

USDA-ARS
U.S. Wheat and Barley Scab Initiative
FY19 Performance Report
Due date: July 24, 2020

Cover Page

Principle Investigator (PI):	Mohamed Mergoum
Institution:	University of Georgia
E-mail:	mmergoum@uga.edu
Phone:	770-467-7831
Fiscal Year:	2019
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
FY19 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
EIN:	58-1353149
Recipient Identifying Number or Account Number:	RARSX0000954801
Project/Grant Reporting Period:	6/21/19 - 6/20/20
Reporting Period End Date:	6/20/2020

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
FY19 Total ARS Award Amount		\$ 86,692



Principal Investigator

07/25/2020

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 research project?

Fusarium Head Blight (FHB) or Scab disease is a major threat to wheat in many US wheat growing regions including the SE regions. In GA and Southeast (SE) during the 2013-2016 period, scab epidemics have resulted in significant loss revenue due to low grain production and unacceptable toxin levels (DON). Therefore, the problems can be solved by UGA breeding program by developing and releasing adapted soft red winter wheat (SRWW) varieties and germplasm with improved FHB resistance and evaluating them in FHB nurseries and regional nurseries for agronomic performance and FHB reactions. The specific objectives of this project are (1) increase acreage planted to wheat varieties exhibiting improved FHB resistance; (2) generate SRWW populations/elite germplasm with high yield and improved diseases resistances including FHB; (3) increase efficiency of coordinated project breeding programs to develop and release FHB resistant varieties; and (4) develop new breeding technologies to further enhance short-term and long-term improvement of FHB resistance and to efficiently introgress effective resistance genes into new germplasm. This project is a collaborative effort with SUNGRAINS and USDA-ARS Genotyping Center, (Dr. Gina Brown-Guedira).

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

Objective 1: Increase acreage planted to wheat varieties exhibiting improved FHB resistance:

a) What were the major activities?

Reaction to FHB was collected on recently released and major commercial cultivars in the Georgia Official Variety Testing trial. Similarly, seed samples of major growing cultivars and elite lines included the state variety trial and regional nurseries were sent to USDA-ARS lab in the University of MN.

b) What were the significant results?

Results on the reaction of the major commercial cultivars and recently released cultivars and elite lines were published in the Georgia Wheat Performance Bulletin and /or GA 2018-2019 Small Grain Performance Tests. Similarly, information on the DON levels in grain were disseminated and made available to end-users including flour mills in the state. Additionally, we have released 4 cultivars in 2019, one in 2018 and 3 in 2017 (Table: Release Germplasm/ cultivars). These cultivars have improved FHB and are being contributing to this objective.

c) List key outcomes or other achievements.

Information on FHB reaction and DON levels of major commercial cultivars and recently released cultivars made available to wheat growers in GA and the SE will encourage them to grow wheat cultivars with improved FHB resistance. In 2019, we released four cultivars: Blanton,

FY19 Performance Report
PI: Mergoum, Mohamed
USDA-ARS Agreement #: 59-0206-8-207
Reporting Period: 6/21/19 - 6/20/20

Rutledge, AGS 3015 and GA09436-16-E12 with improved FHB resistance. This will enhance the wheat acreages grown to FHB resistant cultivars.

Objective 2: Generate SRWW populations/elite germplasm with high yield and improved diseases resistances including FHB.

a) What were the major activities?

In order to continue improving FHB resistance in adapted soft red winter wheat varieties to GA and the SE region, More than 600 bi-parental, 3-way and 4-way crosses were made in 2019 between GA elite breeding lines from different sources of FHB resistance. Among these, crosses between elite breeding lines and adapted genotypes with Fhb1 were made. More than 600 Segregating breeding populations derived from the above crosses were evaluated and advanced to select desirable advanced lines with improved over-all agronomic performance and diseases resistances including FHB. More than a 1000, 150, and 20 lines were included in PYTs, Elite and state yield trails in 2019-10 crop cycle.

b) What were the significant results?

