Project FY22-SW-003: Development of Scab Resistant Wheat Germplasm Adapted to GA and the Southeast Regions

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

Fusarium Head Blight (FHB), also called scab, is a disease causing a global threat to wheat production in the major US wheat growing regions including the Southeast (SE) regions. In the Southeast (SE) and GA, scab disease can result in significant loss in wheat production and quality (DON) resulting in losses in revenue for wheat growers and industry. At UGA, we are solving this problem by developing and releasing adapted soft red winter wheat (SRWW) varieties and germplasm with improved FHB resistance and evaluating them for FHB reaction in GA and in the regional nurseries. The specific objectives of the project are (1) increase acreage planted to wheat varieties exhibiting improved FHB resistance; (2) generate SRWW germplasm with high yield and improved diseases resistances including FHB; and (3) improve efficiency of coordinated project breeding programs to develop and release FHB resistant varieties. This project is a collaborative effort with SUNGRAINS and many USDA-ARS labs including the Genotyping Center at Raleigh NC (Dr. Gina Brown-Guedira) and the lab. quality at Wooster, Ohio (Dr Byung-Kee).

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

Objective 1: Develop high yielding soft red winter wheat (SRWW) germplasm/cultivars with improved FHB resistance and end-use quality.

a) What were the major activities?

In 2024-25 crop cycle, we made about 800 bi-parental, backcrossing and 3-way crosses in order to incorporate and combine FHB genes. The parental genotypes for these crosses involved GA elite breeding lines and cultivars, and most adapted grown cultivars in the SE region with different sources/QTL of FHB resistance. These include crosses between elite breeding lines and adapted genotypes with Fhb1 and major FHB QTL. Segregating breeding populations derived from the above crosses (about 33,000 entries) were evaluated and advanced to select desirable advanced lines with improved agronomic performance and diseases including FHB, insects, and viruses/bacteria resistances. Selected lines at different breeding stages from previous crosses were subsequently included in yield trials. These include about 930, 150, and 20 lines entered in PYTs, Elite, State and regional yield trials in 2024-25 crop cycle. Similarly, recently released and major commercial cultivars were evaluated in GA and the SE States Official Variety Testing (OVT) trials. Seed samples of major growing cultivars and elite lines included the state variety trial and regional nurseries were collected and sent to USDA-ARS lab at the University of MN for DON testing. Similarly, seed sample genotypes included in regional trials were sent to quality laboratory for milling and baking tests.

b) What were the significant results?

In 2024-25, 25 elite SRWW lines with improved FHB resistance were selected and entered in the GA State trial, regional SUGRAINS and Uniform regional trials. All new lines entered in the GA and regional OVTs (22 to 24th series), have some level of FHB resistance and many have Fhb1 gene alone or combined with other minor QTL. The UGA 20 and 21 series recently released by UGA, have improved resistance and low DON level. Other elite lines, including one from 22nd to 24th series are being tested in the State trials. Among these, 3 of them (two from the 22nd series and one from the 23rd series) are being increased for potential release in Summer 2025. All these have improved FHB resistance compared to susceptible checks. We also collected FHB reaction of the major commercial grown cultivars; recently released cultivars; and elite lines. Data is published in the Georgia Wheat Performance Bulletin and /or GA Small Grain Performance Tests. Similarly, information on DON levels was collected on elite germplasm/cultivars and will be disseminated

and made available to end-users including flourmills in the state. Most importantly, **we have released one cultivar in 2024 and one in 2023.** These cultivars have improved FHB. In **addition, three lines are being considered for release in 2025.**

c) List key outcomes or other achievements.

In 2024, we released one cultivar (**GA20E48**). Previously, we released **GA 20 E36** in 2023 and two cultivars (**GA151313-LDH224-19E38 and GA111055-1-19LE12**) in 2022. While all these cultivars were developed using genomic and classical breeding selection, GA202E48 was developed by double haploid. All these cultivars have improved FHB resistance compared to susceptible checks. Particularly, GA20E40 and GA111055-1-19LE12 have *Fhb_1B_JT* and *Fhb_1A_Ne* genes. Information on FHB reaction and DON levels of these cultivars and major commercial grown cultivars are made available to wheat growers and industry in GA and the SE which allows wheat growers and industry to select and grow those wheat cultivars with improved FHB resistance to maximize their income.

Objective 2: Increase efficiency of coordinated project breeding programs to develop and release FHB resistant varieties for the SE region.

a) What were the major activities?

A strong collaborative work among the VDHR (SWW), the SUNGRAINS Universities was very successful for all programs members. This collaboration has allowed a smooth movement and exchange of germplasm namely, FHB resistant elite and adapted germplasm. It also involves many collaborators from the USDA-ARS labs. In particular, the Genotyping Center at Raleigh, NC which assists our programs with GS and MAS of elite germplasm and the USDAR-ARS quality lab at Wooster OH for quality analysis. In addition, we include in our crosses, sources of FHB resistance from the Northern germplasm with an *Rht-b1* background to transfer it into *Rht-D1* background for better adaptation to the Seregipn.

b) What were the significant results?

Each crop cycle, including last season, we have been successfully conducting and evaluating the cooperative nurseries including the Southern Uniform Scab, the Uniform regional trials including South, Eastern and bread Wheat; the SUGRAINS nurseries GAWN, SUNPre and SUNWHEAT. FHB resistant germplasm, crosses, and double haploid lines were exchanged and evaluated over many locations in the SE region.

c) List key outcomes or other achievements.

