USDA-ARS
U.S. Wheat and Barley Scab Initiative
FY18 Performance Report
Due date: July 12, 2019

Cover Page

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Fiscal Year:	2018
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.
FY18 USDA-ARS Award Amount:	$ 80,332
Recipient Organization:	Louisiana State University Office of Accounting Services Baton Rouge, LA 70603
DUNS Number:	783201833
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Project/Grant Reporting Period:	6/1/18 - 5/31/19
Reporting Period End Date:	05/31/19

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
	FY18 Total ARS Award Amount	$ 80,332

Stephen A Harrison July 8, 2019

Principal Investigator 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 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 project?

Fusarium Head Blight (FHB) is a major limiting factor of wheat production in Louisiana and adjacent Gulf Coast states, and has significantly contributed to declining wheat acreage. Losses to FHB in the Gulf Coast are attributable to patterns of heavy rainfall during anthesis, increased production of corn, and a lack of adapted varieties with FHB resistance.

Our goal is to develop high-yielding FHB-resistant wheat varieties adapted to the unique environment of the Gulf Coast region and to provide information necessary to help growers deal effectively with FHB. Objectives of the LSU AgCenter (LSUAC) 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, 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?

1) major activities

Obj 1: New Varieties: Crosses were made in the spring of 2019 between parents with FHB resistance. Molecular markers (Obj 2) were used to determine parental combinations and assist in cross advancement decisions. A misted and inoculated nursery of 3,000 headrows was used to phenotype FHB reaction of LSU breeding lines and regional nursery entries (Obj1,2,3). Advanced breeding lines were screened in several yield trials and in misted, inoculated nurseries.

Genomic selection (Obj1, 2) was utilized to supplement phenotypic data for advancement decisions on breeding lines in preliminary and advanced yield trials.

A trial of 89 F4:6 lines from a cross segregating for *Fhb1* was grown to validate the impact of *Fhb1* under high FHB pressure. A bi-parental population of 200 DHs from AGS2060/AGS2035 was evaluated to develop markers for the QTLs for FHB resistance in AGS2060. (Obj 3) Variety trial entries and regional nurseries were evaluated in misted FHB nurseries.

2) specific objectives

Obj 1, 3) Advanced breeding lines in the SunWheat, Gulf-Atlantic Wheat Nursery, Uniform Southern Fusarium Headblight Nursery, Uniform Southern Soft Red Winter Wheat, Wheat Variety Trials, Georgia Elite Scab Nursery, and several LSU prelims were screened in misted nurseries for FHB and FDK. FDK was determined on 1,775 grain samples that were submitted to the USDA testing lab at the University of Minnesota for DON determination.

Obj 1, 2) Genomic selection was carried out in a collaborative Sungrains project on GAWN and Sunwheat regional nurseries, and on a 570 entry first-year LSU preliminary

yield. GEBVs were generated for yield, rust reaction, and FHB traits including FHB index, FDK, and DON. Advancement decisions for the nursery were based on field data and GEBV's. A number of lines with high GEBV but only moderate phenotypic values were advanced to permit evaluation of the relative value / predictability of GEBV versus phenotypic value in predicting future performance. F1 seed of 8 crosses were submitted for DH development (Obj 1,2). DHs from all Sungrains breeders were shared and evaluated in multiple environments (Obj 2).

3) significant results

(Obj 1) There were 472 new crosses made in the spring of 2019, 211(45%) involving Fhb1 plus other QTL and another 197 (42%) involving parents with known resistance and/or several FHB QTL. 164 of these new crosses were planted in Aberdeen, ID in March 2019, along with F1 seed from Texas, Georgia, South Carolina and Georgia in a shared Sungrains offseason advancement nursery (Obj 2). Seed of eight F1s from the 2018 crossing cycle were submitted for DH development (Obj 1,2). All of the eight DH crosses are between adapted parents with good FHB resistance derived from a variety of QTL.

Fhb1 resulted in a 35% decrease in FDK compared to sister lines lacking *Fhb1* (62% vs 40%). FDK in a misted nursery ranged from 28% to 85% in the F4:6 lines. The heterozygous lines had intermediate levels of FDK. Samples were submitted for DON analysis. FDK and DON were determined on 1802 wheat samples from misted and inoculated nurseries in 2018; and 1775 samples were rated for FDK and summited for DON analysis in 2019 (Obj1, 2). Popvar and molecular markers were utilized to select parents and cross combinations.

4) key outcomes or other achievements

The breeding program made the second most wheat crosses ever in 2018 with 87% of those having a FHB resistant parent and with parents chosen based on marker data as well as field performance. 570 breeding lines were evaluated in a genomic selection yield trial and rated for FHB. A graduate student FHB marker dissertation project completed field and molecular work, and is currently being analyzed and written up. Genomic selection and Popvar cross predictions were used to augment phenotypic data for line advancement and crossing decisions.

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

Four graduate students and a visiting student intern were involved in setting up mist systems, inoculating nurseries, and rating field symptoms for FHB. They also rated FDK in the lab. This provided them with experience and some degree of comfort in screening for scab resistance in wheat lines. A graduate student presented results of the dissertation project at the UWBSI annual forum.

