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

Cover Page

Principle Investigator (PI):	Steve Harrison
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Fiscal Year:	2020
USDA-ARS Agreement ID:	59-0206-0-137
USDA-ARS Agreement Title:	Development of FHB Resistant Wheat Genotypes Adapted to the Gulf Coast and use of DHs to Expedite Variety Development
FY20 USDA-ARS Award Amount:	$ 96,168
Recipient Organization:	Louisiana State University Office of Accounting Services Baton Rouge, LA 70803
DUNS Number:	783201833
EIN:	72-6000848
Recipient Identifying Number or Account Number:	AWD-003029
Project/Grant Reporting Period:	6/1/20 - 5/31/21
Reporting Period End Date:	5/31/2021

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
VDHR-SWW	Development of FHB Resistant Wheat Varieties for the Gulf Coast	$ 82,365
VDHR-SWW	Double Haploids to Expedite Development of FHB Resistant Soft Winter Wheat Varieties	$ 13,803
	FY20 Total ARS Award Amount	**$ 96,168**

Stephen A Harrison

8-14-2021

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

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Project 1: *Development of FHB Resistant Wheat Varieties for the Gulf Coast*

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

Development of FHB resistant wheat varieties with high yield, regional adaptation, and broad disease resistance is the major goal of the LSU wheat breeding program. Proposal objectives align with Research Priorities: Obj 1) Screen all variety trial and regional nursery entries in misted FHB nurseries and publish FHB reaction in order to increase grower adoption of FHB resistant varieties. Obj 2) Develop and release high-yielding FHB resistant varieties adapted to the Gulf Coast. Obj 3) Utilize molecular markers and genomic selection to increase efficiency and genetic gain in developing FHB resistant varieties for the VDHR-SWW. Obj 4) Utilize shared DHs, a shared off-season nursery, and shared regional yield trials with open germplasm access to increase progress for all programs.

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?

Obj 1) Misted and inoculated nurseries were grown at three locations to screen LSU breeding lines, regional nurseries and the statewide variety trials for FHB incidence, *Fusarium* damaged kernels (FDK) and DON content. Over 1500 seed samples were ground and submitted for DON analysis. Obj 2) 512 wheat crosses were made in the spring of 2021 with >90% including FHB resistant parents. Segregating populations were screened and plants with reduced FHB severity were advanced to headrows. 5404 yield plots were evaluated and head selections made from 1376 segregating plots at two locations. Obj 3, 4) Molecular markers for FHB QTL were run on 570 advanced breeding lines that were also in the genomic selection prelim project (WPGS). 1767 first year DHs were evaluated in short rows and selected rows were shared among VDHR-SWW breeders. Obj 4) An off-season nursery of F1 plants from FHB crosses was grown in Idaho during the summer of 2020.

b) What were the significant results?

Obj 1) Excellent data on FHB reaction was collected for the statewide variety trials and all regional yield nurseries in three misted nurseries. Seed from two misted nurseries was rated for FDK and submitted for DON determination. The data on FHB, FDK, and DON was included in the annual Wheat Research Summary published for growers, consultants, and seedsmen. Obj 2) The breeding program made the largest number of crosses to date and most of those contain FHB resistance in both parents. The Wheat Genomic Selection Prelim (WPGS) included 570 breeding lines in first year yield trials at two locations. Obj 3) Genomic selection models, marker QTL information and field data were used to advance 87 breeding lines from WPGS to

replicated yield testing. Obj 4) Three crosses from spring 2021 that combine multiple FHB QTL/genes with high yield have been submitted for development of DH lines. Genomic selection predictions (PopVar), marker data, and regional yield trial data were used to place promising lines from first year regional testing into the crossing plot, saving a couple of years in the breeding cycle.

c) List key outcomes or other achievements.

Obj 1,3) Excellent data was obtained from the misted nurseries. FHB, FDK, and DON data was posted for variety trial and regional nursery entries. The variety trial publication highlighted FHB data and FHB resistance category to encourage growers to plant resistant varieties. Obj 2) Three breeding lines were increased by Georgia Seed Development Commission and LA16020-LDH22, a double haploid, was released in August 2021, only six years after the initial cross. It has excellent yield, disease reaction and FHB resistance. A second line may also be released in 2021. It had the highest yield, 0% stripe rust, and the lowest FDK and DON (misted nursery) ratings of ten entries in the early-maturing variety trial across north Louisiana. Obj 4). First year DH lines selected as headrows in Winnsboro were harvested and shared with all VDHR-SWW breeders to allow them the opportunity to select FHB resistant DHs that perform better in their respective environments than in the Gulf Coast.

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.

The impact of Covid-19 was relatively minor. The breeding crew missed very few days in the lab, field, and greenhouse. Out of state travel was curtailed. The regional spring nursery tour and meeting was scaled back. The offseason nursery for summer 2021 was cancelled.

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

Two graduate students were involved in setting up mist systems, inoculating nurseries, and rating field symptoms for FHB. Graduate students rated FDK in the lab, collected DNA and assisted in running molecular markers for FHB QTL.

