Project FY22-SP-001: Developing Improved Cultivars of North Dakota Hard Spring Wheat

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

A) Developing MR lines of hard spring wheat for North Dakota

Continue to develop new and competitive moderately resistant lines of hard spring wheat for North Dakota and the Northern Plains. Maintain inoculated FHB nurseries to achieve this goal, along with screening the commercial variety trial and uniform nurseries. Selection under natural conditions is conducted when the opportunity occurs.

B) Increasing breeding efficiency for FHB

Develop prediction models using photographs of grain to estimate Fusarium damage and DON
Predict entries in FHB nursery using genomic selection to validate genomic selection models

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

Objective A)

What were the major activities?

In 2023, one inoculated dryland screening nursery and two irrigated screening nurseries were planted. Unfortunately, poor and uneven germination rendered one irrigated nursery useless, and the disease pressure was too little at the dryland trial to obtain data. Therefore, our Prosper, ND site was the sole source of data. We obtained 3156 FDK ratings with the VIBE seed analyzer, 3136 DON results, and 4214 total field visual ratings.

Commercial variety trial data was strong even if from only one location, and data were provided for the annual NDSU publication of variety trial results.

For commercial variety development, experimental lines must be at least moderately resistant (5 or less on 1-9 scale) to be considered for advancement.

A student project began in 2023 to develop new resistant lines of HRSW through marker-assisted speed breeding at the Dalrymple AES Greenhouse at NDSU. 400 spikes from seven populations with highly resistant parents were selected from the F2 generation in August 2023, and we are currently testing F5:6 lines in the FHB nurseries and in a yield trial. These lines were genotyped at the USDA-ARS lab for FHB resistance alleles, as well as dwarfing alleles for one *Rht* locus.

What were the significant results?

Despite relying on one Fhb nursery, advancement data was pooled with previous years and decisions were made. Spatial checks with varying maturity helped to interpret the single location data, but Fhb resistance thresholds were relaxed to offset possible issues from one location of phenotyping. It appears that 2024 will be a very high disease pressure year and these can be sorted out.

List key outcomes or other achievements.

Lines containing the novel Fhb resistance on group 5 from PI 277012, along with Fhb1, Fhb5, and Lr34 were advanced to second year yield testing in 2024 after another FHB screening in 2023.

Objective B)

What where the major activities?
All grain phenotyping was completed with the VIBE analyzer this year. This concluded a 3-year testing period where we compared visual scores to those assigned by the computer software, and DON. This expedited our data collection and increased repeatability. Estimating accuracy for this instrument is challenging, because we rarely know the "correct" answer, but only have the subjective visual score to compare.

For 2024 Y1 (first year yield trial lines), all F5:6 rows were genotyped with the 3k marker array, and agronomic selections from the Yuma, AZ nursery were accompanied by genotyping for major FHB resistance alleles. The goal was to increase the FHB resistance level of new lines. The Y1 trial is 30% smaller after MAS in the line derivation stage.

Genomic prediction models were poor, so known genes were used for selection. The 2024 phenotyping will be used with the 3k genotyping to develop a training population which more closely resembles the current breeding program.

What were the significant results?
This year, our FDK calibration with the VIBE analyzer had an average correlation of r=0.82 with the DON results for elite trials of red wheat. This was substantially higher than the correlation between DON and field visual rating, r=0.38. After some further initial testing, we found that the VIBE had a 20% higher correlation with DON than visual FDK scores. So, we obtained all FDK data with this instrument. Using the VIBE increased the total number of observations increased by 600%, and gave us confidence to move toward eventually decreasing annual DON samples and relying more on the VIBE kernel data. A timely harvest of scabby grain samples, along with calibration refinement, likely improved the quality of the results.

List key outcomes or other achievements.
In terms of selection coincidence, the data from our current calibration of the VIBE seed analyzer has an accuracy well over 80% when compared to visual kernel scoring, and was much closer to DON results. Because these data will never be used alone (we utilize the visual field rating, DON data, and multiple years data where possible), we consider this a great success in terms of repeatability and efficiency.

3. **What opportunities for training and professional development has the project provided?**
Two undergraduate students were trained on VIBE analyzer data collection and DON sample preparation. One graduate student, Amber Hermanson, was trained in rating nursery plots and is the student working on marker assisted speed breeding for FHB resistance. She attended the USWBSI forum in 2023 along with Assistant Breeder Andre Miranda. A recently hired technician working 85% on FHB began work, and will replace Andre's FHB responsibilities.

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

   'ND Thresher' (PI 703392) is a MR hard red spring wheat which was developed by our project, partially through USWBSI funding, which was distributed to seed growers in Spring 2024.

   FHB data are annually provided to stakeholders through the Spring Wheat Variety Trial Results and Selection Guide.

   Project leader A. Green speaks at around 8 Summer field days and 2-3 winter meetings annually where FHB data are included and FHB resistance is discussed.

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

   We are closely monitoring conditions in the 2024 inoculated nurseries and hope to have multiple sites of data for use in 2024. We will also utilize the 3k genotyping data with the results from the 2024 phenotyping to refine our prediction models for genomic selection, and continue to utilize the known major genes to enrich the breeding program. We also plan to expand our VIBE analyzer screening in 2024 to include all three locations, and learn what factors affect the correlation of those data with DON.