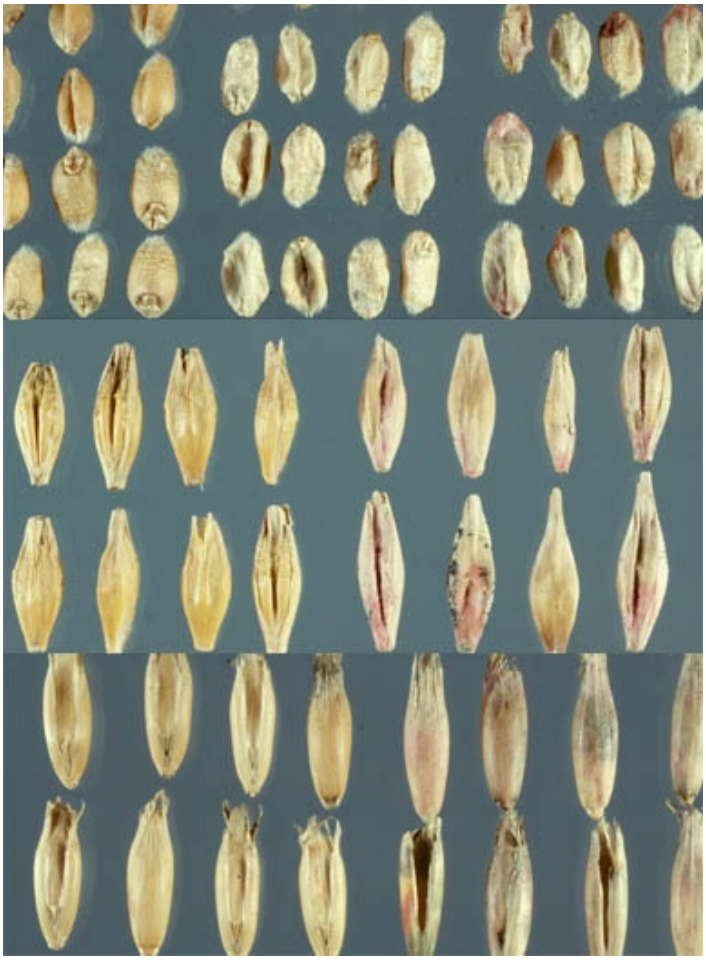

Figure 5: Healthy (left) and fusarium damaged kernels (right) of wheat (top), barley (centre) and oats (bottom).

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