Fusarium head blight in wheat and barley in Saskatchewan in 1998 and 1999

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Overview of Fusarium Head Blight

Fusarium Head Blight (FHB), also known as scab or tombstone, has the potential of becoming an important disease in Saskatchewan. Since its de.tection in the early 1990's FHB has slowly spread westward from the Manitoba border through eastern Saskatchewan. This spread has had a negative impact on yield and quality.

There are many *Fusarium* spp. that can cause FHB. The most important ones are *F. graminearum* and *F. culmorum*. *Fusarium* spp. produce mycotoxins some of which are harmful to humans and livestock. Due to processing problems and potential food safety concerns, tolerance levels for Fusarium damaged kernels (FKD) are very low.

Water-soaked brownish lesions at the base of glumes are distinctive symptoms of FHB. Salmon pink fungal growth is often present along the edge of the glumes to the base of the spikelet. Because there often is premature death and/or bleaching of infected spikelets, symptoms of FHB are most noticeable before maturity of the crop.

Wheat FDK are often smaller, shriveled, bleached, and might have white to light pink mold on them. However, in barley, disease symptoms are less obvious.

Environment plays a very important role in the incidence of this disease. Conditions of high humidity for a minimum of 12 hours are required for infection. Relatively high temperatures (about 25ºC) favour infection by *F. graminearum*.

Cereals are most susceptible to infection at flowering. Later infections do not cause as much damage as those at flowering. Cereal residues from previous crops colonized by *Fusarium* spp. are the main source of inoculum for head infections.

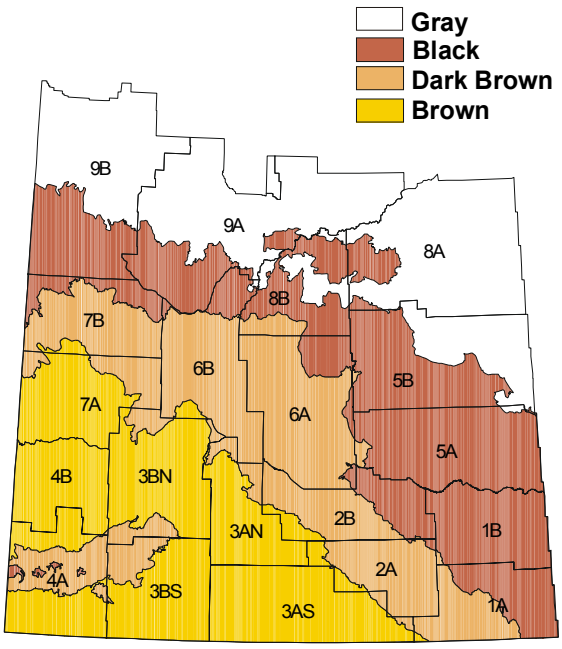

Fig.1. Saskatchewan Crop districts and soil zones

Fusarium head blight survey in 1998-99

A province-wide survey was conducted in Saskatchewan in 1998 and 1999 to determine the incidence and severity of Fusarium head blight (FHB). Number of fields sampled were 68 barley, 107 common wheat and 35 durum wheat in 1998, and 60 barley, 168 common wheat and 42 durum wheat in 1999, covering 18 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).

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.

Results

FHB levels in common and durum wheat and barley in 1998 and 1999

FHB was found in most crop districts surveyed, although mainly at low levels, particularly in 1999 (Table 1). Overall, the percentage number of fields where FHB was detected in 1998 and 1999 was 60% and 65% for barley, and 55% and 50% for wheat (common and durum), respectively (Table 2). Percent fields infected was lowest in Zone I (Brown soil) in the southwest, and highest in Zone III (Black/Gray soil) in the east and north.

Table 1. Number of wheat (common and durum) and barley fields where FHB was found in 1998 and 1999, and average FHB index for each Saskatchewan crop district.

