USDA-ARS
U.S. Wheat and Barley Scab Initiative
FY18 Performance Report
Due date: July 12, 2019

Cover Page

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Fiscal Year:	2018
USDA-ARS Agreement ID:	59-0206-8-207
USDA-ARS Agreement Title:	Development of Scab Resistant Soft Red Winter Wheat Germplasm Adapted to the US Southeast.
FY18 USDA-ARS Award Amount:	$ 86,692
Recipient Organization:	University of Georgia Research Foundation, Inc. Contracts & Grants 240A Riverbend Road, Box 5333 Athens, GA 30602-5333
DUNS Number:	00-431-5578
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Project/Grant Reporting Period:	6/21/18 - 6/20/19
Reporting Period End Date:	06/20/19

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
VDHR-SWW	Enhancement of Scab Resistant Wheat Cultivars Adapted to GA and the Southeast.	$ 76,454
VDHR-SWW	Developing Doubled Haploids to Expedite Variety Development in Soft Red Winter Wheat.	$ 10,238
	FY18 Total ARS Award Amount	$ 86,692

07/12/2019

Principal Investigator Date

* MGMT – FHB Management
FST – Food Safety & Toxicology
GDER – Gene Discovery & Engineering Resistance
PBG – Pathogen Biology & Genetics
EC-HQ – Executive Committee-Headquarters
BAR-CP – Barley Coordinated Project
DUR-CP – Durum Coordinated Project
HWW-CP – Hard Winter Wheat Coordinated Project
VDHR – Variety Development & Uniform Nurseries – Sub categories are below:
SPR – Spring Wheat Region
NWW – Northern Soft Winter Wheat Region
SWW – Southern Soft Red Winter Wheat Region

Project 1: *Enhancement of Scab Resistant Wheat Cultivars Adapted to GA and the Southeast.*

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

Scab disease (or Fusarium Head Blight, FHB) remains a major threat to wheat in many US wheat growing regions including the SE regions. In the four consecutive years (2013-2016) in Georgia and Southeast, scab epidemics have resulted in significant loss revenue due to low grain production and unacceptable toxin levels (DON). This has also caused a significant drop in wheat acreages and production in the above regions. Therefore, the aim of this research is to enhance the development of high yielding soft red winter wheat (SRWW) cultivars with improved FHB resistance and low DON levels. The problems are being solved by developing and releasing improved and adapted SRWW varieties and germplasm with improved FHB resistance combined with disease and insect resistances and evaluating FHB nurseries and regional nurseries for FHB severity and DON levels.

The main goal of our research is to enhance the development of high yielding soft red winter wheat (SRWW) varieties with improved FHB resistance and end-use quality; generate populations for marker assisted selection with QTL associated with both native and exotic FHB resistance; and introgress two or more known FHB resistance QTL into adapted SRWW background by using marker assisted selection. By addressing this goal, we will achieve our main objectives that are: 1) increase acreage planted to wheat varieties exhibiting improved FHB resistance; 2) increase efficiency of coordinated project breeding programs to develop and release FHB resistant varieties; and 3) develop new breeding technologies and germplasm to further enhance short-term and long-term improvement of FHB resistance and to efficiently introgress effective resistance genes into breeding germplasm. This project is a collaborative effort with cooperators from University of Arkansas, Louisiana State University, North Carolina State University, Virginia Tech, and the USDA-ARS Genotyping Center, Raleigh, NC. Marker Assisted Selection accelerates the development of adapted FHB resistant cultivars by the selections within populations containing Fhb1, 5AS, and 3BLMassey, Jamestown (1B, 6A), Neuse (1A, 4A), and Bess (2B and 3B) in the UGA molecular lab and in cooperation with Gina Brown-Guedira, USDA Genotyping Center

2. What was accomplished under these goals?

Objective : Increase acreage planted to wheat varieties exhibiting improved FHB resistance:

1) major activities: Data on the FHB reaction of released wheat cultivars was collected on commercial cultivars in the Georgia Official Variety Testing trial and results were published in the Georgia Wheat Performance Bulletin. Information on the DON levels in grain on major growing cultivars and elite lines included the state variety trial and regional nurseries was obtained and disseminated to made available to end-users including flour mills in the state.

