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?

    Four inoculated and irrigated Fhb nurseries were harvested and had data collected in 2024. The locations were near Fargo, near Prosper, near Osnabrock, and Langdon, ND. In total, 10,462 short rows were screened. 6,459 were harvested and had FDK collected, and of those, 3,570 also underwent DON analysis. In 2024, all Y1 entries were screened for Fhb and other disease major gene/QTL using the known informative markers on the 3k Illumina assay. All grain samples from inoculated nurseries were screened on the VIBE seed analyzer for FDK.

    Commercial variety trial data were collected from two nurseries and contributed for publication of disease ratings in the annual variety trial results and selection guide.

    What were the significant results?

    Strong selection pressure was possible for the first time in over three years thanks to adequate replication across environments. Disease pressure as very high in 2024. Our four locations were planted at various dates, and with our use of spatial check lines which vary in maturity and susceptibility to Fhb, we were able to resolve many environmental differences. We were able to advance two highly resistant lines to the commercial variety trial, which are being considered for pre-release in 2026 as they are evaluated statewide.

    List key outcomes or other achievements.

    Through collaboration with Dr. Steven Xu and the USDA-ARS genotyping lab, we were able to identify a number of experimental lines which were homozygous for the Chromosome 5 resistance from PI277012, as well as Fhb1, Fhb5, and Lr34. These were screened agronomically and are currently being tested in the Y3 advanced yield trials throughout ND in 2025. This would represent a stepwise increase in scab resistance if these lines continue to perform adequately for other traits.

Objective B---What were the major activities?

Grain phenotyping was completed with the VIBE seed analyzer, and we completed a dataset of 3570 genotypes which had full field screening for visual disease rating, as well as FDK and DON.

Throughout 2024, genomic selection models were tested and a good training population of individuals was developed for future selection use.

What were the significant results?

Our models' ability to predict between DON, FDK, and visual symptoms across diverse locations and germplasm varied by location and experiment. DON by FDK when analyzed, had an R^2 of 0.498. Taken alone, this variability led to uncertainty for use in breeding. However, considering the goal of breeding is often to quickly eliminate the most susceptible lines in a breeding cohort, FDK with the VIBE analyzer showed promise for consistently eliminating the most susceptible 10-15%. Ultimately, our visual assessment of FDK was still less accurate and required significantly more resources. The machine relies a great deal on chalky and weathered appearance of grain as a proxy for FHB damage, which can be problematic with dosage effects from varying red color alleles.

Genomic prediction efforts, in collaboration with Dr. Charlotte Brault and with the NDSU Big Data team, showed promise for FHB following the 2024 season, with predictive ability >0.5 for many scab related traits. We are eager to optimize the training population and add the 2025 breeding cohort for future model enhancement. Breeding decisions were made in 2024 and 2025 using these data.

List key outcomes or other achievements.

Our FHB grain data were finished nearly 7 weeks earlier than last year despite having twice as many samples. The automation of the process with the VIBE analyzer has streamlined our efforts substantially.

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

Three 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. A recently hired technician working 85% on FHB began work, and will replace our technician from last year which only remained with our program for 6 months.

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 sold for commercial production in 2025.

'ND Stampede' (PI 705616) is a MR hard red spring wheat which was developed by our project, with help from USWBSI funding. It was distributed to seed growers in Spring 2025.

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 four locations of the 2025 inoculated nurseries and hope to have multiple sites of data at the end of the season. These lines were pre-screened for major Fhb QTL and for low DON and Fusarium damage, using our genomic prediction models.