Post-registration Assessment of Fusarium Head Blight Resistance Levels in Spring Wheat Varieties

Holly Derksen[1], Pam de Rocquigny[1], & Craig Linde[2]

[1] Crop Industry Branch, Manitoba Agriculture, Carman, Manitoba R0G 0J0, holly.derksen@gov.mb.ca, pamela.derocquigny@gov.mb.ca
[2] CMCDC, Manitoba Agriculture, Carberry, Manitoba R0K 0H0, craig.linde@gov.mb.ca

Background & Introduction

➢Spring wheat varieties with improved resistance to Fusarium head blight (FHB) are available to Manitoba producers. Testing to determine a variety's resistance level to FHB, as presented in *SEED MANITOBA*, is conducted during the three years the variety is tested through the variety registration system. However, disease data generated provides limited comparisons with other registered varieties, over limited locations.

➢ A study was initiated in 2009 to evaluate the effect of FHB on spring wheat varieties with varying levels of FHB resistance under natural conditions over a wide geographic area. The study has continued over the past six years with funding from the Western Grains Research Foundation and the Manitoba Wheat and Barley Growers Association as varieties evaluated by the Manitoba Crop Variety Evaluation Team (MCVET) are continually changing.

➢The turnover of varieties produces an unbalanced dataset in terms of the variability of variety composition, years sites. It is possible to use such data in a multi-year analysis, and the mixed model statistical methods described by Smith et al. (2001) and Piepho et al. (2008) are well-suited to this type of data structure.

Objective

➢ To evaluate how spring wheat varieties tested post-registration in the Manitoba Crop Variety Evaluation Trials (MCVET) respond to fusarium head blight under non-misted conditions (natural infection) by assessing harvested samples for fusarium damaged kernels (FDK) and deoxynivalenol (DON) accumulation.

Materials & Methods

➢From 2009 to 2015, composite samples of spring varieties were collected from fourteen MCVET locations, including Arborg, Beausejour, Boissevain, Brandon (2010 only), Dauphin, Hamiota, Melita (2010 only), Neepawa, Portage la Prairie, Rosebank, Souris, St. Adolphe, Stonewall and Thornhill. A total of seventy-two varieties have been tested. Note that not all varieties and sites were sampled each year.

➢BioVision Seed Labs in Winnipeg, Manitoba has conducted the analysis over the past few years. The level of FDK (%) was measured as per the Official Grain Grading Guide of the Canadian Grain Commission. The accumulation of DON (ppm) was measured using the ELISA test method. FHB severity was assessed at various locations by determining FHB Index (% incidence x % mean spike proportion infected / 100) approximately three weeks after anthesis, at Zadoks Growth Stage 73-85.

➢The mixed model analysis was used to calculate a model-based estimate of FDK and DON level long term means, adjusting for factors such as Variety, Year, Site and their interactions.

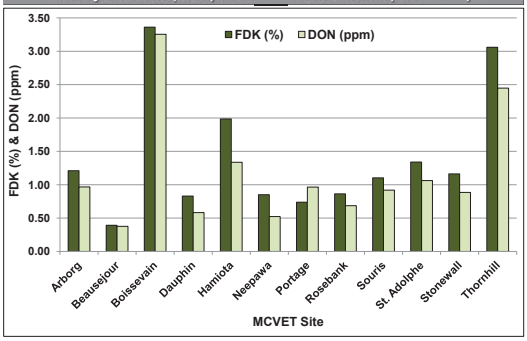
Results & Discussion

➢No fungicides were applied to the trials and the severity of FHB was a result of natural infection. Levels of infection were generally low over the seven years of the study, with the highest levels of FDK and DON observed in 2015 and 2010, respectively (Table 1). In the years 2009, 2011 and 2013, DON levels were higher than the FDK observed in the harvested samples. FDK and DON had the strongest correlation in 2011 (R^2=0.95) and the weakest correlation in 2012 (R^2=0.53).

Table 1: Fusarium Damaged Kernel (FDK) and Deoxynivalenol (DON) Levels Measured at Various MCVET Sites from 2009 to 2014

Year	2009	2010	2011	2012	2013	2014	2015
FDK (%)	0.32	2.04	0.82	0.71	1.64	1.41	3.07
DON (ppm)	0.60	1.78	1.07	0.89	1.30	1.39	1.71
R^2 value	0.81	0.74	0.95	0.53	0.85	0.84	0.74

Figure 1: Average Levels of Fusarium Damaged Kernel (FDK) and Deoxynivalenol (DON) at Twelve MCVET Sites (2009-2015)



➢Levels of infection were also variable by site (Figure 1). Over the seven years of the study, the sites of Boissevain, Hamiota and Thornhill had higher levels of infection based on FDK and DON levels.

➢Generally, spring wheat varieties rated as Susceptible (S) consistently showed higher FHB severity within the field (data not shown), as well as FDK and DON levels (Figures 2 and 3). However, data also shows there is variability of performance within the five resistance categories ranging from Resistant (R) to Susceptible (S).

➢Variance and component analysis of FDK using mixed model analysis revealed that Variety and the interaction of Year and Site represented the greatest proportion of the variability. Genetics and site characteristics within any given year (local weather, seeding date, etc.) therefore were the main drivers determining FDK levels in this study.

Results & Discussion continued

➢ Variety and the interaction of Year by Site represented almost all the variability for DON levels.

➢Therefore, DON levels may be a more consistent indicator of resistance gene expression versus FDK and suggests that visual symptoms may either exaggerate DON levels in some varieties more than others, or that in certain years despite having visual symptoms DON levels have not yet reached detectable levels.

➢It is important to note that the relationship between FDK and DON levels vary from year to year. The results from 2016 are still being analyzed, but anecdotal reports indicate that DON levels will exceed FDK observed.

