Fusarium head blight in Saskatchewan in 1998-2000

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Overview of Fusarium Head Blight

Fusarium head blight (FHB), also known as scab or tombstone, is a cereal disease which can wipe out entire crops. It has been estimated that for wheat alone, average yield losses of 10% ($45 million) have occurred annually in Manitoba since 1993. The monetary loss to the industry doubles to nearly $100 million when cleaning, mycotoxin testing, grade reduction, and quality losses are included.

There are many *Fusarium* spp. that can cause FHB. *F. graminearum* is the most prevalent pathogen in FHB-affected areas of North America. It appears to have spread westward from Manitoba to eastern Saskatchewan. Besides affecting grain yield and quality, some *Fusarium* spp. produce mycotoxins which may be harmful to humans and livestock. Because of these effects, tolerance levels for Fusarium damaged kernels (FDK) are very low.

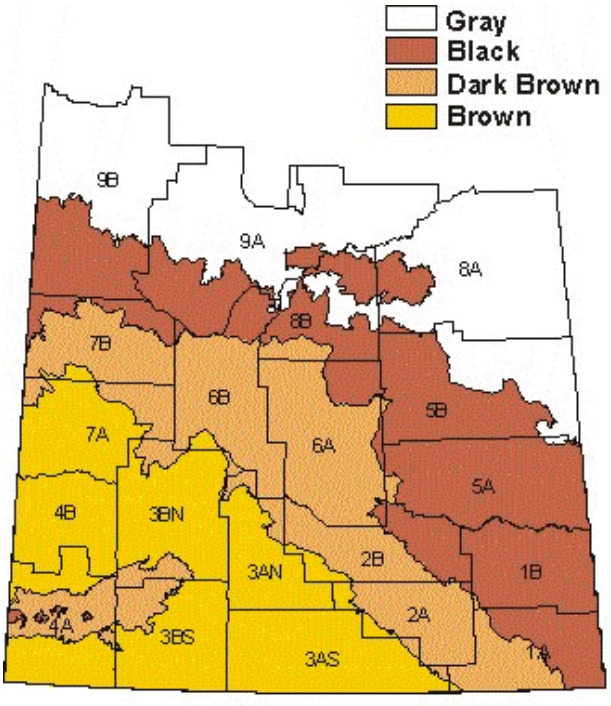

Fig.1. Saskatchewan Crop districts and soil zones

Water-soaked brownish lesions at the base of glumes are distinctive symptoms of FHB. Because there often is premature death and/or bleaching of infected spikelets, symptoms of FHB are most noticeable before maturity of the crop. Infected kernels are often smaller, shriveled, bleached, and might have white to light pink mold on them. However, in barley, disease symptoms are less obvious.

High humidity for a minimum of 12 hours are required for infection, and relatively high temperatures (about 25°C) favour infection by *F. graminearum*. Cereals are most susceptible to infection at flowering.

Province-wide surveys were conducted in Saskatchewan for the last three years to monitor the development of FHB and determine the *Fusarium* spp. involved. These field surveys were supported by Agriculture Development Fund and conducted with the assistance of extension agrologists. In addition, seed surveys to determine the presence and incidence of FDK have been conducted by the Canadian Grain Commission using grain samples sent from across the province after harvest. We report here on data collected in 2000 through both surveys, and compare these

with data obtained in previous years.

Fusarium head blight survey 2000

In 2000 the number of fields sampled were 63 barley, 152 common wheat and 61 durum wheat, covering 20 crop districts (CD) (Fig. 1).

Heads from 50 plants, at milk to dough stages, were sampled randomly from each field and analyzed at the Crop Protection Lab of Saskatchewan Agriculture and Food. Heads were analyzed for disease incidence (percent number of heads infected) and severity (percentage of infected glumes).

A FHB index (percent number of heads affected x mean severity of infection/100) was determined for each field. An average FHB index was calculated for infected fields in each CD, and for CDs grouped by soil zone (Zone I in Brown, II in Dark Brown and III in Black/Gray soil) (Fig. 1). Glumes and kernels from infected heads were surface sterilized in 0.05% NaOCl for 1 minute and plated on potato dextrose agar for identification of *Fusarium* spp.

FHB was found in a total of 62% of the common wheat and 56% of the durum wheat fields surveyed. This was higher than in previous years for common wheat (Table 1; Fernandez et al., 1999; 2000a). Mean FHB indexes were also higher in 2000 (1.7% in common, 1.2% in durum wheat) than in 1999 (1.1% in common, 0.5% in durum wheat) but lower than in 1998 (3.0% in common, 2.3% in durum wheat).

