USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY19 Final Performance Progress Report
Due date: October 28, 2021

Cover Page

Principle Investigator (PI):	Steve Harrison
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Fiscal Year:	2019
USDA-ARS Agreement ID:	59-0206-8-206
USDA-ARS Agreement Title:	Development of FHB Resistant Wheat Genotypes Adapted to the Gulf Coast and Use of DHs to Expedite Variety Development
FY19 USDA-ARS Award Amount:	$ 80,332
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:	GR-00004477
Project/Grant Reporting Period:	6/1/19 - 9/30/21
Reporting Period End Date:	9/30/2021

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
VDHR-SWW	Development of FHB Resistant Wheat Genotypes Adapted to the Gulf Coast and Use of DHs to Expedite	$ 70,094
VDHR-SWW	Developing Doubled Haploids to Expedite Variety Development in Soft Red Winter Wheat	$ 10,238
	FY19 Total ARS Award Amount	**$ 80,332**

Stephen A Harrison

10-24-2021

Principal Investigator Date

* MGMT – FHB Management
FST – Food Safety & Toxicology
R – Research
S – Service (DON Testing Lab)
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 Genotypes Adapted to the Gulf Coast and Use of DHs to Expedite*

1. **What are the major goals and objectives of the research project?**
   Fusarium Head Blight (FHB) is a major limiting factor and has significantly contributed to acreage decline in the region. Losses to FHB in the Gulf Coast are attributable to patterns of heavy rainfall during anthesis, more corn acres, and a lack of adapted varieties with FHB resistance. Our goal is to accelerate development of FHB resistant wheat varieties adapted to this unique environment and to provide information necessary to help growers deal effectively with FHB. Objectives of the LSU AgCenter wheat breeding project are to: 1) develop and release high-yielding FHB resistant varieties; 2) increase efficiency of coordinated breeding programs through sharing of F1s and DH populations, marker development, introgression of useful genes using MAS-population enrichment, and Kasp-marker screening of regional nurseries and breeding lines; and 3) screening of varieties and advanced breeding lines for FHB reaction to help growers make wise variety choices

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): 963 wheat crosses were made during the grant period. All regional nurseries and many advanced LSU breeding lines were phenotyped in misted and inoculated nurseries at three locations (4,000 rows, Obj 1,3). Segregating populations were screened and individual heads showing reduced FHB severity were advanced to headrows (Obj 1). ~5000 yield plots were evaluated at three locations each year and head selections made from ~1800 segregating plots at two locations (Obj 1, 3). Molecular markers for FHB were run on 670 advanced breeding lines in the genomic selection project. A graduate student completed his PhD on FHB. Genomic selection was carried out on SunGrains nurseries and an LSU prelim. (Obj 3). DHs were shared among breeders in the region after the initial selection.

   b) **What were the significant results?**
   Obj 1) LA16020 DH with good FHB resistance was released in 2021 (Obj 1). New crosses included 138 with Fhb1 and 401 with known FHB QTL. All regional nurseries and many advanced breeding lines were phenotyped in misted and inoculated nurseries at three locations (4,000 rows) and data was shared with other breeders. Resistant plants of segregating populations in screening nurseries containing *Fhb1* and other QTL were harvested and advanced to headrows. About 2,000 samples were rated for *Fusarium*-damaged kernels (FDK) and 1506 were submitted for DON analysis. An Fhb1 yield trial was evaluated at two locations.

   Obj 2) increase efficiency: A graduate dissertation was completed and paper published that identified several new QTL in a DH population. A collaborative SunGrains

genomic selection program evaluated approximately ~4,000 preliminary breeding lines (570 from LSU) and five advanced generation regional yield trials. GEBV values, FHB marker data, and field phenotyping (yield and FHB) were combined for selection and advancement. (Obj 2). Seed of four F1s from the 2019 crossing cycle of parents with known FHB QTL were submitted to NC State for DH development (Obj. 1, 2). The Virginia Tech marker enrichment DH project produced a number of DHs with a pyramid of FHB QTL. Seed of DHs produced by SunGrains breeders (7 universities) were shared among all breeders after initial selection. Data from regional nurseries were compiled and summarized for all breeding programs. PopVar predictions from regional nurseries were used to choose parents for a crossing block and to predict cross performance. Crossing lists were exchanged among breeders. LA12275LDH-56 in the USDA southern regional nursery (USSRWWN) yielded 108% (3rd) of the mean with FDK at 43% of the test mean.