To continue improvement for FHB resistance in adapted soft red winter wheat varieties, more than 500 bi-parental, 3-way and 4-way crosses were made in 2018 between GA elite breeding lines from native sources of FHB resistance derived lines from Jamestown, Truman/Bess, Neuse, IL04-10721, IL00-8530, and IL97-1828, and Hilliard. Elite breeding lines have also been crossed to lines that have *Fhb1* including lines from MD (MD 08-26-H2-7-12-9, MD08-26-H2-7, MDC07026-F2-19-13-4, MD09W272-8-4-14-8); NC (NC14-23372); IL (IL07-4415), KY (K06C-1178). Segregating breeding populations (500) developed from above crosses were evaluated and advanced (40,000 head-rows) to select desirable pure lines with improved over-all agronomic performance and diseases resistances including scab.

2) specific objectives: generate SRWW populations/elite germaplsm with high yield and improved diseases resistances including FHB.

3) significant results: Many lines with improved FHB resistance were entered in the GA State trial. Among these lines GA141077-G5-G95-18E53F, GA15328-18E52F, GA141077-G5-G95-18ESc27F, GA12505B14-18LE23F having *Fhb1*. Two lines GA 09436-16LE12 and GA 09129-16E55 among four lines that are potential for release in 2019 have low DON level and GA 09129-16E55 showed lower FHB severity as well. Another eight elite lines that are being tested in the State trials. Five (GA13VA-FHB-DH83-17EL53, GA10654-17LE46, GA10389-17LE56, GA091537-17A29, GA1035-DH49-17LE52) of them showed lower FHB severity and DON. Many other elite lines have been identified with good FHB resistance derived from Jamestown, (GA09129-16E56 (991109-6E8 *2/ IL00-8530), and GA061471-15LE38 (AGS 2020 /6/ 061636 /5/ Yr15 //99406 /3/ AGS 2000 /4/ 97186)). GA09129-16E56 had similar FHB ratings as Jamestown and Bess for incidence, index and ISK. GA09129-16E56 has the QTL 1A and 4A from Neuse, and 1B from Jamestown; GA061471-15LE38 has the QTL 4A from Neuse and 1B from Jamestown. All these lines will be used as a source of resistance in future crosses.

4) key outcomes or other achievements: USG 3640 (GA 08535-15LE29) was the last UGA released wheat cultivar with improved FHB resistance. Previously, two elite lines, GA051207-14E53 (AGS 3040), and JT141-14E45 (AGS 3030) with QTLs for FHB resistance were released in 2017.

Objective 2: Increase efficiency of coordinated project breeding programs to develop and release FHB resistant varieties:

1) major activities: A successful and efficient collaborative effort between the University of Georgia and Louisiana State University, North Carolina State University, University of Arkansas, Virginia Tech was accomplished. This collaborative also include the USDA-ARS Genotyping Center, Raleigh, NC with assistance in phenotyping of mapping populations and elite breeding lines. We also include 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 pool.

2) specific objectives: Increase efficiency in breeding SRWW for FHB resistance regionally

3) significant results: A cooperative evaluation of nurseries including the Southern Uniform Scab, the Uniform Southern Wheat, GAWN, and SUNWHEAT nurseries; and the exchange of resistance germplasm, crosses, and double haploid lines and joint evaluation over locations of these germplasm sources is now well established.

4) key outcomes or other achievements: DH lines were selected with pyramiding QTL of FHB resistance from different sources including advanced and elite lines with Jamestown, MD03W61-09-7 (*Fhb1*), MD08-26-H2-7 (*Fhb1* 5AS 2DL), MD08-29-E9-26 (Fhb1 5AS 2DL*)*, AGS 3030 (GA JT141-14E45), and Hilliard as FHB resistance parent donors. and will be evaluated for grain yield in 2019.

