Survey for Head Blight of Cereals and Stalk Rot of Corn Caused by *Fusarium graminearum* in Alberta in 2011

FINAL RESULTS REPORT

Prepared by

R.J. Howard[1], G.C. Daniels[1], M.W. Harding[1], T.K. Turkington[2], and P. Laflamme[3]

[1]Alberta Agriculture and Rural Development, Crop Diversification Centre South, 301 Horticultural Station Road East, Brooks, AB T1R 1E6

[2]Agriculture and Agri-Food Canada, Research Centre, 6000 C & E Trail, Lacombe, AB T4L 1W1

[3]Alberta Agriculture and Rural Development, Pest Surveillance Branch, 307 J.G. O'Donoghue Building, 7000 – 113 Street, Edmonton, AB T6H 5T6

Table of Contents

List of Figures

List of Tables

Executive Summary

- A survey of 31 counties, municipal districts and special areas of the Province was undertaken in 2011 to update information on the prevalence and geographical distribution of fusarium head blight (FHB) on cereals and corn, with emphasis on spring wheat.
- The survey regions were chosen in order to:
    - Monitor the perimeter area surrounding the more heavily infested southern Alberta municipalities, identified in the 2010 fusarium head blight survey, for spread of *Fusarium graminearum* (*Fg*) into this area,
    - Repeat the surveys of three central Alberta counties (Ponoka, Two Hills, Wainwright) where low levels of *F. graminearum* were identified in 2010 to determine if this pathogen was gaining a foothold in these areas,
    - Survey areas that were missed in 2010 to ensure that all municipalities in the province were sampled to a minimum of 1% of wheat acreage over the two years of surveys.
- Nearly 450 cereal and corn fields across Alberta were surveyed between July and November for *Fusarium graminearum* (*Fg*), the primary pathogen causing FHB in cereals and stalk rot in corn in southern Alberta, and a declared pest under the Agricultural Pests Act.
- Cereal head and stubble samples, as well as stalk samples of corn, were collected and analyzed.
- In 2011, five cereal fields were found to be positive for the presence of *Fg*. Three were found in the County of Warner, one in Wheatland County and one in the M.D. of Wainwright. All three of these municipalities had positive fields in 2010 as well.
- Five municipalities that had positive fields in 2010 (Two Hills, Ponoka, Willow Creek, Cardston and Forty Mile) were clear of *Fg* in samples taken in 2011
- For 2012, the following survey priorities are recommended:
    - Perform a more extensive survey in the M.D. of Wainwright to determine the extent of the *Fg*-infested area.
    - Continue monitoring the perimeter region to the west and north of the *Fg*-infested southern counties.
    - Support Agriculture Service Boards and Applied Research Associations, who plan to conduct FHB surveys in their respective jurisdictions, by providing staff training and technical advice in support of these activities.

Background

Fusarium head blight (**FHB**) is a serious fungal disease of wheat, barley and oats, which can also affect other small cereal grains, corn and forage grasses. FHB can be caused by a number of pathogenic *Fusarium* species and has also been called scab, tombstone, head blight, pink mold and whitehead in some older published reports. FHB was first described in 1884 in England and was initially recognized as a fungal disease in North America about 120 years ago. Repeated severe epidemics of FHB occurred in the U.S.A. from 1915 through the 1920s. The first report of this disease in Canada was in 1919. In the 1940s, FHB erupted in eastern Canada and the east-central U.S.A. FHB was reported less frequently during the 1950s, 60s and 70s, but in the early 80s there were large outbreaks of FHB in eastern Canada, Manitoba, and in the U.S. wheat states from North Dakota to Kansas. A severe outbreak of FHB in Manitoba in 1993 brought the problem to prominence for the Canadian Prairies (Stack 2003). Outbreaks of FHB can usually be traced to four main scenarios: 1) Widespread planting of highly susceptible varieties, 2) Existence of colonized residue from previous crops, 3) Presence of corn in rotation with small grains, and 4) Weather conditions favourable for *Fusarium* infection (Stack 2004).

The *Fusarium* species of most concern as a cause of FHB in cereals is *Fusarium graminearum* Schwabe (***Fg***) (teleomorph *Gibberella zeae* Petch), which can have a significant economic impact on cereal production in two main ways. Firstly, it can reduce yield and grade through the formation of fusarium-damaged kernels (FDK), and secondly, it can have a significant negative effect on the end-use quality of grain used for feed, milling, malting, brewing and ethanol production because it produces fungal toxins (vomitoxins), such as deoxynivalenol (DON), and reduces the quality of grain fractions, such as starch, bran and germ. *Fg* is only one of many species of *Fusarium* that can cause FHB, but it is considered the most important one in Canada because of the significant impact it can have on yield and grain quality, its ability to produce several different toxins, and its abundance in eastern Canada and the eastern prairies (Clear and Patrick 2010). Recent research has shown that *Fusarium graminearum* also has the potential to cause disease in and have an economic impact on potatoes [tuber dry rot] (Estrada et al 2010), sugar beets [root rot] (Christ et al 2011) and dry beans [root rot] (Gambhir et al. 2009), in addition to cereals and corn.

Economic losses from FHB in the Northern Great Plains and central U.S.A. were estimated at $2.7 billion from 1998 to 2000. Losses from FHB in Canada have ranged from $50 million to $300 million annually since the early 1990s (Nganje et al. 2002). In 2005, a report on “Economic Risk Assessment of the Potential Future Development and Impact of FHB caused by *Fusarium graminearum* in Alberta” was published by Alberta Agriculture and Food, Edmonton (Heikkila and Verchomin 2005). The average annual projected total costs to Alberta crop production over a nine-year period ranged from $3 million to a high of $49 million per year, with the risk analysis suggesting that total losses could be as high as $64 million in a year. Actual costs may have been even higher since the modeling was based on actual conditions in Manitoba in 2003, which were unusually dry, resulting in limited FHB development that year. Additional costs incurred by livestock producers or grain processors were not considered in the assessment.

Disease surveys by Agriculture and Agri-Food Canada (AAFC), the Canadian Grain Commission (CGC), and Alberta Agriculture since the early 1990s, along with anecdotal reports from industry agronomists and local producers, showed that *Fg* was being found with increasing frequency in southern Alberta, especially in highly susceptible durum and soft white wheat varieties being grown under irrigation (Clear and Patrick 2010; Turkington et al. 2005; Laflamme 2006). Seed growers in southern Alberta are concerned about the risk of their fields becoming infested with low levels of *Fg*. Fortunately, however, the pathogen has rarely been encountered in central and northern Alberta.

