

# Alberta *Fusarium graminearum* Management Plan



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Developed by the Alberta Fusarium Action Committee

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*Alberta* Agriculture and  
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## 1. EXECUTIVE SUMMARY:

*Fusarium graminearum* (*F. graminearum*) is a pathogen that can infect and cause serious losses on cereals, grasses and corn. Fusarium head blight (FHB) is caused by this fungus and is associated with three major problems: (1) reduction in yield due to fusarium damaged kernels (FDK), (2) downgrading of samples due to the presence of FDKs in harvested grain, and (3) having a negative effect on the quality and marketability of grain due to the production of toxins such as deoxynivalenol (DON) which are poisonous to humans and livestock.

*F. graminearum* has been present mostly in eastern Canada since at least 1919 and has crept towards the west over the last few decades. It was known to be present at low levels in Alberta since 1989 and in 1999 *F. graminearum* was added as a regulated pest on Alberta's *Agricultural Pests Act*. Since that time, this pathogen has become well established on wheat and corn in irrigated areas of southern Alberta. Central to northern parts of the province have experienced lower levels of *F. graminearum*, but recently these areas have seen an increase in the frequency and incidence of head blight caused by *F. graminearum*, while in the Peace region, it is rarely reported.

The need to update the Alberta *Fusarium graminearum* Management Plan (FgMP) was agreed to at a meeting of the Fusarium Action Committee (FAC) held in Lacombe on February 10, 2014. This revision was deemed necessary because of the significant increase in *F. graminearum* detections in wheat samples from south and central Alberta over the past few years, particularly 2012-13 and following the receipt of a third-party, science-based review of the FgMP conducted in December 2013 by Dr. Andy Tekauz (retired) formerly located at the Cereal Research Centre in Winnipeg.

The key changes proposed for the November 2014 version of the Management Plan include:

- Updating the estimates of yield and quality losses caused by FHB in the section “Economic Impact of Fusarium Head Blight” (pages 9-10).
- Reflecting on the widening geographical distribution of FHB caused by *F. graminearum* (*Fg*) in Alberta in the section “The Changing Situation with *F. graminearum* in Alberta (pages 11-12).
- Providing a rationale for the need to designate areas of the province where *F. graminearum* is “Commonly Found (CF)” or “Not Commonly Found (NCF)” so that appropriate Best Management Practices (BMP) can be taken by cereal and corn producers and users (pages 11-14).
- Revising the BMP for the CF areas to allow the use of cereal seed containing low levels of *F. graminearum* ( $\leq 5\%$ ), which represents a minimal risk of increasing soil inoculum levels in fields where the pathogen is already well established (pages 14-21).
- Specifying guidelines for the designation of CF and NCF areas based on the proportion of yearly grain samples testing positive for *F. graminearum* (pages 11-14).

The objective of the FgMP is to minimize the introduction, escalation and spread of *F. graminearum* in areas of Alberta where it is not commonly found and to provide guidelines for reducing the economic impact where it is commonly found. Definitions of CF and NCF areas of the province have been established along with specific guidelines to be followed when determining CF and NCF designations. A CF designation applies in areas where 20% of cereal seed samples test positive for *F. graminearum*. Any areas with less than 20% of cereal seed samples testing positive for *F. graminearum* will be considered as NCF. **In CF areas, seed intended for sowing will be allowed up to a maximum 5% *F. graminearum* incidence level.** NCF areas will retain the non-detectable level of *F. graminearum* for seed intended for sowing.

Data collected over three or more consecutive years will be used to determine CF designations at the municipal level. The data will come from various sources such as private seed labs, the Canadian Grain Commission, the Agricultural Services Board, and provincial surveys.

BMPs are outlined for the management of *F. graminearum* in CF and NCF areas of the province. Beneficial practices will apply equally in both CF and NCF areas with the one exception that seed intended for sowing will be allowed up to a maximum 5% *F. graminearum* incidence level in CF areas.

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## **2. FUSARIUM HEAD BLIGHT OVERVIEW**

### **What is it?**

Fusarium head blight (FHB) is a serious fungal disease of wheat, barley and oats, and can infect other cereal grains and grasses. It is caused by *F. graminearum* and several other *Fusarium* species, including *F. culmorum*, *F. avenaceum* and *F. pseudograminearum*. This disease can also affect corn, where it is referred to as Fusarium stalk, ear or kernel rot and Gibberella stalk or ear rot.

### **Where did it come from?**

FHB was first recognized as a fungal disease in North America about 120 years ago. Repeated severe epidemics of FHB occurred in the United States from 1915 through the 1920s. The first report of FHB in Canada was in 1919. In the 1940s, FHB erupted in eastern Canada and the east-central USA. FHB was less frequently encountered during the 1950s, 60s and 70s, but in the early 80s, major outbreaks occurred in eastern Canada (Manitoba) and in the USA wheat states from North Dakota to Kansas. A severe outbreak in Manitoba in 1993-94 brought the problem to prominence for the Canadian Prairies and also saw *F. graminearum* emerge as the most common and damaging of species impacting cereal production in Manitoba. In the decade that followed, *F. graminearum* slowly spread across Saskatchewan and into southern Alberta, where it became well-established on wheat and corn in the irrigated areas of Crop Districts 1 and 2.

### **Why has FHB spread across the Canadian Prairies?**

Disease outbreaks can be traced to several events including the widespread planting of highly susceptible varieties, the existence of colonized residue from previous crops, especially with short rotations, the presence of corn in rotations with small grains, and weather conditions favorable for the infection of susceptible crops. Airborne spore spread accounts for the majority of localized *Fusarium* species movement between fields, but other means of dispersal can include the planting of infested seed, the movement of infested soil on farm machinery and equipment, and the spreading of infested straw on fields.

### **Why is it of concern?**

FHB causes problems in two ways. First, it reduces yield and grade by producing fusarium-damaged kernels (FDK), and second, it can have a significant negative effect on the quality of grain intended for the feed, malting, milling, biofuel (ethanol) and brewing industries. FDK may contain fungal toxins (mycotoxins), such as deoxynivalenol (DON, or vomitoxin), that are highly toxic to livestock and humans above certain threshold levels. Furthermore, FDK may produce poor quality malt and flour, and it can reduce alcohol yields during fermentation.

