USDA-ARS
U.S. Wheat and Barley Scab Initiative
FY20 Annual Performance Progress Report
Due date: August 31, 2021

Cover Page

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Fiscal Year:	2020
USDA-ARS Agreement ID:	59-0206-0-147
USDA-ARS Agreement Title:	Development of Scab Resistant Soft Red Winter Wheat Germplasm Adapted to the US Southeast
FY20 USDA-ARS Award Amount:	$ 95,615
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:	RARSX0001223501
Project/Grant Reporting Period:	6/21/20 - 6/20/21
Reporting Period End Date:	6/20/2021

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
VDHR-SWW	Developing Scab (FHB) Resistant Wheat Germplasm Adapted to GA and the Southeast	$ 82,364
VDHR-SWW	Double Haploids to Expedite Development of FHB Resistant Soft Winter Wheat Varieties	$ 13,251
	FY20 Total ARS Award Amount	**$ 95,615**

08/30/2021

Principal Investigator — Date

* MGMT – FHB Management
FST – Food Safety & Toxicology
R- Research
S – Service (DON Testing Labs)
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

FY20 Annual Performance Progress Report
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Project 1: *Developing Scab (FHB) Resistant Wheat Germplasm Adapted to GA and the Southeast*

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

Scab, also called Fusarium Head Blight (FHB) disease is a major threat to wheat in many US wheat growing regions including the SE regions. In GA and Southeast (SE), scab epidemics can result in significant loss revenue due to low grain production and unacceptable toxin levels (DON). The problems is being 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 germplasm with high yield and improved diseases resistances including FHB; (3) improve efficiency of coordinated project breeding programs to develop and release FHB resistant varieties; and (4) Implement 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 many USDA-ARS labs including the Genotyping Center at Raleigh NC (Dr. Gina Brown-Guedira and her team).

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

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

a) **What were the major activities?**
The evaluation of our HRSW germplasm to FHB is conducted, particularly 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 are collected and sent to USDA-ARS lab in the University of MN for DON testing.

b) **What were the significant results?**
Data on the reaction of the major commercial grown cultivars; recently released cultivars; and elite lines are published in the Georgia Wheat Performance Bulletin and /or GA 2020-2021 Small Grain Performance Tests. Similarly, information on the DON levels in grain were disseminated and made available to end-users including flourmills in the state. Additionally, **we have released 3 cultivars in 2020, four in 2019 and one in 2018** (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 grown cultivars and recently released or potential releases cultivars are made available to wheat growers in GA and the SE will encourage them to grow those wheat cultivars with improved FHB resistance. In 2020, we released and licensed THREE cultivars: AP 1983 (GA10407-17E8); AGS 2021 (GA11656-17E11); and PGX 20-15 (GA10268-17LE16). This is following the four release (Blanton, Rutledge, AGS 3015 and GA09436-16-E120 with improved FHB resistance in 2019. This will enhance the wheat acreages grown to FHB resistant cultivars.

Objective 2: Generate SRWW germplasm with high yield and improved diseases resistances including FHB

a) What were the major activities?

With the aim to continue introgressing FHB resistance in SRWW varieties adapted to GA and the SE region, about 800 bi-parental, backcrossing and 3-way crosses are made in 2020. These crosses involved GA elite breeding lines from different sources of FHB resistance and most adapted grown cultivars in the region. Among these, crosses between elite breeding lines and adapted genotypes with Fhb1 are among our top priority. 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/insect/viruses/bacteria resistances including FHB. More than 1000, 150, and 20 selected lines were included in PYTs, Elite, state and regional yield trials in 2020-21 crop cycle.

b) What were the significant results?

More than 25 elite lines with improved FHB resistance were entered in the GA State trial, regional SUGRAINS and Uniform regional trials. All the lines newly entered in the 2020 and 2021 GA and regional OVTs (18-19-20 series), have FHB resistance and some of them have *Fhb1* gene. Among the recently released UGA lines (16 and 17 series), many have improved resistance and low DON level. Another 20 elite lines (18, 19 and 20 series) that are being tested in the State trials. Among the five 18 series lines, 4 of them are being released and two of them have *Fhb1* gene providing them with good FHB resistance.

c) List key outcomes or other achievements.

In 2020, we released THREE cultivars: AP 1983 (GA10407-17E8); AGS 2021 (GA11656-17E11); and PGX 20-15 (GA10268-17LE16). All of them have improved FHB resistance compared to susceptible checks. Previously, in 2019, we released four cultivars with various FHB resistance.