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Advisors and Cooperators

Advisors:

Alberta Agriculture and Rural Development

Ron Howard
Research Scientist, Plant Pathology
Pest Surveillance Branch
Crop Diversification Centre South
301 Horticultural Station Road East
Brooks, Alberta T1R 1E6
Phone: (403) 362-1328; Fax: (403) 362-1326
Email: ron.howard@gov.ab.ca

Michael Harding
Research Associate, Plant Pathology
Pest Surveillance Branch
Crop Diversification Centre South
301 Horticultural Station Road East
Brooks, Alberta T1R 1E6
Phone: (403) 362-1338; Fax: (403) 362-1326
Email: michael.harding@gov.ab.ca

Jim Broatch
Pest Management Specialist
Pest Surveillance Branch
5030 – 50th Street
Lacombe, Alberta T4L 1W8
Phone (403)782-8619; Cell: (403)877-4687
Email: jim.broatch@gov.ab.ca

Paul Laflamme
Head, Pest Surveillance Branch
307 J.G. O'Donoghue Building
7000 – 113 Street
Edmonton, Alberta T6H 5T6
Phone: (780) 422-4911; Fax: (780) 427-1057
Email: paul.laflamme@gov.ab.ca

Agriculture and Agri-Food Canada

T. Kelly Turkington
Research Scientist, Plant Pathology
Lacombe Research Centre
6000 C & E Trail
Lacombe, AB T4L 1W1
Phone: (403) 782-8138; Fax: (403) 782-6120
Email: kelly.turkington@agr.gov.ca

Agriculture Research and Extension Council of Alberta (ARECA)

Applied Research Association	Municipal Districts Surveyed
Battle River Research Group (BRRG)	M.D. of Wainwright
Gateway Research Organization (GRO)	Westlock County, Parkland County
Mackenzie Applied Research Assoc. (MARA)	Mackenzie County

Other Participating Organizations

Organization	Municipal Districts Surveyed
Alberta Innovates Technology Futures (AITF) Vegreville, AB	County of Two Hills, County of Vermilion River
Alberta Agriculture & Rural Development Crop Diversification Centre South Brooks, AB	Special Area 2, Special Area 3, M.D. of Pincher Creek, Cardston County, Ponoka County
Innovotech Inc. Brooks, AB	Corn survey of Special Area 2, Starland County, Kneehill County;

Agriculture Service Board Surveyors

- Beaver County
- Birch Hills County
- Clear Hills County
- County of Forty Mile
- County of Grande Prairie
- County of Vermilion River
- County of Warner
- County of Wetaskiwin
- Kneehill County
- Lac Ste. Anne County
- Leduc County
- M.D. of Acadia
- M.D. of Bonnyville
- M.D. of Foothills
- M.D. of Peace
- M.D. of Spirit River
- M.D. of Willow Creek
- Rockyview County
- Starland County
- Sturgeon County
- Wheatland County
- Woodlands County
- Yellowhead County

Survey Protocols

Introduction

A comprehensive survey for fusarium head blight (FHB) of cereals and corn was carried out in 2010, coordinated by Alberta Agriculture and Rural Development (AARD). While this survey gave a good indication of the status of fusarium head blight infection throughout the province, additional monitoring for the disease in 2011 was recommended to include municipalities under the following considerations:

1. Municipalities omitted or under-represented in the 2010 survey.
2. Repetition of the wheat survey in three central Alberta counties where fields positive for FHB were identified in 2010.
3. Wheat and corn surveillance of counties on the periphery of the southern region where FHB is commonly found.

The total number of fields to be assessed in 2011 was anticipated to be 350-400 wheat/barley fields and up to 30 corn fields. Actual field totals were 437 cereal fields and 9 corn fields. Any municipalities not included under categories 1-3, but which intended to perform their own surveys, were encouraged to submit samples through this program. In all municipalities, awareness of clubroot, a destructive soil-borne disease of canola and mustard, was raised to ensure that surveyors performed recommended sanitation procedures for footwear, vehicles and equipment to prevent accidental spread of this disease.

Sampling Protocol for Cereal Heads

Wheat was the focus of the survey because it is more prone to FHB than barley and because disease symptoms are easier to recognize on wheat than on other cereal crops. Also, durum varieties, in particular, have a poor to very poor resistance to *Fg* infection when compared to other cereal varieties (Table 1). As a result, durum fields were specifically sought for sampling and results for durum are reported separately within the body of this report. The targeted number of fields for each municipality is shown in Table 2. These targets were generated by sampling approximately 1-2% of the total wheat acreage for each municipality based on the 2006 Census of Agriculture. Exceptions were made in Yellowhead and Brazeau counties in that barley samples were requested due to the very low wheat acreage in relation to barley acreage in those municipalities. In addition, some counties chose to include barley fields in their surveys for their own information purposes and when difficulty in obtaining sufficient wheat samples was encountered. A map of Alberta municipal districts is shown in Figure 1.

Cereal heads were chosen as the preferred method of sampling in order to provide a kernel incidence for FHB caused by *Fg* in infected fields and to allow simple, microscopic observation for the presence of *Fusarium* spores. For municipalities running their own surveys, the choice of sampling pre-harvest heads or post-harvest stubble was optional.

In each field, surveyors took head samples along a W-shaped path, staying at least 50 m away from any edge of the field (Figure 2). At 10 sites along the path, 30 heads were collected at random (300 heads per field). Plants were selected between the late milk stage[1] and any point up to full maturity. Heads from different sites in the field were pooled into a single sample, the location of each field was recorded and, where possible, background information on the variety, rotation and irrigation regime was collected. The heads were brought back to a central location and air dried, placed into a sturdy cardboard box and shipped to Alberta Agriculture at Crop Diversification Centre South (**CDCS**) in Brooks, AB for processing. At CDCS, the heads were threshed by hand in a shallow pan with a ribbed rubber mat in the bottom using a hand-held block with the same matting mounted to its bottom. The heads were placed in the pans and crushed against the bottom mat with the block until all of the kernels had been extracted. Chaff was blown off with a stream of compressed air and 100 kernels were counted out at random, packaged and sent to BioVision Seed Labs in Edmonton, AB for laboratory testing for the presence of *Fg*. The threshing equipment was cleaned and sterilized between samples to avoid cross-contamination.

Sampling Protocol for Cereal Stubble

For those surveying cereal stubble, up to thirty stubble pieces, consisting of the bottom portion of the stems, including the first node and the attached root systems, were collected at each of 10 sites along the survey path in the same manner as with head samples. Samples were shipped to CDCS and processed by removing the leaf sheath surrounding the first node above the soil line and trimming the stem to approximately 0.5 cm on either side of the node. One hundred nodes were packaged and sent to BioVision Seed Labs, Edmonton, AB to test for the presence of *Fg* using the agar plating method.

Sampling Protocol for Corn Stalks

Although 30 corn fields of any variety were originally targeted for sampling in those municipalities that bordered on the areas of known FHB infestation, in actuality, corn was not grown in significant quantity in this region of the province. As a result, only 9 fields were sampled in total. Just prior to or immediately following harvest, corn residue (stalk) samples were collected along a diamond-shaped (Figure 3) path, starting at least 50 m in from the edge of each field with at least 50 m between sampling sites. At each of 10 sites along the sampling path, 10 corn stalk pieces were collected non-selectively. Stalk pieces were cut to approximately 15 cm in length and included the first node towards the base of the stalk. Following shipping to CDC south, tissue pieces (3-5 cm in long) were cut from the interior of the nodes and plated on agar for culture development. These cultures were then shipped to BioVision Seed Labs for analysis for the presence of *Fg*.

Identification and Characterization of *Fusarium* Isolates

Analysis of cereal seed, cereal stubble and corn stalks for *Fg* was carried out by BioVision Seed Labs, Edmonton, AB under the direction of Ms. Holly Gelech, Manager – Business Development. An agar plate method was used to isolate *Fusarium* species from tissue samples. Presumptive *Fg* isolates were selected based on cultural characteristics, such as mycelial color, growth characteristics and

[1] Feekes growth scale 11.1-11.4, Zadoks growth scale 77-92

conidiospore morphology, followed by molecular confirmation by polymerase chain reaction (PCR) analysis.

