USDA-ARS
U.S. Wheat and Barley Scab Initiative
FY17 Preliminary Final Performance Report
Due date: July 31, 2018

Cover Page

Principle Investigator (PI):	Mohamed Mergoum
Institution:	University of Georgia
E-mail:	mmergoum@uga.edu
Phone:	770-228-7289
Fiscal Year:	2017
USDA-ARS Agreement ID:	59-0206-4-033
USDA-ARS Agreement Title:	Development of Scab Resistant Soft Wheats adapted to the Southeast.
FY17 USDA-ARS Award Amount:	$ 59,602
Recipient Organization:	University of Georgia Research Foundation, Inc. Contracts & Grants 240A Riverbend Road, Box 5333 Athens, GA 30602-5333
DUNS Number:	00-431-5578
EIN:	58-1353149
Recipient Identifying Number or Account Number:	25-21-RD316-385
Project/Grant Reporting Period:	6/21/17 - 6/20/18
Reporting Period End Date:	6/20/2018

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
VDHR-SWW	Development of Scab Resistant Soft Wheats Adapted to the Southeast.	$ 49,698
VDHR-SWW	Developing Double Haploids to Expedite Variety Development in SRWW.	$ 9,904
	FY17 Total ARS Award Amount	$ 59,602

M. Mergoum 07/28/18

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: *Development of Scab Resistant Soft Wheats Adapted to the Southeast.*

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

During 4 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). The goal 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 soft red winter wheat varieties and germplasm with improved FHB resistance combined with other disease and insect resistances and evaluating FHB nurseries and regional nurseries for FHB severity and DON levels.

Our objectives are to enhance the development of high yielding soft red winter wheat (SRWW) varieties with improved FHB resistance and end-use quality; to generate populations for marker assisted selection (MAS) with QTL associated with both native and exotic FHB resistance; and to introgress two or more known FHB resistance QTL into adapted SRWW background by using MAS. 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? *Address items 1-4) below for each goal or objective.*

1) Major activities

To increase wheat acreage in GA and surrounding regions, our major activities focused in improving wheat varieties exhibiting improved FHB resistance. To accomplish that, information on the FHB reaction of wheat cultivars was collected on commercial cultivars in the Georgia Official Variety Testing trial and results were published in the Georgia Wheat Performance Bulletin. To continue improvement for FHB resistance in adapted soft red winter wheat varieties, numerous (500) bi-parental, 3-way and 4-way crosses were made between GA elite breeding lines from native sources of FHB resistance derived lines from Truman/Bess, Jamestown, Neuse, IL04-10721, IL00-8530, and IL97-1828, and Hilliard. Elite breeding lines have also been crossed to lines that have *Fhb1* (NC14-23372, MDC07026-F2-19-13-4, IL07-4415, MD09W272-8-4-14-8, K06C-1178). Segregating breeding populations (500) were evaluated and advanced (20,000 headrows) to select desirable pure lines with improved over-all agronomic performance and disease resistance. The efficiency of coordinated project breeding programs to develop and release FHB resistant varieties is being addressed through a collaborative efforts between the University of Georgia and Louisiana State University, North Carolina State University, University of Arkansas, Virginia Tech and the USDA-ARS Genotyping Center, Raleigh, NC. This

collaboration includes assistance in phenotyping of mapping populations and elite breeding lines; 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 (DH) lines and joint evaluation over locations of these germplasm sources. DH lines are being selected with pyramiding QTL of FHB resistance sources from Jamestown and various other sources including 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. The selected lines will be evaluated for grain yield in 2019. Northern FHB resistant germplasm with an Rht-b1 background is being transferred into Rht-D1 background for better adaptation to the Southeast.

Our breeding efforts emphasized the development of 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. Marker Assisted Backcrossing (MABC) of QTL (*Fhb1*, 2DL, 5AS (Ning 7840), and 3BL (Massey), 1B (Jamestown), 1A, 4A (Neuse), and 2B, and 3B (Bess) into SRWW background was 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 will greatly facilitate the development of cultivars that have more improved and effective FHB resistance. Improved derived lines with *Fhb1* and other QTLs were evaluated among elite lines and backcross populations. Widely adapted cultivars, such as Savoy, SS5550, and AGS 2033 were used as recurrent parents to develop homozygous lines with combinations of *Fhb1*, 2DL, and 5AS 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 rust and stripe rust genes. GA lines with the QTL *Fhb1* and 5AS are being identified based on 2017 and previous data.

