

## **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?**

Scab or Fusarium Head Blight (FHB) is a disease causing a global threat to wheat production in the major US wheat growing regions including the Southeast (SE) regions. In GA and the SE scab epidemics can result in significant loss revenue for wheat growers due to low grain yield and high DON toxin levels. At UGA, the problem is being solved by developing and releasing adapted soft red winter wheat (SRWW) varieties and germplasm with improved FHB resistance and evaluating them in FHB, GA and regional nurseries for FHB reaction and agronomic performance. 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?**

Improving FHB resistance of SRWW varieties adapted to GA and the SE region continued by making 830 bi-parental, backcrossing and 3-way crosses in 2023-24 crop cycle. These crosses involved GA elite breeding lines and cultivars, and most adapted grown cultivars in the region with different sources/QTL of FHB resistance. Among these, crosses between elite breeding lines and adapted genotypes with Fhb1 are among our top priorities. Segregating breeding populations derived from the above crosses (about 35,000 entries) were evaluated and advanced to select desirable advanced lines with improved agronomic performance and diseases, insect, and viruses/bacteria resistances including FHB. Selected lines at different breeding stages were included in yield trials. These include about 950, 150, and 20 lines entered in PYTs, Elite, State and regional yield trials in 2023-24 crop cycle. Also, 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 lab. for milling and baking tests.

#### **b) What were the significant results?**

25 elite SRWW lines with improved FHB resistance were selected and entered in the GA State trial, regional SUGRAINS and Uniform regional trials in 2023-24. All new lines entered in the GA and regional OVTs (21-23<sup>rd</sup> series), have some level of FHB resistance and many have Fhb1 gene alone or combined with other minor QTL. The UGA 19 and 20 series recently released by UGA, have improved resistance and low DON level. Other elite lines including one from 21<sup>st</sup> to 23<sup>rd</sup> series are being tested in the State trials. Among these, 6 of them (GA20E48 and 5 from the 21<sup>st</sup> series are being increased for potential release in Summer 2024. All these have good 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 2023 and two in 2022.** These cultivars have improved FHB. In **addition, at least one cultivar is being considered for release in 2024.**

**c) List key outcomes or other achievements.**

In 2023, we released one cultivar, . Previously, in 2022, we released two cultivars: GA151313-LDH224-19E38 and GA111055-1-19LE12. These have improved FHB resistance compared to susceptible checks. Particularly, GA111055-1-19LE12, it has *Fhb-1BJT* gene.

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. This encourages wheat growers to select and grow those wheat cultivars with improved FHB resistance in appropriate environmental conditions 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?**

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

**b) What were the significant results?**

In the last cropping season, we successfully conducted and evaluated 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 of this germplasm.

**c) List key outcomes or other achievements.**

Among the elite lines included in State and Regional trials, five DH lines have various QTL for FHB resistance derived from different sources including advanced and elite 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 20 series such GA-20E48 and the 21<sup>st</sup> series including potential lines for release that currently increased, 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 the efficiency to introgress FHB resistance into elite germplasm.

**a) What were the major activities?**

FHB control requires combining many FHB resistance genes/QTLs of resistance and a good field and consistent screening test to facilitate the development of adapted cultivars with improved FHB resistance. 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). Derived DH elite lines with *Fhb1* and other QTLs are also evaluated for FHB. UGA adapted and recently released cultivars (AGS3030, AGS3026, AGS3043, GA20E48...), are used as recurrent parents to develop DH lines with combinations of *Fhb1*, 2DL, 5AS, and other QTL with improved FHB resistance. We are cooperating with the USDA Genotyping Centers, (Dr. Gina Brown –Guedira) to evaluate populations with *Fhb1* and other *fhb* QTLs pyramided with leaf and stripe rust, and hessian fly genes.

**b) What were the significant results?**

Twenty elite lines were selected from 23 E/LE series having high yield and varying resistance and ATL/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 and were tested in different state and regional trials and being increased for potential release. These lines were included in GA 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 DH promising 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.**

Among the 20th series that were candidate for release in 2023, GA20 E36 was released. However, GA20E48, a DH line with *Fhb1* gene of resistance to FHB was purified in 2023-204 crop cycle and will be presented for release in 2024. Similarly, four lines the 21 series (GA12505-18LE23Fand GA15VDH-FHB-MAS23-18LE43F) were increased for potential release in 2024. These lines have good yield with QTL including *Fhb1* that enhance their resistance to FHB disease. Many DH lines and elite lines of the 22 and 23 series were identified with *Fhb1* QTL and good performance.

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

Three graduates and several undergraduate students were trained in evaluating/screening germplasm included in the scab nurseries. They were also involved in preparing samples for DON testing and FHB nursery preparation. Similarly, a lab/field tour was given to graduate students and teachers involved in the PBGG 6000 practicum course in 2023 and 2024 highlighting the importance of scab, research being conducted, and achievements made.

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

Many lab/field tours were given to graduate students and teachers involved in the PBGG 6000 practicum course in 2023 highlighting the importance of scab, research being conducted, and achievements made. Many visitors, including private sectors licensing companies, have been updated on current FHB research and achievements made because of USWBSI funding. 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 generations 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 will be continued. State and regional testing in collaboration with programs in the Southeast and SUNGRAINS will continue.