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

An in-person field day was held in April at the Macon Ridge Research Station that highlighted variety resistance, FHB screening, the breeding program, and fungicide control of FHB. The September 2020 issue of Louisiana Crops featured a grower-oriented article on FHB resistance breeding and fungicide management. The Research Summary

detailing results of the statewide variety trials highlighted varietal resistance and classified varieties according to FHB reaction.
https://www.lsuagcenter.com/~/media/system/8/c/9/9/8c9920cfdc7db214a60be8e169fa61d7/volume%2010%20issue%208%20september%202020%20updatepdf.pdf

Project 2: *Double Haploids to Expedite Development of FHB Resistant Soft Winter Wheat Varieties*

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

Objectives are to: (1) Utilize doubled haploid (DH) technology to decrease the breeding cycle and release FHB resistant varieties more quickly and efficiently. Develop new DHs that combine yield, adaptation, and FHB resistance. **2) Implement a topcross enrichment DH program** to pyramid effective FHB QTL and increase frequency of those pyramids in DHs derived from those populations. Prior to selection of crosses for DH production, enrich crosses for FHB QTL and other important QTL using established markers and the USDA ARS Eastern Regional Small Grains Genotyping Lab. 3**) Share selected DHs with all VDHR-SWW breeders** to increase efficiency of the coordinated project breeding programs to develop and release FHB resistant varieties from DHs. This will ensure DH lines undergo robust, multilocation evaluation and provide appropriate information needed to justify release and licensing to companies for marketing to growers.

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?

Obj 1, 3) The 1766 new DHs evaluated as headrows during the 2020-21 cycle were a combination of lines derived from LSU crosses and DHs shared by other VDHR-SWW programs. The 148 DHs selected from this group were advanced to the Genomic Selection Prelim tested at two locations. The advanced yield trials and regional trials include 213 LSU DHs. Obj 2) Topcrosses made by the Virginia Tech program were screened at the Eastern Wheat Genotyping Lab and selected plants submitted for DH development. **Obj 3)** Eighty-four DHs selected and harvested as first year headrows were shared with other VDHR-SWW breeders to allow them the opportunity for selection and advancement.

b) What were the significant results?

Obj 1) The DH LA16020-LDH22 was released as a variety in 2021, only six years after the initial cross. It has excellent yield and very good FHB resistance. **Obj 2)** The new DHs evaluated in 2021 included 128 from the Virginia-Tech coordinated marker enriched topcross program that had FHB1 and H13. **Obj 3)** 84 new DHs were shared with all VDHR-SWW breeding programs with the understating that each program has the ability to select, advance, and release DHs from other programs as long as the originating program does not plan to release that DH.

c) List key outcomes or other achievements.

Obj 1) Release of LA16020-LDH22 provides Gulf Coast producers with a greater choice of FHB resistant varieties in the seed market and is key to reducing DON presence within the national wheat supply chain. Obj 3). Sharing selected DHs across the entire VDHR-SWW is a new initiative that should increase impact of investment and result in release of additional FHB resistant varieties.

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.

The impact of Covid-19 was relatively minor. The breeding crew missed very few days in the lab, field, and greenhouse. Out of state travel was curtailed. The regional spring nursery tour and meeting was scaled back and the summer offseason nursery was cancelled for the year.

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

Two graduate students were involved in setting up mist systems, inoculating nurseries, and rating field symptoms for FHB. Graduate students rated FDK in the lab, collected DNA and assisted in running molecular markers for FHB QTL.

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

Seed from all DH lines that were advanced and harvested by each VDHR-SWW breeding program will be shared to every member. Three to five grams of seed per DH line will be shared to allow each breeder to grow DH lines in headrows, including their respective FHB nurseries. This is a valuable collaborative effort that helps to maximize the return on investment by enabling more breeders a chance to look at many more DH lines, which is beneficial given that a DH line may perform better in a given region that elsewhere.

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY20 award period (6/1/20 - 5/31/21). 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 FY20 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 FY20 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 FY20 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 FY20 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 (6/1/20 - 5/31/21). 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**
LA16020-LDH22	SRW - Soft Red Winter	MR - Moderately Resistant	3	2021
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 (6/1/20 - 5/31/21**) 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:

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

Journal publications.

Dylan L. Larkin, Amanda L. Holder, R. Esten Mason, David E. Moon, Gina Brown-Guedira, Paul P. Price, Stephen A. Harrison, and Yanhong Dong. 2020. Genome-wide analysis and prediction of Fusarium head blight resistance in soft red winter wheat. Crop Science. https://doi.org/10.1002/csc2.20273
Status: Published
Acknowledgement of Federal Support: YES

Carpenter NR, Wright E, Malla S, et al. Identification and validation of Fusarium head blight resistance QTL in the U.S. soft red winter wheat cultivar 'Jamestown'. Crop Science. 2020, 60:2919–2930. https://doi.org/10.1002/csc2.20307
Status: Published
Acknowledgement of Federal Support: YES

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

Nothing to report.

Other publications, conference papers and presentations.

Harrison et al. 2020 SMALL GRAIN PERFORMANCE TRIALS. LAES Research Summary No. 222. August 2020. https://www.lsuagcenter.com/profiles/aiverson/articles/page1600097198289
Status: Published
Acknowledgement of Federal Support: YES

Harrison, Stephen, Paul (Trey) Price and Boyd Padgett. Fusarium Head Blight of Wheat (Scab) in Louisiana. Sept. 2020. Louisiana Crops Newsletter. https://www.lsuagcenter.com/profiles/lblack/articles/page1600347669454
Status: Published
Acknowledgement of Federal Support: YES