### **What is FHB costing the agricultural industry?**

Losses to the cereal grain industry in Canada have ranged from \$50 million to \$300 million annually since the early 1990s. Direct and secondary economic losses due to FHB for all crops in

the Northern Great Plains and central USA were estimated to be \$2.7 billion from 1998 to 2000 alone.

### **What is being done about it?**

In 1999, *F. graminearum*, the most aggressive of the *Fusarium* species causing FHB, was added as a declared pest to Alberta's *Agricultural Pests Act*. In late 2002, after an extensive public consultation process, Alberta Agriculture and Rural Development released the first comprehensive Alberta *Fusarium graminearum* Management Plan. The Plan was updated and re-released in 2009 and 2012. A digital copy of the Plan can be downloaded from Alberta Agriculture's website 'Ropin' the Web at <http://www.agric.gov.ab.ca>. The Ministry has maintained an active public awareness campaign for FHB in recent years, and a number of free bulletins, posters and factsheets are available through the Ministry's website Ropin' the Web. Province-wide surveys, to determine the distribution of *F. graminearum* across Alberta were performed in 2001-3, 2006 and 2010-11.

### **What is the current state of FHB in Alberta?**

*F. graminearum* has been present at very low levels in Alberta since 1989. However, it has been increasing in incidence and severity in southern and central Alberta. FHB has caused grade reductions due to the presence of FDKs, especially in durum and highly susceptible red spring and soft white wheat varieties grown under irrigation. Fortunately, FHB and *F. graminearum* have been less common outside of the irrigated areas of southern Alberta; however, both have been reported from all seven crop districts in Alberta in the past decade. As a result of its introduction to Alberta, *F. graminearum* is now **commonly found** in some regions and **not commonly found** in others. Changes in the chemotype profile of the pathogen have occurred in the eastern Prairies. Although the new "3ADON" chemotype remains at relatively low levels in Alberta at this time, the proportion of this chemotype relative to the old 15ADON type has dramatically increased in the eastern prairies and is slowly increasing in southern Alberta. In 2010, about 10 per cent of the *F. graminearum* isolates collected during the provincial FHB survey were of the 3ADON type.

## **3. OBJECTIVE OF THE ALBERTA FUSARIUM GRAMINEARUM MANAGEMENT PLAN**

The key objective of the management plan is to minimize the introduction, escalation and spread of *F. graminearum* in areas of Alberta where this pathogen is NOT COMMONLY FOUND, while providing guidelines to reduce the economic impact in areas where it has become established and is now COMMONLY FOUND.

## **4. REGULATORY STATUS OF FUSARIUM GRAMINEARUM IN ALBERTA**

*F. graminearum* is a declared pest under Alberta's *Agricultural Pests Act*. This Act is the legislative authority for enforcement of control measures for named pests in Alberta.

- ❖ Under Alberta’s *Agricultural Pests Act*, the owner or occupant of land has the responsibility of taking measures to prevent the establishment of a pest on any land or property and to control or destroy all pests on the land or property.
- ❖ Section 22c of the *Agricultural Pests Act* states: “No person shall for propagation purposes acquire, sell, distribute or use any seed, root, tuber or other vegetable material containing a pest.”
- ❖ Pest inspectors are appointed by the local municipality or by the Minister of Agriculture and Rural Development. By virtue of the office, an Agricultural Fieldman is a pest inspector under the *Alberta Agricultural Service Board Act*. Pest inspectors have the power to enter land at a reasonable hour, without permission, to inspect for pests and collect samples.
- ❖ Enforcement of pest control measures is the responsibility of the municipal authority. Agricultural Fieldmen are responsible for enforcing pest control measures in their respective municipalities.
- ❖ Municipalities have the authority to enhance the standard for any named pest within their own jurisdiction.
- ❖ At least four *Fusarium* species have been routinely associated with FHB in cereal grains in Alberta. These are *F. avenaceum*, *F. culmorum*, *F. graminearum* and *F. pseudograminearum*. **Only, *F. graminearum* is a declared pest under the *Agricultural Pests Act* and the provisions of the Act and its associated Regulation, and do not apply to the other *Fusarium* species.**
- ❖ The BMPs specified in this plan recognize that FHB caused by *F. graminearum* is entrenched in some areas of the province and yet is relatively non-existent in others. As a result, a strictly preventative approach to managing the spread of this pathogen is no longer practical in areas where it is well established. The management practices outlined in this plan have been tailored to meet the needs of producers in both the “commonly found” and “not commonly found” areas of the province. A minimum standard can no longer apply to all municipalities across the province. Given the changing status of *F. graminearum* in Alberta, the focus of this plan for areas where the disease is commonly found will be on minimizing the economic impact of this pathogen. For areas where it is not commonly found, a traditional preventative approach is recommended.

## **5. THE IMPORTANCE OF HAVING A MANAGEMENT PLAN**

### **Mycotoxin Production:**

***F. graminearum* produces mycotoxins, including deoxynivalenol (DON) and zearalenone. The presence of these mycotoxins reduces the marketability and end-use potential of grain.**

- ❖ Livestock and poultry are sensitive to DON. Zearalenone has estrogenic effects and, depending on the concentration, ingestion can result in reproductive dysfunctions.