Obj3) FHB and FDK data were collected at two locations for the statewide variety trials. Heavy natural infection facilitated collection of FDK data in a fungicide protected and non-protected split. Fungicide protection gave a 12.3 bu/acre yield advantage and 2.3 lbs/bu test weight with a decrease in FDK of 7% (14% vs 7%). There was a wide range in variety response to fungicide with FHB resistant varieties having small gains and those varieties with moderate levels of resistance showing the greatest benefit.

c) List key outcomes or other achievements.

The release of LA16020 provides growers with a regionally adapted cultivar with high yield and good FHB resistance. The genomic selection program combined marker data with field phenotyping and GEBVs to increase accuracy and efficiency of selection. FDK and DON data from two locations for state variety trials was presented in a variety of ways to growers to encourage their adoption of resistant varieties. A graduate student FHB marker dissertation project was completed and published. Genomic selection and Popvar cross predictions augmented phenotypic data for line advancement and crossing decisions. 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.

We were impacted by COVID-19 due to shutdowns that occurred during April and May of 2020 during peak note-taking, selection, and harvest. The PI did most of the travel for selection and note-taking at stations outside of Baton Rouge, lodging in a hunting camp for days. Harvest was reduced with few student workers available. However, we collected

good data and harvested all seed increases, headrows, and yield nurseries in North Louisiana. The long-term impact is minimal.

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

Graduate students participated in all FHB project activities.

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

A online "Virtual Wheat Field Day" in April highlighted FHB research. The LSU wheat breeding program maintains two wheat websites for data and state trials. Completed variety trial reports are posted on the LSU AgCenter variety trial website. Data on FHB severity, FDK, and DON for the regional nurseries are published in the official reports. A Fusarium article targeted to growers, with data on variety reaction and fungicide efficacy, was published (https://www.lsuagcenter.com/profiles/lblack/articles/page1566934266862) in the September 2019 issue of Louisiana Crops and on the USWBSI website.

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?

A primary objective of the VDHR-SWW research area is to increase 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 three to four years and allow efficient marker assisted selection and gene pyramiding. This proposal addresses Research Priorities; 1) Increase and document acreage seeded to varieties with improved FHB resistance; 2) Increase efficiency of coordinated project breeding programs, and; 3) Implement new breeding technologies and germplasm. The objective of this project is to efficiently develop homozygous breeding lines that contain effective combinations of FHB resistance QTL in a high-yielding and adapted background that leads to quicker release or FHB resistant varieties to meet grower demand.

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?

Eight F1 plants from the Virginia Tech collaborative marker facilitated FHB gene pyramid project were selected by LSU and submitted to the NC State DH Lab in the fall of 2019. The VTDH lines all combined Fhb1 with several other FHB QTL in an adapted background. F1 seed of four 2019 LSU crosses were sent to the NC State DH Lab in the fall of 2019 for DH development. These all contained *Fhb1* in one or both parents combined with other FHB QTL, high yield and good agronomic performance. 1766 new DHs evaluated as headrows during the 2020-21 cycle. The 451 wheat crosses made in the spring of 2020 and 512 in 2021 were prioritized for use in development of DHs and 14 candidate crosses were chosen. Two of these were submitted to the NC State DH Lab in July 2020. Several others will be submitted to either NC State or Heartland this fall for DH development.

b) What were the significant results?

DHs developed for FHB resistance have become a major component of the LSU breeding program. LA20141 is a cross between two of the five highest-yielding lines (LA12275DH-56 /GA15VDH-FHB-MAS23-18LE43F) in the regionwide USDA USSRWWN. The parents have very good FHB resistance with FDK values of 43% and 30% of the test mean and also combine resistance to leaf rust, stripe rust, and Hessian Fly with high yield and good agronomic traits. The second cross involves one of the same lines crossed to a very high-yielding LA breeding line from the seven state SunGrains/ Sunwheat nursery that had FDK of 42% of the test mean. LA16020-LDH22, a double haploid, was released in August 2021, only six years after the initial cross.