Many lines with improved FHB resistance were entered in the GA State trial, regional SUGRAINS and Uniform regional trials. All the 11 lines newly entered in the 2019 GA OVT, have FHB resistance and 6 of them have Fhb1 gene. Among the four released UGA lines in 2019, two lines GA 09436-16LE12 and GA 09129-16E55 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. Among the five 17 series lines, three of them are considered for release in 2020 and one has good FHB resistance.

c) List key outcomes or other achievements.

In 2019, we released four cultivars: Blanton, Rutledge, AGS 3015 and GA09436-16-E12. All of them have improved FHB resistance, particularly AGS 3015. Prior to 2019, USG 3640 (GA 08535-15LE29) was released 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 3: Increase efficiency of coordinated project breeding programs to develop and release FHB resistant varieties:

a) What were the major activities?

A successful and efficient collaborative effort between the SUNGRAINS Universities and Virginia Tech was accomplished. This collaborative also included the USDA-ARS Genotyping Center, Raleigh, NC with assistance GS and MAS of elite breeding lines. 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 pool.

FY19 Performance Report
PI: Mergoum, Mohamed
USDA-ARS Agreement #: 59-0206-8-207
Reporting Period: 6/21/19 - 6/20/20

b) What were the significant results?

A cooperative evaluation of nurseries including the Southern Uniform Scab, the Uniform Eastern and bread 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.

c) List key outcomes or other achievements.

Elite and DH lines were selected with pyramiding QTL of FHB resistance from different sources including advanced and elite lines with Jamestown, Hilliard, MD03W61-09-7 (Fhb1), MD08-26-H2-7 (Fhb1 5AS 2DL), MD08-29-E9-26 (Fhb1 5AS 2DL), AGS 3030 (GA JT141-14E45), and AGS 3015(GA 09129-16E55) as FHB resistance parent donors. These are being evaluated for grain yield in 2019-2020.

Objective 4: Develop new breeding technologies to further enhance short-term and long-term improvement of FHB resistance and to efficiently introgress effective resistance genes into new germplasm:

a) What were the major activities?

A Marker Assisted Selection (MAS) and Backcrossing (MABC) methods to select/advance elite lines and introgress 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 were performed. Pyramiding and combining FHB resistant QTLs coupled with good field and consistent screening test is facilitating well the development of cultivars that are adapted and have improved and effective FHB resistance. Derived elite lines with Fhb1 and other QTLs were evaluated among elite lines and backcross populations. Widely adapted and recently released cultivars, were used as recurrent parents to develop homozygous lines with combinations of Fhb1, 2DL, 5AS, and other QTL with improved FHB resistance. 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.

b) What were the significant results?

Many lines 19E/LE trials identified as a good yielding lines with the QTL Fhb1 are being used. These lines are being tested in GA OVT, SUNGRAINS and Uniform regional trials. Similarly, many DH promising lines with various levels of FHB resistance and having multiple FHB QTL, including *Fhb1* are being used.

c) List key outcomes or other achievements.

Four lines among the 18 series (GA141077-G5-G95-18E53F, GA15328-18E52F, GA141077-G5-G95-18ESc27F, GA12505B14-18LE23F) have good yield with the QTL Fhb1. Many other DH lines (including GA15VDH-FHB-MAS23-18LE43F, 15VDH-FHB-MAS23-18LE45F, 15VDH-

FY19 Performance Report
PI: Mergoum, Mohamed
USDA-ARS Agreement #: 59-0206-8-207
Reporting Period: 6/21/19 - 6/20/20

FHB-MAS30-18ESc43F, 15VDH-FHB-MAS22-18ESc41F, 15VDH-FHB-MAS30-18ELDH29F, 15VDH-FHB-MAS10-18LEDH16F, 15VDH-FHB-MAS27-07-18ADH33F) and many 19 series lines were identified with Fhb1 QTL and good performance.

3. Was this research impacted by the COVID-19 pandemic (i.e. university shutdowns, reduced or lack of support personnel, etc.)? If yes, please explain how this research was impacted or is continuing to be impacted.

COVID-19 had significant impact on our FHB research activities at GA. Due to limited human resources, restrictions on traveling and other guidelines set up by the UGA, taking FHB notes and harvest samples for FDK and DON were affected. Particularly, evaluation of FHB severity on 0-9 scale was taken only on most elite trials. Harvest of seed samples from scab nurseries for DON was only limited to graduate student project.