	Crop District																	
Crop/year	1A	1B	2A	2B	3A	3B	4A	4B	5A	5B	6A	6B	7A	7B	8A	8B	9A	9B
Wheat (common and durum)																		
1998																		
#fields/total	7/12[1]	6/6	3/6	9/17	1/2	2/15	-[2]	2/6	4/4	7/9	8/13	3/8	1/7	5/8	5/7	2/5	2/5	11/12
FHB index	3.7	1.6	1.4	1.4	0.2	1.5	na	0.5	8.7	8.6	4.1	1.1	0.2	2.0	0.3	0.4	0.9	1.7
1999																		
#fields/total	13/14	3/4	1/7	11/21	1/8	0/14	1/7	0/1	4/6	9/19	8/15	6/16	1/8	2/14	13/15	9/13	11/12	13/16
FHB index	1.3	0.6	0.9	0.4	<0.1	na	<0.1	na	1.0	0.8	0.7	1.3	1.6	0.3	0.4	1.1	2.0	1.1
Barley																		
1998																		
#fields/total	2/4	2/2	2/2	2/5	0/3	0/4	-	1/2	4/4	5/7	2/4	2/2	0/2	2/4	8/10	1/3	4/4	4/6
FHB index	1.9	0.4	0.3	0.4	na	na	na	0.1	1.5	0.7	0.5	0.6	na	0.3	0.5	1.5	0.4	8.0
1999																		
#fields/total	3/4	2/2	2/2	1/3	1/1	1/2	2/4	-	3/3	8/8	3/6	2/6	0/2	2/4	1/1	3/4	4/5	2/5
FHB index	0.4	1.0	0.1	0.5	<0.1	0.3	0.1	na	0.4	1.1	3.7	1.7	na	0.1	3.2	0.6	1.4	0.4

[1] Number of fields with FHB/total number of fields sampled.

[2] not sampled.

Overall, the FHB index was low in 1998 and 1999. On average, it was lower in 1999 than in 1998 (Table 2). For all crops, the average FHB index was lowest in Zone I and highest in Zone III. It was also lower in barley than in wheat in all soil zones in 1998.

Table 2. Percent wheat (common and durum) and barley fields infected with FHB in Saskatchewan in 1998 and 1999, and average FHB index for each soil zone.

Crop/Year	Zone I [1]	Zone II	Zone III	Mean
	----------%----------			
Wheat (common and durum)				
1998				
% fields infected	20	55	77	55
FHB index	0.7	2.5	3.4	2.8
1999				
% fields infected	8	47	73	50
FHB index	0.6	0.9	1.1	1.0
Barley				
1998				
% fields infected	9	57	78	60
FHB index	0.1	0.7	1.8	1.4
1999				
% fields infected	44	52	82	65
FHB index	0.2	1.3	1.0	1.0

[1]Zone I:Brown soil; II:Dark Brown soil; III:Black/Gray soil.

Pathogens isolated from infected field crops

There were more *Fusarium* spp. in Zones II (Dark Brown soil zone) and III (Black/Gray soil zone) than in Zone I (Brown soil zone) (data not shown). *Fusarium poae* was the species most frequently isolated from infected heads, and was more common in 1998 than in 1999. On average for all zones, *F. poae* was isolated at a frequency of 36% and 23% (common and durum wheat) and 68% and 40% (barley) in 1998 and 1999, respectively. In 1998, *F. graminearum* was the second most frequently isolated *Fusarium* spp. (average of 28% in common and durum wheat and 14% in barley). However, in 1999 *F. graminearum* was present at lower levels (2% in common and durum wheat and 11% in barley). Conversely, the frequency of *F. avenaceum* was much lower in 1998 (5% in common and durum wheat and 0.4% in barley) than in 1999 (36% in common and durum wheat and 23% in barley). The incidence of *F. culmorum* was similar in1998 and 1999 (average frequency for both years of <10% in common and durum wheat and <1% in barley). The most important *Fusarium* spp. associated with FHB, *F. graminearum* and *F. culmorum*, were for the most part absent from Zone I in both years.

Impact of weather on development of FHB?

