

Development of Fusarium head blight (FHB) resistant winter wheat cultivar in crosses with a Brazilian spring wheat, Frontana, as the resistance donor parent

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INTRODUCTION

Over the past 20 years, Fusarium head blight caused by *Fusarium graminearum*, has gained national and international prominence as one of the most devastating cereal diseases. Fusarium head blight (FHB) continues to cause economic and product quality/safety damage to the Canadian wheat crop. FHB affects almost all wheat growing regions of the world where warm, moist conditions prevail during the flowering and grain-filling period (Mesterhazy, 1983). In Canada, the estimated losses to the cereal grain industry from 1993 to are in excess of \$1 billion (Fernando, 1999) through impacts on every aspect of the grain industry (Gilbert and Tekauz, 2000). The disease not only reduces crop productivity but also renders the highest yields into a non-cashable currency due to mycotoxin residues.

Several types for resistance to FHB have been characterized: 1) resistance to initial infection, 2) resistance to spread following infection, 3) resistance to kernel infection, 4) reduced mycotoxin production, 5) yield maintenance in the presence of disease (Mesterhazy, 1995; Chen, 1996). These components have been related to various morphological or physical factors (Schroeder and Christensen, 1963; Mesterhazy, 1995) including head type, spike density, plant phenology, trapped anthers, plant height, and rate of grain fill (Stack, 1999). Based on the complexity of the resistance mechanisms, it is not surprising that numerous studies have shown that FHB resistance is conditioned by multiple genes with dominant or additive effects. Pandeya (1998) concluded that genes conferring FHB resistance in wheat were located on most of the chromosomes of the A, B and D genomes.

Genetic variability is essential for the development of FHB resistant cultivars. Sources of resistance/tolerance have been introduced to North America from China, Brazil, Europe and Japan (Fedak et al., 2001). Canada's first FHB-resistant wheat cultivar, a soft red winter wheat named 'FT Wonder' was registered in

2002, through the collaborative efforts of AAFC and Hyland Seeds. Two new cultivars of soft white winter wheat were registered in January 2003. These cultivars derive their resistance from the Brazilian cultivar 'Frontana'. Resistance from other germplasm is in various stages of development.

Continued development of FHB resistant winter wheat is of vital importance in Ontario, Quebec and Atlantic Canada. Despite the likelihood of escape in western Canada, incorporation of FHB resistance into winter wheat is important, particularly for the moister eastern prairies. Furthermore, the incorporation of FHB resistance into new CWRW cultivars may allow national registration for all parts of Canada.

MATERIALS AND METHODS

Fusarium resistance breeding in winter wheat began in the early 1980s. Frontana (a Brazilian spring wheat) was found to be a tolerant variety, and it had the tolerance to initial infection (Type I resistance). Frontana was then crossed with our standard winter wheat cultivars, such as Fredrick, Harus and Augusta in 1984. Individual plants in the F1 were back-crossed to the three commercial cultivars to restore phenotype and restoration of winter wheat growth habits. Subsequent selfing and selections for FHB resistance led to the development of four winter type FHB resistant donor genetic stocks FHB 143, 147, 148 and 161, of germplasm development and the actual utilization for cultivar development as follows:

RESULTS AND DISCUSSIONS

Figures 1 and 2 depict the results of three cycles of inoculation and selections. One of the main findings was that the Visual Symptom Rating and DON contents were not related