- ❖ Lightweight, shriveled, fusarium-damaged kernels (FDK) may contain high concentrations of DON. Levels greater than 30 parts per million (ppm) in wheat and barley have been detected in other provinces.
- ❖ In non-ruminants, such as hogs, contamination of feed grain with as little as 1 ppm DON can result in reduced feed consumption and, consequently, a reduction in animal growth. At concentrations of 5 ppm or more, feed refusal can occur. Young pigs are more sensitive to the effects of DON and may exhibit feed refusal, vomiting and reduced weight gain with dietary concentrations of less than 1 ppm. Most hog producers have a zero tolerance for DON in the feed they use.
- ❖ Adult beef cattle can tolerate higher levels of DON without known detrimental effects. Some studies have shown that cattle can feed on grain that has up to 12 ppm DON, but calves and pregnant cows may have problems at lower levels of contamination.
- ❖ Agriculture and Agri-Food Canada guidelines for acceptable feed are 1 ppm DON for swine, dairy cattle and horses, and 5 ppm for beef cattle, sheep and poultry.
- ❖ The presence of compounds associated with DON may also affect the production of beer. Mycotoxins may affect its taste and/or cause gushing or excess foaming. Most malting companies now have a zero tolerance or very low tolerance (<1 ppm) for DON and test for it before purchasing grain stocks.
- ❖ Bread making is also affected by the DON-forming *Fusarium* species. Flour changes colour and the bread does not rise normally. The baking process does not destroy DON.
- ❖ The presence of DON in food products is increasingly being regulated and tolerance limits have been established in many countries. A zero tolerance exists for DON in baby and infant foods.
- ❖ Several methods, both chemical and physical, have been studied as potential methods of detoxifying DON. Unfortunately, there is no easy, economical way to reduce the toxicity of the mycotoxin-contaminated kernels, or the products derived from them.

### **Risk of Spread:**

**The presence of a virulent pathogen in sufficient quantity, a susceptible host, and a favorable environment are requirements for the development of disease in a crop.**

- ❖ Historical survey data has shown that *F. graminearum* is commonly found in most of the municipalities in southern Alberta. More recent information indicates that this pathogen is now being detected with increasing intensity and frequency in central Alberta. The presence of FDK has resulted in downgrading of wheat delivered to many elevators in southern and central Alberta; however, it is still relatively rare in the northern regions of the province.
- ❖ On a medium - to long-term basis, short distance (field to field) spread of *F. graminearum* can introduce newer types of this pathogen (e.g. the 3ADON chemotype) into Alberta, as

well as influencing further spread within Alberta. The 3ADON chemotype is capable of producing considerably more DON on infected grain compared to the 15ADON chemotype.

- ❖ The long-distance spread of wind-borne ascospores is improbable. Dispersal of ascospores occurs over relatively short distances. Ascospore survival is significantly reduced after exposure to natural UV radiation from the sun. Long distance spread could potentially occur via movement of infested seed and crop residues and soil attached to various types of equipment that are routinely used in farm fields. Erosion of soil containing bits of *Fusarium*-infected crop residues may also be a method of dispersal, but would be less important compared with infected grain, straw or stalks, or significant amounts of infested soil and/or stubble on tillage equipment.
- ❖ Alberta's environment is not a barrier to the spread of *F. graminearum*. The increasing appearance of the pathogen in many regions of Alberta, not just in southern areas, indicates its potential to develop across the province. Moreover, the pathogen is well-established in most cereal-growing regions of Saskatchewan, including areas with similar moisture and rainfall conditions to those occurring in Alberta, for example in west central Saskatchewan and east central Alberta. Recent modeling research predicts that the potential range of FHB caused by *F. graminearum* may include the entire prairie region, but is of special concern in higher rainfall regions, such as the Parkland Zone. Irrigated regions were also predicted to be at risk from this pathogen, which has been confirmed given the development of damaging levels in irrigated fields over the past decade.
- ❖ FHB is a disease of economic importance in southern Alberta, especially under irrigation, and it is becoming established in wetter regions, such as central Alberta.
- ❖ Once the pathogen establishes, it will readily overwinter on infected crop residues.
- ❖ *F. graminearum* is a seed-borne and seed-transmitted pathogen. Infected seed, or feed, along with infested crop residues, such as straw, represent the greatest source of inoculum for introducing *F. graminearum* to areas of Alberta where the pathogen is currently not commonly found, such as the non-irrigated regions of central and northern Alberta.

## **6. ECONOMIC IMPACT OF FUSARIUM HEAD BLIGHT**

- ❖ FHB caused by *F. graminearum* has been a serious disease in Manitoba and eastern Saskatchewan for over two decades. Losses have been estimated to be in the millions of dollars annually.
- ❖ In 2004, an economic assessment of the potential cost to Alberta crop production was based on matching Alberta crop districts with Manitoba crop districts having similar projected FHB risk levels. Given annual variability in disease development in these similar risk areas in Manitoba, projected average annual costs over a modeled nine-year period in Alberta could range from \$3 million to as high as \$49 million. The risk analysis also suggested that total losses could possibly have been as high as \$64 million.

- ❖ The greatest projected economic losses were projected to occur in central and east-central Alberta and in the irrigated districts of southern Alberta.
- ❖ CWRS wheat and barley were expected to experience the greatest losses due to their extensive acreages.
- ❖ Over the modeled nine-year period, projected per acre costs (grade and yield reductions combined) due to *F. graminearum* under irrigation ranged up to \$30 to \$50 per acre and \$52 to \$132 per acre for CWRS and durum wheat, respectively, depending on the crop district and modeled year. Under dryland production, the maximum per acre costs were lower, but could range up to \$50 per acre depending on the crop district and modeled year.
- ❖ In 2009, grade reductions in southern Alberta due to the presence of FDK were estimated to have cost affected growers approximately \$30 to \$39 per acre in durum, \$10 per acre in SWS and \$9 to \$33 per acre for CWRS, depending on the crop district. These estimates did not include reductions in yield, which would have also occurred.
- ❖ A case example of the cost of a severe FHB outbreak in a dryland field of Canadian Western Red Spring Wheat (11.5% protein) in southern Alberta is presented in the following table (after Heikkila, Alberta Agriculture and Rural Development, Edmonton, 2014).

Parameters	Statistics		
Initial grade	#1		
Yield (bu/ac) <sup>a</sup>	50		
Average price (\$/ton) <sup>b</sup>	223		
Disease severity	0.4%	1.0%	2.0%
Yield loss (bu/ac)	0.04	0.10	0.20
Grade impact	#1 to #2	#1 to #3	#1 to Feed
Value of grade loss (\$/ton) <sup>b</sup>	5.95	18.73	75.24
Revenue loss (\$/ton)	8.33	26.05	103.19

<sup>a</sup> Average CWRS wheat yield in 2012

<sup>b</sup> Average CWRS wheat price (2008-12)

## **7. THE CHANGING SITUATION WITH *FUSARIUM GRAMINEARUM* IN ALBERTA**

- ❖ When the original *FgMP* plan was developed in 2001-2002, *F. graminearum* and symptoms of fusarium head blight in wheat crops and in harvested grain were found relatively infrequently in the province.
- ❖ However, subsequent establishment of this pathogen in southern Alberta has occurred, leading to more frequent detection of *F. graminearum* and symptoms in both wheat and corn, especially under irrigation.
- ❖ In contrast, the occurrence of *F. graminearum* and symptoms of fusarium head blight in wheat and barley crops and harvested grain are less commonly seen in areas outside of the irrigated regions of southern Alberta.

