USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY19 Final Performance Progress Report
Due date: August 31, 2021

Cover Page

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Fiscal Year:	2019
USDA-ARS Agreement ID:	59-0206-7-005
USDA-ARS Agreement Title:	Development of FHB-Resistant Wheat Cultivars for the Midsouth
FY19 USDA-ARS Award Amount:	$ 89,782
Recipient Organization:	University of Arkansas 305 Administration Bldg. Fayettevllle, AR 72701
DUNS Number:	191429745
EIN:	71-6003252
Recipient Identifying Number or Account Number:	0403-05710-24-2538
Project/Grant Reporting Period:	6/1/19 - 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 Cultivars for the Midsouth	$ 79,657
VDHR-SWW	Developing Doubled Haploids to Expedite Variety Development in Soft Red Winter Wheat	$ 10,125
	FY19 Total ARS Award Amount	**$ 89,782**

Jason Kelley

August 31, 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

Project 1: *Development of FHB Resistant Wheat Cultivars for the Midsouth*

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

1) Develop and release high yielding, FHB resistant cultivars.
2) Increase breeding efficiency through collaborative phenotyping, marker development and introgression of new genes using marker-assisted (MAS) and genomic selection (GS).
3) Screen and report the reactions of breeding lines and currently grown commercial cultivars to FHB using misted inoculated nurseries.

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

a. Objective 1: Develop and release high yielding, FHB resistant cultivars adapted to Arkansas and the mid-south.

a) What were the major activities?

The major activities on a yearly cycle for this objective include developing new breeding populations, advancement of breeding populations and lines using phenotypic, molecular marker and genomic prediction data and release of breeding lines as varieties.

b) What were the significant results?

i. FY19: 681 crosses made, the majority containing moderate resistance and FHB.
ii. FY20: 383 crosses made, the majority expected to contain moderate resistance.
iii. FY19: 4,800 breeding lines and varieties screened for FHB resistance.
iv. FY20: 693 breeding lines and varieties and 899 DH lines screened for FHB resistance.
v. FY19: ~1,800 samples were harvested for FDK and sent for DON analysis
vi. Numerous breeding lines containing *FHB1* were yield tested in FY19.

c) List key outcomes or other achievements.

Breeding lines with increased levels of FHB resistance and high grain yield were identified. AR06146E-1-4 was released.

- **Objective 2: Increase breeding efficiency through collaborative phenotyping, marker development and introgression of new genes using marker-assisted (MAS) and genomic selection (GS).**

For FY19:

a) What were the major activities?

The major activities of this objective include genotyping of new breeding lines with markers for known QTL and whole genome genotyping of new breeding lines for determining genomic estimated breeding values (GEBV).

b) What were the significant results?

i. Molecular marker data was used to select parents for crossing.
ii. 550 new breeding lines genotyped and FHB prediction models developed
iii. Molecular marker data generated on 550 breeding lines
iv. Manuscript on development of genomic prediction models was published.
v. Review manuscript published related to genomic selection methodology.

c) List key outcomes or other achievements.

Molecular markers and genomic selection are identifying FHB resistant lines earlier in the breeding cycle and at higher frequency.

For FY20:

Due to the loss of the original P.I., Dr. Esten Mason, no genotyping of new breeding lines was undertaken in FY20.

- **Objective 3: Screen and report the reactions of breeding lines and currently grown commercial cultivars to FHB using misted inoculated nurseries.**

a) What were the major activities?

Evaluating multiple SunGrains, USDA and commercial nurseries for reaction to FHB in misted and inoculated nurseries.

b) What were the significant results?

i. FY19: 96 entries in the Official Variety Trial were screened for FHB.
ii. FY20: 93 entries in the Official Variety Trial were screened for FHB.
iii. Other cooperative nurseries screened included GAWN, SUNWHEAT, SUNPRE, UESSRWWN, and USSRWWN.

c) List key outcomes or other achievements.

Results of the Official Variety Test were published in print and online (Arkansas Crop Variety Improvement Program (uada.edu)) and are accessible through ScabSmart. Data for the USDA nurseries was published by the nursery organizers.

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.

This research was not impacted by COVID-19.

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

During the FY19 granting period, four graduate students (2 Ph.D. and 2 M.S.) were trained in the rating and breeding for FHB resistance, the use of molecular markers and genomic selection. No training and professional development were provided in FY20.

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

During FY19, research results were published in scientific journals, extension publications and presented at meetings where target audience and stakeholders were present, including the annual United States Wheat and Barley Scab Initiative Meeting. Material was also available online through the state of Arkansas Variety Testing website (Arkansas Crop Variety Improvement Program (uada.edu)) which is easily accessible to researchers, seedsmen and others. Specific outputs are listed in the Publications, Conference Papers, and Presentations section of this report.

A University of Arkansas Extension publication (Wheat Update) was developed to assist wheat growers on variety selection and provided FHB resistance ratings on commercially available wheat varieties that had been tested in the Official Wheat Variety Testing trials during the 2019-2020 season (published in September 2020). An updated version was also published in August 2021from 2020-2021 growing season data https://www.uaex.uada.edu/farm-ranch/crops-commercial-horticulture/wheat/)

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 goal of this proposal is use double haploid technology to combine favorable loci for more rapid improvement of FHB resistance. This is done in a collaborative manner with exchange of DH lines.