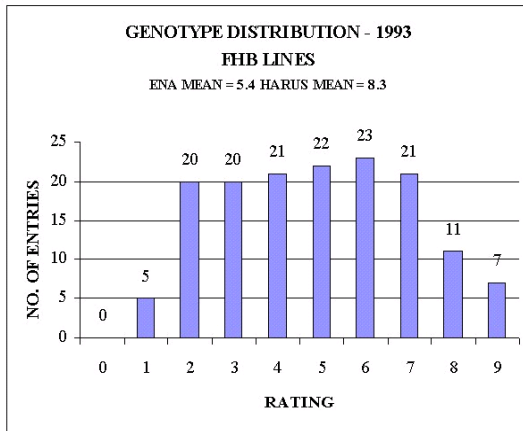


Figure 1. Third cycle selection for VSR

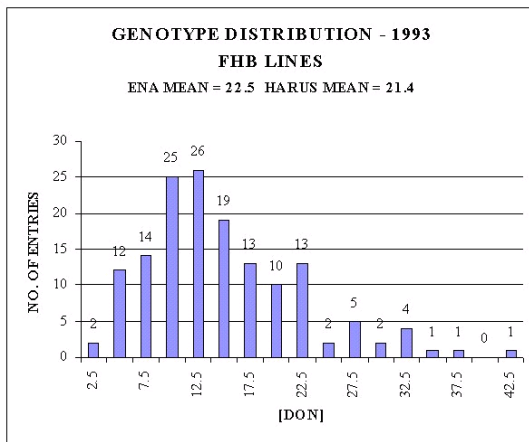


Figure 2. Third cycle selection for DON

Cultivar development study

The doubled haploids were evaluated for their agronomic and disease (FHB) resistance. Over the past three years, the following cultivars were developed: A line, OTH 017-033, from the cross FHB 147 and Casey was released as and registered as FT Wonder. FT Wonder consistently showed resistance in terms of VSR and DON (Table 3). The commercialization of FT Wonder began during the fall of 2005 (Table 3).

Our results clearly indicate that the most suitable procedure for the inoculation was the spore suspension spray. The method closely mimics the natural infection process. The results from the point inoculation were inconsistent in delineating susceptible and resistant genetic lines. Fusarium-damaged kernels were much more closely related to the DON content of the lines.

We have developed two first soft-white winter wheat cultivars, FT Action and Ashley. The data set for FT Action is given in the Table 4.

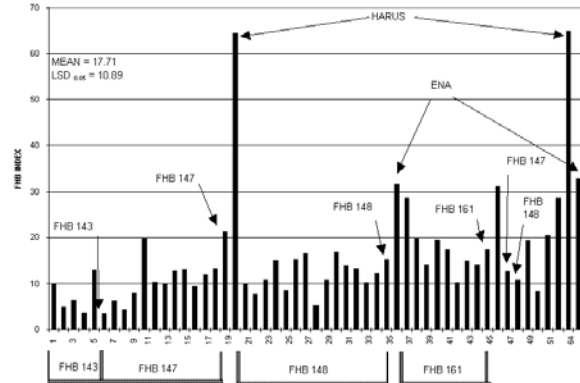


Figure 3. Sub-lines of the four selected FHB resistant genetic stocks

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Table 3. Comparative FHB ratings for FT-Wonder (OTH 017-033), a soft red winter wheat cultivar.

	97-98		98-99		99-00		00-01	
	Nairn %	Index Nairn %	Ottawa Index %	Nairn Index %	Nairn DON (ppm)	Nairn Index %	Nairn DON (ppm)	Ottawa Index %
AUGUSTA	25.0	62.5	47.5	65.0	6.0	30.0	0.64	30.0
AC Ron	25.0	80.0	54.0	70.0	6.0	40.0	0.47	22.5
Freedom	15.0	52.5	43.7	45.0	4.0	25.0	0.43	25.0
2540	25.0	80.0	44.0	70.0	5.6	32.5	1.60	15.0
OTH017-033	5.0	20.0	10.0	25.0	1.9	7.5	0.23	12.5
Check Mean	15.0	52.5	43.7	45.0	4.0	32.5	0.43	25.0

Table 4. Comparative FHB performance of OTH 013-081 (FT Action), a soft white winter wheat (DH from the cross Augusta x FHB 148)

Station yr Varieties	2000	2001	2002 natural	2002 Inocu.	2002 natural	Overall mean	
	Inocu.	Inocu.				Inocu.	Natural
	FHBI	FHBI	0-9	FHBI	0-9	FHBI	
Augusta*	52.3	34.2	2.2	24	2.6	36.8	2.4
AC Ron**	45.8	35	2.2	26.7	4.7	35.8	3.5
Freedom**	26.8	32.5	3	21.3	1.5	26.9	2.3
P2540**	17.3	36.7	4.8	19.7	4.2	24.6	4.5
OTF 013-081	12	5.8	0.7	8.5	1.4	8.76	1.1