- ❖ To address these contrasting circumstances with regard to *F. graminearum* in Alberta, two broad areas are identified: 1) NOT COMMONLY FOUND (NCF), which refers to those areas of the province where *F. graminearum* and symptoms of this disease continue to be found infrequently; and 2) COMMONLY FOUND (CF), which refers to those areas where *F. graminearum* and symptoms of this disease are found with regularity.
- ❖ Identification of these two broad areas will help target best management practices that help to limit further introduction and spread of this pathogen in NCF areas, while limiting the economic impact of this pathogen in CF areas.

## **8. DESIGNATION OF COMMONLY FOUND AND NOT COMMONLY FOUND**

The 2015 revision of the FgMP introduces a separate designation, and management strategy, for areas where *F. graminearum* is CF compared to those areas where it is NCF. CF areas are defined as those areas where *F. graminearum* is detected in at least 20%<sup>1</sup> of cereal seed samples for three consecutive years. NCF areas are where the pathogen is either detected in less than 20% of cereal seed/grain samples, or not detected.

The determination of CF areas is to be made by ARD based on data deemed suitable by ARD. Suitable data sources include but are not limited to:

- Seed test results from commercial seed testing labs,
- Provincial surveys for *F. graminearum* that include sampling and testing of heads or residues collected from 1% to 2% of cereal fields in a municipality,
- Other surveys for *F. graminearum* that include sampling and testing of heads or residues collected from a representative number of fields in a municipality.
- Canadian Grain Commission harvest survey results where *F. graminearum* is confirmed to be causal.

The 20% incidence level of *F. graminearum* on seed/grain/residue samples required as the threshold for a CF designation is based on two principles:

1. What is known about the distribution of *F. graminearum* in Alberta, and other provinces, from historical survey results, seed testing lab results, and the Canadian Grain Commissions harvest survey results,
  2. What is known about the dispersive potential of the fungus (see section 8.1)?
- Evidence of 20% incidence for **THREE CONSECUTIVE YEARS** is required before a CF designation is confirmed. This is to avoid the possibility of a brief “flash” of *F. graminearum*, which subsequently abates to sub-threshold levels.

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<sup>1</sup> The 20% of seed samples testing positive for *F. graminearum* for a municipality is to be determined by Alberta Agriculture and Rural Development. Additionally, sampling and testing of cereal heads from 1% to 2% of fields in a municipality, or sampling 10 – 20 fields in each municipality, can also be used to determine CF status.

- It is anticipated that some jurisdictions may be clearly CF or NCF based on the available data on the occurrence of *F. graminearum* but that the status of others will remain ‘undetermined’ until additional data can be obtained and assessed.
- The distribution of *F. graminearum* in Alberta is dynamic. Annual field surveys that randomly evaluate fields for the presence/absence and severity of *F. graminearum* in all of Alberta’s cereal-producing municipalities are recommended in order to establish where *F. graminearum* is truly CF, versus NCF. Additionally, field surveys of cereal material e.g. nodes, can also be used in the determination of areas where *F. graminearum* is CF. Field surveys must also be conducted in such a manner to adequately represent the area in question. The determination of what is adequate will be made by ARD specialists. ARD specialists will make the decision as to whether a municipality is designated as CF or NCF for *F. graminearum*.

The designation of CF areas will result in a change in focus, away from preventing establishment towards a focus on managing the pathogen. The NCF areas will continue to employ all prevention and management options. In both CF and NCF regions a seed test report or certificate of analysis indicating the incidence of *F. graminearum* will be required. Additionally, all sound management practices will be applied in both CF and NCF regions, including proper crop rotations, use of approved fungicides (seed treatments and in-crop applications), avoiding corn in close rotation with small grains, use of resistant varieties, proper water management under irrigation, control voluntary crop and weeds, residue and harvest management along with other recommended practices.

In the NCF areas, the best management practices will include all preventative strategies such as: proof of *F. graminearum* non detectable in seed samples; application of a seed treatment effective against *Fusarium sp.*; seed testing positive for *F. graminearum*, whether treated with fungicide or untreated, are not to be used for planting in an NCF area; and infested straw from a crop found to have *F. graminearum* should be chopped to facilitate rapid decomposition in the field, and if fed to livestock or used as bedding, should not come in contact with soil.

It is anticipated that the designation of CF and NCF areas will allow for sensible and effective management options for all producers under these scenarios.

Note: The **agar plate** test is the recommended test for the detection of *F. graminearum* on cereal and corn samples in NCF and CF areas of the province.

*“All cereal and corn intended for use as seed in NCF areas of Alberta must be accompanied by a laboratory report with the results of an agar plate test showing that the seed lot in question was tested and found to be non-detectable for viable *F. graminearum*. The PCR test, which determines the presence or absence of DNA of *F. graminearum*, does not discriminate between viable and non-viable DNA nor is it quantitative; therefore, an agar plate test is the preferred means of testing for and quantifying levels of viable *F. graminearum* in seed.”*  
(Section A.1)