Survey Results

Influence of Environmental Conditions on Fusarium Head Blight Development

For *Fusarium* head infection to occur in cereal crops, three conditions must coincide. Firstly, a susceptible variety must be planted. Secondly, inoculum in sufficient quantity for infection must be available. Thirdly, an environment suitable for infection and disease development is needed. This is often referred to as the "Disease Triangle." Wheat is at its most susceptible to *Fusarium* infection during anthesis (flowering) (Feekes growth stage 10.5.1 – 10.5.3) (Sutton 1982). In Alberta, depending on year and location, anthesis in spring cereals usually occurs anywhere from early to late July. For high levels of head infection to occur then, it is essential that an adequate supply of *Fusarium* inoculum be available during the flowering period and that environmental conditions also be favorable, i.e. warm and moist or humid (Calpas et al. 2003; McMullen et al. 2008). The optimal conditions for infection are prolonged periods (48-72 hours) of high humidity coinciding with warm temperatures (24-29°C). However, infection can occur even at cooler temperatures, such as 9-10°C, when high humidity (>90%) persists for longer than 72 hours. In the absence of precipitation, irrigation can provide the required humidity. This has led to relatively high FHB levels in the irrigated regions of southern Alberta in recent years. Although detection of *Fg* in field surveys and grain sample analyses has mainly occurred in southern Alberta over the past decade, this pathogen has been found in all seven crop districts in Alberta at one time or another, albeit at low levels in most. Figure 4 presents data from the Canadian Grain Commission demonstrating *Fg* isolated from wheat samples from each Alberta crop district in 2008.

2011 Growing Season Overview

In 2011, cooler-than-average temperatures reduced growing degree day (GDD) accumulations in most areas of the province, with only a few isolated areas in the northern Alberta and the Peace Region having higher than average growing degree day (GDD) accumulations (Figure 5). At the same time, moisture levels through the central, northern and Peace regions of the province were higher than average during the month of July, in some cases at 1 in 25 year levels (Figure 6). Precipitation levels were at seasonal levels in southern Alberta. Because of these weather conditions, cereal and corn crops tended to mature later than usual in many regions of the province and, in some cases, delayed maturity may have extended the flowering period, lengthening the window for *Fusarium* head infection in cereal crops. Given the above-normal precipitation over the central, northern and Peace regions of the province and seasonal precipitation levels in southern Alberta, conditions were favourable for the development of FHB in cereals throughout the province, though perhaps not as favourable in southern Alberta as in 2010, when early season precipitation levels were much higher.

Recently, a new online tool called WeatherFarm[2] has been developed by the Canadian Wheat Board and its cooperators, to aid in demonstrating the risk of a crop developing FHB based on current environmental conditions. The model is generated by temperature and humidity measurements from more than 800 weather stations throughout the Prairie Provinces. Examples of this model for Alberta from July 15 and August 1, 2011 are shown in Figure 7. Under this model, crops in central/northern Alberta and the Peace Region were under optimal environmental conditions to develop the disease in mid-July and the risk of infection would have been dependent upon the timing of anthesis, the level of FHB resistance in the variety planted, and the presence of sufficient inoculum in the region to spread the pathogen.

2011 Survey Overview

The purpose of the 2011 survey was primarily to monitor the municipalities on the perimeter of the irrigated counties in which *Fg* was found in 2010, to survey counties that were omitted or under-represented in the 2010 survey, and to survey municipalities in central and northern Alberta where *Fg* was found in 2010 to determine if the disease is spreading in any of these areas. As a result, of the counties in southern Alberta where *Fg* was found at levels greater than 10% of fields in 2010, only the County of Warner was targeted for surveillance in 2011. This was due to interruption of the 2010 stubble survey by the combination of a late harvest and an early snowfall. The County of Forty Mile and the M.D. of Willow Creek performed their own surveys and supplied samples for this report.

In all, 9 corn fields and 437 cereal fields (415 by head survey and 22 by stubble survey) were surveyed across Alberta between July and October of 2011 (Table 3). The majority of fields visited were in central and northern Alberta (47.7%), followed by southern Alberta (40.3%) and the Peace Region (11.9%). Cereals comprised the majority of fields surveyed (98%), with the largest proportion of samples collected being seed (93%), followed by stubble (4.9%) and corn (2.0%). In total, only five cereal fields were found to be positive for the presence of *Fg*. Three of these positive fields were in the County of Warner, one was in Wheatland County and one was in the M.D. of Wainwright (Figure 8). Corn samples were only taken in municipalities on the perimeter of the infected region of southern Alberta, and all were negative for the disease (Figure 9).

Fg was found only in head (seed) samples at a level of 1.2%, while *Fg* was not found in any cereal stubble or corn stalk samples (Table 3). By contrast, in 2010, 13.6% of head samples and 6% of stubble samples taken in the province contained *Fg* (not shown). Since the more heavily infected region of the province was excluded from the 2011 survey, the much lower rate of infection is not surprising.

Results based on survey priorities

Fg was not found in any of the municipalities missed during the 2010 survey and all five positive fields identified were in municipalities that contained one or more positive fields in 2010. Rates of infection were lower in Warner in 2011 (8.3%) as compared to 2010 (17.4%), but the rate of infection in

[2] This crop management tool is available at http://www.weatherfarm.com

Wainwright and Wheatland was relatively unchanged. Five counties that had positive fields in 2010 (Two Hills, Ponoka, Willow Creek, Cardston and Forty Mile) were clear of *Fg* in samples taken in 2011 (Table 6). It is worth noting that dryland fields were selected by the County of Forty Mile in order to determine if the disease was less likely to infect dryland versus irrigated fields in that county. This supposition was confirmed as no *Fg*-positive dryland fields were detected in that county in 2011 whereas 45.7% of the fields surveyed there in 2010, which were mostly irrigated, were positive for *Fg*.

The perimeter region for the disease was arbitrarily defined as the region to the North and West of the municipalities with higher *Fg* levels in 2010 (>10% of fields infected). This perimeter region consisted of: Special Areas 2 and 3, Starland County, Kneehill County, Wheatland County, Rockyview County, the M.D. of Foothills, the M.D. of Willow Creek, and Cardston County. For this perimeter region, only a single positive cereal field was identified, which was located in Wheatland County. Corn, where it could be found, was also surveyed in this region as a sentinel crop, since rates of stalk rot infection in corn fields were very high in the FHB-infested areas of the province in the 2010 survey (86.4% of corn fields in the southern region were positive for *Fg*). No corn fields were positive for *Fg* in the perimeter counties in 2011, and only a single cereal field in Wheatland County was shown to be infected with *Fg*, with a kernel incidence of only 1%. These results would imply that FHB has not been able to achieve a strong foothold in these municipalities, though it may be still be found in incidental amounts.

Of the three central and northern municipalities where *Fg* was found in 2010, only Wainwright had a positive field in 2011, again it was only a single field. This finding may be of concern since it equates to 5.6% of the surveyed fields in the M.D. of Wainwright being shown to be positive for *Fg* in back-to-back years; however, since only a single positive field was identified each year, the disease may still only be present at low levels within this municipality.

Identification of *Fusarium* species by Region

The results of the *Fusarium* identification analysis by crop type and region are summarized in Table 3. Ten fields were initially flagged as presumptive positive for *Fg* out of a total of 446 surveyed (2.2%). Twenty-eight *Fusarium* subcultures were obtained from these 10 fields. *Fg* comprised 90% of the total number of *Fusarium* isolates originating from head samples in the south, while *F. pseudograminearum* (*Fpg*) made up 100% of the isolates from stubble samples (Table 4). As *Fpg* is primarily a root and crown pathogen, it is expected to be more likely to occur in stubble samples than in head samples. Only a single *Fg* isolate was found outside of southern Alberta, which was in the M.D. of Wainwright.