In most crop districts, the amount of precipitation in the growing season (June through end of August) was higher in 1999 than in 1998. In both years, there was precipitation in most crop districts during flowering, more in 1999 than in 1998 (Fig. 2). In 1999, flowering occurred the third and fourth week of July in the majority of crops, however some may have occurred before (beginning of July) or later (into the first week of August) due to variations in seeding dates and cool weather. In 1998, flowering in most cases occurred earlier than in 1999 (mostly around the second week of July). Weekly precipitation also varied among crop districts. Because seeding

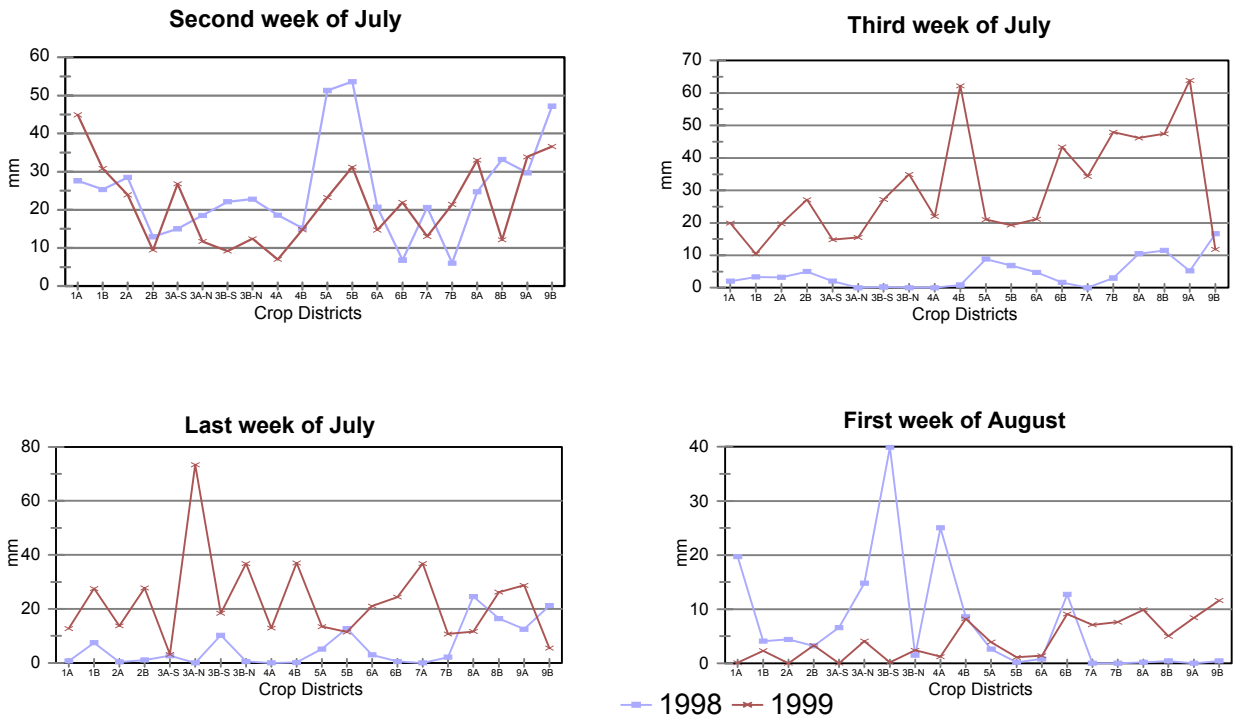

Fig. 2. Average weekly total precipitation (mm) for Saskatchewan crop districts for 1998 and 1999.

was very spread out in 1999, and to some extent in 1998, it is difficult to reach any conclusions regarding the impact that precipitation might have had on the development of FHB. However, it is apparent that the amount of precipitation *per se* during flowering would not explain differences in FHB development between 1998 and 1999.

Average temperatures for most crop districts during the period crops would have been flowering, and afterwards, were lower in 1999 than in 1998, except for the last week of July (Fig. 3). Lower temperatures favoured the development of *F. avenaceum*, a weak pathogen, over that of *F. graminearum* in 1999. Cooler weather prevalent in most of the province in 1999 might also explain the overall lower levels of FHB in 1999 than in 1998.