2) specific objectives

Among the specific objectives include the generation of FHB populations for marker assisted selection (MAS) with QTL associated with both native and exotic FHB resistance. Subsequently, introgression of multiple known FHB resistance QTL into adapted SRWW background by using MAS is implemented.

Similarly, to implement Genomic Selection (GS) for FHB, collaboration with the USDA-ARS Raleigh genotyping Center (Dr. Gina Brown –Guedira) and the SUNGRAINS group, we developed a panel of SRWW genotypes for as a training population to develop accurate models and markers to be used in GS for the SRWW breeding programs in the future. At UGA, our program has developed a panel that will be used for GA GS training material. Another panel is being developed for Association Mapping that will be used for mapping genes for FHB as well as other related traits. To achieve these objectives, phenotypic data need to be developed. In 2018, the GS training population was tested in GA and evaluated for many traits, including FHB. Additional phenotypic data is needed to help us identify strong markers for GB. While the SRWW region may have many similar challenges such as FHB,

diseases such rusts, GA has to develop germplasm with specific adaption that allow our GA farmers to maximize their benefit form modern and newly developed cultivars. It is well documented that each breeding program may end up with two types of adaptation genes (molecular markers): a group of genes that provide general adaptation and these genes (markers) may be identified using a large SRWW panel such as the one that is being developed by the SUNGRAINS group. For the specific adaption for GA environments, a panel formed with mainly UGA material may help us identify those genes that operate only in GA environments. Similar efforts deployed by other partnering programs in the SRWW region, will allow the development and use of GS techniques in a timely manner. Our goal is to improve our breeding selection efficiency in wheat cultivars adapted to our region with acceptable FHB resistance levels to make profitable for the wheat growers in GA and the Southeast region.

Furthermore, we continue using the summer nurseries to rapidly advance single and 3-way crosses and use of double haploids (DH) as two other very efficient ways to speed up the cultivar development and release. Summer nurseries save us one cycle and DH allow us to reach homozygosity in one generation. Combining all these methods with GS will enhance more our breeding efficiency and accuracy while hasting the development of new FHB varieties.

3) significant results

We released two lines; GA JT 141-14E45 and GA051207-14E53 that were identified as having moderate FHB resistance and produced higher yield and test weight than the check AGS2035. These two released lines were licensed to the Ag South Genetics (AGS) and named AGS3030 and AGS3040. Another elite line 15E29, with moderate FHB resistance will be proposed for release in 2018.

Data are being analyzed to select elite lines with resistance from *Fhb1* to be entered in the GA state variety trial in 2019. Elite lines are being identified with good FHB resistance derived from Jamestown and from various other sources to be further evaluated as potential lines for release. These lines were included in the Scab nurseries. While some of these lines have Fhb1, other have other major FHB QTLs such 1A, 4A, and 6A from Neuse; 2B and 3B from Bess; and 1Bfrom Jamestown. These elite lines also possess important resistant genes for Hessian fly (HI3) and rusts (Lr37Yr I7Sr38).

Over 200 elite breeding lines were evaluated at two locations for FHB resistance and agronomic performance. Over 15 lines were selected with high yield and moderately scab resistances were tested in state yield trials, and the Southern Scab Nursery. An additional 150 lines will be further tested for yield and scab resistance.

4) key outcomes or other achievements

Fusarium head blight and DON data for entries in the State Official Variety Trial was generated and reported along with agronomic performance data in the varietal characteristics table of the GA Small Grain Performance Trials. Fungicide trials were performed to determine the best management and fungicide effectiveness for scab improvement.

Producers are better informed on the importance of use of best cultivars with FHB resistance and the use of fungicides to control FHB. Use of Scab Smart has been promoted to producers to allow for the improvement in the timing of fungicide applications. Producers can made better decisions in the selection of FHB resistant varieties for planting with information provided in the GA State Varietal Performance Trial bulletin. With the use of Scab Smart and improved application of fungicides, producers will have a chance to reduce scab severity and DON levels in their wheat crop.

