

## **Project FY22-SP-005: Breeding and Genomic Selection for Fusarium Head Blight Resistance in Spring Wheat**

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### **1. What are the major goals and objectives of the research project?**

Objective 1) Develop Fusarium head blight resistant wheat germplasm and varieties adapted for commercial production in Minnesota and the surrounding region

Objective 2) Characterize the level of FHB resistance of all wheat varieties grown in the region

Objective 3) Use DNA markers to characterize potential parental lines and utilize MAS and genomic selection to increase frequency of FHB QTLs in advanced lines

### **2. What was accomplished under these goals or objectives? (For each major goal/objective, address these three items below.)**

#### **What were the major activities?**

Objectives 1-2: Scab nurseries were established at two field sites, Crookston and St. Paul, in 2023. A total of 1,119 genotypes + checks were evaluated in 1 to 3 replications for a total of 3,3430 single row plots across the two locations. We evaluated the FHB reaction of external germplasm from the 2023 Uniform Regional Scab Nursery (29 lines) and 2023 Regional Performance Nursery (31 lines) and 43 named varieties in our statewide performance trials. We completed Visual Scabby Kernel (VSK) assessment of all materials from these nurseries and received DON data from select materials, predominantly the most advanced nurseries. FHB ratings (1-9 scale) were assigned to all the named varieties.

Objective 3: We obtained GBS data from 2081 F<sub>6</sub> lines using GBS. Genomic predictions were formulated from a training population of a subset of 210 F<sub>6</sub> lines and 49 parents that were phenotyped for FHB field disease severity, VSK and test weight. Marker-assisted selection was also used to characterize parental lines (done in-house) and the F<sub>6</sub> lines (in cooperation with the USDA-ARS Small Grains Genotyping Center in Fargo). We routinely use DNA markers to screen for genes that provide resistance to Fusarium head blight, leaf rust, Ug99 stem rust resistance, semi-dwarfing, and high molecular weight glutenins that are necessary for good baking quality. The Fargo Genotyping Center provided data on 14 gene-specific markers on 2032 of the 2018 F<sub>6</sub> lines and their 49 parents, generating 29,134 marker data points. We used the MAS data from the 14 markers, genomic predictions for FHB, and gluten strength from the GlutoPeak instrument and observations from our winter nursery in New Zealand, including seed size measurements to select a set of 521 lines for entry into preliminary yield trials in spring 2024. In addition, since Fall 2023 we screened 742 individual F<sub>1</sub> plants from topcrosses and backcrosses and 74 parents from Fall 2023 and Spring 2024 crossing blocks for as many as 85 markers in-house, generating a total of 28,260 datapoints.

### **What were the significant results?**

- Our Crookston and St. Paul FHB screening nurseries provided good data in 2023. FHB symptoms were slow to develop in the Crookston nursery, due in part to cold nighttime temperatures in mid-July. As a result, disease symptoms were very slow to develop and by the time later maturing lines were beginning to show symptoms the earlier maturing lines were senescing. Therefore, we did not collect in-field disease severity data but did harvest the nursery which provided discriminatory VSK and DON data. Disease index in the AY1 (with named varieties) at St. Paul averaged 18.6% (range 2-75%), St. Paul VSK averaged 16.3% (4-73%) and Crookston VSK was 12.1 (4-55%). The Crookston nursery produced high DON levels, averaging 10.6 ppm (range 2.3-26.6) while St. Paul was unexpectedly low, averaging 2.7 ppm (0.5-10.5). From the 2023 FHB nursery data and results from previous years, the FHB resistance of 43 current spring wheat cultivars was assessed and reported.
- We used genomic selection at the F<sub>6</sub> stage for FHB to help select lines to advance to our 2024 preliminary yield trials.
- 'MN-Torgy', released in 2020 was the 2<sup>nd</sup> most popular wheat in Minnesota in 2023, according to a variety survey conducted by the MN Assoc. of Wheat Growers. MN-Torgy was grown on 18.6% of the state's 1.3 million acres.

### **List key outcomes or other achievements.**

High yielding wheat varieties with high grain protein content, good straw strength and good scab resistance are in demand by wheat growers because they greatly influence the profitability of wheat production in Minnesota. Recent releases include 'Linkert' (2013), 'Bolles' (2015), 'Shelly' (2016), 'Lang-MN' (2017), 'MN-Washburn' (2019), 'MN-Torgy' (2020), and 'MN-Rothsay' (2022). University of Minnesota developed spring wheat varieties accounted for an estimated 33.8% of Minnesota's 1.3 million spring wheat acres in 2023. MN-Torgy, released in 2020, was the no. 2 wheat variety in Minnesota in 2023, grown on 18.6% of the state's wheat acres and MN-Rothsay (2022 release) was on 6.3%. UMN-developed varieties were also grown on more than 10% of North Dakota's 5.6 million spring wheat acres. Germplasm from our breeding program is being used as parents by private and public breeding programs in the region. We also coordinate the testing and reporting of performance testing of ~45 public and private released hard spring wheat varieties per year in statewide trials to assess their performance in yield nurseries, end-use quality, and reactions to important diseases. This information is critical for growers to make informed choices among varieties.

### **3. What opportunities for training and professional development has the project provided?**

All members of my project, regardless of what species they work on (wheat, intermediate wheatgrass, or field pennycress) help with inoculation and scoring of our FHB nurseries. This provides them with knowledge of the importance of this disease and our screening methodologies. Postdoc Charlotte Brault (funded by Fiedler USWBSI project) attended and presented at the Scab Forum in Cincinnati and Plant and Animal Genome Conference in San Diego.

**4. How have the results been disseminated to communities of interest?**

Wheat cultivar performance, including FHB reaction, of 43 spring wheat cultivars was assessed and reported to growers via print media, web-accessible publications, winter meetings, and field day presentations. We routinely enter five lines in the regional FHB nursery and a variety candidate performance nursery. The data of these nurseries is publicly available and other participants in the nursery have access to cross with this germplasm.

**5. What do you plan to do during the next reporting period to accomplish the goals and objectives?**

This is a continuous breeding program so plans are to continue all objectives as proposed.