Occurrence of *Fusarium graminearum* on Different Crop Types

A summary of the percentage of fields confirmed to have *Fg* by crop type is given in Table 5. Although the overall rate of *Fg* infection in seed samples was quite low (1.2%), Fg was found in three different crop types (two wheat, two durum and one barley sample). While disease presence in the province was high in barley samples (12.5%) compared to durum (8%) and spring wheat (0.5%), these results are biased both by the low number of barley samples collected (8) and the fact that the infected barley and durum samples all originated from the County of Warner, which had a high level of *Fg* infection, in general, in both 2010 and in 2011. Within this county, infection rates were: durum (2/13 fields), barley

(1/3 fields) and wheat (0/20 fields). These results would indicate that the susceptibility of durum varieties is an issue of consequence in the infected area of the province.

Comparison to Canadian Grain Commission Results

Annually, the Canadian Grain Commission tracks downgraded grain samples across the Prairie Provinces for a variety of diseases. In 2011, while the quantity of samples downgraded due to FDK decreased in Manitoba and Saskatchewan, in relation to 2010, in Alberta the rate remained unchanged at 4% of samples (data not shown). The average percentage of grain samples downgraded due to FDK in each crop district is shown in Table 7. FDK percentages dropped significantly in durum to < 3% of samples in CD 1 and 2, and rates were significantly lower in wheat from Crop Districts 1, 4 and 5. Rates of FDK in CD2 were relatively unchanged and higher in CD3, whereas levels in CDs 6 and 7 were higher than in 2010. It is important to note that FDK can be caused by fungi other than *Fg* and that the CGC did not plate out samples of FDK to determine the causal fungi. The *Fg*-positive samples obtained from Crop District 2 (Warner and Wheatland) and Crop District 4 (Wainwright) in the 2011 FHB survey were determined by agar plating and PCR testing. This result demonstrates the possibility that FDK data from the CGC may vary from the actual occurrence of *Fg* at specific locations. In general, however, FDK determinations by the CGC are predictive of *Fg* incidence in areas where this pathogen is well established, such as in the irrigated areas of southern Alberta.

Conclusions and Future Recommendations

Conclusions

The 2011 survey results were consistent with previous findings that FHB caused by *Fg* remains well established in southeastern (CD 1) and south-central (CD 2) Alberta, and can occur sporadically outside of these areas at very low levels (e.g. CD 4). At this time, the disease does not appear to be significantly spreading to areas outside of the irrigated counties in southern Alberta; however, the sporadic appearance of the disease in neighboring municipalities and throughout the province should be expected to continue, especially in years where seasonal conditions are optimal for spread of the causal fungi and for head infection of cereals. Climatic conditions through most of Alberta in 2009-2011 were relatively conducive for the development of FHB, so the survey was well-timed to detect the presence of this disease.

Cereal growers in southern Alberta have come to realize the importance of FHB and its impact on yield and quality. Many are actively taking steps to manage the disease by following management practices advocated in the Alberta *Fusarium graminearum* Management Plan and crop protection guides. The corn industry seems relatively unconcerned about the fusarium ear and stalk rot at this time because growers feel that yield losses in that crop have not reached economic levels. Producers in central and northern areas of the province remain concerned about FHB spreading into their areas and are taking preventative steps to deter this from happening. Many of the producers and cooperators involved in the 2010 FHB survey stressed the importance of continuing to monitor the spread of FHB and *Fg* in Alberta to periodically determine the relative disease risk and to assess the effectiveness of the

preventative and best management practices currently in use. Thus, there are some differences in the disease-management strategies being used in areas such as CD1, CD2 and possibly CD3, where the disease is well- established compared to those areas where Fg is not commonly found. In the infested counties in the southern region, producers are employing **Best Management Practices** that include the use of diverse rotational crops, irrigation scheduling, seed and foliar fungicide applications, composted manure, and disease-tolerant wheat and barley varieties, and minimizing the use of common seed. In the remainder of the province, the emphasis is on preventing the introduction of the disease through a dedicated **Disease Prevention Program** that includes practices such as scouting cereal fields for presence of the disease, testing common seed for freedom from *Fg*, proper storage, transport and handling of feed grains, straw and hay from *Fg*-infested areas of western Canada, and applying seed treatments.

Recommendations for Future Surveillance Activities

A number of short- and long-term options exist for future surveillance activities for FHB in Alberta. The choice of these options at any given time will mainly depend upon current survey priorities of Agriculture Service Boards and the Pest Surveillance Branch of AARD, the degree of economic impact that FHB is having on the cereal industry, and perceived significant changes in the causal *Fusarium* species and/or chemotypes involved in the FHB disease complex.

For 2012, the following survey priorities are recommended:

- Re-visit the M.D. of Wainwright, where positive fields infested with *Fg* were detected in both 2010 and 2011. The number of fields examined should be expanded in order to more accurately assess the geographical distribution and incidence of the FHB caused by *Fg* in cereal fields.

- Continue to monitor the "perimeter municipalities" bordering the heavily infested counties in southeastern and south-central Alberta to the north and west to include more cereal and corn fields in order to determine if *Fg* is becoming well entrenched in these areas as well. The municipalities that would be surveyed again include M.D. of Foothills, M.D. of Willow Creek, Cardston County, Wheatland County, Special Areas 2 and 3, and M.D. of Acadia.

- Survey the more heavily infested counties in southern Alberta with an emphasis on irrigated vs. dryland fields and provide maps of the disease progression at the sub-county level for more accurate risk assessment.

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- Agriculture Service Board Fieldmen (pg. 8)
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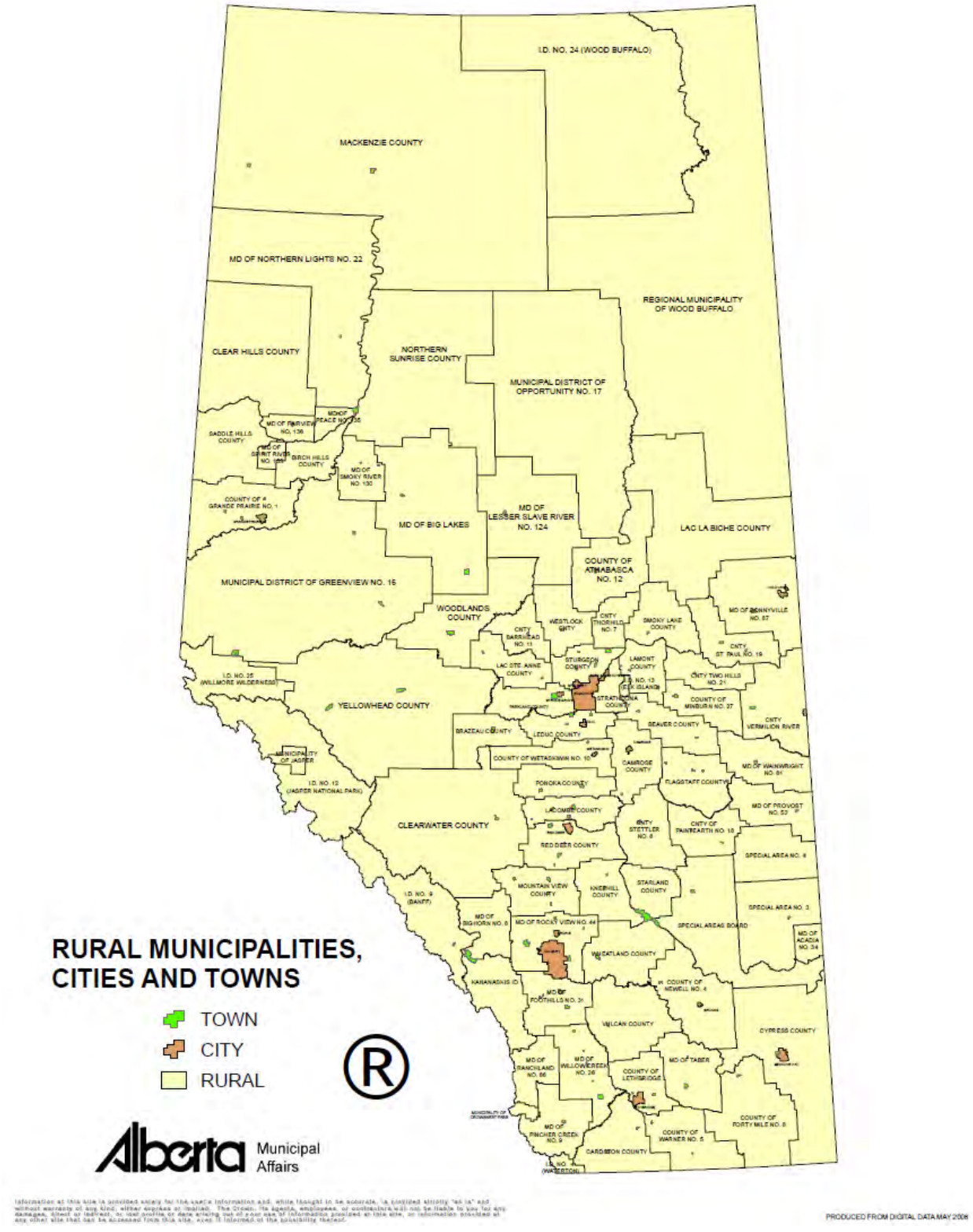


