

Report for FY22-HW-004: Developing Winter Wheat Varieties with Enhanced Resistance to FHB for South Dakota

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

Our primary goal is to develop and release new superior winter wheat varieties with enhanced resistance to FHB and reduce fungal mycotoxins, primarily deoxynivalenol (DON), to limit the loss of grain yield and quality. The specific objectives of this proposal are 1) to develop FHB-resistant and low DON winter wheat varieties for South Dakota and surrounding regions; (2) pyramiding major and minor genes for FHB resistance by developing and implementing phenotypic and genomic selection models for SDSU winter wheat program.

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

What were the major activities?

More than 120 crosses (2025-2026) were performed to combine FHB resistance, including *Fhb1*, *Fhb6*, *Fhb7*, *Fhb9*, and native sources of resistance to FHB, into South Dakota breeding materials. Nearly 101 populations were advanced to F2:3 using speed breeding of mini bulks, and plants were selected from 80 F2:4 mini bulk populations in the field in summer 2025. For the 2026 growing season, we planted 52 speed-breeding F2:4 mini bulk populations in the field and selected them in summer 2026.

Breeding lines and released cultivars from other public and private breeding programs were evaluated in a locally grown mist-irrigated and inoculated FHB field nursery. These nurseries include the South Dakota Crop Performance Testing nursery (CPT), and the Hard Winter Wheat FHB nursery (Public and Private). State Variety/Crop Performance trials (with and without fungicides at Brookings) were conducted to determine the impact of FHB on different varieties and elite lines.

We evaluated genome-wide selection models and developed high-throughput, phenotyping-based machine learning models for FHB using RGB/NIR/hyperspectral imaging to predict disease incidence, FDK, and DON content.

What were the significant results?

‘SD Pheasant’ released in Fall 2023 demonstrated excellent yield potential, protein, and test weight, and moderate tolerance to FHB in 2025 trials and has started picking acres in South Dakota.

In summer 2025, FHB data were collected on 46 Elite and 126 Advanced Yield Trial entries from the SDSU winter wheat breeding program in mist-irrigated FHB nurseries. One experimental line carrying *Fhb1* from Elite entered state variety trials and the NRPN trial in 2026, ranking 10th in Elite trials in 2025. More than 10 PYT entries showed good FHB resistance and good agronomic characteristics and were advanced to AYT for 2026.

The FHB disease ratings on regional germplasm in the Northern Hard Winter Wheat FHB Public and Private Nurseries and South Dakota CPT were made available to South

Dakota producers and colleagues at other participating institutions and private industries.

State Variety/Crop Performance trials (with and without fungicides at Brookings) were conducted to determine the impact of FHB on different varieties and elite lines. In 2025, application of fungicide (Prosaro) at flowering showed a yield benefit of 9.7 bu/acre at Brookings in the State Variety Trials (CPT) trial. The data have been shared through extension publications and with the cooperators.

List key outcomes or other achievements.

A new hard red winter wheat variety, 'SD Vivian', was released in fall 2025. SD Vivian is a semi-dwarf variety with excellent yield potential under dryland, good test weight, and excellent grain protein content; It is resistant to tan spot and moderately resistant to stem rust and hessian fly, with good milling and baking characteristics.

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

A graduate student (100%) and a postdoc (partially 60%) were supported by this grant. The research was presented at the 2025 FHB forum. The graduate student participated in the Data to Science (D2S): UAS-based High Throughput Phenotyping Analysis for Plant Breeding Programs workshop at CANVAS, Salt Lake City, in November 2025, and also presented at the 2025 National FHB Forum.

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

FHB resistance ratings collected on released cultivars are made available to growers as part of the annual South Dakota Crop Performance Testing Hard Winter Wheat report. Additionally, data collected from Northern Hard Winter Wheat FHB Public and Private Nurseries is shared with colleagues from both public and private breeding programs. The results from this project were shared through field days and articles in appropriate popular press sources, word of mouth, Twitter, brochures, and Extension press releases from the Agricultural Experiment Station.

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

We will continue to 1) develop FHB-resistant and low DON winter wheat varieties for South Dakota and surrounding regions; (2) pyramid major and minor genes for FHB resistance by developing and implementing phenotypic and genomic selection models for the SDSU winter wheat program.