Project FY22-SW-006: Developing FHB-resistant Soft Red Winter Wheat for Texas and the Gulf-Atlantic Region

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

   The overarching goal of this proposal is to use traditional breeding techniques, a misted-nursery, and marker-assisted selection (MAS) to develop FHB resistant soft red winter wheat (SRWW) cultivars and to share germplasm with other Southern U.S. programs. Our specific objectives are to 1) develop, screen, and release SRWW that combine superior yield and end-use quality with tagged native FHB resistance, 2) use MAS to complement traditional breeding methods and improve gain from selection, and 3) enter promising FHB-resistant lines into Southeastern University Grains (SunGrains) scab nurseries to facilitate development of resistant cultivars. New FHB-resistant SRWW cultivars with high yield potential, tolerance to other biotic and abiotic stresses, and superior end-use quality will provide effective means of resistance not only in Texas but also in other areas in the Southern U.S. where TAM wheat is adapted and where FHB levels require adequate host plant resistance

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

   What were the major activities?
   A mist-irrigated FHB evaluation nursery was established at the main campus in College Station, Texas for evaluating incidence and disease severity. We have specifically evaluated the Texas Soft Uniform Variety Trial (SUVT), Uniform Southern SRWW Nursery (USSRWWN or USSN), the Uniform Southern Winter Wheat Scab Nursery (USWWSN or USN), the Gulf-Atlantic winter wheat nursery (GAWN), and the soft wheat elite (SWE) in 2024 and 2025. FDK was evaluated for all samples in 2024 and 2025. The DON results from U. of Minnesota (UMN) were shared for 115 lines in 2024 and 224 lines (154 lines had 2 replications) were sent to UMN in 2025. 5 grams of seeds from harvested samples were scanned using a HP scanner and analyzed for seed traits using GrainScan software in the same way as described for hard wheat.

   MAS has been integrated into the soft wheat breeding through the SunGrains program in collaboration with the genotyping lab at Raleigh, NC. Genomic prediction has been part of the selection in the collaboration with NCSU wheat breeding program. In the winter 2024/2025 greenhouse crossing block, 10 crosses were made using a scab resistant parent with the major gene, Fhb7, and approximately 150 crosses with scab resistant parents possessing the major gene Fhb1 or other Fhb QTL. In the second 2025 greenhouse crossing block, an additional 10 top crosses have been made between the Fhb7 F1 crosses and elite

Texas soft red winter wheat parents. The results of these top crosses will be sent to the genotyping lab at Raleigh, NC in 2025 and lines with Fhb7 will be advanced in the introgession project. Texas crossing parents which possess additional Fhb genes and QTL as well as superior agronomic qualities were chosen. The successful results of this project will be made available to all SunGrains breeding programs.

What were the significant results?

The nursery had high uniform infection in 2024. A total of 130 lines were e
valuated for INC, SEV, and FDK for two reps. INC ranged from 4 to 90% with a mean of 53%, SEV ranged from 9 to 89% with means of 51%, FHBI ranged from 3 to 79% with means of 31%, FDK ranged from 3 to 70% with means
of 24%, and DON ranged from 0.8-23.8 ppm with a mean of 6.3 ppm.

The correlations of scab traits and the kernel traits were analyzed based on all 130 soft wheat lines in 2024. INC, SEV, and FHBI were significantly and positively correlated to each other ($r=0.59$-0.89, $P<0.001$). INC was also significantly correlated with DON ($r=0.31$, $P<0.001$), with seed area and width ($r=0.25$, $P<0.01$), with seed perimeter and length ($r=0.19$-0.2, $P<0.05$) but not significant with FDK and TKW. FDK was significantly and positively correlated with DON ($r=0.52$, $P<0.001$) while it was negatively correlated with seed width ($r=-0.28$, $P<0.01$) and seed weight ($r=-0.54$, $P<0.001$).

In 2025, a total of 224 soft wheat lines with 378 headrows were planted in the scab nursery. These include our TX advanced elite lines from SWE, and regional elite lines from Texas, Louisiana, Arkansas, Georgia, Florida, Virginia, South Carolina and North Carolina. All HRs have been evaluated for INC, SEV, and FHBI. FDK is in the process and DON samples were sent to UMN for evaluation. INC ranged from 0 to 90% with the mean of 57.6%, SEV ranged from 0 to 90% with the mean of 58.1%, and the FHBI ranged from 0 to 81% with a mean of 37.2%.

List key outcomes or other achievements.

There is an increase in the Fhb1 frequency in our germplasm. We expect to release this type of resistance in about two years. A tray of F1 crosses with Fhb1 was prepared and shipped to the Montana State University spring wheat breeding program for rapid generation advancement and seed increase. Introgression of Fhb7 into our soft winter wheat germplasm began in the winter of 2024. Topcrossing and accelerated generation advancement of lines with Fhb7 began in spring/summer 2025. We plan to have advanced lines with combined Fhb1 and Fhb7 ready for release in the next 8-10 years. Prior to release, this germplasm will be available to other members of SunGrains for crossing parents within the next two years. A wheat line TX23D8588 derived from TX15D9253/LA08080C-31-1 has the Fhb resistance 1B QTL from Jamestown, and 4A QTL from Neuse along with H13, Lr18, Tr4BL. Approximately 80% of our mid-generation lines now have one or more sources of Fhb resistance.

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

Two technicians and one graduate student were trained in symptom rating, including disease incidence, severity, and FDK, as part of this project.
One new graduate and a new postdoc were trained on the embryo dissection and colchicine treatment for doubled haploid development. In total, we trained 2 PhD student, 2 technicians, and one postdoc on DHL development.

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

Data of regional nurseries has been shared widely with soft wheat breeders in the 8 states. Results were communicated in producer meetings and field days. Any future significant outcomes of this project will also be highlighted in popular press articles. Furthermore, results will be communicated to scientific peers via peer-reviewed scientific journals upon the release of current candidates screened during 2025. A manuscript is in the preparation for publication on scab traits and seed traits. Summarized results were presented in the National FHB Forum at Austin, TX in December of 2024.

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

FHB incidence, severity, index, FDK and DON will be summarized, and resistant germplasm and cultivars will be released. The final project report will be prepared to summarize the progresses that have been made during the last four years.