Figure 1. Map of Alberta Counties, Municipal Districts and Special Areas.

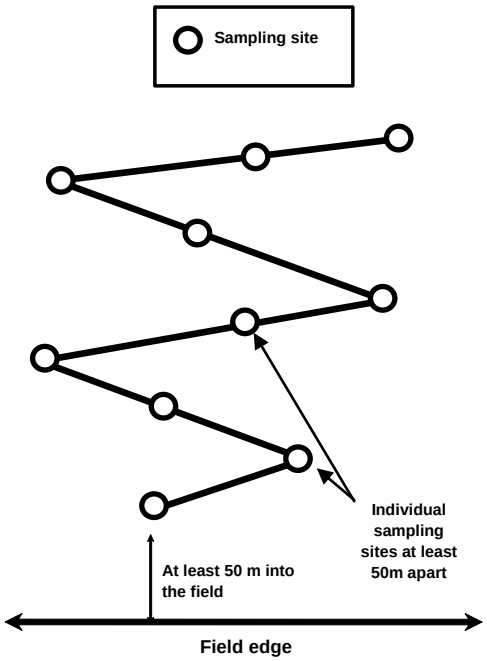


Figure 2. W-shaped sampling path showing cereal sampling locations.

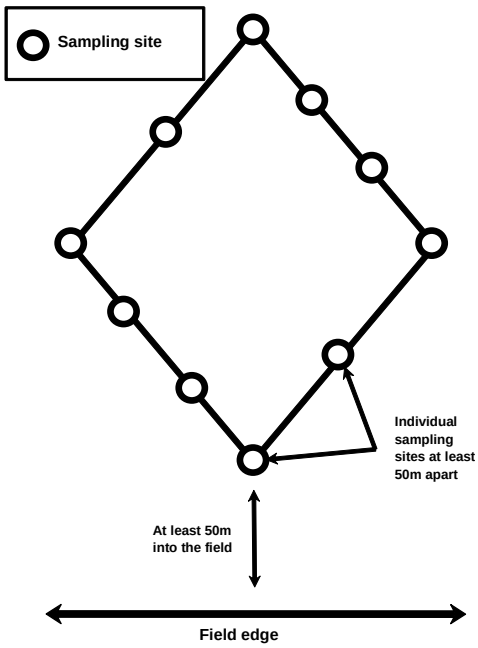


Figure 3. Diamond-shaped sampling path for corn sampling locations.

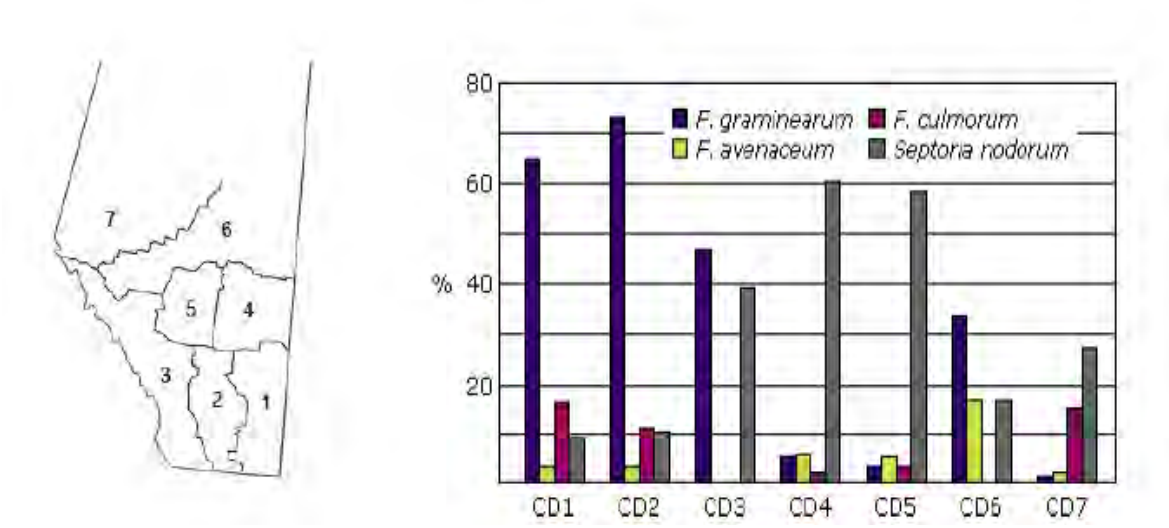


Figure 4. Map of the Canadian Grain Commission crop districts in Alberta and fungal species infecting fusarium-damaged kernels (FDK) in Alberta crop districts in 2008 based on analysis of wheat samples delivered to grain elevators.

