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

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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 local 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.

Material & 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, Rosebush, Souris, St. Adolphe, Stonewall and Thornhill. A total of seventy-two varieties were implemented 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 2009 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 (R²=0.95) and the weakest correlation in 2012 (R²=0.53).

» 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 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.

» 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.

» Levels of DON (%) were also variable over limited locations. A weak correlation was observed between FDK and DON levels through the years of the study. The sites of Arborg, Boissevain, Hamiota and St. Adolphe showed the greatest correlation (R²=0.85) while the weakest correlation was observed in 2012 (R²=0.74). However, data also shows there is variability of performance within the five resistance categories ranging from Resistant (R) to Susceptible (S).

» For the 2009-2015 data, the effect of Variety and the interaction of Variety and Site were significant, as a result in the 2009-2015 data, the interaction of Variety and Site were significant. The results from 2016 are still being analyzed, but anecdotal reports indicate that DON levels will exceed FDK observed.

» 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.

Summary & Next Steps

» 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 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).

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

<table>
<thead>
<tr>
<th>Year</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>FDK (%)</td>
<td>0.32</td>
<td>2.04</td>
<td>0.82</td>
<td>0.71</td>
<td>1.64</td>
<td>1.41</td>
<td>3.07</td>
</tr>
<tr>
<td>DON (ppm)</td>
<td>0.60</td>
<td>1.78</td>
<td>1.07</td>
<td>0.89</td>
<td>1.30</td>
<td>1.39</td>
<td>1.71</td>
</tr>
</tbody>
</table>

Results & Discussion continued

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» Manitoba Crop Variety Evaluation Team (MCVET) for funding to test 2014 and 2015 samples.

» Manitoba Wheat and Barley Growers Association for funding to test from 2012 to 2013, and Pest Management Centre, ANFC from 2009 to 2011.

Sources


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

Figure 2: Fusarium Damaged Kernel (FDK) and Deoxynivalenol (DON) Comparisons of Wheat Varieties in the CPSR, CNHR, CWSP, & CWSWS/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)

Figure 4: Fusarium Damaged Kernel (FDK) and Deoxynivalenol (DON) Comparisons of CWRS Wheat Varieties (2009-2015)

Figure 5: Fusarium Damaged Kernel (FDK) and Deoxynivalenol (DON) Comparisons of CWRS Wheat Varieties (2009-2015)