## Background

- ❖ In some areas of Alberta since the mid to late 2000's *F. graminearum* has been more frequently detected as part of routine testing by commercial seed testing laboratories or as part of research activities.
- ❖ Prior to 2005, the Canadian Grain Commission harvest survey results for Alberta indicated very low levels of fusarium damaged kernels (FDK) with most being from southern AB. For example, from 1998 to 2005 the % of wheat samples with FDK ranged from 0.1 to 3.0% (<http://www.grainscanada.gc.ca/str-rst/fusarium/fdk-fusaries-eng.htm>). After 2006 the Canadian Grain Commission rather than reporting the percent of samples with FDK started reporting the % of samples where FDK was the main downgrading factor. In 2009, subsequent information from the Canadian Grain Commission indicated that 9.9% and 11.2% of the FDK in AB Crop Districts 1 and 2, respectively, were downgraded due to FDK. In 2009 and in subsequent years, *F. graminearum* was the most commonly found pathogen associated with these FDK's, but this was primarily in southern AB, while FDK's elsewhere in the province were typically due to other species of *Fusarium* or to the glume blotch pathogen, *Stagonospora nodorum*.
- ❖ In areas of Alberta the detection of *F. graminearum* from seed and crop residue has been increasing since the mid 2000's. For example, prior to the mid 2000's the percent of seed samples from southern AB with detectable levels of *F. graminearum*, ranged from 0 to less than 5%, while in central and northern Alberta this pathogen was either not detected or detected at very low levels. Starting in the mid to late 2000's the percent of wheat samples from some southern AB regions with detectable levels of *F. graminearum* started to increase and is now routinely over 20%.

### 1. Areas where *Fusarium graminearum* is Commonly Found

- ❖ In areas where *F. graminearum* is commonly found and is well established in crop residues the incidence of seed samples with detectable levels of *F. graminearum* is routinely over 20%.
- ❖ Within Alberta each municipality is divided up into Township/Range grids that contain 36 sections, which are 6 miles by 6 miles. Research into the dispersal of wind-borne ascospores suggest that fusarium head blight infections within a field primarily arise from spores of *F. graminearum* produced within the field or from adjacent fields. However, research has also shown that spores can be trapped hundreds of feet in the air with spore dispersal potentially occurring within a mile to several mile radius of the source. Thus, if *F. graminearum* is being detected in at least 20% of the seed samples (i.e. fields) from a municipality, this would likely mean that no field would be more than 3 or 4 miles away from a source of inoculum (i.e. infested residues).

## 2. Areas where *F. graminearum* is Not Commonly Found

- ❖ In some areas of Alberta *F. graminearum* continues to be either not found or detected infrequently during routine testing by commercial seed testing laboratories, or surveys and research activities.
- ❖ Municipalities where *F. graminearum* has either not been detected, or infrequently detected, can be considered as areas where *F. graminearum* is not commonly found.

## 9. **BEST MANAGEMENT PRACTICES (BMP) FOR FHB IN ALBERTA**

### **Section A. BMP for areas of Alberta where *Fusarium graminearum* is not commonly found (NCF)**

In an attempt to minimize the spread of *F. graminearum* in the province for those areas where this pathogen is not commonly found and to address the needs of all sectors of the industry, **a best management practices (BMP) approach should be applied to the seed and feed industries.** Best management practices in Section A will apply to areas where *F. graminearum* is **Not Commonly Found (NCF areas)** in relation to seed intended for planting in Alberta, and to the handling of cereal, corn and cereal/corn grain products used as feed that have not been tested and found to have non-detectable levels of *F. graminearum*.

**NOTE: Grain products include straw, screenings and pelleted feed.**

### **1. BMP Approach for Cereals and Corn Intended for Use as Seed.**

**Objective: To prevent the movement of *F. graminearum* infected seed and the introduction of *F. graminearum* from infected seed into fields where *F. graminearum* is not commonly found (NCF).**

- ❖ All cereal and corn intended for use as seed in NCF areas of Alberta must be accompanied by a laboratory report with the results of an agar plate test showing that the seed lot in question was tested and found to be non-detectable for viable *F. graminearum*. The PCR test, which determines the presence or absence of DNA of *F. graminearum*, does not discriminate between viable and non-viable DNA nor is it quantitative; therefore, an agar plate test is the preferred means of testing for and quantifying levels of viable *F. graminearum* in seed. An initial DNA test can be used to confirm the presence or absence of *F. graminearum*, but positive samples should then be followed by a plate test to confirm pathogen viability and provide a quantitative value for incidence of *F. graminearum*.
- ❖ All cereal and corn intended for use as seed in Alberta should also be treated with a registered fungicide, prior to planting, which includes the genus *Fusarium* on the label list of fungi that are controlled. Organic producers must test multiple random samples from a seed lot to ensure that the seed is non-detectable for *F. graminearum*.

- ❖ The laboratory analysis reporting that a representative sample of the lot of cereal or corn intended for use as seed was tested according to the accepted protocol for an agar plate test and found to be non-detectable for *F. graminearum* must accompany the lot and be available for inspection at any time during the transportation and handling of the lot.
- ❖ The end user of the cereal or corn intended for use as seed must maintain the reports of laboratory analysis certifying that each lot of cereal grain intended for use as seed brought in by the end user, was found to be non-detectable for *F. graminearum*. These test report certificates must be readily available for inspection.
- ❖ Cereal and corn intended for use as seed that test positive for *F. graminearum* should be properly and effectively disposed of. These lots may be sold for food or feed, but treated (fungicide or insecticide) lots must be disposed of and buried in a landfill for NCF areas of Alberta. If the cereal grain is sold as feed it should be handled in accordance with Section 2. Seed where *F. graminearum* is detected may be transported using reasonable precautions and marketed as seed in regions of Alberta where *F. graminearum* is established and commonly found (e.g. to CF areas) or for use as seed outside of the province.
- ❖ If cereal or corn fields are found to have been planted with cereal seed infected with *F. graminearum*, the fields will be subject to the control measures outlined in Section 3. Field control strategies will be initiated as soon as a field infection or infestation is detected.

## **2. Best Management Practices (BMP) for cereal, corn and cereal/corn grain products not tested for *F. graminearum* and intended for use as feed, bedding or industrial uses.**

**Objective: To minimize the risk of spread of *F. graminearum* in feed or bedding from infested to non-infested areas in Alberta**

The following BMP are the control measures to be followed for handling *F. graminearum*-infected cereal, corn and grain products at unloading, loading, storage and feeding sites.