Producers were presented with educational information to use the best tools to control FHB. Information has been provided on the best cultivars with FHB and the best time for fungicide application (few days after flowering) and the best fungicide (Prosaro and Caramba) to use for the control of FHB.

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

Presentations have been given at the Annual Forum of the Wheat and Barley Scab Initiative, Small Grain and Soybean Expo, county agent training meeting, and producers' small grain meeting.

One PhD Student was provided training for the second year in the evaluation of breeding germplasm for scab resistance in the field. Training was also provided to 2 technicians and 3 undergraduates in the evaluation of breeding germplasm for scab resistance in the field.

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

FHB data has been published in the GA Small Grain Performance Trial bulletin. Presentations have been given at the Annual Forum of the Wheat and Barley Scab Initiative, Small Grain and Soybean Expo, county agent training meeting, and producer's small grain meeting.

Project 2: *Developing Double Haploids to Expedite Variety Development in SRWW.*

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

Our goal 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? *Address items 1-4) below for each goal or objective.*

1) major activities

DH lines were pyramid for QTL of FHB resistance sources from Jamestown, MD08-26-H2-7 (Fhb1 5AS 2DL), MD07026-F2-19-13-3 (Fhb1), AGS 3030 (GA JT141-14E45), and Hilliard. About 550 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 headrows. Based on 2017 data, double haploid lines combining a wide array of pyramid scab QTL (Fhb1, 2DL, 5AS, 1B, 1A, 4A and 3B) with high grain yield and good disease resistance will be identified. These double lines will be evaluated in 2019 at multiple locations. Several DH lines with good scab resistance will be tested in state trials in 2019.

2) specific objectives

The use of DH main objective is to use this technique to shorten the variety development time. However, we also aim specifically to expand the use of DH for the entire Southern Winter Wheat region by the coordinated development of at least five breeding populations and one mapping population through DH production followed by collaborative phenotyping across the region once the DH lines are developed and seed is increased for testing. Data collected on this material was shared among the breeders in the SE and particularly between the SUNGRAINS group. Several DH with Fhb1 and other major QTLs from known checks with good resistance to FHB such as Jamestown were selected and advanced.

3) significant results

Six lines with FHB resistance were selected from elite yield trials and will be entered in 2019 State variety trials. Similarly, more than 20 DH lines were entered in Elite trials. Most lines in SVT trace their FHB resistance to MD08-26-H2-7 / VA09W-73 // VA12W-54, MD08-26-H2-7 / VA11W-278.

4) key outcomes or other achievements

The DH technique has allowed for FHB resistant lines to be tested two year earlier than traditional breeding methodology. This has resulted in entering six DH lines in SVT in 2019 which will hasten the delivery of high–impact FHB resistant varieties in a short period of time. Over 150 DH lines will be tested for FHB and yield and agronomic performance next year.

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

(See project 1)

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, Small Grain and Soybean Expo, county agent training meeting, and producer's small grain meeting. FHB data has been published in the GA Small Grain Performance Trial bulletin.

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY17 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 FY17 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 FY17 award period?** No

   If yes, how many?

3. **Have any post docs who worked for you during the FY17 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 FY17 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 FY17 award period. All columns must be completed for each listed germplasm/cultivar. Use the key below the table for Grain Class abbreviations. *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

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 FY17-FPR_Instructions for detailed instructions for listing publications/presentations about your work that resulted from all of the projects included in the FY17 grant. Only include citations for publications submitted or presentations given during your award period (6/21/17 - 6/20/18). 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. p

Journal publications.

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

Other publications, conference papers and presentations.

Mohamed Mergoum, Jerry Johnson, James Buck, and Zhenbang Chen. 2017. FHB Resistance and Agronomic Performance in Georgia Soft Red Winter Wheat Germplasm. In: S. Canty, B. Wiermer and D. Van Sanford (Eds.), *Proceedings of the 2017 National Fusarium Head Blight Forum*. Milwaukee, WI, US.
Status: Abstract published and poster presented
Acknowledgement of Federal Support: Yes (Poster) and No (Abstract)