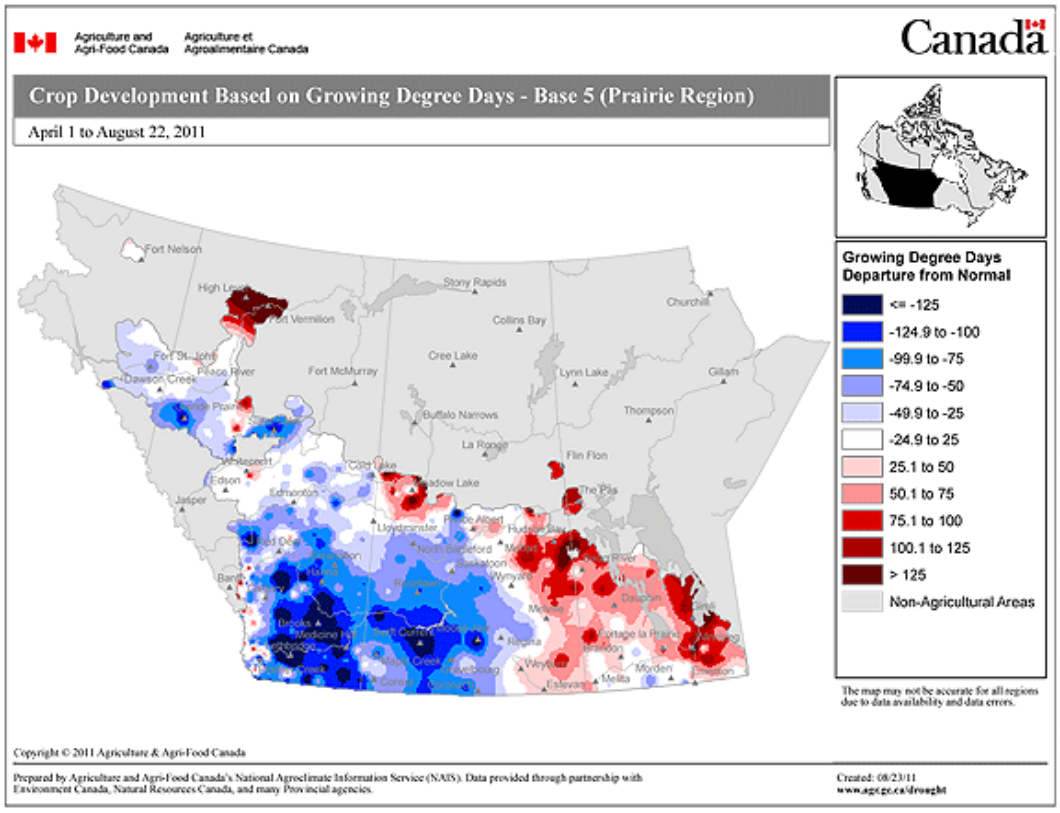


Figure 5. Growing degree days as departure from normal for the Prairie Provinces in 2011.

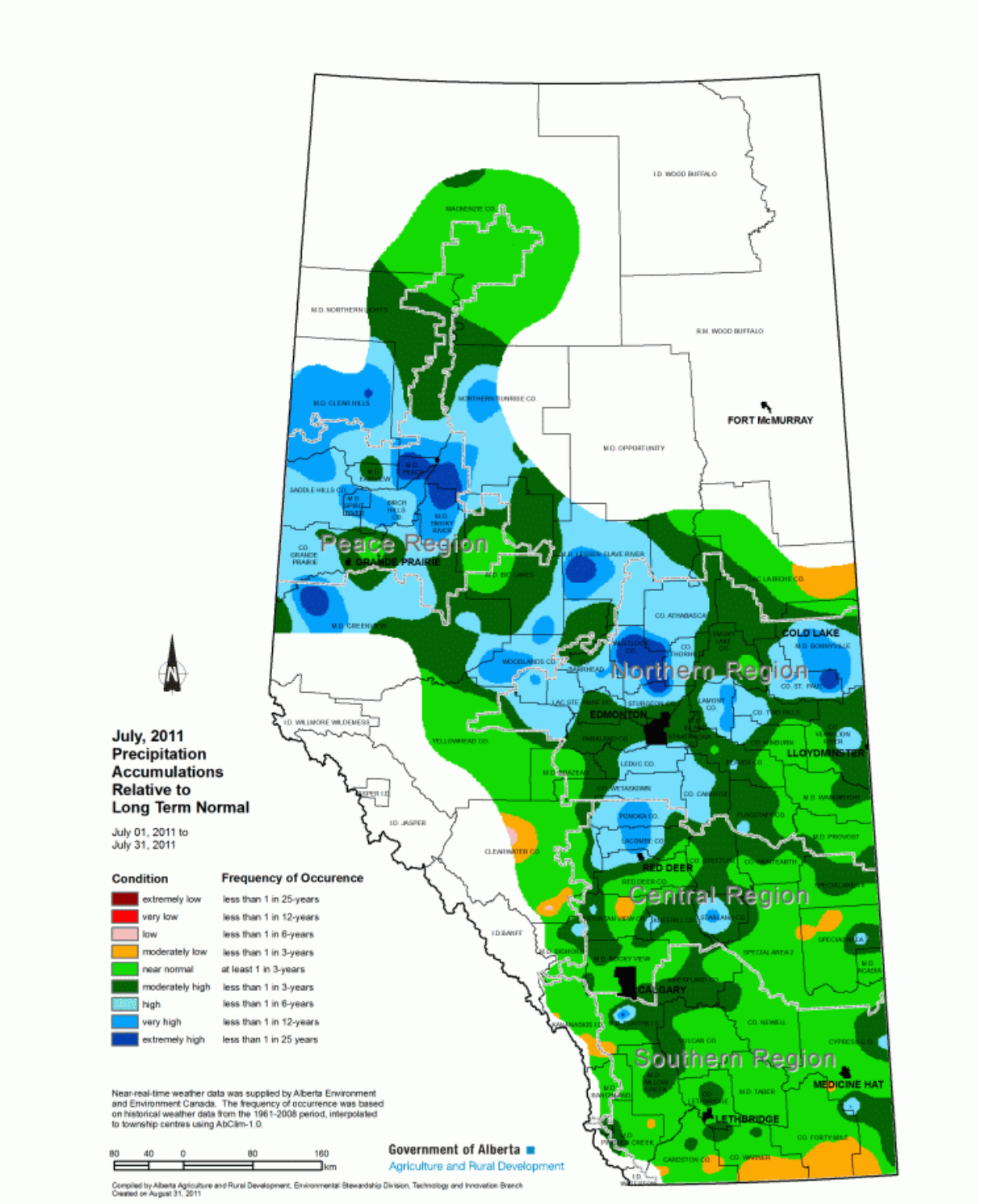


Figure 6. Precipitation as departure from normal for Alberta in July 2011.

A.

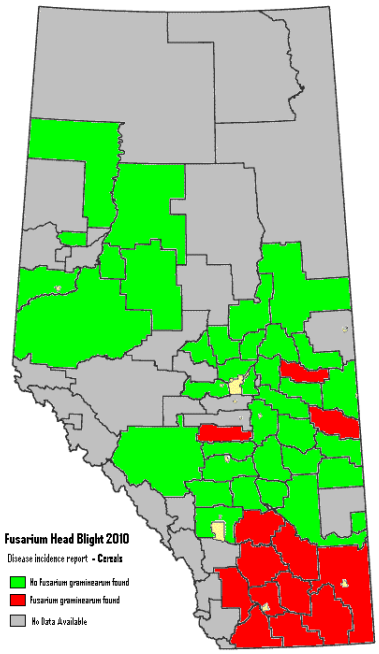
B.

Figure 7. Risk of developing FHB infection in spring wheat varieties with poor FHB resistance.

A. Under environmental conditions from July 15, 2011.

B. Under environmental conditions from August 1, 2011.

2010:



2011:

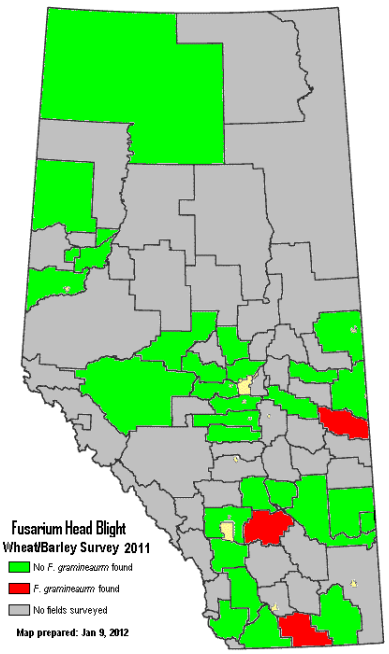
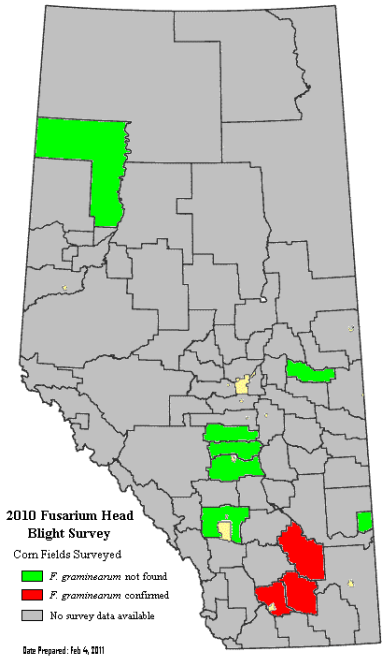


Figure 8. Map of Alberta municipalities in which *Fusarium graminearum* was detected in cereal samples.