Summary & Next Steps

➢ Although FHB infection will always be highly influenced by environment, producers should select varieties with improved resistance as results of this study indicates varieties with improved resistance generally had lower severity, FDK and DON levels. Variety selection, in combination with other management strategies including crop rotation and fungicide application, are key management strategies for mitigating the impact of FHB.

➢ Using data derived over two or more growing seasons over multiple sites is always recommended to provide the best indicator of variety performance. Using the mixed model statistical analysis to generate long term means for FDK and DON levels is more accurate since more data is used to assess each variety, and perhaps more importantly the summary for each variety will be based on a larger range of environments (from all sites and across all years).

➢ As advances are made in breeding, it is important to evaluate disease resistance of varieties pre- and post-registration. Multi-year, multi-site data will increase accuracy in predicting variety reaction to FHB. Further analysis with the incorporation of additional parameters such as seeding date and maturity may also offer further insight of the influence of variety and local weather conditions on the production of symptoms and DON levels.

➢ As some grain buyers transition to requiring DON testing prior to delivery, providing additional information on variety reaction to FHB, and more specifically to DON accumulation, will be critical information for producers and industry

➢ Continued monitoring of the relationship between FDK and DON is important as FDK remains the Canadian Grain Commission's grading factor used to try and predict DON levels.

Figure 2: Fusarium Damaged Kernel (FDK) and Deoxynivalenol (DON) Comparisons of Wheat Varieties in the CPSR, CNHR, CWSP, CWSWS, & CWHWS Wheat Classes and Class Designation Pending Varieties (2009-2015)

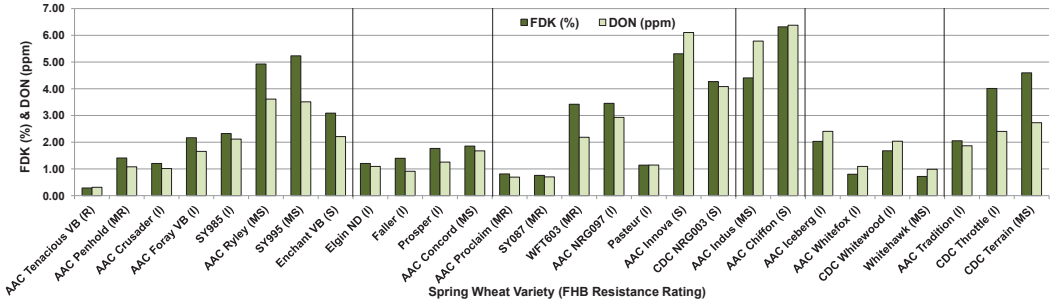
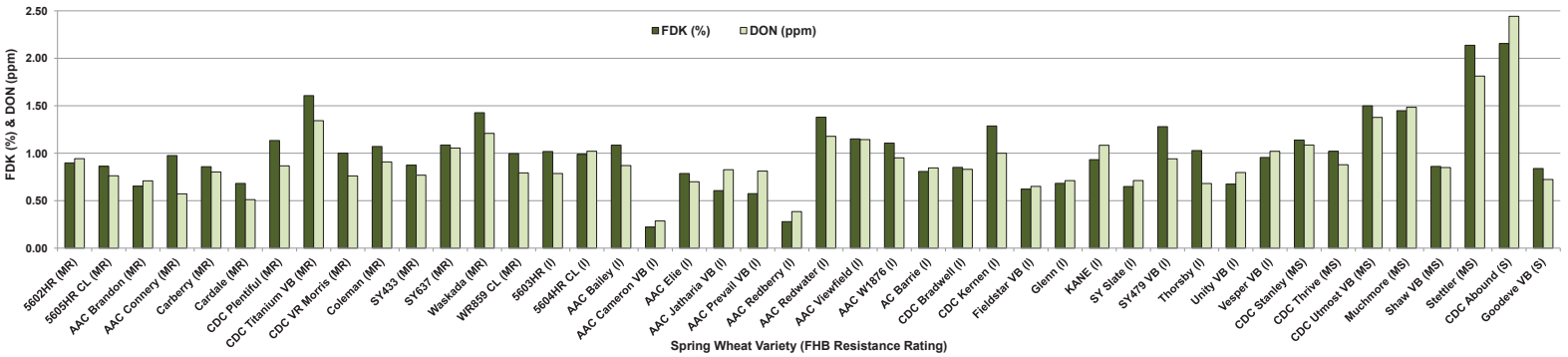


Figure 3: Fusarium Damaged Kernel (FDK) and Deoxynivalenol (DON) Comparisons of CWRS Wheat Varieties (2009-2015)



Acknowledgements

➢ Manitoba Crop Variety Evaluation Team (MCVET) & Patti Rothenburger, MCVET Chair, for providing in-kind support.
➢ BioVision Seed Labs for conducting the FDK and DON analysis.
➢ Manitoba Wheat and Barley Growers Association for providing funding to test 2014 and 2015 samples.
➢Western Grains Research Foundation for funding support from 2012 to 2013, and Pest Management Centre, AAFC from 2009 to 2011.

Sources

➢ *Seed Manitoba 2017* - Variety Selection & Growers Source Guide. www.seedmb.ca
➢ Official Grain Grading Guide. August 1, 2015 Canadian Grain Commission. http://www.grainscanada.gc.ca/oggg-ocgg/ggg-gcg-eng.htm
➢ Piepho, H.P., J. Mohring, A.E. Melchinger and A. Buchse. 2008. BLUP for phenotypic selection in plant breeding and variety testing. Euphytica. 161: 209-228.
➢ Smith, A., B. Cullis and A. Gilmour. 2001. The analysis of crop variety evaluation data in Australia. Aust. N.Z. J. Stat. 43: 129-145.