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

One graduate and four undergraduates students were trained in protocol for screening and evaluating germplasm for scab resistance.

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

Two posters were presented at the 2019 Annual Forum of the Wheat and Barley Scab Initiative (see publications section); presentation at the Small Grain and Soybean Expo, Annual, Forum was delivered to county agents, stakeholders, and producers at the small grain meeting. Similarly, a lab/field tour was given to graduate students and teachers involved in the PBGG 6000 practicum course in 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 research project?

The main objective of this research is increase the efficiency of coordinated project breeding programs in developing and releasing FHB-resistant varieties using Doubled haploids (DH) techniques. Using DH will shorten the variety development time in fall-sown small grains by approximately four years. We aim 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 DH facility at Kansas State University (Plant Innovations Facility) and in cooperation with Dr. Paul Murphy, NCST, and Dr. Carl Griffey, VPI, was used to produce the DH lines from several crosses.

3. What was accomplished under these goals or objectives? *(For each major goal/objective, address items a-b) below.)*

a) What were the major activities?

DH allow us to generate rapidly homozygous lines with many QTL of FHB resistance from various sources. From the 150 DH lines evaluated in yield trials and 3000 DH lines were evaluated in head-rows, 15 and 330 lines were advanced to State and elite trials in 2019-20. These include sources from different breeding programs in the region. Among these, sources with Fhb1 and QTL from Jamestown, Hilliard, MD03W61-09-7 (Fhb1), MD08-26-H2-7 (Fhb1 5AS 2DL), MD08-29-E9-26 (Fhb1 5AS 2DL), AGS 3030 (GA JT141-14E45), and AGS 3015(GA 09129-16E55). In addition, several UGA elite DH with FHB resistance are being in crosses to generate new generation of DH with scab resistance sources mentioned above and elite lines in the GA and regional trials.

b) What were the significant results?

Several UGA elite DH with FHB resistance are tested in Elite, GA State or regional trials. This includes GA15VDH-FHB-MAS23-18LE43F, 15VDH-FHB-MAS23-18LE45F, 15VDH-FHB-MAS30-18ESc43F, 15VDH-FHB-MAS22-18ESc41F, 15VDH-FHB-MAS10-18LEDH16F, 15VDH-FHB-MAS27-07-18ADH33F. 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 include UGA DH GA131246LDH-18E35 and GA14436LDH-18LE26.

c) List 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-MAS10-18LEDH16F, 15VDH-FHB-MAS27-07-18ADH33F, GA14436LDH-18LE25, GA14436LDH-18LE26 were promising lines and are being increased for potential release in the future.

FY19 Performance Report
PI: Mergoum, Mohamed
USDA-ARS Agreement #: 59-0206-8-207
Reporting Period: 6/21/19 - 6/20/20

- 3. Was this research impacted by the COVID-19 pandemic (i.e. university shutdowns, reduced or lack of support personnel, etc.)? If yes, please explain how this research was impacted or is continuing to be impacted.**

DH production was outsourced to a lab out of UGA. However, we expect delay in delivering these DH due to COVID-19 impact on the institution that is charged of producing these DH.

- 4. 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.

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

Two posters were presented at the 2019 Annual Forum of the Wheat and Barley Scab Initiative (see publications section); presentation at the Small Grain and Soybean Expo, Annual, Forum was delivered to county agents, stakeholders, and producers at the small grain meeting. Similarly, a lab/field tour was given to graduate students and teachers involved in the PBGG 6000 practicum course in 2019 highlighting the importance of scab, research being conducted and achievements made.

FY19 Performance Report
PI: Mergoum, Mohamed
USDA-ARS Agreement #: 59-0206-8-207
Reporting Period: 6/21/19 - 6/20/20

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY19 award period (6/21/19 - 6/20/20). 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 FY19 award period?**

N/A

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 FY19 award period?**

N/A

If yes, how many?

3. **Have any post docs who worked for you during the FY19 award period and were supported by funding from your USWBSI grant taken faculty positions with universities?**

N/A

If yes, how many?