2010:



2011:

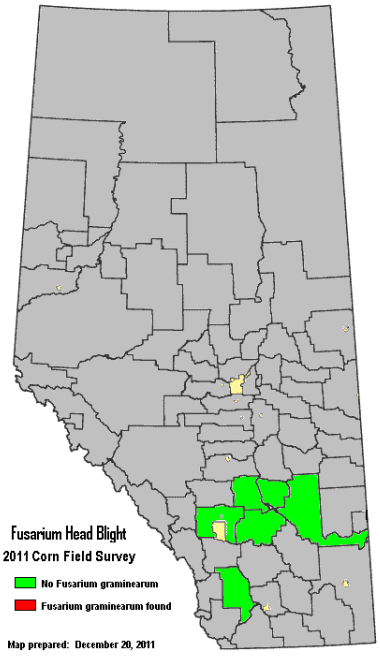


Figure 9. Map of Alberta municipalities in which *Fusarium graminearum* was detected in corn samples.

Table 1. Fusarium head blight reaction of cereal varieties for Alberta.

Based on Varieties of Cereal and Oilseed Crops For Alberta - 2011, AARD Agdex 100/32

T.K. Turkington [1], and K. Xi [2]

[1] Agriculture and Agri-Food Canada Lacombe, AB; [2] Alberta Agriculture and Rural Development (AARD), Lacombe, AB

*Fusarium Head Blight Reaction**

Good (G) | Fair (F) | Poor (P) | Very Poor (VP)

Wheat, Triticale, and Oat

CWRS	
5602HR	G
BW878	G
Carberry	G
Waskada	G
5603HR	F
5604HR CL	F
AC Barrie	F
AC Cadillac	F
Alikat	F
CDC Bounty	F
CDC Kernen	F
Fieldstar VB	F
Glenn	F
Kane	F
Katepwa	F
McKenzie	F
AC Elsa	P
AC Intrepid	P
AC Splendor	P
Alvena	P
CDC Abound	P
CDC Alsask	P
CDC Go	P
CDC Stanley	P
CDC Thrive	P
CDC Utmost VB	P
Journey	P
Muchmore	P
Shaw VB	P
Somerset	P
Stettler	P
Superb	P
Unity VB	P
CDC Imagine	VP
CDC Osler	VP
CDC Teal	VP
Goodeve	VP
Harvest	VP
Infinity	VP
Lillian	VP
Lovitt	VP
Park	VP
Peace	VP
Prodigy	VP
Roblin	VP
AC Eatonia	XX

CPS Red	
5702PR	P
AC Taber	VP
5700PR	VP
5701PR	VP
AC Crystal	VP
AC Foremost	VP

CPS White	
Snowhite475	VP
Snowhite476	VP

CWWS	
Kanata	F
Snowbird	P
Snowstar	P

CWAD	
AC Avonlea	P
Brigade	P
CDC Verona	P
Enterprise	P
Eurostar	P
Kyle	P
AC Morse	VP
AC Navigator	VP
Commander	VP
Strongfield	VP

SWS	
AC Meena	P
Sadash	P
Bishaj	VP
AC Andrew	VP

Winter wheat (WW)	
CDC Buteo	G
Norstar	G
AC Bellatrix	F
AC Tempest	F
CDC Harrier	P
CDC Osprey	P
Peregrine	P
Broadview	VP
CDC Falcon	VP
McClintock	VP
Radiant	VP
Accipiter	VP
AC Readymade	XX
CDC Clair	XX
CDC Kestrel	XX
CDC Ptarmigan	XX
CDC Raptor	XX
Sunrise	XX

Triticale	
Pronghorn	G
AC Ultima	F
Bunker	F
Bumper	P
Tyndal	P
Companion	XX

Oat	
All varieties	XX

CWES	
CDC Rama	F
Amazon	P
Bluesky	P
Laser	VP

Barley (row type)

General purpose	
Conlon (2)	G
CDC Cowboy (2)	G
CDC Dolly (2)	G
CDC Mindon (2)	G
Seebe (2)	G
Xena (2)	G
Busby (2)	F
CDC Austenson (2)	F
CDC Coalition (2)	F
CDC Trey (2)	F
Champion (2)	F
McLeod (2)	F
Ponoka (2)	F
Trochu (6)	F
AC Harper (6)	P
CDC Helgason (2)	P
Manny (6)	P
Niobe (2)	P
AC Lacombe (6)	VP
AC Ranger (6)	VP
AC Rosser (6)	VP
Chigwell (6)	VP
Stander (6)	VP
Sundre (6)	VP

Semi-dwarf	
CDC Bold (2)	VP
Mahigan (6)	VP
Vivar (6)	VP

Hulless	
CDC McGwire (2)	G
CDC Carter (2)	F
Millhouse (2)	F
Tyto (6)	P
Falcon (6)	VP

Malting	
Harrington (2)	G
Merit 57 (2)	G
TR05671 (2)	G
AC Metcalfe (2)	F
CDC Copeland (2)	F
CDC Kendall (2)	F
CDC Meredith (2)	F
Cerveza (2)	F
Major (2)	F
Newdale (2)	F
Stellar ND (6)	F
Bentley (2)	P
CDC Mayfair (6)	P
CDC Reserve (2)	P
CDC Select (2)	P
Legacy (6)	P
CDC Battleford (6)	VP
CDC Clyde (6)	VP
CDC Kamsack (6)	VP
CDC Yorkton (6)	VP
Excel (6)	VP
Tradition (6)	VP
Formosa	XX

Relative reactions of small grain cereals

Most susceptible ← → Least susceptible

Durum--CWS--CPS--WW--ES--CWRS--Triticale--6-row barley--2-row barley--Oat

*Under conditions favourable for disease all small grain cereals will sustain damage.
Ratings are largely based on data from screening nurseries in Manitoba.
Winter wheat may avoid significant FHB because it matures earlier than spring types.
**XX = insufficient data to describe.

Table 2. Field targets for the 2011 Fusarium head blight survey.

	Municipal District / County	2011 Wheat/ Durum target	2011 Barley target	2011 Corn Target
Counties not surveyed for *Fg* in 2010	Pincher Creek	2		
	Special Area No.3	11		
	Bonnyville	1		
	Brazeau	-	1	
	Lac Ste. Anne	1		
	Leduc	7		
	Wetaskiwin	6		
	Woodlands	1		
	Yellowhead	-	2	
	Birch Hills	12		
	Clear Hills	6		
	Mackenzie	12		
	Peace	5		
	Saddle Hills	10		
	Spirit River	6		
Central AB counties with *Fg* in 2010	Ponoka	6		
	Wainwright	18		
	Two Hills	11		
Counties on the perimeter of the heavily infected area	Cardston	18		4-5
	Foothills	12		4-5
	Kneehill	29		4-5
	Starland	19		4-5
	Special Area No.2	13		4-5
	Rockyview	18		4-5
	Wheatland	42		4-5
Counties under-represented in the 2010 survey	Beaver	18		
	Sturgeon	12		
	Vermillion River	22		
	Warner	36		
	Westlock	10		

Table 3. *Fusarium graminearum* survey results by region and sample type in 2011.

