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 2024. A total of 1,089 genotypes + checks were evaluated in 1 to 3 replications for a total of 3,322 single row plots across the two locations. We evaluated the FHB reaction of external germplasm from the 2024 Uniform Regional Scab Nursery and Regional Performance Nurseries (37 lines each) and 51 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 2061 F_6 lines using GBS. Genomic predictions were formulated from a training population of a subset of 211 of the F_6 lines and 40 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_6 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 2392 lines (2061 F_6 lines with the 211 training population lines replicated twice, and their 40 parents replicated three times), generating 33,488 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 392 lines for entry into preliminary yield trials in spring 2025. In addition, since Fall 2024 we screened 1,006 individual F_1 plants from topcrosses and backcrosses and 65 parents from Fall 2024 and Spring 2025 crossing blocks for as many as 87 markers in-house, generating a total of 22,200 datapoints.

What were the significant results?

- Our Crookston and St. Paul FHB screening nurseries provided excellent data in 2024. Disease index in the AY1 (with named varieties) at St. Paul averaged 43% (range 18-87%), and Crookston was 40.5% (8-74%). Our St. Paul nursery VSK averaged 19.3% (4-73%) and Crookston VSK was 21.2 (6-65%). The Crookston nursery produced high DON levels, averaging 15.0 ppm (6.7-31.4) while St. Paul averaged 5.5 ppm (2.2-9.6).
- The 2024 FHB nursery data and results from previous years was used to assign a 1-9 FHB rating of 51 spring wheat cultivars.
- We used genomic selection at the F_6 stage for FHB to help select lines to advance to our 2025 preliminary yield trials.
- According to a variety survey conducted by the MN Assoc. of Wheat Growers. MN-Rothsay, released in 2022, was the no. 2 wheat variety in Minnesota in 2024, grown on 21.7% of the state's 1.22 million wheat acres and MN-Torgy (2020 release) was on 11.9%

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 were grown on more than 1 million acres in 2024, accounting for an estimated 37.8% of Minnesota's 1.5 million spring wheat acres in 2024. MN-Rothsay, released in 2022, was the no. 2 wheat variety in Minnesota in 2024, grown on 21.7% of the state's wheat acres and MN-Torgy (2020 release) was on 11.9%. UMN-developed varieties were grown on > 9% of North Dakota's 5.4 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 ~50 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 the spring wheat breeding project, including technicians, postdocs, graduate and undergraduate students 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 Austin, TX, and presented posters and seminars at the University of Minnesota during the past year.

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

Wheat cultivar performance, including FHB reaction, of 51 spring wheat cultivars was assessed and reported to growers via print media, web-accessible publications, winter meetings, and field day presentations. I gave an invited presentation at the 2024 National FHB Forum, highlighting breeding progress for FHB resistance. For 2025 we entered 8 lines in the regional FHB nursery (URSN) and six lines in the regional variety candidate performance nursery (URN). 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.