Table 1
Incidence of Fusarium head blight and disease severity (FHB index) in common and durum wheat and barley in Saskatchewan from 1998 to 2000.

Soil Zone	Common wheat		Durum wheat		Barley	
	% affected fields[#affected fields/total]	FHB [1] index	% affected fields[#affected fields/total]	FHB index	% affected fields[#affected fields/total]	FHB index
	%					
1998						
Zone I	16 [3/19]	1.3	27 [3/11]	0.2	9 [1/11]	0.1
Zone II	49 [22/45]	2.4	68 [13/19]	2.9	57 [12/21]	0.7
Zone III	74 [2/43]	3.7	100 [5/5]	2.0	78 [28/36]	1.8
Mean:	53	3.0	60	2.3	59	1.4
1999						
Zone I	0 [0/20]	-	23 [3/13]	0.6	44 [4/9]	0.1
Zone II	43 [26/61]	1.2	58 [15/26]	0.5	52 [13/25]	1.3
Zone III	73 [60/82]	1.1	67 [2/3]	0.6	82 [23/28]	1.0
Mean:	53	1.1	57	0.5	65	1.0
2000						
Zone I	14 [3/21]	0.5	38 [10/26]	0.5	25 [2/8]	0.5
Zone II	62 [32/52]	1.8	72 [21/29]	1.5	88 [15/17]	0.5
Zone III	75 [59/79]	1.8	50 [3/6]	0.9	79 [30/38]	0.7
Mean:	62	1.7	56	1.2	75	0.6

[1] FHB index calculated as (percent # heads affected x mean severity of infection)/100.

Overall, 75% of barley fields surveyed were affected by FHB, a higher proportion compared to 1999 (65%) or 1998 (59%) (Table 1; Fernandez et al. 1999; 2000b). However, the mean FHB index was lower in 2000 (0.6%) than in 1999 (1.0%) or 1998 (1.4%). In 2000, the incidence of FHB was lower for 2-row (67%) than 6-row (90%) barley. Conversely, the average FHB index was higher for 2-row (0.9%) than 6-row (0.2%) barley. This is similar to results from the 1999 survey.

Compared to previous years, the percentage of barley, common and durum wheat fields affected has remained constant or experienced a small increase (Table 1). However, the severity of the disease (FHB index) appears to have decreased. This might be a reflection of more producers growing FHB-tolerant varieties such as AC Barrie, especially in the most affected areas of the province. Throughout the last three years, the percentage of infected fields and the average FHB index has remained the lowest in the south-west and highest in eastern and northern districts.

Fusarium spp. isolated from infected heads

Overall, for the three years of surveys, the most common species isolated from infected heads have been *F. avenaceum*, *F. graminearum*, *F. poae* and *F. sporotrichioides* (Table 2). *F. avenaceum* was most common in 1999 and 2000 and *F. sporotrichioides* in 2000. The latter was the most commonly isolated species in 2000. *F. graminearum* was more common in 1998 than in the last two years, especially in common and durum wheat. *F. culmorum* was isolated from few fields.

Table 2
Percentage of fields where *Fusarium* spp. were isolated from common and durum wheat and barley in Saskatchewan from 1998 to 2000.

	Common/Durum Wheat			Barley		
	1998	1999	2000	1998	1999	2000
	%					
F. avenaceum	10	56	43	2	43	34
F. culmorum	12	5	4	2	0	6
F. graminearum	38	6	19	20	18	11
F. poae	57	43	41	83	60	51
F. sporotrichioides	29	33	76	22	40	77

Seed Survey 2000

6056 wheat seed samples were sent by producers from across Saskatchewan to the Canadian Grain Commission in the fall of 2000 and examined for the presence of FDK. A total of 365 samples (6%) were found to have FDK. The average level of FDK in these samples was 6%. The highest incidence was in samples from the southeast corner of the province (28%), whereas the lowest incidence were in samples from southwest SK, where only a few samples had detectable amounts of FDK.

Fusarium damaged kernels from samples sent to the Canadian Grain Commission were cultured to identify the causal fungi, following the procedure described above. *F. graminearum* was found in nearly 80% of the FDK from the south-east, but in less than 1% of FDK from central-west districts. *F. graminearum* was the dominant species only in eastern crop districts. Overall, the most common species for the province was *F. avenaceum*, whereas *F. sporotrichoides* and *F.*

poae were recovered at low levels. Similar results were obtained in the seed surveys conducted in 1999 and 1998.