Region	Crop	Fields Surveyed	Confirmed Positive Fields	Confirmed Positive (%)
South	cereal stubble	22	0	0.0
	cereal seed	154	4	2.6
	corn	4	0	0.0
	All crops	180	4	2.2
Central	cereal stubble	-	-	-
	cereal seed	102	0	0.0
	corn	5	0	0.0
	All crops	107	0	0
Northeast	cereal stubble	-	-	-
	cereal seed	74	1	1.4
	corn	-	-	-
	All crops	74	1	1.4
Northwest	cereal stubble	-	-	-
	cereal seed	32	0	0.0
	Corn	-	-	-
	All crops	32	0	0
Peace	cereal stubble	-	-	-
	cereal seed	53	0	0.0
	corn	-	-	-
	All Crops	53	0	0
Entire Province	cereal stubble	22	0	0.0
	cereal seed	415	5	1.2
	corn	9	0	0.0
	Total	**446**	**5**	**1.1**

Table 4. Identification of *Fusarium* isolates from *Fg*-presumptive positive fields.

Region	Sample type	Presumptive Positive Fields	Isolates tested	*Fusarium graminearum*	*Fusarium pseudograminearum*
South	nodes	4	17	0%	100%
	seed	5	10	90%	10%
Central/Northern	nodes	0	0	-	-
	seed	1	1	100%	0%
Peace	nodes	0	0	-	-
	seed	0	0	-	-
Province	All types	10	28	35.7%	64.3%

Table 5. *Fusarium graminearum* survey results by region and crop type for 2011.

	Seed			Stubble / Stalk			Total		
Crop	Surveyed Fields	Positive Fields	Disease presence (%)	Surveyed Fields	Positive Fields	Disease presence (%)	Surveyed Fields	Positive Fields	Disease presence (%)
Southern region									
Wheat	124	1	0.8	21	0	0.0	145	1	0.7
Durum	25	2	8.0	-	-	-	25	2	8.0
Barley	5	1	20.0	1	0	0.0	6	1	16.7
Barley/oats mix	-	-	-	-	-	-	-	-	-
Corn	-	-	-	4	0	-	4	0	0
All crops	154	4	2.6	26	0	0	180	4	2.2
Central/Northern regions									
Wheat	205	1	0.5	-	-	-	205	1	0.5
Durum	-	-	-	-	-	-	-	-	-
Barley	2	0	0.0	-	-	-	2	0	0
Barley/oats mix	1	0	0.0	-	-	-	1	0	0
Corn	-	-	-	5	0	0	5	0	0
All crops	208	1	0.5	5	0	0	213	1	0.5
Peace region									
Wheat	53	0	0.0	-	-	-	53	0	0
Durum	-	-	-	-	-	-	-	-	
Barley	-	-	-	-	-	-	-	-	-
Barley/oats mix	-	-	-	-	-	-	-	-	-
Corn	-	-	-	-	-	-	-	-	-
All crops	53	0	0	-	-	-	53	0	0
Provincial Totals									
Wheat	382	2	0.5	21	0	0	403	2	0.5
Durum	25	2	8.0	-	-	-	25	2	8
Barley	7	1	14.3	1	0	0	8	1	12.5
Barley/oats mix	1	0	0	-	-	-	1	0	0
Corn	-	-	-	9	0	0	9	0	0
All crops	415	5	1.2	31	0	0	446	5	1.1

Table 6. *Fusarium graminearum* survey results by municipality for 2011.

		Cereal Seed			Cereal Stubble			Corn Stalks		
Municipal District / County	Crop District	Surveyed Fields	Confirmed Positive Fields	Positive Fields (%)	Surveyed Fields	Confirmed Positive Fields	Positive Fields (%)	Surveyed Fields	Confirmed Positive Fields	Positive Fields (%)
Southern Region										
Acadia	**1**	5	0	0	-	-	-	-	-	-
Cardston	**3**	18	0	0	-	-	-	-	-	-
Foothills	**3**	12	0	0	-	-	-	-	-	-
Forty mile	**1**	15	0	0	-	-	-	-	-	-
Pincher Creek	**3**	-	-	-	2	0	0	-	-	-
Special area No.2	**1**	13	0	0	-	-	-	1	0	0
Special area No.3	**1**	11	0	0	-	-	-	-	-	-
Warner	**2**	36	3	8.3	-	-	-	-	-	-
Wheatland	**2**	44	1	2.3	-	-	-	2	0	0
Willow Creek	**3**	-	-	-	20	0	0	1	0	0
Region		154	4	2.6	22	0	0	4	0	0
Central/Northern regions										
Beaver	**4b**	18	0	0	-	-	-	-	-	-
Bonnyville	**6**	2	0	0	-	-	-	-	-	-
Kneehill	**2**	50	0	0	-	-	-	2	0	0
Lac Ste. Anne	**6**	1	0	0	-	-	-	-	-	-
Leduc	**5**	5	0	0	-	-	-	-	-	-
Parkland	**5**	1	0	0	-	-	-	-	-	-
Ponoka	**5**	8	0	0	-	-	-	-	-	-
Rockyview	**3**	18	0	0	-	-	-	1	0	0
Starland	**2**	20	0	0	-	-	-	2	0	0
Sturgeon	**5**	12	0	0	-	-	-	-	-	-
Two Hills	**4b**	11	0	0	-	-	-	-	-	-
Vermilion River	**4b**	25	0	0	-	-	-	-	-	-
Wainwright	**4a**	18	1	5.6	-	-	-	-	-	-
Westlock	**6**	10	0	0	-	-	-	-	-	-
Wetaskiwin	**5**	6	0	0	-	-	-	-	-	-
Woodlands	**6**	1	0	0	-	-	-	-	-	-
Yellowhead	**6**	2	0	0	-	-	-	-	-	-
Region		208	1	0.5	0	0	0	5	0	0
Peace Region										
Birch Hills	**7**	6	0	0	-	-	-	-	-	-
Clear Hills	**7**	6	0	0	-	-	-	-	-	-
Grande Prairie	**7**	20	0	0	-	-	-	-	-	-
Mackenzie	**7**	10	0	0	-	-	-	-	-	-
Peace	**7**	5	0	0	-	-	-	-	-	-
Spirit River	**7**	6	0	0	-	-	-	-	-	-
Region		53	0	0	0	0	0	0	0	0
Province										
Total		**415**	**5**	**1.2**	**22**	**0**	**0**	**9**	**0**	**0**

Table 7. Percentage of grain samples downgraded due to Fusarium-damaged kernels (FDK) in Alberta (2010-2011).

Crop District	CWRS (%FDK)		CWAD (% FDK)	
	2010	2011	2010	2011
1	4.6	0.0	22.5	1.8
2	8.1	9.1	10.5	2.9
3	0.0	4.9	0.0	0.0
4	5.7	2.5	--	--
5	6.8	2.4	--	--
6	0.0	2.9	--	--
7	0.4	2.0	--	--

Information provided by the Canadian Grain Commission.
CWRS = Canadian Western Red Spring Wheat; CWAD = Canadian Western Amber Durum Wheat.