Among the elite lines included in State and Regional trials, including several DH lines, have major (Fhb1, Fhb1-JT…) or combined QTL for FHB resistance derived from different sources including advanced and elite UGA/SUNGRAINS/VDHR (SRWW) lines with Jamestown (Fhb-1BJT), Hilliard, MD03W61-09-7 (Fhb1), MD08-26-H2-7 (Fhb1 5AS 2DL), MD08-29-E9-26 (Fhb1 5AS 2DL), recently released UGA cultivars (GA19E38, GA19LE12, AGS3026, 3043, USG 3725, …). These include the 23 series (GA23E37F), 22 series (GA22E8 and GA22LE15) which are potential for release in 2025. Similarly, it includes the 20 series such GA-20E48 (released in 2024) and the 21st series (GA131246LDH-86-21E2, GA15490ID-19-5-21LE2, GA141045-9-3-2-21LE7, and GANC12915-167-21E3). Other lines with Fhb resistance genes including GA17634DH-08-21E36, GA15036 ID-13-21E22, GA141045-9-3-2-21LE7 and GA12213-10-7-21LE24 were evaluated for their performance and FHB reaction 2023-24 crop cycle.

Objective 3: Implement modern breeding technologies to enhance efficiency to introgress FHB resistance into elite germplasm.

a) What were the major activities?

To control FHB disease genetically requires combining many FHB resistance genes/QTLs. A good field and consistent screening test to facilitate the development of adapted cultivars with improved FHB resistance is necessary to screen for FHB resistance. In addition, Genomic Selection

(GS), Marker Assisted Selection (MAS) and Marker Assisted Backcrossing (MABC) methods are used to select elite lines with many known FHB QTL including *Fhb1*, 2DL, 5AS (Ning 7840), 3BL (Massey), 1B (Jamestown), 1A, 4A (Neuse), and 2B, and 3B (Bess) and other QTL. Derived DH elite lines with *Fhb1* and other QTLs are also evaluated for FHB. UGA adapted and recently released cultivars with high FHB resistance (AGS3030, AGS3026, AGS3043, GA20E48…), are used as recurrent parents to develop DH lines with combinations of Fhb1, 2DL, 5AS, and other QTL to improve FHB resistance. Our cooperation with the USDA Genotyping Centers, (Dr. Gina Brown – Guedira team) allow us to conduct GS and to characterize our populations with *Fhb1* and other fhb QTLs pyramided with other major disease (leaf and stripe rust), and hessian fly insect genes.

b) What were the significant results?

From 2024 UGA Elite trials, 20 elite lines were selected with high yield and varying resistance and QTL/genes of FHB including *Fhb1*. These lines were subjected to GS/MAS to validate the existence of genes for traits that were selected for. including FHB. These lines were included in GA and neighboring states OVT, SUNGRAINS and next year, the top 10 lines will be included on the Uniform South Wheat (USW) (four lines) regional trials or SUNGRAINS regional trial GAWN (6 lines). Similarly, many promising DH lines with various levels of FHB resistance and having multiple FHB QTL, including Fhb1 were tested in yield trials.

c) List key outcomes or other achievements.

In Summer 2024, GA20E48, a DH line with Fhb1 gene of resistance to FHB was released and licensed to a company via JoMar. GA20E48 was the top line in the regional USW trials. Many companies have bided on it and JoMar had the highest bid. This bid was the highest ever for any UGA and SUNGRAINS previously released cultivars. Similarly, there UGA lines the 22nd and 23rd series (GA22E8, GA22LE25 and GA23E37F) are being increased for potential release in 2025. These lines have good yield with QTL including *Fhb1* that enhance their resistance to FHB disease. Many other UGA lines and elite lines of the 23rd and 24th series were identified with Fhb1 QTL and good performance are being tested for potential release in 2026 and 2027.

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

Several undergraduate students, three graduates and 2 young scholars were trained in evaluating/screening germplasm included in the scab nurseries. They were also involved in preparing samples for DON testing and FHB nursery operations including inoculation, scoring disease and harvest. Similarly, a lab/field tour was given to graduate students and teachers involved in the PBGG 6000 practicum course in 2024 and 2025 highlighting the importance of scab, research being conducted, and achievements made.

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

Field days and lab tours were given to graduate students and teachers involved in the PBGG 6000 practicum course in 2024 highlighting the importance of scab, research being conducted, and achievements made. Many visitors, including private sectors licensing companies, have been invited and updated on current FHB research and achievements made because of critical funding by USDA-ARS via USWBSI. Evaluation and reaction of major grown cultivars are also published in Georgia Wheat Performance Bulletin and /or the annual GA Small Grain Performance Tests.

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

Continue making crosses to combine FHB resistance genes with other economic traits, generating segregating populations with new combinations for economic traits and diverse FHB resistance genes/QTL using adapted elite/cultivars as recurrent parents. New sources of FHB will be used as donor parents in the above crosses. Pyramiding FHB genes will continue. Intensive testing under artificial FHB inoculation (Scab nursery) will be continued. State and Intensive testing under artificial FHB inoculation (Scab nursery) will be continued. State and regional testing in collaboration with programs in the Southeast and SUNGRAINS will continue.