**NOTE: Grain products include screenings and pelleted feed, and straw for bedding, feeding, and mulching or soil reclamation.**

- ❖ Feed grain/grain products should not be stored in uncovered piles or in contact with the soil. Site where grain/grain products were stored should be properly cleaned up.
- ❖ All loading/unloading sites handling feed grain should use both a wind fence and drop sock when loading or unloading grain to prevent grain/grain product dust blow-off from the loading/unloading site. A covered loading/unloading facility is preferred.
- ❖ Feed grain and grain products should be unloaded in such a manner that spillage does not occur. Grain and grain products should not come into contact with the soil.

- ❖ All modes of transport of feed grain and grain products should be securely covered to prevent spillage during transport. All trailers and grain cars transporting grain should be structurally sound and leak proof to eliminate grain loss.
- ❖ All transport vehicles/units hauling untested grain and grain products should have the box/trailers/cars thoroughly swept clean of any residual grain/ grain products and gates closed before being allowed to leave the unloading site. The sweepings should be placed in a compost site such that the grain/straw reaches a temperature of 60 to 70 °C for two weeks.
- ❖ Feed grain/grain products should not come in contact with the soil during feeding. Range feeding livestock is not recommended. Bunk feeding is the preferred method.
- ❖ Feed grain/grain products and straw suspected of being infested with *F. graminearum* can be feed to cattle, but the pathogen may end up in the manure. Proper composting, where pile temperatures are allowed to reach at 60-70°C for at least two weeks, has been shown to eliminate Fg.
- ❖ If feed grain/grain products are spilled at any time during the feeding/handling process, they should be completely recovered and composted such that the grain/grain products reach a temperature of 60 to 70°C for at least two weeks.

### 3. Management of *Fusarium graminearum*-infested fields

**Objective: To minimize the risk of spread of *F. graminearum* from infested to non-infested fields in Alberta.**

If *F. graminearum* is found in a cereal or corn crop, the Agricultural Fieldman for the local municipality may enforce the following procedures:

- ❖ Prior to maturity, infected crops should be cut and ensiled immediately. Ensure that the load is securely covered to prevent spillage or losses from wind erosion during transport. The silage should be fed to cattle in such ways that will prevent spillage of the silage from feed bunkers onto the soil.
- ❖ In mature crops, the grain can be harvested and fed to cattle in NCF or CF areas of the province. Ensure that the load is securely covered to prevent spillage and from having it blow off trucks and trailers during transport.
- ❖ Remove any loose crop residues from all equipment before leaving an infested field.
- ❖ Control volunteer cereals and grassy weeds on infested land, including headlands.
- ❖ To reduce levels of *F. graminearum* on infested land to manageable levels, it is recommended that non-host crops, such as canola, alfalfa, clover or field peas, should be grown for a minimum of three years following the detection of the disease. After a three-year rotation, cereal seed from cultivars with the best resistance available to *F. graminearum* and treated with a recommended fungicide can be planted.

- ❖ Avoid corn in rotation with small grain cereals or planting cereals in fields immediately adjacent to corn. Corn is also a host of *F. graminearum*, where it causes seed rots, seedling blight, root rot, stalk rot and ear rot. Research has shown that *F. graminearum* and mycotoxin levels in harvested grain are higher for small grain cereals grown in rotation with corn.

#### **4. Transportation of cereals, corn and grain products**

**Objective: To minimize the risk of spread of *F. graminearum* during transportation from infested to non-infested areas in Alberta.**

**NOTE: Grain products include screenings and pelleted feed, and straw for bedding, feeding, mulching, or soil reclamation,**

- ❖ All cereals, corn grain products and straw transported in the province should be securely covered. No grain or grain product or straw should be allowed to blow off the vehicle while in-transport. Vehicles with unsecured loads could be detained until the load is securely covered.
- ❖ If, during the transportation and handling process, cereal and corn grain for use as seed imported into the province is found to be either, not treated with a fungicide or is not accompanied by a certificate of laboratory analysis could be detained until the certificate of lab analysis can be obtained or the appropriate seed treatment is arranged or both.
- ❖ Cereal, corn or grain products that are trans-shipped through Alberta are exempt from the requirement of a certificate of laboratory analysis if the load is not handled or redistributed from a facility in Alberta and the load is securely covered.

### **Section B. BMP for areas of Alberta where *Fusarium graminearum* is commonly found (CF)**

In an attempt to minimize the impact of FHB caused by *F. graminearum* in the province for those areas where this pathogen is commonly found and to address the needs of all sectors of the industry, **a best management practices approach will be applied to the seed and feed industries with a focus on management of the pathogen in CF areas rather than prevention of its introduction as outlined for NCF areas in Section A of the Management Plan.** The best management practices outlined in Section B will allow for appropriate management in areas where *F. graminearum* is **Commonly Found (CF)**.

**NOTE: Grain products include straw, screenings and pelleted feed.**

#### **1. Best Management Practices for Cereal and Corn Intended for Use as Seed**

**Objective:** To balance the need to manage *F. graminearum*, while providing access to seed options for growers and marketers as well as recognizing that infested crop residues are the most important source of *F. graminearum* in the CF areas.

- ❖ All cereal and corn intended for use as seed in CF areas of Alberta must be accompanied by a laboratory report showing that the seed lot in question was tested and the presence and level of infestation with *F. graminearum* is indicated so that producers can make informed choices in relation to seed and crop management strategies. Seed with no or very low ( $\leq 5\%$ ) levels of detection with *F. graminearum* must be used. Seed that is more heavily contaminated ( $> 5\%$ ) must not be used. As the level of infection increases producers may encounter seed quality concerns that may lead to emergence and stand establishment issues. Moreover, higher levels of seed infection may represent an important source of *F. graminearum*, especially in relation to the new “3ADON” chemotype of the pathogen. Caution should be exercised when sourcing seed, especially from eastern Prairies where the 3ADON chemotype has displaced the 15ADON chemotype as the most predominant form of *F. graminearum*.
- ❖ All cereal and corn intended for use as seed in Alberta should also be treated with a registered fungicide prior to planting, which includes the genus *Fusarium* on the label list of fungi that are controlled. Organic producers should test multiple random samples from a seed lot to ensure that the seed is either non-detectable for *F. graminearum* or that the level of infection is very low ( $\leq 5\%$ ) and will not affect seed quality in relation to emergence and stand establishment.
- ❖ A laboratory analysis report certifying that a representative sample of the lot of cereal or corn intended for use as seed was tested for *F. graminearum* according to an accepted agar plate protocol must accompany the lot and be available for inspection at any time during the transportation and handling of the lot.
- ❖ The end user of the cereal or corn seed must maintain the reports of laboratory analysis certifying that each lot of grain intended for use as seed, as brought in by the end user, was tested for *F. graminearum* with the presence/absence and/or level indicated. These report certificates must be readily available for inspection.
- ❖ Cereal and corn intended for use as seed that tests positive for *F. graminearum* must be utilized in CF areas of Alberta. If the cereal grain is sold as feed it should be handled in accordance with Section 2. Seed where *F. graminearum* is detected may be transported using reasonable precautions and marketed as seed in regions of Alberta where *F. graminearum* is commonly found (CF), or for use as seed outside of the province.