4. **Have any post docs who worked for you during the FY19 award period and were supported by funding from your USWBSI grant gone on to take positions with private ag-related companies or federal agencies?**

N/A

If yes, how many?

FY19 Performance Report
 PI: Mergoum, Mohamed
 USDA-ARS Agreement #: 59-0206-8-207
 Reporting Period: 6/21/19 - 6/20/20

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 FY19 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
Rutledge (GA09377-16LE18)	SRW	MS/MR	4	2019
AGS 3015 (GA09129-16E55)	SRW	MR	3	2019
Blanton (GA071518-16E39)	SRW	MS/MR	4	2019
GA09436-16-E12	SRW	MS/MR	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

FY19 Performance Report
PI: Mergoum, Mohamed
USDA-ARS Agreement #: 59-0206-8-207
Reporting Period: 6/21/19 - 6/20/20

Publications, Conference Papers, and Presentations

Instructions: Refer to the FY19-FPR_Instructions for detailed more instructions for listing publications/presentations about your work that resulted from all of the projects included in the FY19 grant award. Only citations for publications published (submitted or accepted) or presentations presented during the **award period (6/21/19 - 6/20/20)** should be included. If you did not publish/submit or present anything, state 'Nothing to Report' directly above the Journal publications section.

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

De Wolf, E., D. Shah, P. Paul, L. Madden, S. Crawford, D. Hane, S. Canty, R. Dill-Macky, D. Van Sanford, K. Imhoff and D. Miller. 2019. "Impact of Prediction Tools for Fusarium Head Blight in the US, 2009-2019." In: S. Canty, A. Hoffstetter, H. Campbell and R. Dill-Macky (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum* (p. 12), Milwaukee, WI; December 8-10. University of Kentucky, Lexington, KY.

Status: Abstract Published and Poster Presented

Acknowledgement of Federal Support: YES (Abstract and Poster)

Journal publications.

Ahmed ElFatih A. ElDoliefy, Ajay Kumar, James A. Anderson, Karl D. Glover, Sujan Mamidi, Elias M. Elias, Raed Seetan, Mohammed Alamri, Shahryar F. Kianian, Suraj Sapkota, Andrew Green and **Mohamed Mergoum**. 2020. Genetic dissection of Fusarium head blight disease resistance in spring wheat 'Glenn'. *Euphytica*. Published on line
<https://doi.org/10.1007/s10681-020-02610-0>.

Status: Published

Acknowledgement of Federal Support: Yes (Manuscript)

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

Other publications, conference papers and presentations.

Ghimire, Bikash; **Mergoum, Mohamed**; Johnson, Jerry; Glenn, Anthony; Bowen, Kira L.; Youmans, J.; Sapkota, Suraj; Martinez, Alfredo D.; Buck, J. **2019**. "Understanding the Genetic Diversity of Fusarium Species Causing Fusarium Head Blight (FHB) of Wheat in Georgia." In: Canty, S., A. Hoffstetter, H. Campbell and R. Dill-Macky (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum* (p. 71), Milwaukee, WI; December 8-10. University of Kentucky, Lexington, KY.

Status: Abstract Published and Poster Presented

Acknowledgement of Federal Support: Abstract (No); Poster (No)

FY19 Performance Report

PI: Mergoum, Mohamed

USDA-ARS Agreement #: 59-0206-8-207

Reporting Period: 6/21/19 - 6/20/20

Mergoum, M., J. Johnson, J. Buck, Z. Chen, S. Harrison, R. Mason, P. Murphy, G. Brown-Guedira, A. Ibrahim, R. Sutton, et al. **2019**. “GA09129-16E55 (AGS 3015), a New Soft Red Winter Wheat Cultivar Adapted to the US Southeast with Improved FHB Resistance.” *In*: Canty, S., A. Hoffstetter, H. Campbell and R. Dill-Macky (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum* (p. 101), Milwaukee, WI; December 8-10. University of Kentucky, Lexington, KY.

Status: Abstract Published and Poster Presented

Acknowledgement of Federal Support: Abstract (Yes); Poster (Yes)