There were 37 LSU DHs in replicated yield trials in 2019-20 and most of those were from 2014 and 2015 crosses. An additional 50 DHs were in the genomic selection preliminary yield trial.

DHs from LSU were exchanged with and evaluated by the SunGrains breeders. There were 1200 DHs from other SunGrains universities evaluated in headrows in the spring of 2020 and 634 DHs from LSU.

c) List key outcomes or other achievements.

The impact of DHs on speed of variety development is pretty obvious when examining regional yield trials. All three LSU lines in the USDA USSRWWN regional trial are DHs from 2013 – 2015 crosses (5 – 7 years since cross) and all three have yields in the top 25% and two have FDK values of ≤ 43% of the test mean. Five of six LSU lines in the SunGrains Gulf-Atlantic regional trial are DHs and 10/15 in the SunWheat regional trial are DHs. The DH cultivar LA16020LDH-22 was released in five years, about half the normal time.

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.

We were impacted by COVID-19 due to shutdowns that occurred during April and May during peak note-taking, selection, and harvest. Crossing and development of new DHs were minimally impacted since they occurred prior to shutdowns. Field work involving selection and advancement of DHs was more difficult but impact was minimal since all selections and harvest were accomplished, though with difficulty and some trepidation. .

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

Graduate students participated in crossing activities and field selection. They ran markers used in some of the crossing and advancement decisions. They also set up and managed the misted nurseries.

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

DHs are an integral part of the breeding program and have been shared with collaborating breeders.

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the **FY19 award period (6/1/19 - 9/30/21)**. 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? 1

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 <u>full or partial</u> support through the USWBSI during the **FY19 award period (6/1/19 - 9/30/21)**. 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
LA16020LDH-22	SRW - Soft Red Winter	MR-MS	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
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 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 (6/1/19 - 9/30/21**) 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 J.P. Murphy. 2020. "Mapping of Fusarium Head Blight Resistance in NC13-20076 Soft Red Winter Wheat." In: Canty, S., Hoffstetter, A., and Dill-Macky, R. (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.

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. 2020. 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.

Dylan L. Larkin, R. Esten Mason, Amanda L. Holder, David E. Moon, Gina Brown-Guedira and Stephen A. Harrison. 2019. Genome Wide Analysis and Prediction of Fusarium Head

Blight Resistance in Soft Red Winter Wheat (p. 100). In: S. Canty, A. Hoffstetter, H. Campbell and R. Dill-Macky (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum.* Milwaukee, WI; December 8-10.

Status: Abstract Published and Poster Presented

Acknowledgement of Federal Support: YES (Abstract and Poster)

Mohamed Mergoum, Jerry Johnson, James Buck, Zhenbang Chen, Stephen A. Harrison, Richard E. Mason, J. Paul Murphy, Gina L. Brown-Guedira, Amir M. H. Ibrahim, Russell L. Sutton, Bryan E. Simoneaux and Md A. Babar. 2019. GA09129-16E55 (AGS 3015), A New Soft Red Winter Wheat Cultivar Adapted to the US Southeast with Improved FHB Resistance (p. 101). In: S. Canty, A. Hoffstetter, H. Campbell and R. Dill-Macky (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum,* Milwaukee, WI; December 8-10.

Status: Abstract Published and Poster Presented

Acknowledgement of Federal Support: YES (Abstract and Poster)

Harrison, S. A., P. Price, and G. B. Padgett. 2019. Fusarium head blight of wheat (scab) in Louisiana. Louisiana Crops Newsletter. 9:7.

Status: Article Published online

Acknowledgement of Federal Support: YES

Harrison, S.A., P. Price, et al. 2019. Small Grain Performance Trials. LAES Research Summary No. 219. https://www.lsuagcenter.com/profiles/aiverson/articles/page1566999757879

Status: Article Published online

Acknowledgement of Federal Support: YES

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