FHB and environmental conditions

The amount of precipitation from the last week of June to the second week of August was higher in 1999 and 2000 than in 1998. For this period of time, the average precipitation for the province was 114 mm in 1998, 154 mm in 1999 and 161 mm in 2000, whereas the total precipitation was 2286 mm in 1998, 3082 mm in 1999 and 2897 mm in 2000. Mean temperatures for the same time period were highest in 1998 (19.6°C), followed by 2000 (18.0°C), with 1999 having the lowest temperatures (16.5°C).

Some of the differences in the prevalence of the *Fusarium* spp. and FHB levels among years might be explained by environmental conditions. For example, lower temperatures in 1999 and 2000, especially in the former, appeared to have favoured the development of *F. avenaceum*, a weak pathogen. The more pathogenic *F. graminearum* did not develop as well under lower temperatures in 1999 as it did in 1998 or 2000. This would explain, at least partly, the lower FHB levels in 1999 than in the other two years.

Conclusions

Based on the head and seed surveys conducted from 1998 to 2000, FHB remains present at low levels in Saskatchewan and it is for the most part localized in eastern and northern areas. These surveys also showed that the prevalence of the *Fusarium* spp. could vary significantly over the years, mostly in response to environmental conditions. However, *F. graminearum*, the most important pathogen causing FHB in North America, remains among the least common species in Saskatchewan and is mostly concentrated in eastern areas. Although overall, results from the analysis of heads and seeds are general in agreement, two of the most common species isolated from infected heads collected in the field, *F. sporotrichioides* and *F. poae*, were recovered infrequently from FDK after harvest. These two are weak pathogens which might not be causing visually distinguishable FDK symptoms, and therefore would not be expected to cause downgrading.

The following strategies should be adopted in order to prevent the further spread of FHB in years where environmental conditions favour its development, and minimize crop losses in affected areas.

Strategies for the control of Fusarium Head Blight

1) Choice of variety: Wheat tends to be more susceptible than barley. In general, hard red spring (HRS) wheat is less susceptible than Canada Prairie Spring, durum or winter wheat. At the present time, there are no registered wheat or barley varieties that are resistant to FHB; however there are less susceptible varieties. AC Barrie, AC Cora, AC Majestic, AC Cadillac, CDC Bounty, Katepwa and McKenzie are the most tolerant HRS varieties. Two-row barley also appear to be more tolerant than six-row barley varieties. Two-row malting varieties tolerant to FHB are AC Metcalfe, AC Oxbow, AC Bountiful, CDC Kendall, and Harrington. CDC Sisler

is the only six-row malting variety with tolerance to this disease. CDC Dawn, Condor, CDC Freedom, CDC Gainer, AC Hawkeye, Phoenix and CDC Silky are hulless varieties with some tolerance to FHB.

2) Crop Rotations: A rotation with corn and small grain cereals can increase FHB. Rotating with a non-cereal crop for more than two years should help to reduce inoculum. However, a crop rotation with a non-cereal crop may not help to reduce FHB infection if adjacent cereal fields are infected. Inoculum for infection could also derive from grassy weeds.

3) Clean Seed and Seed Treatment: Use of clean seed is especially important in areas where FHB is not yet a problem. Producers should avoid purchasing seed from areas where FHB has been a problem in the past. Lab testing of seed for possible infection by *F. graminearum* is recommended. Seed treatments, when properly applied, may help control poor germination and seedling emergence caused by seed infection. However, if the seed is infected with *F. graminearum*, seed treatments might not alone prevent the introduction of this pathogen to uninfected areas, but can serve as an extra precaution. In any case, treatment of seeds would not control FHB, since inoculum for infection of heads comes from crop residues and/or infected grasses.

4) Stubble Management: *Fusarium* spp. surviving on cereal stubble act as a source of inoculum. Encouraging decomposition of residues through chopping and spreading the straw might help to reduce inoculum. Burying residue through tillage also increases the decomposition rate. However, residue buried by tillage can later be brought to the surface and, if not completely decomposed, be a possible risk of infection.

These cultural control measures would have a greater impact when levels of inoculum are low. Careful inspection of fields to determine the presence and severity of FHB is very important. A build-up of inoculum might increase the disease levels and reduce the options for control. Preventing the spread of FHB through the use of clean seed should be the most important control strategy for areas still uninfected.

References

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