Objective 3: Develop new breeding technologies and germplasm to further enhance short-term and long-term improvement of FHB resistance and to efficiently introgress effective resistance genes into breeding germplasm:

1) major activities: A Marker Assisted Backcrossing (MABC) method for introgression of many known FHB QTL (*Fhb1*, 2DL, 5AS (Ning 7840), and 3BL (Massey), 1B (Jamestown), 1A, 4A (Neuse), and 2B, and 3B (Bess) into SRWW background is being performed using high yielding and moderately resistant FHB lines as recurrent parents. Pyramiding and combining FHB resistant QTLs coupled with good field and consistent screening test is facilitating well the development of cultivars that have improved and effective FHB resistance. Improved derived lines with *Fhb1* and other QTLs were evaluated among elite lines and backcross populations. Widely adapted and recently released cultivars, such as SS5550, AGS 2024, AGS 2033, AGS 3030, AGS 3040, and USG3640 were used as recurrent parents to develop homozygous lines with combinations of *Fhb1*, 2DL, 5AS, and other QTL with improved FHB resistance. These lines will be evaluated for agronomic performance and leaf and stripe resistance in 2019. Our molecular marker laboratory has cooperated with the USDA Genotyping Centers, (Dr. Gina Brown –Guedira) to evaluate populations with *Fhb1* pyramid with leaf and stripe rust, and hessian fly genes.

2) specific objectives: Use novel techniques to enhance SRWW geramplsm for FHB

3) significant results: Many line including GA141077-G5-G95-18E53F, GA15328-18E52F, GA141077-G5-G95-18ESc27F, GA12505B14-18LE23F identified as a good yielding lines with the QTL *Fhb1*. Other DH lines including GA15VDH-FHB-MAS23-18LE43F, 15VDH-FHB-MAS23-18LE45F, 15VDH-FHB-MAS30-18ESc43F, 15VDH-FHB-MAS22-18ESc41F, 15VDH-FHB-MAS30-18ELDH29F, 15VDH-FHB-MAS10-18LEDH16F, 15VDH-FHB-MAS27-07-18ADH33F with various levels of FHB resistance and having multiple FHB QTL, including Fhb1 are being used.

4) key outcomes or other achievements: GA141077-G5-G95-18E53F, GA15328-18E52F, GA141077-G5-G95-18ESc27F, GA12505B14-18LE23F identified as a good yielding lines with the QTL *Fhb1*. Other DH lines including GA15VDH-FHB-MAS23-18LE43F, 15VDH-FHB-MAS23-18LE45F, 15VDH-FHB-MAS30-18ESc43F, 15VDH-FHB-MAS22-18ESc41F, 15VDH-FHB-MAS30-18ELDH29F, 15VDH-FHB-MAS10-18LEDH16F, 15VDH-FHB-MAS27-07-18ADH33F have *Fhb1* QTL.

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

Graduate and undergraduates students were trained in protocol for screening and evaluating germplasm for scab resistance.

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

Oral presentations and posters have been given at the Annual Forum of the Wheat and Barley Scab Initiative; the Small Grain and Soybean Expo, Annual, Forum of the Wheat and Barley Scab Initiative, county agent training meeting, and producer's small grain meeting.

A field day for high schools students and teachers from the Spalding County, GA was held in March 2019 highlighting the importance of scab, research being conducted and achievements made.

Project 2: *Developing Doubled Haploids to Expedite Variety Development in Soft Red Winter Wheat.*

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

The goal of this research is to increase the efficiency of coordinated project breeding programs in developing and releasing FHB-resistant varieties. Doubled haploids (DH) shorten variety development time in fall-sown small grains by approximately four years. Our objective is to expand the use of this technique for the whole Southern Winter Wheat region by the coordinated development of at least five breeding populations through DH production followed by collaborative phenotyping across the region once the DH lines are developed and seed is increased for testing. The doubled haploid facility at Kansas State University (Plant Innovations Facility) and in cooperation with Dr. Paul Murphy, NCST, and Dr. Carl Griffey, VPI, will be used to produce the DH lines from several crosses.

