Project FY22-HW-010: Breeding for Scab Resistance in NE HWW by Optimizing Introgression and Selection

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1. **What are the major goals and objectives of the research project?**
   Obj. 1 Increase the proportion of University of Nebraska wheat breeding crosses targeted towards FHB resistance and DON accumulation*:* In
   Obj. 2 Improve evaluation and selection of germplasm with increased FHB resistance and reduced DON accumulation*.*
   Obj. 3: Evaluate the effect of genotype x fungicide treatments for FHB in our conventional vs intensive management breeding trials.

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

What were the major activities?

Obj 1- We completed crossing blocks in 2024 and 2025 to introgress FHB resistance. New in March 2025, we added Fhb7^{The2} germplasm from Dr. Xiwen Cai to our crossing block.
Obj 2- We continue to evaluate the FHB regional nurseries for public and private breeding programs in the hard winter wheat region. We also evaluate the UNL preliminary yield trial, advanced yield trial, and elite yield trial.
Obj 3- We planted yield trials to evaluate variety performance in fungicide vs no fungicide applied experiments. These trials were faced with significant stripe rust infection in 2024, but due to drought conditions in 2025, little disease presence was observed.

What were the significant results?

Obj 1- In 2024, we made 32 planned crosses to introgress *Fhb1* and 15 crosses involving *Fhb6*. Three of the *Fhb6* crosses also involved *Fhb1.* Seventy-five other crosses were made using parents that have good phenotypic tolerance to FHB or reduced DON levels. In total, 28% of the crosses we made in 2024 involve some form of tolerance to FHB. In March 2025, we made 32 planned crosses to introgress *Fhb1* and 4 crosses involving *Fhb6*. One of the *Fhb6* crosses also involved *Fhb1*. 108 other crosses were made using parents that have good phenotypic tolerance to FHB or reduced DON levels. New in 2025, we began introgressing *Fhb7^{The2}* sourced from Dr. Xiwen Cai. We made 29 crosses with *Fhb7^{The2}* including one with *Fhb1*. In total, 35% of the crosses we made in 2025 involve some form of tolerance to *FHB*. We are especially excited by the evidence that *Fhb7* is complementary to *Fhb1* and *Fhb6* as well as native, quantitative resistance. We look forward to testing this material in the field.

Obj 2- The 2024 FHB Mist Nursery was grown in Lincoln, NE at the Havelock Research Farm. Weather conditions were warm and humid and generally conducive to disease pressure. The rows were inoculated with corn spawn 4 weeks before anthesis and sprayed with F. graminearum conidial inoculum at anthesis. Mean severity, incidence, and FHB index for the 2024 wheat nurseries screened are presented in Table 3.

The 2025 UNL FHB nursery was planted in October 2024. Nursery entries include a subset of the UNL preliminary yield trial for genomic selection validation, the advanced and elite yield trial entries, the NUWSSN, and HWW-CP entries. In addition, we planted a trial for CSU grad student Emily Billow. Emergence was uneven due to drought conditions at planting, but the field received some moisture in late October and throughout the winter. Inoculation with corn spawn took place on 4/25/2025, 5/3/2025, and 5/10/2025. A Fusarium spore suspension was applied on 5/21/25. The data collection from the 2025 trials is complete.

Table 3: Mean nursery results for the 2024 Wheat FHB Irrigated Nursery in Lincoln, NE

2024 Nursery	Average Severity	Average Incidence	Average Index	Average FDK	Average DON (ppm)
UNL Advanced Breeding Lines	18	9.2	3.4	1.6	1.48
UNL Preliminary Breeding Lines	14	10	3	NA	NA
NUWSSN	13.7	14.8	4.3	1.2	0.81
HWWCP entries	22.6	14.7	6.4	2.2	2.33

Obj 3- We planted yield trials to evaluate variety performance in fungicide vs no fungicide applied experiments. In 2024, we observed significant differences between treated and untreated plots. However, the differences in performance between the treated and untreated plots was primarily due to the presence of stripe rust. Phenotypic observations for FHB in the untreated plots showed that the disease was minimal compared to stripe rust and likely did not affect yield or test weight.

List key outcomes or other achievements.

We have generated multiyear FHB phenotype data for all our key UNL wheat nurseries as well as for the regional screening nursery supported by Dr. Jessica Rupp at KSU. This data is being used to inform selection and advancement decisions as well as to select parents for crossing to develop superior breeding lines with increased FHB resistance. We also have submitted crosses for the Doubled Haploid generation project at Texas A&M led by Dr. Shuyu Liu.

In Dec 2025, UNL released NE Daybreak (PVP pending) a new wheat variety. It is susceptible to FHB. However, 2 of the 3 upcoming wheat varieties from UNL are moderately resistant to FHB.

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

This project and the UNL BAR-CP project have supported a summer research intern in 2023-2025. Interns receive training in wheat breeding and genetics, field data collection, harvest and data analysis. 2025 Intern Francisca Dzorlevo arrived in March 2025 and will complete an FHB genomic prediction project using wheat data generated via this project. This project also supported travel for PI K. Frels to attend the 2024 FHB Forum.

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

We share updates on all nurseries with collaborators as well as at conferences and presentations. We also include updates on FHB infections, prevention, and research at field days such as the annual UNL Wheat Variety Tours.

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

May 2025-July 2025: Field-based phenotyping of elite, advanced, and potentially preliminary breeding nurseries as well as regional nurseries. Management of misted nursery including inoculation, plot management, data collection, and harvest. Preliminary development of genomic prediction models. Selection of lines for fall crossing block.
July 2025-Sept 2025: Harvest field disease nursery, data analysis, processing samples for DON analysis, genomic selection model testing with preliminary 2025 phenotypic data, selection of breeding lines based on GEBV and phenotypic data.
Sept- Oct 2025: Complete fall crossing block. Fall planting in the field, selection of lines for winter crossing block.
Nov 2025-Jan 2026: Advance lines for backcrossing, DNA extraction for genome-wide marker analysis if available
Feb-March 2026: Analysis of genome-wide marker data, testing new training model optimization, complete main barley crossing block for the year, prepare inoculum for the field season.
April 2026: Plant selected lines for additional backcrossing and/or three-way crosses.