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

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Background & Introduction

Varietal resistance to fusarium head blight (FHB) is of importance to producers, as this fungal disease reduces yields, but more importantly can result in a quality downgrade due to the presence of fusarium damaged kernels (FDK). Testing to determine a varieties' resistance to FHB is conducted during the three years the variety is tested through the variety registration system. While this provides good information on resistance to FHB, the data generated provides limited comparisons with other registered varieties.

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. This study has continued as the 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, and 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. More details can be found in Friesen et al. (2016).

Objective

To evaluate how spring wheat varieties tested post-registration in MCVET trials respond to fusarium head blight under conditions of natural infection by assessing harvested samples for fusarium damaged kernels (FDK) and deoxynivalenol (DON) accumulation.

Materials & Methods

Composite samples of spring wheat varieties were collected from sixteen MCVET locations from 2009 to 2020. Sites include Arborg, Beausejour, Boissevain, Brandon, Dauphin, Hamiota, Melita, Neepawa, Portage la Prairie, Roblin, Rosebank, Souris, St. Adolphe, Stonewall, Swan River and Thornhill. A total of 84 wheat varieties have been tested. Not all varieties and sites were sampled each year.

SGS in Winnipeg, Manitoba 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.

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

No fungicides were applied to the trials and the severity of FHB was a result of natural infection. Levels of infection were generally low, with the highest levels of FDK and DON observed in 2015 and 2016 (Table 1). Over the 12 years of the study the average levels of FDK and DON were strongly correlated, with $R^2 = 0.84$ (data not shown).

Levels of infection were variable by site. Due to the nature of the data, in which all sites were not sampled in all years, individual site data is not shown.

Table 1. Fusarium damaged kernel (FDK) and deoxynivalenol (DON) levels measured at various MCVET sites from 2009 to 2020.

Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
FDK (%)	0.32	2.04	0.82	0.71	1.64	1.41	3.07	4.88	1.4	0.12	0.24	0.32
DON (ppm)	0.60	1.78	1.07	0.89	1.30	1.39	1.71	4.95	1.7	0.17	0.17	0.31

Figure 1. Fusarium damaged kernel (FDK) and deoxynivalenol (DON) comparisons for CWRS wheat varieties (2009-2020).

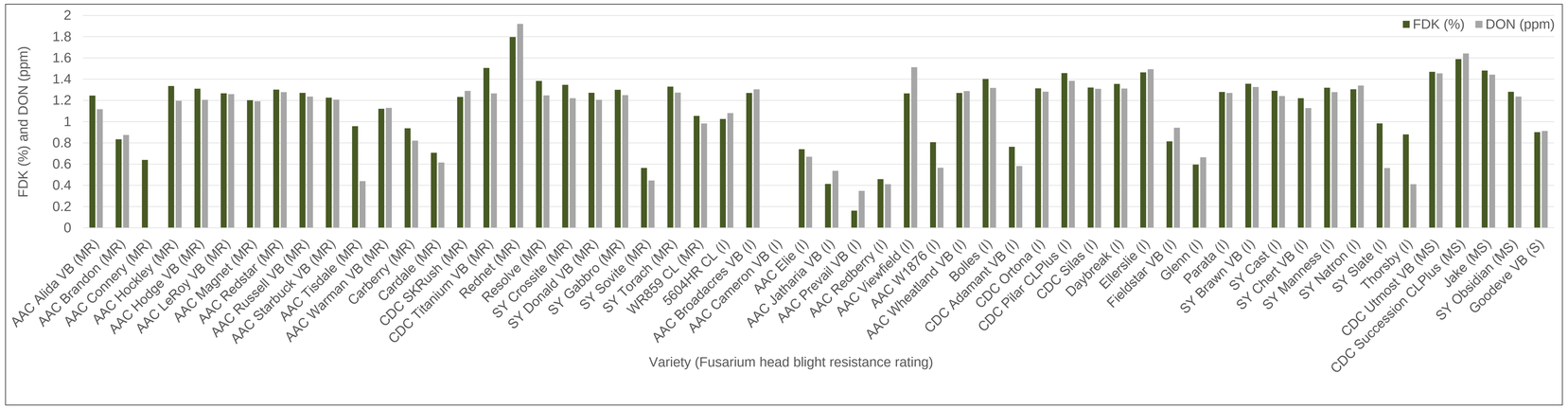


Figure 2. Fusarium damaged kernel (FDK) and deoxynivalenol (DON) comparisons for spring wheat varieties in the CNHR and CPSR classes (2009-2020).