Objective 3: Improve efficiency of coordinated project breeding programs to develop and release FHB resistant varieties

a) What were the major activities?

The collaborative effort among the SUNGRAINS Universities and Virginia Tech has been very successful for all programs. It is allowing a smooth movement and exchange of elite and adapted germplasm with FHB resistance among collaborative programs.This collaborative also included many of the USDA-ARS labs. This includes in particular, the Genotyping Center, Raleigh, NC with assistance in GS and MAS of elite germplasm. 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.

b) What were the significant results?

A well and successful 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 well established.

c) List key outcomes or other achievements.

Many 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. In addition, many new lines from the 18 series (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) and 19 series are added to this list. These are evaluated for their performance and FHB reaction 2020-2021.

Objective 4: Implement 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?

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. Genomic, 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 are performed. Derived elite lines with *Fhb1* and other QTLs are evaluated among elite lines and backcross populations. Widely adapted and recently released cultivars, are used as recurrent parents to develop homozygous 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?

Many lines from 20 and 19E/LE series identified as a good yielding lines with the QTL *Fhb1*, were subjected to GS/MAS are being increased for release or potential release. These lines are also 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 tested.

c) List key outcomes or other achievements.

Two among the four lines 18 series that are being released in 2021 (GA12505B14-18LE23Fand GA15VDH-FHB-MAS23-18LE43F) have good yield with the QTL *Fhb1*. These are the FIRST SRWW cultivars that will be released with *Fhb1* gene. In addition, many other DH lines (including, GA15VDH-FHB-MAS23-18LE43F that is being released) 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 and/or restrictions, reduced or lack of support personnel, etc.)? If yes, please explain how this research was impacted or is continuing to be impacted.

COVID-19 is impacting our FHB research activities at GA although limited human resources, restrictions on traveling and other guidelines set up by the UGA are less restrictive due to vaccination. FHB notes and harvest samples for FDK and DON were relatively slowed and reduced. Particularly, evaluation of FHB severity was taken only on most elite trials. Harvest of seed samples from scab nurseries for DON was limited to elite trials.

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

Three graduates and several undergraduates students were trained in screening and evaluating germplasm for scab resistance. They were also involved in preparing samples for DON testing and FAB nursery preparation.

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

Two posters were presented; one at the 2020 Annual Forum of the Wheat and Barley Scab Initiative (see publications section) and the other at the APS annual meetings. Similarly, a lab/field tour was given to graduate students and teachers involved in the PBGG 6000 practicum course in 2020 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 double haploid (DH) main goal is increase the efficiency of coordinated project breeding programs in developing and releasing FHB-resistant varieties using DH techniques. This shortens the variety development time in fall-sown small grains by approximately four years. We are expanding 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 (Heartland/Plant Innovations Facility) is used to produce the DH lines from several crosses

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

a) What were the major activities?

The DH technique allows us to generate rapidly homozygous lines with many QTL of FHB resistance from various sources. From about, 200 DH lines evaluated in yield trials and 300 DH lines were evaluated in head-rows, about 15 and 150 lines were advanced to State and elite trials in 2020-21. These include sources from different breeding programs in the region. Among these, sources with Fhb1 and QTL from our UGA and regional programs (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), AGS 3015(GA 09129-16E55), GA15VDH-FHB-MAS23-18LE43F, and GA12505B14-18LE23F). 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 and several 19 series lines. Among other lines with high yield, many DH lines with a wide array of pyramided 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, and 6 elite lines from the 19 series that are being increased as potential release in 2022

c) List key outcomes or other achievements.

<u>GA131246LDH-18E35 and GA15VDH-FHB-MAS23-18LE43F were promising lines and were increased and being released in 2021</u>. Among the six 19 series that are increased for potential release (GA 151313-LDH224-19E38; GA 111055-19LE12; GA 121012-19LE8; GA

11052-19LE15; GANC 12642-19LE16F; and GA 151254-LDH071-19E32), two of them are DH.

3. **Was this research impacted by the COVID-19 pandemic (i.e. university shutdowns and/or restrictions, 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 had 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?**

Many graduate students and several undergraduate are 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; one at the 2020 Annual Forum of the Wheat and Barley Scab Initiative (see publications section) and the other at the APS annual meetings. Similarly, a lab/field tour was given to graduate students and teachers involved in the PBGG 6000 practicum course in 2020 highlighting the importance of scab, research being conducted and achievements made.