## **2. Best Management Practices for cereal, corn and cereal/corn grain products not tested for *Fusarium graminearum* and intended for use as feed, bedding or industrial uses.**

**Objective: To minimize the risk of spread of *Fusarium graminearum* in feed or bedding from infested areas to non-infested areas in Alberta.**

The following best management practices should be followed for handling *F. graminearum*-infected cereal, corn and grain products at unloading, loading, storage and feeding sites.

These measures apply to all operations handling feed grain or grain products that have not been tested and found to be non-detectable for *F. graminearum*. These measures will also help to minimize the spread of weed seeds.

**NOTE: Grain products include screenings and pelleted feed, and straw for bedding, feeding, mulching, or soil reclamation.**

- ❖ It is recommended that feed grain/grain products not be stored in uncovered piles or in direct contact with the soil. Sites where grain/grain products were stored should be properly cleaned up.
- ❖ All loading/unloading sites handling feed grain should consider the use of both a wind fence and drop sock when loading or unloading grain to prevent grain/grain product dust from blowing off the loading/unloading site. A covered loading/unloading facility is preferred.
- ❖ Feed grain and grain products should be unloaded in such a manner that spillage does not occur. It is recommended that any spilled products not come into contact with the soil.
- ❖ All modes of transport of feed grain and grain products should be securely covered to prevent spillage during transport. All trailers and grain cars transporting grain should be structurally sound and leak proof to eliminate grain loss.
- ❖ All transport vehicles/units hauling untested grain and grain products should have the box/trailers/cars thoroughly swept clean of any residual grain or grain products and gates closed before being allowed to leave the unloading site. The sweepings should be placed in a compost site such that the grain/straw reaches a temperature of 60 to 70 °C for two weeks.
- ❖ Feed grain/grain products should not come in contact with the soil during feeding. Range-feeding livestock is not recommended. Bunk feeding is the preferred method.
- ❖ Feed grain/grain products and straw suspected of being infested with *F. graminearum* can be feed to cattle, which will aid in elimination of the pathogen or can be composted where compost temperatures reach at 60-70°C for at least two weeks.
- ❖ Caution should be exercised when sourcing feed, straw, screenings, etc., especially from eastern Prairie regions where the 3ADON chemotype has displaced the 15ADON chemotype as the most predominant *F. graminearum* chemotype.
- ❖ If feed grain/grain products are spilled at any time during the feeding/handling process, they should be completely recovered and composted such that the grain/grain products reach a temperature of 60 to 70 °C for at least two weeks.

### **3. Management of *Fusarium graminearum*-infested fields.**

**Objective: To minimize the risk of development and impact of *Fusarium graminearum* in areas of Alberta where the pathogen is commonly found (CF areas).**

- ❖ To reduce levels of *F. graminearum* on infested land to levels that will not result in an economic impact for cereal producers, it is recommended that non-host, broadleaved crops, such as canola, alfalfa, clover or field peas, should be grown for at least three years after a cereal crop. Following cultivation of a non-host crop for at least three years, FHB-resistant cereal cultivars should be grown and seed should be treated with a recommended fungicide to limit *Fusarium*-related seed and seedling blight issues.
- ❖ Avoid corn in rotation with small grain cereals or planting cereals in fields immediately adjacent to corn fields. Corn is also a host of *F. graminearum*, where it causes seed rots, seedling blight, root rot, stalk rot and ear rot. Research has shown that *F. graminearum* and mycotoxin levels in harvested grain are higher for small grain cereals grown in rotation with corn.
- ❖ Field location can be an important consideration as *F. graminearum* can spread from one field to the next. If practical, avoid planting small grain cereals immediately adjacent to cereal or corn fields where elevated levels of *F. graminearum* are suspected to occur.
- ❖ Growers should plant cereal varieties with the best available levels of FHB resistance. Consult the latest edition of the Alberta Seed Guide for information on the resistance/susceptibility status of currently recommended cereal varieties.
- ❖ Producers growing small grain cereals under irrigation may be able to reduce the risk of head and seed infection by careful water management. Irrigation should be limited for 5-10 days after flowering to help avoid the humid conditions that favor head infection. Excessive irrigation during the flowering period can greatly increase the risk of FHB and resulting yield losses, grade reduction, and mycotoxin contamination. In addition, it is recommended that producers consider increasing seeding rates, which helps to reduce tiller formation and shorten the flowering period for the entire crop, thus reducing the time that irrigation should be limited. For more information see *FHB and Irrigation Management – Frequently Asked Questions* at <http://www.agriculture.alberta.ca/>
- ❖ When an elevated risk of FHB is suspected, growers should consider the use of as many management options as possible for FHB management. Options include use of resistant cultivars, higher seeding rates to reduce tillering, stagger seeding dates to prevent all fields flowering at once, use cultivars that produce fewer tillers, avoid irrigation during anthesis, a well-timed fungicide application. Consult the *Alberta Crop Protection* guide for more details on fungicides. Factors related to an elevated FHB risk include: short intervals between cereal crops; planting into or next to fields with *F. graminearum*-infested cereal or corn residues; use of a susceptible cereal variety; and/or where irrigation is being used or where weather conditions favor inoculum production and host infection.
- ❖ In mature crops where FHB has occurred, growers are advised to adjust their combines to blow out *Fusarium*-damaged wheat kernels, which are lighter than the other seeds, and

infected chaff as a way of improving the grade and reducing toxin levels in harvested grain, especially wheat.

