Project FY22-NW-004: Development of Scab Resistant SRW Wheat Varieties and Cooperative Phenotyping

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1. **What are the major goals and objectives of the research project?**
   These goals of this project are to 1) Increase and document the number of varieties with improved FHB resistance and high grain yield and grain quality that are tested in statewide variety trials and available to farmers, to reduce DON in the US grain supply and 2) Increase efficiency of the development and release of FHB resistant varieties and germplasm.

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

   What were the major activities?
   Between May 2024 and April 2025 we completed field experiments, sent leaf tissue on about 1300 new breeding lines for genotyping, analyzed data to estimate total genetic values and genomic estimated breeding values, summarized variety testing results and provided results to growers in a report, made selection decisions based on genomic estimated breeding values and advancement decisions based on total genetic value, planted new field experiments and crossing blocks, made approximately 250 carefully chosen crosses to generate new lines, advanced segregating populations derived from new crosses in the greenhouse, identified lines for licensing to seedsmen, and communicated to growers about controlling scab at outreach events.

   Our field experiments consisted of a) yield trials across 9 locations, b) seed increases at Urbana, IL to amplify seed for eventual commercial production, and c) nurseries at Urbana, IL including a fall-planted single plant nursery to derive new lines more rapidly, and an inoculated and misted scab resistance evaluation nursery. In our scab nursery we evaluated all our breeding materials as well as several cooperative nurseries and the official state variety trial.

   What were the significant results?
   We obtained excellent phenotypic data from yield trials and the scab nursery. All our 2024 experiments produced reliable data. Levels of scab incidence, severity, Fusarium damaged kernels, and Deoxynivalenol were extremely high in the nursery. Scab incidence and severity was also high in our yield trials in Urbana and Neoga Illinois due to a natural epidemic.

   Among all the preliminary and advanced lines that we tested in 2024 in our trials, 55% exhibited scab resistance levels higher than that of our moderately resistant check IL07-19334. Broken down by breeding stage, the percentage of breeding lines at least as scab-resistant as IL07-19334 was 56%, 44%, and 63% for stage 2, stage 3, and stage 4 cohorts respectively. Among all our preliminary and advanced lines tested in 2024, only four lines were more susceptible than our susceptible check Kaskaskia, and none were more susceptible than the susceptible check Pioneer 25R74.

   List key outcomes or other achievements.
   In Fall 2024 we licensed three breeding lines to an established seed company, and shared seed of two additional lines to that same company under a material transfer agreement

(MTA). Our data on these varieties indicates that they are in the 'Moderate (M)' category for scab resistance. Also in Fall 2024, we shared four varieties with a second seed company under an MTA for potential licensing the following year. These four varieties are in the 'Moderately Resistant (MR)' category for scab resistance.

In addition to disseminating germplasm, the breeding program achieved a significant milestone. For the first time in 2024, we selected lines from our rapid breeding single-plant nursery pipeline as parents for crossing. This achievement means that we have shortened our breeding cycle to four years using a combination of speed breeding techniques and genomic selection. We anticipate further reductions in cycle duration as we begin to select parents for crossing prior to phenotyping in 2025.

3. **What opportunities for training and professional development has the project provided?**
This project has given graduate students and undergraduates the opportunity to gain experience evaluating and identifying symptoms of FHB resistance. Undergraduate students have also learned about the technical processes of plant breeding and have gained exposure to agricultural research. Four of the undergraduate students, Fernanda Rutkoski, Matheus Corsico, Jan Carlos Achirids Salgado, and Gianluca Franchino were visiting student interns from outside the US. They stayed for six months and learned and grained experience with scab resistance phenotyping while participating in our breeding program. Fernanda Rutkoski completed an undergraduate research project that examined the relationship between scab resistance, yield, and test-weight in the 2024 official state variety trial. She found that scab-resistant varieties were not higher yielding, even when under epidemic conditions, however scab-resistant varieties had significantly higher test weight under epidemic conditions. Fernanda Jurkowski also documented our scab resistance evaluation protocol and we published it on the web at: https://www.scabusa.org/pdfs/SOP_phenotyping_scab_resistance_final.pdf.

4. **How have the results been disseminated to communities of interest?**
Results of the breeding program, in the form of germplasm, has been shared with private seed companies for licensing.

Results of scab resistance evaluation on varieties in the Illinois State Variety trial have been published on the variety testing website: http://vt.cropsci.illinois.edu/wheat.html. We communicated about how to select scab resistant varieties to growers in multiple presentations at outreach events. The outreach events included our Small Grains field day at the University of Illinois, the Southern Illinois Wheat Tour hosted by the Illinois Wheat Association, and at a Field and Bean educational event hosted by the Illinois Soybean Association.

5. **What do you plan to do during the next reporting period to accomplish the goals and objectives?**
During the next reporting period we will conduct the same major activities as in this reporting period. It's important that we conduct these major activities every year to accomplish the goals and objectives of this project.

In addition, during the next reporting period we will submit at least one publication that is in preparation. This publication results from our breeding methods research on optimizing trial designs to maximize the accuracy of parent selection. We had planned to submit this article during FY24, but needed more time.