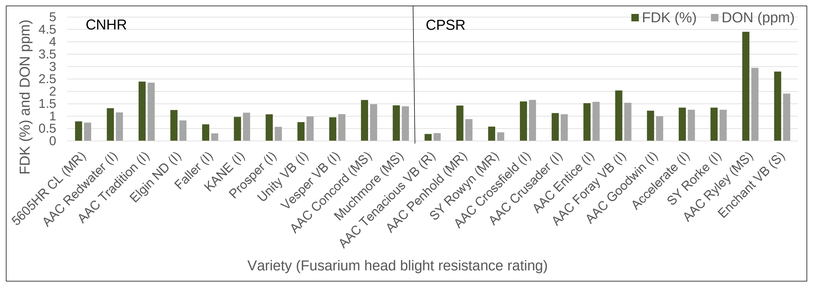
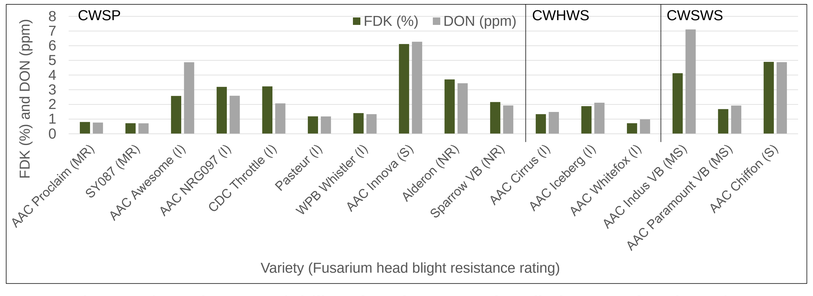


Figure 3. Fusarium damaged kernel (FDK) and deoxynivalenol (DON) comparisons for spring wheat varieties in the CWSP, CWHWS, and CWSWS classes (2009-2020).



FDK and DON data shows variability of performance for all classes of spring wheat within the five resistance categories ranging from Resistant (R) to Susceptible (S). In the CPSR and CWSP wheat classes, varieties rated as S generally showed higher FDK and DON levels (Figure 2 and 3).

Variance and component analysis of FDK revealed that Year represented the greatest proportion of the variability, followed by the interaction of Year, Location, and Variety. Location and the interaction of Location and Variety represented the lowest proportion of variability. Environmental and site characteristics within any given year were therefore the main drivers determining FDK levels in this study. The interaction of Year, Location, and Variety suggests ranking changes among varieties, depending on year and region.

Year and Variety represented the greatest proportion of variability for DON levels. Location and Location by Variety represented a small proportion of variability, similar to FDK.

DON levels may be a more consistent indicator of resistance gene expression verses FDK and suggests that visual symptoms may possibly 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.

The relationship between FDK and DON varies from year to year and variety to variety. In some instances DON levels exceeded FDK observed.

Summary & Next Steps

- FHB infection is highly influenced by environment. However, producers should continue to select varieties with improved resistance to FHB. Variety selection, in combination with other management strategies including crop rotation and fungicide application, are key management strategies for mitigating the impact of FHB.
- Data derived over multiple growing seasons and over multiple sites provides 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. The summary for each variety (Figures 1, 2, and 3) is based on a larger range of environments, as this data is derived over multiple locations and years.
- As new varieties are continually being released and advances are being made in breeding, it continues to be important to evaluate disease resistance of varieties both pre- and post-registration. Multi-year and site data will increase accuracy in predicting variety reaction to FHB.
- FDK remains the Canadian Grain Commission's grading factor used to try and predict DON levels in wheat. Continued monitoring of the relationship between FDK and DON is important to determine if the relationship between the two factors remains consistent. If the relationship between FDK and DON changes where FDK is not accurately predicting DON levels, modifications to the grading standards may be necessary.

Acknowledgements

- Manitoba Crop Variety Evaluation Team (MCVET) for providing in-kind support.
- Manitoba Crop Alliance for providing funding to test the 2020 samples.
- Manitoba Wheat and Barley Growers Association for funding support from 2014 to 2019, Western Grains Research Foundation for funding support for 2012 and 2013, and Pest Management Centre, AAFC from 2009 to 2011.

Sources

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