USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY16 Final Performance Report
Due date: July 28, 2017

Cover Page

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Fiscal Year:	2016
USDA-ARS Agreement ID:	59-0206-4-033
USDA-ARS Agreement Title:	Development of Scab Resistant Soft Wheats adapted to the Southeast.
FY16 USDA-ARS Award Amount:	$ 59,718
Recipient Organization:	University of Georgia Research Foundation, Inc. Contracts & Grants 240A Riverbend Road, Box 5333 Athens, GA 30602-5333
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Project/Grant Reporting Period:	6/21/16 - 6/20/17
Reporting Period End Date:	06/20/17

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
VDHR-SWW	Development of Scab Resistant Soft Wheats Adapted to the Southeast.	$ 49,795
VDHR-SWW	Developing Double Haploids to Expedite Variety Development in SRWW.	$ 9,923
	FY16 Total ARS Award Amount	**$ 59,718**

M. Mergoum
Principal Investigator

07/27/17
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

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Project 1: *Development of Scab Resistant Soft Wheats Adapted to the Southeast.*

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

For four consecutive years (2013-2016), scab epidemics in Georgia and Southeast US regions, have resulted in significant loss revenue due to low grain production and unacceptable toxin levels (DON). Resistant varieties that are adapted to the Southeast with the level of FHB resistance from native resistance (Jamestown, Neuse, and Truman/Bess) or Fhb1- derived lines are needed. Populations with broadly adaptive cultivars or their derivatives with (Fhb1) and native resistant sources are being evaluated to developed FHB resistant varieties.

The main objectives of the UGA wheat breeding program are to enhance the development of high yielding soft red winter wheat (SRWW) varieties with improved FHB resistance and end-use quality. Specific objectives include generating populations for marker assisted selection (MAS) with QTL associated with both native and exotic FHB resistance; and introgression of 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. MAS accelerates the development of adapted FHB resistant cultivars by the selections within populations for lines with Fhb1, 2DL, 5AS, and 3BLMassey, Jamestown (1B, 6A), Neuse (1A, 4A), and Bess (2B and 3B) genes/QTL in the UGA molecular lab and in cooperation with USDA Genotyping Center in NC (Gina Brown-Guedira). Data and DON samples from the Uniform Southern FHB nursery grown in Georgia are being submitted for analyzes.

2. What was accomplished under these goals? *Address items 1-4) below for each goal or objective.*

1) major activities

To continue improvement for FHB resistance in adapted soft red winter wheat varieties, more than 400 bi-parental, 3-way and 4-way crosses were made between elite breeding lines and native sources of FHB resistance derived lines from Truman/Bess, Jamestown, Neuse, IL07-19334, Hilliard, NC11-22289, NC8248-26, and MO 080104. Elite breeding lines were also crossed to lines that have Fhb1 (NC09-20986, MDC07026-F2-19-13-4, IL07-4415, LANC8170-41-2 and KY 97C-02-32) and native sources of FHB resistance derived from newly improved lines derived from Truman/Bess, Jamestown, Neuse, IL07-19334, Hilliard, NC11-22289, and NC8248-26. Segregating breeding populations (500) will be evaluated and advanced (14,000 head rows) to select desirable pure lines with improved over-all agronomic performance and disease resistance.

Increase efficiency of coordinated project breeding programs to develop and release FHB resistant varieties has been accomplished through 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 with 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 lines and joint evaluation over locations of these germplasm sources. DH lines were selected with pyramiding QTL of FHB resistance sources from Jamestown, MD03W61-09-7 (Fhb1), MD08-26-H2-7 (Fhb1), NC 8170-4-3 (Fhb1), SS 8629 (GA 031134-10E29), and LA05102C8-8 and were evaluated for grain yield. Northern FHB resistant germplasm with an Rht-b1 background have been transferred into Rht-D1 background for better adaptation to the Southeast.

Marker Assisted Backcrossing (MABC) of QTL (Fhb1, 2DL, 5AS (Ning 7840); 5AS (Ernie); 3BL (Massey); 1B (Jamestown); 1A and 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 greatly facilitated 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, SS550, 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 were evaluated for agronomic performance and leaf and stripe resistance. Our molecular marker laboratory cooperated with the USDA Genotyping Centers to evaluate populations with Fhb1 pyramid with leaf rust and stripe rust genes.

