Project FY22-HW-007: Development of Scab Resistant Cultivars for Kansas

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1. **What are the major goals and objectives of the research project?**
   The major goals and objectives of this research project is to aid in the development of hard red and white winter wheat cultivars adapted for Kansas and the Great Plains region with improved resistance to scab. The short-term objectives of this research are to 1) test existing local cultivars for their reaction to scab, 2) test advanced breeding lines for reaction to scab, 3) test exotic germplasm lines for reaction to scab, 4) test the public Hard Winter Wheat (Kansas, Nebraska, Colorado, South Dakota, North Dakota, Montana, Oklahoma, Texas) Nursery and the private (Bayer, LimaGrain, and Syngenta) for reaction to scab, and 5) incorporate newly identified sources of scab resistance into the KS wheat breeding program. This particular project is wheat pathology-based and works in heavy coordination with breeders, geneticists, and others across the region to do a blind field evaluation of cultivars.

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

   What were the major activities?
   The following activities regarding evaluation were completed: 1) Hard Winter Wheat FHB Nursery: 15 entries each (120 total) from FHB breeding programs in Kansas, Nebraska, Oklahoma, Colorado, Texas, South Dakota, Montana, and North Dakota were evaluated. Check cultivars were added to the above entries; Everest (moderately resistant), Karl 92 (intermediate), and Overley (susceptible). The Northern Nursery uses checks Emerson (R-MR) and Flourish (susceptible.) 2) Private Breeder Winter Wheat FHB Nursery: 15 entries (45 total) from three major private wheat breeding programs Three check cultivars were added to the above entries; Everest (moderately resistant), Karl 92 (intermediate and grain quality), and Overley (susceptible). 3) Kansas Commercial Cultivar FHB Nursery: 15-25 common Kansas commercial cultivars are integrated into the FHB Regional Screening Nurseries. 4) Kansas Intrastate FHB Nursery: 30 advanced breeding lines from wheat breeders at Kansas State University, 8 varieties from the USDA Hard Winter Wheat Genetics Resource Unit, Manhattan, KS. 5) Wheat Breeding FHB Nurseries: Additional breeding material, mostly involving populations for recurrent selection, from Dr. Allan Fritz' wheat breeding programs, multiple varieties from the USDA Hard Winter Wheat Genetics Resource Unit. These nurseries are planted each fall. They were inoculated using corn spawn inoculum, heading date was recorded, and all entries were evaluated throughout season. Plots were harvested for FDK and DON analysis. In addition, we prepare and provide corn spawn inoculum to AgriPro Syngenta based in Junction City, KS and The Land Institute, Salina, KS to aid the evaluation of FHB resistance in additional pools. Our site additionally hosts FHB evaluation nurseries for KSU Wheat Breeding, USDA wheat breeding, the USDA Genotyping Lab, The Wheat Genetics Resource Center, and the Akhunov Wheat Genetics Lab, where we prepare inoculum, maintenance the field site, inoculate, provide irrigation, and assist with evaluation.

   What were the significant results?
   Until involvement in the USDA Scab Initiative, there was little effort to identify sources of scab resistance in Kansas breeding programs. The Initiative has resulted in the development of accurate and efficient field testing nurseries that are providing useful ratings for current cultivars in Kansas and advanced breeding lines. This screening effort now includes entries from winter wheat breeding programs throughout the Great Plains region. The long-term goal of the research is to develop, deploy, and advertise winter wheat cultivars adapted for Kansas with improved levels of resistance to scab.

List key outcomes or other achievements.

In 2009, Kansas State University released the first hard red winter wheat cultivar adapted to Kansas selected for improved levels of resistance to scab. This variety "Everest" is still a top variety in KS representing more than 60% of the acres planted in regions of the state most prone to FHB. KSU released a new variety, Zenda, with moderate levels of resistance to FHB in 2016, several private breeding programs have also released varieties with improved resistance to FHB including Bob Dole, WB4269, WB4699 and SY Benefit. The screening nurseries supported by the USWBSI were essential in the development of these varieties. In 2021 KS Ahern, with a moderate response to FHB was released. Additionally, three key lines with exceptionally high levels of resistance have been identified carrying quantitative resistance and will continue in the breeding program. These lines, collectively, KS16FHB0211 carry resistance, currently suspected to be 2-3 genes that result in phenotypes with 20% greater resistance than the MR check. These varieties have all been evaluated in our nursery. A key additional component is that these have been evaluated for their response to fungicide as well. Three varieties that have been screened in the nursery have been released including KS Territory, KS Big Bow, and KS Providence. In 2022, KS Providence was both a top performer in the field and was one of the highest grossing varieties of 2023, while also serving as an important parent selection for future work. In 2024, the new variety 'Scab Stryker' was released by OSU, with myself as second author. Of current unofficial note, progress within the KSU wheat breeding program is now requiring a more stringent evaluation due to increased resistance, thereby requiring us to modify protocols and signifying great improvements in the last 8 years.

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

The FHB screening nursery provided training opportunities for 2 graduate students within the Applied Wheat Pathology Lab to gain hands-on experience in the operation and rating of these multi-disciplinary projects. Students are involved in every aspect of the project from planting, harvesting and processing the diseased grain. Additionally, the FHB nursery was a tour stop for multiple tour groups, including the North Central American Phytopathogical Society Annual meeting (June '24) and for REU (Research and Extension Opportunity for Undergraduates) hosted by our department.

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

Reports of the phenotyping nurseries are sent to all cooperating breeding programs as both preliminary results and full results. Information about current wheat varieties is released via KSU extension publications "Wheat Variety Disease and Insect Ratings, 2024" and "Kansas Performance Tests with Winter Wheat Varieties". Both publications are available as "hard copy" or online. Plant disease management reports were also published. These results are available through the Plant Management Network. Lastly, two new KS wheat varieties were registered through the journal of plant registrations, as well as numerous varieties from other states (please see other breeder report data).

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

We have established a strong and consistent program that reliably contributes to the regional breeding programs. We will continue to seek to grow our collaborations, techniques, and influence to meet the goals of both the HWW-CP and the USWBSI as a whole. We will continue to use the nurseries as teaching opportunities to equip the next generation of scientists to contribute to research for wheat improvement.