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

A wheat field day at the Macon Ridge Research Station highlighted FHB breeding efforts and FHB reaction of variety trial entries. The LSU wheat breeding programs maintains two websites for dissemination of data generated as part of this project. The first website (http://www.wheat.lsu.edu/index.shtml), the 'Wheat Breeding Data Site' is used as a repository for trial data tables and variety trial information to facilitate timely release of that information to growers, consultants, seedsmen, and extension agents. The second website (shttp://sungrains.lsu.edu/index.shtml) serves the Sungrains breeding group as a public and breeder-only repository of data from Sungrains breeding programs. 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 for those nurseries.

Project 2: *Developing Doubled Haploids to Expedite Variety Development in Soft Red Winter Wheat.*

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

The goal of the collaborative FHB project is to accelerate the development of FHB resistant varieties containing complementary FHB resistance genes through utilization of MAS for population enrichment of three-way F1s followed by development of doubled haploids from selected F1 plants. Alternately, two-way crosses between adapted parents that contain multiple FHB resistance genes may be used in lieu of three-way crosses. The use of doubled haploids in winter wheat breeding programs decreases variety development time by approximately four years, which brings resistant varieties to the grower sooner. Use of DH's also effectively turns the region into a large recurrent selection program that rapidly recombines superior FHB resistant germplasm across programs.

2. What was accomplished under these goals?

1) major activities

The Virginia Tech program initiated a collaborative DH project to pyramid Fhb1 with other important QTL in adapted backgrounds with high potential to produce commercially viable varieties. The topcross F1 plants were evaluated with markers by the USDA-ARS Eastern Wheat Genotyping Lab and selected plants were sent to the Heartland Institute for production of DH's. The LSU program received 225 DHs from Heartland Institute that were developed by this collaborative effort in the previous cycle. Many DHs from the 2017-18 cycle were evaluated in preliminary yield plots. F1 seed of eight new crosses made during the spring of 2018 were submitted to the North Carolina State University DH Lab for development of new DHs. The eight new crosses combine FHB resistance sources on both sides of the pedigree and some of them have Fhb1 on both side (fixed).

A large number of DH lines were screened in the field during 2018-19 for agronomic performance and disease resistance with emphasis on FHB. Those lines with parentage that includes major FHB QTL were also screened in misted, inoculated nurseries. A LSU Fusarium preliminary yield trial was also evaluated by the University of Arkansas.

2) specific objectives

The LSU program received 225 DH lines back in September that came from individual plants from several crosses that contain desired QTL combinations in the program coordinated by Virginia Tech. These were packaged as headrows for evaluation during the 2018-19 growing season. An additional 277 LSU DHs from an alternative funding source were increased in headrows during spring of 2018 and evaluated in yield plots during 2018-19. 1743 total DHs were shared among Sungrains universities and evaluated in multiple environments.

3) significant results

Five of six LSU entries in the Sungrains (plus Virginia Tech) Gulf-Atlantic Wheat Nursery (GAWWN) advanced regional yield nursery (GAWN) were DHs. These included two of the five highest-yielding lines in the trial, with the highest-yielding line also showing good FHB resistance. Likewise, 11 of 12 LSU entries in the regional SunWheat nursery were also DH and 22 of 40 LSU entries in the Sungrains preliminary wheat nursery (SunPre) were DHs. 170 additional DHs were evaluated in LSU preliminary yield trials including 111 in a genomic selection preliminary yield trial.

4) key outcomes or other achievements

The LSU wheat breeding program is has completely integrated the use of DH's with marker-assisted selection and offseason nurseries to move quickly from initial cross through DH production to field yield trial evaluation of DH's containing desired FHB QTL. This results in moving breeding lines to advanced and regional yield testing and release sooner than possible without use of DHs.

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

Four graduate students and a visiting student intern received exposure to the concepts of population enrichment using Marker Assisted Selection and doubled haploids.

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

Not applicable – see project 1

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY18 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 FY18 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 FY18 award period?**
   no

   If yes, how many?

3. **Have any post docs who worked for you during the FY18 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 FY18 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 FY18 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**
none				

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 FY18-FPR_Instructions for detailed instructions for listing publications/presentations about your work that resulted from all of the projects included in the FY18 grant. Only include citations for publications submitted or presentations given during your award period (6/1/18 - 5/31/19). If you did not have any publications or presentations, state 'Nothing to Report' directly above the Journal publications section.

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

> Conley, E.J., and J.A. Anderson. 2018. Accuracy of Genome-Wide Prediction for Fusarium Head Blight Associated Traits in a Spring Wheat Breeding Program. In: Proceedings of the XXIV International Plant & Animal Genome Conference, San Diego, CA.
> Status: Abstract Published and Poster Presented
> Acknowledgement of Federal Support: YES (poster), NO (abstract)

Journal publications.

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

Other publications, conference papers and presentations.

Alejandro Castro1, Kelly Arceneaux, Niranjan Baisakh, Stephen Harrison, Esten Mason and Paul Price. 2018. Identification of QTLs for resistance to Fusarium Headblight (*Fusarium graminearum)* in a doubled haploid population between AGS2060 and AGS2035. Abstract published and poster presented. In Proceedings of the 2018 UWBSI Conference. December, 2018, p110.
Status: Published
Acknowledgement of Federal Support: Yes

R. Esten Mason, Dylan Larkin, and Stephen Harrison. 2018. Genome wide association analysis and prediction of FHB resistance in soft red winter wheat. Abstract published and poster presented. In Proceedings of the 2018 UWBSI Conference. December, 2018, p123.
Status: Published
Acknowledgement of Federal Support: Yes