2. What was accomplished under these goals?

1) major activities: More than 500 DH lines were evaluated in yield trials for grain yield and test weight and scab and leaf and stripe rust resistance. An additional 3500 DH lines were evaluated in head-rows. Double haploid techniques are being used to generate rapidly DH lines with many QTL of FHB resistance from various sources. These include sources from different breeding programs in the region. Among these, Jamestown, MD08-26-H2-7 (*Fhb1* 5AS 2DL), MD07026-F2-19-13-3 (*Fhb1*), AGS 3030 (GA JT141-14E45), and Hilliard are the main parental lines. In addition, several UGA elite DH with FHB resistance are being in crosses to generate new generation of DH with scab resistance. This includes GA15VDH-FHB-MAS23-18LE43F, 15VDH-FHB-MAS23-18LE45F, 15VDH-FHB-MAS30-18ESc43F, 15VDH-FHB-MAS22-18ESc41F, 15VDH-FHB-MAS30-18ELDH29F, 15VDH-FHB-MAS10-18LEDH16F, 15VDH-FHB-MAS27-07-18ADH33F.

2) specific objectives: To increase the efficiency of coordinated project breeding programs in developing and releasing FHB-resistant varieties using Doubled haploids (DH) techniques.

3) significant results: Several UGA elite DH with FHB resistance are being including GA15VDH-FHB-MAS23-18LE43F, 15VDH-FHB-MAS23-18LE45F, 15VDH-FHB-MAS30-18ESc43F, 15VDH-FHB-MAS22-18ESc41F, 15VDH-FHB-MAS30-18ELDH29F, 15VDH-FHB-MAS10-18LEDH16F, 15VDH-FHB-MAS27-07-18ADH33F. These later lines are tested in the State trials and are potential for release in the future. Among other lines with high yield, many DH lines with a wide array of pyramid scab QTL (Fhb1, 2DL, 5AS, 1B, 1A, 4A and 3B) were found also to have good resistances to other foliar disease and Hessian fly. These DH lines are being evaluated in 2018-19 crop cycle at multiple locations. These include UGA DH and other selected from crosses made colleagues in the region; GA131246LDH-18E35, GA15VDH-FHB-

MAS23-18LE43F, 15VDH-FHB-MAS23-18LE45F, 15VDH-FHB-MAS30-18ESc43F, 15VDH-FHB-MAS22-18ESc41F, 15VDH-FHB-MAS30-18ELDH29F, 15VDH-FHB-MAS10-18LEDH16F, 15VDH-FHB-MAS27-07-18ADH33F, GA14436LDH-18LE25, GA14436LDH-18LE26, GA14438LDH-18LE31.

4) key outcomes or other achievements: GA131246LDH-18E35, GA15VDH-FHB-MAS23-18LE43F, 15VDH-FHB-MAS23-18LE45F, 15VDH-FHB-MAS30-18ESc43F, 15VDH-FHB-MAS22-18ESc41F, 15VDH-FHB-MAS30-18ELDH29F, 15VDH-FHB-MAS10-18LEDH16F, 15VDH-FHB-MAS27-07-18ADH33F, GA14436LDH-18LE25, GA14436LDH-18LE26, GA14438LDH-18LE31having Fhb1 and other QTL showed good FHB resistance . Several of these DH lines with good scab resistance are being evaluated further in the GA State Variety and regional trials for potential release.

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

Graduate students were trained in protocol for screening and evaluating germplasm for scab resistance.

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

Presentations have been given at the Annual Forum of the Wheat and Barley Scab Initiative; the Small Grain and Soybean Expo, 2018 Annual Plant Center Retreat, county agent training meeting, and producer's small grain meeting.
A field day for high schools students and teachers from the Spalding County, GA was given in March 2019 highlighting the importance of scab, use of DH technique in research being conducted on FHB and achievements made.