- ❖ If *F. graminearum*-infested grain will be used as livestock feed, grain samples should be evaluated for mycotoxin levels, specifically deoxynivalenol (DON). Knowledge of mycotoxin levels will provide guidance as to whether the grain is suitable for feeding, especially for more sensitive animals such as swine.
- ❖ Remove any loose crop residues from all equipment before leaving an infested field.
- ❖ Control volunteer cereals and grassy weeds on infested land, including headlands.

#### **4. Transportation of cereals, corn and grain products**

**Objective: To minimize the risk of spread of *F. graminearum* during transportation from CF areas to NCF areas in Alberta.**

**NOTE: Grain products include screenings and pelleted feed, and straw for bedding, feeding, mulching, or soil reclamation.**

- ❖ All cereals, corn and grain products and straw transported in CF areas should be securely covered. If material is to be transported into NCF areas, then recommendations for FHB prevention in NCF areas should be followed (see Section A). No grain or grain products should be allowed to blow off the vehicle while in-transport.
- ❖ If, during the transportation and handling process into NCF areas, cereal and corn grain for use as seed imported into the province is found to be either, not treated with a fungicide or is not accompanied by a certificate of laboratory analysis could be detained until the certificate of lab analysis can be obtained or the appropriate seed treatment is arranged or both.
- ❖ Cereal, corn or grain products that are trans-shipped through either CF or NCF areas of Alberta are exempt from the requirement of a certificate of laboratory analysis if the load is not handled or redistributed from a facility in Alberta and that the load is securely covered during conveyance.

## **10. RESPONSIBILITIES**

### **1. Alberta Agriculture and Rural Development (AARD), Pest Surveillance Branch**

- ❖ Co-ordinate the Alberta *Fusarium graminearum* Management Plan.
- ❖ Provide training, regulatory support and consultation to inspectors enforcing the Alberta *Agricultural Pests Act* and Regulation.
- ❖ Prepare and provide technical information on *Fusarium graminearum* diagnoses and management recommendations to inspectors and field staff.
- ❖ Provide training in disease surveillance and FHB identification.

- ❖ Review and periodically update the Alberta *Fusarium graminearum* Management Plan in consultation with the Fusarium Action Committee as required.
- ❖ Facilitate surveillance activities in conjunction with stakeholders from various levels of government and industry.
- ❖ Co-ordinate provincial awareness activities for FHB amongst cereal and corn producers and allied industries through a variety of media and extension activities.
- ❖ Designate municipalities as CF or NCF for *F. graminearum*

## 2. Agricultural Service Boards (ASB)

- ❖ Provide support and resources to the Agricultural Fieldmen in carrying out their duties.
- ❖ In consultation with ARD and with input from other sources of expertise and information (i.e. the Canadian Grain Commission, surveillance data from various sources) ASB's should identify whether their municipality is designated as an area where *F. graminearum* is not commonly found (NCF) or is an area where *F. graminearum* is commonly found (CF).
  - ❖ Commonly found areas are those municipalities where annual surveillance activities have found that at least 20% of tested samples of seed, grain and/or crop residues (e.g., lower stem node pieces or crown tissues, are positive for *F. graminearum*). Once the 20% threshold has been reached or exceeded for three consecutive years, the area should be designated as commonly found.
  - ❖ Not commonly found areas are those municipalities where surveillance activities have found that less than 20% of annual tested samples of seed, grain and/or crop residues (e.g., lower stem node pieces or crown tissues) are positive for *F. graminearum*, or have not been  $\geq 20\%$  for three consecutive years.
- ❖ Agricultural Fieldmen will monitor their respective municipalities for *F. graminearum* and enforce control measures as necessary to meet the objectives of the Alberta *Agricultural Pests Act and Regulation*.
- ❖ Provide recommendations and information to farmers on FHB prevention and control based on the Alberta *Fusarium graminearum* Management Plan and other relevant sources of information.
- ❖ Conduct field surveys and maintain records of FHB infestations, if found.

## 3. Landowner/Occupant, Seed/Grain/Feed Processors And End Users

- ❖ Take responsibility to control, destroy or prevent the establishment of *F. graminearum* as outlined in the Alberta *Agricultural Pests Act and Regulation*.
- ❖ Observe and practice all management practices to meet the objectives of the Alberta *Fusarium graminearum* Management Plan.

#### **4. Oil, Gas, Power, Construction And Trucking Industries**

- ❖ Observe and practice all management practices to meet the objectives of the Alberta *Fusarium graminearum* Management Plan.
- ❖ Provide a forum to represent the interests and views of Alberta's agricultural industry regarding the management of *F. graminearum*.
- ❖ Recommend management strategies for *F. graminearum* for inclusion in the Alberta *F. graminearum* Management Plan.
- ❖ Educate Alberta's crop and livestock industries about *F. graminearum* and the threat it represents to producers, processors and other stakeholders.
- ❖ Will review and evaluate the Alberta *F. graminearum* Management Plan in consultation with AARD, as required.

#### **5. Cooperative Seed Cleaning Plants And Mobile Commercial Seed Cleaners**

- ❖ In NCF areas, ensure that all seed lots to be cleaned are tested and found to be non-detectable for *F. graminearum* prior to cleaning.
- ❖ In CF areas, ensure that all seed lots to be cleaned are tested and found to have  $\leq 5\%$  incidence of *F. graminearum* prior to cleaning.
- ❖ Inform cereal producers about the impact and management of FHB caused by *F. graminearum*.

#### **6. Fusarium Action Committee (FAC) Membership**

Representatives of the following organizations comprise the FAC:

- ❖ Alberta Association of Agricultural Fieldmen (AAAF)
- ❖ Provincial Agriculture Service Boards (ASB) Committee
- ❖ Alberta Association of Municipal Districts and Counties (AAMD&C)
- ❖ Alberta Seed Growers Association (ASGA)
- ❖ Association of Alberta Co-op Seed Cleaning Plants
- ❖ Alberta Corn Committee
- ❖ Alberta Grains Council
- ❖ Canadian Seed Trade Association
- ❖ Alberta Beef Producers
- ❖ Alberta Barley Commission