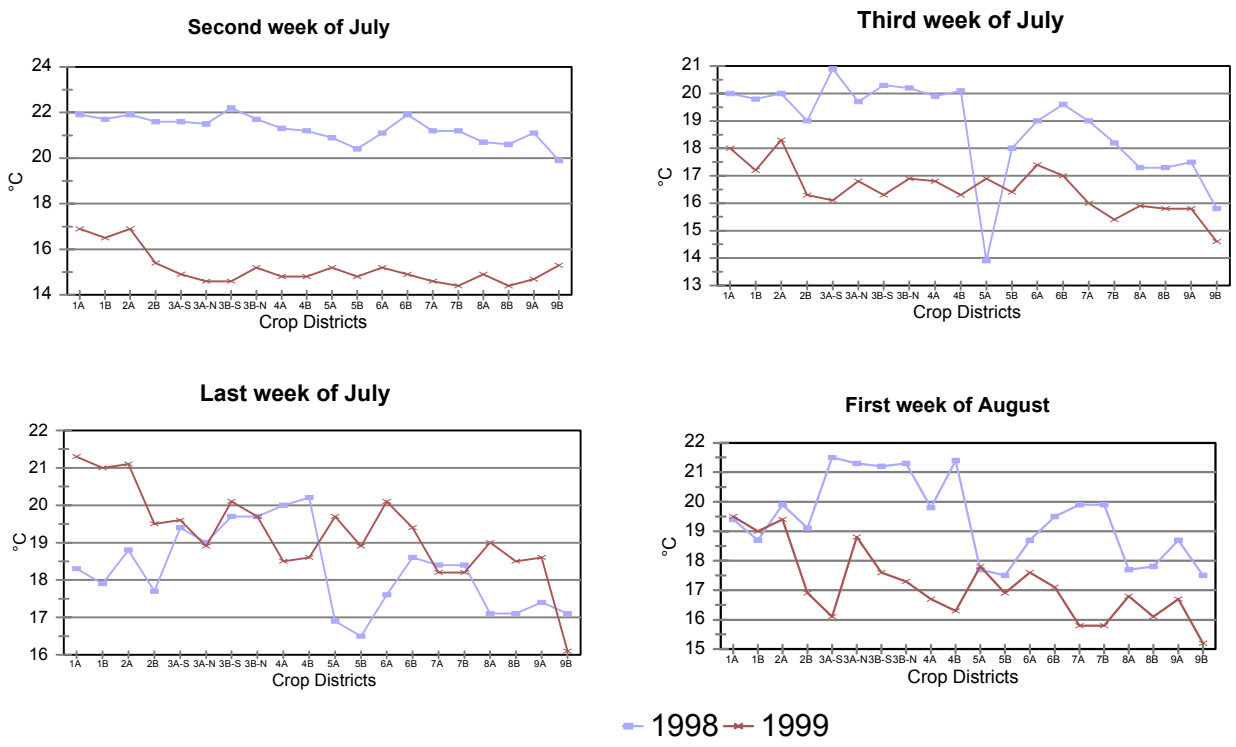

Fig. 3. Average weekly temperature (ºC) for Saskatchewan crop districts for 1998 and 1999.

Conclusions

Based on the provincial surveys conducted in 1998 and 1999, FHB remains present at low levels in Saskatchewan and it is for the most part localized in eastern and northern areas. These surveys also confirmed that the development of this disease is very dependent on environmental conditions. Although the establishment of this disease in affected areas is believed to have been caused by higher levels of precipitation in the last decade, the most optimum conditions for its development (high levels of precipitation and temperatures) are not common in most parts of Saskatchewan during flowering of cereal crops.

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: At the present time, there are no registered wheat or barley varieties that are resistant to FHB; however there are less susceptible varieties. 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. AC Barrie, AC Cora, Katepwa, AC Majestic, McKenzie, and AC Cadillac are the most tolerant HRS varieties. Two-row barley also appear to be more tolerant than six-row barley varieties. Two-row malting varieties with good tolerance to FHB are AC Metcalfe, AC Oxbow, CDC Stratus, AC Bountiful; CDC Kendall has some tolerance. CDC Sisler is the only six-row malting variety with good 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 a minimum of one year, preferably 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 prevent the introduction of this pathogen to uninfected areas. In any case, treatment of seeds would not provide season long control, as 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 in the next season. 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.

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