Project FY22-HW-005: Developing FHB-resistant Hard Red Winter Wheat for Texas and the S. Great Plains

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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 and marker-assisted selection (MAS) to develop FHB-resistant hard red wheat (HRW) cultivars adapted to Texas and the Southern Great Plains. Our specific objectives are to 1) develop, screen, and release HRW that combine superior yield and end-use quality with tagged or native FHB resistance, 2) use MAS to complement traditional breeding methods and improve gain from selection, and 3) enter promising FHB-resistant lines into regional nurseries to facilitate development of resistant cultivars. New FHB-resistant HRW cultivars with high yield, tolerance to other stresses, and superior end-use quality will provide effective means of resistance not only in Texas but also in other areas of the central and southern Great Plains 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 successfully established at the College Station main campus for evaluating incidence (INC), disease severity (SEV), FDK, and DON in the 4th year. We moved to a new area in the farm close to an irrigation system providing greater water pressure for misting. We have specifically evaluated the Southern Regional Germplasm Nursery (SRPN), Texas elite lines (TXE), and breeding lines in advanced (STA1, STA2) and preliminary yield trials (STAP1-3). In addition, some selected segregating populations with known FHB resistant parents were planted in the scab nursery. This nursery had heavy scab infection in 2024 with a total of 738 headrows (HRs) and in 2025 with a total of 700 HRs for hard wheat. Heading dates, INC and SEV were rated in the field before head color turned. FDK is currently underway through manual ratings and DON samples have been sent to the NDSU lab for analysis of the 2025 samples. About 5 g seed samples of each line were scanned using a HP scanner and analyzed with grain scan software for kernel parameters including seed length, width, perimeter, area, and thousand kernel weight. The 2024 seed samples have been analyzed for both scab traits and seed traits and the analyses for 2025 seed samples are in progress.

   Another nursery was planted near Dumas, TX by the Amarillo breeding program. Selected trials were planted into heavy corn residue and irrigated by pivot and bordered with taller triticale to make favorable scab infection micro-environments. This is the fourth consecutive year, but the scab infection was not enough for good scab ratings in both 2024 and 2025. This location contained the SRPN, Texas Uniform Variety Trial, TXE, and the Advanced breeding trials with 760 rows in 2024 and 320 rows planted in 2025.

What were the significant results?

In the 2024 College Station nursery, DON values ranged from 0.1-69.1 ppm with a mean of 26 ppm. INC ranged from 0-100%, with a mean of 41%. Severities ranged from 0-100%, with a mean of 39%. FHB Index (FHBI=INC*SEV/100) ranged from 0 to 72%, with a mean of 19%. FDK ranged from 2.5 to 55%, with a mean of 24%.
Based on 160 lines from SRPN, TXE, and Advanced breeding lines, the correlations among INC, SEV, FHBI were significantly and positively correlated (r= 0.66-0.85, P<0.001) while all three traits were positively and significantly associated with FDK (r=0.31-0.38, P<0.01) and DON (r=0.16-0.20, P<0.05). However, only SEV was significant with seed area and width (r=0.1-0.21, P<0.05). FDK and DON were significantly correlated (r=0.44, P<0.001) while FDK was significantly correlated with seed length (r=0.15, P<0.05) and negatively associated with seed weight (r=-0.22, P<0.01). In addition, DON was significantly and negatively associated with seed perimeter and kernel weight (r=-0.26, r=-0.32, P<0.001). all seed traits were highly correlated with each other (r=0.52-0.88, P<0.001).
Based on 40 Texas elite lines, the correlations among INC, SEV, FHBI were significantly and positively correlated (r= 0.71-0.9, P<0.001) while all three traits were positively and significantly associated with seed area, seed width, and thousand kernel weight (r=0.33-0.39, P<0.05). FDK was highly correlated with DON (r=0.67, P<0.001), seed length (r=0.32, P<0.05), and weight (r=-0.37, P<0.05). DON was negatively related to seed weight (r=-0.37, P<0.05). All seed traits were highly correlated (r=0.64-0.86, P<0.001) except seed length with width (r=0.39, P<0.05) and with weight (r=0.45, P<0.01). Advanced breeding lines and SRPN followed similar trends as TXE. FDK and DON were not correlated with each other in the SRPN and STA2.

In the 2025 College Station scab nursery, based on 502 lines from SRPN, TXE, STA and STP, INC ranged from 0 to 100%, SEV ranged from 5 to 100%, and FHB Index ranged from 0.25-100%.

In 2025, a set of 152 advanced breeding lines were conducted GBS and 78 alleles of major gene maker screening including Fhb1and Fhb9. Some of them have Fhb1 that can be used as parents for next crossing. With the scab data collected last 2 seasons in the scab nursery, genomic prediction will be used for selecting scab resistance alleles.

List key outcomes or other achievements.
From the 2024 scab nursery data, 14 TAMU breeding lines had DON values of <2 ppm. Hard wheat lines TX22M6061 and TX22M6048 had overall lower scab parameter values across all traits. Twelve more lines were found with DON of < 2 ppm out of 160 lines, so these lines can be used for resistance in different breeding strategies. Eight lines from the 2024 TXE were advanced to the 2025 SRPN and 3 had moderate scab resistance. Twenty lines were advanced from STA to TXE and 5 lines (TX17A1247- BI6, TX21M5141, TX21M5443, TX17A1247- BI8, TX21M5445) had moderate scab resistance (DON<2 ppm). Sixty lines were advanced from STP to STA and 13 lines had lower FDK (index of <20%). One variety release candidate, TX20M4131, has a FHB index of 2%.

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.

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

Data of regional nurseries has been shared with 9 breeding programs in the HRW region. Results were communicated in producer meetings and field days in 2024 and 2025, and the National FHB Forum at Austin, Texas and the Crop Science Society of Crop Sciences at San Antonio, Texas in 2024. 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 the project terms in 2025. The two-year results will be presented at the Texas Plant Protection Association in December of 2025.

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

The scab nursery data from 2025 will be analyzed, summarized, and reported next including FDK and DON. Additionally, the next report is the final report for this 4-year project so there will be summarized results from 4 years. A manuscript is in preparation to summarize the results. Potential release candidates will be determined by that time.