Project FY24-HW-001: Breed FHB resistant cultivars via doubled haploid and marker-assisted backcrossing

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

   The major goal is to develop FHB resistant germplasm and cultivars by pyramiding FHB resistant genes. The objective is to pyramid Fhb1, Fhb6, Fhb7 and other major QTL into hard red winter wheat for breeders and geneticists.

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

   What were the major activities?

   Major steps for developing DH lines: 1) F_1 plants were pollinated with the corn pollen just before the anthesis stage; 2) Corn pollinated spikes were treated with 2,4-Dichlorophenoxyacetic acid (2,4-D) synthetic auxin solution (a plant growth hormone) to induce haploid embryo formation; 3) Seeds were dissected 18 days after pollination to rescue haploid embryos, cultured them on the growth media, and vernalized the seedlings for 6-8 weeks; 4) Vernalized seedling were transplanted into soil pots and grown to 2-3 tillers and treat the crown and roots with colchicine for chromosome doubling; 5) Transplanted and grow the colchicine treated seedlings in the greenhouse till physiological maturity. 6) seed increase for DHLs.

   In the Fall 2023, 460 F_1 seeds as progenies of parental lines with Fhb1, Fhb6, and several major QTL were received from five breeding programs in the hard winter wheat region and more than 2176 embryos were rescued through seed dissection from March to July,2024. A total of 650 haploid seedlings were transplanted into pots from June 7 to August 15. A total of 634 seedlings were treated with colchicine solution from July 10 to September 23. The colchicine treated plants were moved to the greenhouse to grow to maturity after they recovered from the treatment. By July of 2025, a total of 351 DHLs were harvested with seed amount ranged from a few seeds to a few grams. They will be planted in the GH or head rows in the field for seed increase to get more seeds then distribute to collaborators.

   A set of 140 DHLs that were harvested in 2022 and 2023 were planted in the 2025 scab nursery. Disease incidence (INC) and disease severity (SEV) ranged from 5 to 100% with respective means as 61% and 51%. The FHB index (FHBI) (=INC*SEV/100) ranged from 0.3 to 100% with a mean of 33.7%. Among the 140 DHLs that had enough seeds to be planted in the field, 121 lines were planted in College Station, and 44 lines were planted in Uvalde additionally.

   Due to the shortage of employees, no new set of seeds for developing DHs was requested in the fall of 2024 from collaborators. The project will be continued in the fall of 2025 and 2026 to develop DHLs for the region as planned in the proposal.

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In the spring of 2024, we collected 2176 embryos but the germination of embryos to plant seedlings was low. We were expecting to produce more than 1000 DH lines even if the embryo germination rate reach at 50%.
For those 140 DHLs tested in the College Sation scab nursery, 44 DHLs had FHBI scores <15%. Their Fusarium-damaged kernels (FDK) and deoxynivalenol (DON) are under evaluation. All DH lines will be shared with all collaborating 8 breeding programs in the HRWW region.

List key outcomes or other achievements.

Among 121 DHLs that were harvested from the field in College Station, 7 lines had higher yield than first check cultivars TAM 116 and four out of seven had very good agronomic traits. Additional 18 DHLs had higher yield than the top cultivar TAM 114. Among the 44 lines planted in Uvalde, two lines TX23DH97 and TX23DH219 had a higher yield than TAM 116 and an additional 18 lines had a higher yield than TAM 114.

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

In addition to two PhD students, one new PhD student and a new postdoc were trained for the whole process of DHL development. With the previous postdoc left for a new position, we hired a new postdoc Sumandeep Bazzer who started on June 3, 2024. We trained her and another PhD student, Luke Whiteley who came to Amarillo to help the seed dissection for embryos rescue. They have done a good job to maintain the plant growth. Unfortunately, Sumandeep left the program due to her family moving in January 2025. Our previous postdoc, Yahya Rauf, who was trained on the DHL development, has come back to work with us on DHL development since May 2025. In total, we trained 3 PhD students and two postdocs in this project.

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

Project progress was discussed with the regional collaborators in annual meeting, presented in the ASA-CSSA-SSSA tri-society meeting at San Antonio in November 2024 and the National FHB Forum meeting at Austin, Texas in December 2024. Scab trait data from both hard and soft wheat are in the process of analyses, summary and manuscript are under preparation.

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

As our new team is starting, the new geneticist Dr. Junli Zhang will work with Dr. Yahya Rauf in Amarillo to mainly work on the DHL development with pyramided genes including Fhb1, Fhb6 and FHb7, as well as major QTL. I will lead the team in College Station partially working on the DHL development to make sure that we will develop the number of DHLs as proposed. With the facilities in the new AgriLife Research Center in Canyon, Texas including new labs and growth rooms, we will utilize them to develop DHLs more efficiently. Some DHLs will have enough seeds to share with collaborators in the first generation. Markers linked to major genes or QTL will be screened on the DHLs developed.