

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

Note: Report must cover the *entire* duration of the project period of performance, May 1, 2022-July 30, 2026.

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 2025. A total of 1,228 lines + checks were evaluated in 1 to 3 replications for a total of 3,546 single row plots across the two locations. We evaluated the FHB reaction of external germplasm from the 2025 Uniform Regional Scab Nursery (38 lines) and Regional Performance Nursery (40 lines + FHB checks) 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.

Over the entire 4-year grant period, 4,772 lines were evaluated for FHB reaction at two locations per year, a total of 13,222 rows. The FHB reaction of an average of 47 named varieties per year, representing >95% of the state's wheat acreage, were reported each year in print media, web-accessible reports, winter meetings, and field day presentations.

Objective 3: We obtained GBS data from 2,299 F₆ lines using GBS. Genomic predictions were formulated from a training population of a subset of 210 of the F₆ lines and 53 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 F₆ 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 16 gene-specific markers on 2,615 lines (2,299 F₆ lines with the 210 training population lines replicated twice, and their 53 parents replicated three times), generating 41,840 marker data points. We used the MAS data from the 16 markers, genomic predictions for FHB, seed size, pre-harvest sprouting, 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 2026. In addition, since Fall 2025 we screened 1,778 individual F₁ plants from topcrosses and backcrosses and 57 parents from Fall 2025 and Spring 2026 crossing blocks for as many as 93 markers in-house, generating a total of 44,580 datapoints.

Over the entire 4-year grant period, 9,709 F₆ lines were genotyped using GBS markers and gene-specific markers, generating 150,746 gene-specific marker datapoints. A total of 110,673 gene-specific marker datapoints were generated from our screening of crossing parents and BC1/TC1 individuals in-house.

What were the significant results?

- Our Crookston and St. Paul FHB screening nurseries provided excellent data in 2025. Disease index in the AY1 (with named varieties) at St. Paul averaged 38% (range 19-88%), and Crookston was 33% (8-73%). Our St. Paul nursery VSK averaged 28% (11-85%) and Crookston VSK was 16% (4-40%).
- The 2025 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 F₆ stage for FHB to help select lines to advance to our 2026 preliminary yield trials.
- According to a variety survey conducted by the MN Assoc. of Wheat Growers. MN-Rothsay, released in 2022, was the no. 1 wheat variety in Minnesota in 2025, grown on 28.3% of the state's 1.1 million wheat acres and MN-Torgy (2020 release) was on 10.4%. Both varieties are rated as a '4' (moderately resistant) to FHB on our 1-9 rating scale.

During the 4-year grant period, across our 8 inoculated, misted FHB screening nurseries, disease averaged 31%, VSK 18%, and DON 8 ppm, providing a high level of discrimination among FHB resistance/susceptibility level of the lines tested. Genomic prediction for FHB and other important traits was used to help select among an annual pool of ~2,400 F₆ lines to a selected set of ~400 Preliminary Yield Trial lines each year and all lines in yield trials are tested for FHB reaction each year.

List key outcomes or other achievements.

High yielding wheat varieties with acceptable 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 across the region in 2025, accounting for an estimated 42% of Minnesota's 1.15 million spring wheat acres. UMN-developed varieties were grown on >10.6% of North Dakota's 5 million spring wheat acres in 2025.

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 more than 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.

During the 4-year grant period, University of Minnesota developed wheat varieties were grown on an average of 37% of the state's wheat acres, representing more than 1.9 million acres. This is significant because most of the UMN varieties are moderately resistant (3 or 4 on 1-9 scale) to FHB, representing some of the most resistant varieties available to growers.

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 Denver, CO and presented posters and seminars at the University of Minnesota during the past year. She was invited to do a presentation in the workshop “Innovative Approaches and Technologies for Crop Improvement” before the AGBT conference in Phoenix, AZ in April 2026 and attended and presented a poster at the International Wheat Congress in May 2026 in Bologna, Italy. Other professional development included leading two class periods in a plant breeding class in Fall 2025.

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. For 2026 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?

Not applicable, this is the final report for the agreement.