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY18 award period. The term "support" below includes any level of benefit to the student, ranging from full stipend plus tuition to the situation where the student's stipend was paid from other funds, but who learned how to rate scab in a misted nursery paid for by the USWBSI, and anything in between.

1. **Did any graduate students in your research program supported by funding from your USWBSI grant earn their MS degree during the FY18 award period?**
   No.
   If yes, how many?

2. **Did any graduate students in your research program supported by funding from your USWBSI grant earn their Ph.D. degree during the FY18 award period?**
   No.
   If yes, how many?

3. **Have any post docs who worked for you during the FY18 award period and were supported by funding from your USWBSI grant taken faculty positions with universities?**
   No.
   If yes, how many?

4. **Have any post docs who worked for you during the FY18 award period and were supported by funding from your USWBSI grant gone on to take positions with private ag-related companies or federal agencies?**
   No.
   If yes, how many?

Release of Germplasm/Cultivars

Instructions: In the table below, list all germplasm and/or cultivars released with full or partial support through the USWBSI during the FY18 award period. All columns must be completed for each listed germplasm/cultivar. Use the key below the table for Grain Class abbreviations.

NOTE: Leave blank if you have nothing to report or if your grant did NOT include any VDHR-related projects.

Name of Germplasm/Cultivar	**Grain Class**	**FHB Resistance** (S, MS, MR, R, where R represents your most resistant check)	**FHB Rating** (0-9)	**Year Released**
JT141-14E45 / **AGS 3030**	SRW	MR	3	2018
GA 051207-14E53 / **AGS 3040**	SRW	MS	5	2018
GA 08353 15E29/ **USG3640**	SRW	MS	4	2019

Add rows if needed.

NOTE: List the associated release notice or publication under the appropriate sub-section in the 'Publications' section of the FPR.

Abbreviations for Grain Classes

Barley - BAR
Durum - DUR
Hard Red Winter - HRW
Hard White Winter - HWW
Hard Red Spring - HRS
Soft Red Winter - SRW
Soft White Winter - SWW

Publications, Conference Papers, and Presentations

Instructions: Refer to the FY18-FPR_Instructions for detailed instructions for listing publications/presentations about your work that resulted from all of the projects included in the FY18 grant. Only include citations for publications submitted or presentations given during your award period (6/21/18 - 6/20/19). If you did not have any publications or presentations, state 'Nothing to Report' directly above the Journal publications section.

NOTE: Directly below each reference/citation, you must indicate the Status (i.e. published, submitted, etc.) and whether acknowledgement of Federal support was indicated in publication/ presentation. See example below for a poster presentation with an abstract:

> Conley, E.J., and J.A. Anderson. 2018. Accuracy of Genome-Wide Prediction for Fusarium Head Blight Associated Traits in a Spring Wheat Breeding Program. In: Proceedings of the XXIV International Plant & Animal Genome Conference, San Diego, CA.
> Status: Abstract Published and Poster Presented
> Acknowledgement of Federal Support: YES (poster), NO (abstract)

Journal publications.

Books or other non-periodical, one-time publications.

Other publications, conference papers and presentations.

Andrew Green1 , Justin Leier1 , Ying Lin1 , Shaobin Zhong1 , Xuehui Li1 , Andrew Friskop1 , Steven Xu2 , Xiwen Cai1 , Richard Frohberg1 , Robert Stack1 and Mohamed Mergoum. 2018. BREEDING FOR FHB RESISTANCE IN NORTH DAKOTA: MORE QUESTIONS THAN ANSWERS. In: Canty, S., A. Hoffstetter, B. Wiermer and R. Dill-Macky (Eds.), Proceedings of the 2018 National Fusarium Head Blight Forum (p. 114). East Lansing, MI/Lexington, KY: U.S. Wheat & Barley Scab Initiative.
Status: Abstract Published and Oral Presentation Presented
Acknowledgement of Federal Support: YES (Oral), Yes (abstract)