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY20 award period (6/21/20 - 6/20/21). 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?**
   ☐Yes ☐No ☒ Not Applicable
   If yes, how many? Click to enter number here.

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?**
   ☐Yes ☐No ☒ Not Applicable
   If yes, how many? Click to enter number here.

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?**
   ☐Yes ☐No ☒ Not Applicable
   If yes, how many? Click to enter number here.

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?**
   ☐Yes ☐No ☒ Not Applicable
   If yes, how many? Click to enter number here.

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 FY20 award period (6/21/20 - 6/20/21). 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	FHB Rating (0-9)	Year Released
AP 1983 (GA10407-17E8)	SRW	MS - Moderately Susceptible	4-6	2020
AGS 2021 (GA11656-17E11)	SRW	MS - Moderately Susceptible	4-6	2020
PGX 20-15 (GA10268-17LE16)	SRW	MS - Moderately Susceptible	4-6	2020
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year

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

Publications, Conference Papers, and Presentations

Instructions: Refer to the PR_Instructions for detailed more instructions for listing publications/presentations about your work that resulted from all of the projects included in the FY20 grant award. Only citations for publications published (submitted or accepted) or presentations presented during the **award period (6/21/20 - 6/20/21**) 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:

Z.J. Winn, R. Acharya, J. Lyerly, G. Brown-Guedira, C. Cowger, C. Griffey, J. Fitzgerald, R.E. Mason and J.P. Murphy. 2020. "Mapping of Fusarium Head Blight Resistance in NC13-20076 Soft Red Winter Wheat." In: S. Canty, A. Hoffstetter, and R. Dill-Macky (Eds.), *Proceedings of the 2020 National Fusarium Head Blight Forum (*p. 12.), Virtual; December 7-11. Online: https://scabusa.org/pdfs/NFHBF20_Proceedings.pdf.
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: YES (Abstract and Poster)

Journal publications.

Bikash Ghimire , Alfredo D. Martinez-Espinoza, Bhawana Ghimire, Bennett Harrelson, John D. Youmans, **Mohamed Mergoum**, and James W. Buck. **2020**. First Report of Fusarium poae Causing Fusarium Head Blight of Wheat in Georgia, USA. **Plant Disease.**
https://doi.org/10.1094/PDIS-08-20-1779-PDN
Status: Published
Acknowledgement of Federal Support: No (Pub not applicable to this agreement)

Bikash Ghimire, Suraj Sapkota, Bochra A. Bahri, Alfredo D. Martinez-Espinoza, James W. Buck, and **Mohamed Mergoum**. **2020**. Fusarium Head Blight and Rust Diseases in Soft Red Winter Wheat in the Southeast United States: State of the Art, Challenges and Future Perspective for Breeding. **Front. Plant Sci., Published online: https://doi.org/10.3389/fpls.2020.01080**
Status: Published
Acknowledgement of Federal Support: No (Pub not applicable to this agreement)

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 cv. 'Glenn'. Euphytica. Published on line **https://doi.org/10.1007/s10681-020-02610-0**
Status: Published
Acknowledgement of Federal Support: Abstract (Yes); Poster (Yes)

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

None

Other publications, conference papers and presentations.

Bikash Ghimire, Mohamed Mergoum, Suraj Sapkota, John Youmans, Sumit Pradhan, Md Ali Babar, Alfredo D. Martinez-Espinoza, and James W. Buck. 2020. A preliminary genome-wide association study of Fusarium head blight resistance in soft winter wheat in the southeast United States. 2020 APS virtual annual meeting, August 10-14, 2020.
Status: Published
Acknowledgement of Federal Support: Abstract (Yes); Poster (Yes)

Bikash Ghimire, Mohamed Mergoum, Alfredo D. Martinez-Espinoza and James W. Buck. 2020. "Genome-Wide Association Analysis for Fusarium Head Blight Resistance in Elite Soft Red Winter Wheat Lines." *In:* Canty, S., A. Hoffstetter, and R. Dill-Macky (Eds.), Proceedings of the 2020 National Fusarium Head Blight Forum (p.107). East Lansing, MI: U.S. Wheat & Barley Scab Initiative.
Status: Published
Acknowledgement of Federal Support: Abstract (Yes); Poster (Yes)