2) specific objectives

Specific objectives include the generation of populations for marker assisted selection (MAS) with QTL associated with both native and exotic FHB resistance; and introgression of two or several known FHB resistance QTL into adapted SRWW background by using MAS.

In collaboration with The USDA-ARS Raleigh genotyping Center (Dr. Gina Brown – Guedira) and the SUNGRAINS group, a panel of SRWW genotypes was devolved as a training population to develop accurate models and markers to be used in Genomic Selection (GS) for the SRWW breeding programs in the future. Particularly for the UGA program, we aim to develop our own panel that will be used for GA GS training material. Another panel will be developed for Association Mapping that will be used for mapping genes for FHB as well as other related traits. While the SRWW region may have many similar challenges such as FHB, GA has to develop germplasm with specific adaption that allow 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.

In addition, we aim to 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

Two elite lines, GA JT 141-14E45 and GA051207-14E53 were identified as having moderate FHB resistance and produced higher yield and test weight than the check AGS2035. These two lines will be submitted for release. Additional elite lines were identified with a high level of FHB resistance which was similar to the resistant controls, Bess and Jamestown and were also identified with QTLs: GA051477-13ES4 (1A 6A Neuse), GA051207-13ES11 (1A, 4A, 6A Neuse), GA061050-13ES18 (4A Neuse, 2B and 3B Bess) and GA071171-14ES (1B 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 resistance and will be 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

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

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

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 in the evaluation of breeding germplasm for scab resistance in the field. Training was also provided to 2 technicians in the evaluation of breeding germplasm for scab resistance in the field.

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 producers' small grain meeting. FHB data has been published in the GA Small Grain Performance Trial bulletin.

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

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

The main objective of our scab research at UGA 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 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. This proposal will quickly provide inbred breeding lines having several diverse FHB resistance genes (exotic and native) to six breeding programs for testing in the Southern Winter Wheat (SWW) region and also provide useful markers for selecting the Catbird resistance that has been one of the most effective sources of FHB resistance in the SWW region. The doubled haploid facility at Kansas State University (Plant Innovations Facility) will be used to produce the approximately 200 DH lines per cross.

2. What was accomplished under these goals? *Address items 1-4) below for each goal or objective.*

1) major activities

The DH population, GA131220 (MD08-26-H2-7 (Fhb1, 5AS, 2DL) / GA031293-10LE34), with about 200 lines generated by the Heartland, Plant Innovations Facility were planted as head-rows at two locations. 31 DH lines from GA131220 population were selected and evaluated for yield and agronomic performance with an addition 20 DH lines selected from NC and VA DH shared lines. From another cross, GA14031, (MD08-26-H2-7 (Fhb1, 5AS, 2DL) / GA031293-10LE34//Jamestown), about 500 DH lines with the potential of 4 QTL for scab resistance and GA141124 (GA JT 141-14E45 / VA 11W-230) (257 rows) were also evaluated in head-rows.

2) specific objectives

While our main objective is to use DH to shorten the variety development time, we also aim specifically to expand the use of this technique for the whole 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.

3) significant results

31 DH lines from GA131220 population developed in previous year were selected and evaluated for yield and agronomic performance with an addition 20 DH lines selected from NC and VA DH shared lines.

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 will result in the delivery of high–impact FHB

resistant varieties in a short period of time. Over 200 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 producers 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 FY16 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 FY16 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 FY16 award period?** NO

   If yes, how many?

3. **Have any post docs who worked for you during the FY16 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 FY16 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 FY16 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**
Progeny 16-1	SRW	MS	6	2016
Progeny 16-4	SRW	MS	6	2016

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 FY16-FPR_Instructions for detailed instructions for listing publications/presentations about your work that resulted from all of the projects included in the FY16 grant. Only include citations for publications submitted or presentations given during your award period (6/21/16 - 6/20/17). If you did not have any publications or presentations, state 'Nothing to Report' directly above the Journal publications section.

Nothing to report.

Journal publications.

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

Other publications, conference papers and presentations.