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?**
In FY19, F_1 plants from two populations were sent to North Carolina State University with a target of producing 300 double haploid lines. Based on molecular marker screening, all were positive for *FHB1*. In total, 350 new double haploids produced through the scab initiative were evaluated in misted and inoculated nurseries in FY19 with a select number harvested for future evaluation. There were 2,655 total doubled haploids (including USWBSI and other sources) tested in the program.

b) W**hat were the significant results?**

- In FY19, yield data was collected on 250 double haploids.
- These 250 lines, plus 100 others were screened for FHB resistance in two misted, inoculated nurseries in FY20. Data were shared with other breeders who had received the same lines for testing. In addition, 283 new double haploid lines were included in the misted, inoculated nurseries.
- In FY19, selected double haploids were sent to other breeders for cooperative testing.
- In FY19, three lines with FHB1 were tested in the Arkansas Official Variety Trial.
- In FY20, eight lines with FHB1 were tested in the Arkansas Official Wheat Variety Testing Trials.

c) List key outcomes or other achievements.

Double haploid lines with a high level of resistance were identified and advanced.

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.

This research was not impacted by COVID-19.

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

During the FY19 granting period, four graduate students (2 Ph.D. and 2 M.S.) were trained in the rating and breeding for FHB resistance, the use of molecular markers and genomic selection.

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

Research results were published in scientific journals, extension publications and presented at meetings where target audience and stakeholders were present, including the annual United States Wheat and Barley Scab Initiative Meeting. Material was also available online through the state of Arkansas Variety Testing website (http://www.arkansas-variety-testing.com/) which is easily accessible to researchers, seedsmen and others. Specific outputs are listed in the Publications, Conference Papers, and Presentations section of this report.

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the **FY19 award period (6/1/19 - 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 FY19 award period?**
   ☒Yes ☐No ☐ Not Applicable
   If yes, how many? One MS student (Jamison Murry)

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 **FY19 award period (6/1/19 - 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
ARO-6146E-	SWW - Soft White Winter	R - Resistant	1	2019
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
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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 - 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.

Larkin, D.L., Lozada, D.N., **Mason, R.E.** 2019. Genomic selection – considerations for successful implementation in wheat breeding programs. Agronomy. 10.3390/agronomy9090479.
Status: Published
Acknowledgement of Federal Support: Yes

Larkin, D L., Holder, A.L., Mason, R.E., Moon, D.E., Brown-Guedira, G., Price, P.P., and Dong, Y. (2020). Genome-wide analysis and prediction of Fusarium head blight resistance in soft red winter wheat. *Crop Science, n/a* (n/a). doi:10.1002/csc2.20273.
Status: Published
Acknowledgement of Federal Support: Yes

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

Nothing to report.

Other publications, conference papers and presentations.

Invited Talks:

Mason, R.E. Partnering to predict: Centralized genomic selection in southeastern wheat breeding programs. Texas Wheat Workers Conference, Aug 27-28, 2019, Texas A&M University, College Station, TX.
Status: Oral Presentation
Acknowledgement of Federal Support: Yes

Mason, R.E., Brown-Guedira, G., Lyerly, J. Partnering to predict: Centralized genomic selection in southeastern wheat breeding programs. Eastern and Southern Wheat Workers Meeting, April 23-25, 2019, Raleigh, NC.
Status: Oral Presentation
Acknowledgement of Federal Support: Yes

Poster and Oral Presentations:

Larkin, D.L., **R.E. Mason**, A.L. Holder, D.E. Moon, G. Brown-Guedira, and S.A. Harrison. 2019. "Genome wide association analysis and prediction of Fusarium head blight resistance in soft red winter wheat." In: S. Canty, A. Hoffstetter, H. Campbell and R. Dill-Macky (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum* (p. 100), Milwaukee, WI; December 8-10. University of Kentucky, Lexington, KY.
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: No

Larkin, D.L., **R.E. Mason**, A.L. Holder, D.E. Moon, G. Brown-Guedira, and S.A. Harrison. 2019. Genomic selection for Fusarium head blight resistance in wheat. Five-minute rapid oral presentation presented at: 2019 National Fusarium Head Blight Forum, Milwaukee, WI. 8-10 Dec.
Status: Oral Presentation Presented
Acknowledgement of Federal Support: No

Larkin, D.L., **R.E. Mason**, A.L. Holder, D.E. Moon, G. Brown-Guedira, and S.A. Harrison. 2019. Genome wide association analysis and prediction of Fusarium head blight resistance in soft red winter wheat. ASA, CSSA and SSSA International Annual Meeting, San Antonio, TX. 10-13 Nov. Poster 1542.
Status: Poster Presented
Acknowledgement of Federal Support: No

Larkin, D.L., **R.E. Mason**, A.L. Holder, D.E. Moon, G. Brown-Guedira, and S.A. Harrison. 2019. Genomic selection for Fusarium head blight resistance in wheat. ASA, CSSA and SSSA International Annual Meeting, San Antonio, TX. 10-13 Nov.
Status: Five-minute rapid oral presentation presented
Acknowledgement of Federal Support: Yes

Larkin, D.L., **R.E. Mason**, A.L. Holder, G. Brown-Guedira, and S.A. Harrison. 2019. Genome wide association analysis and prediction of FHB in soft red winter wheat. The Eastern Wheat Workers / Southern Small Grain Workers Conference, Raleigh, NC. 23-25 Apr.
Status: Poster Presented
Acknowledgement of Federal Support: Yes

Larkin, D.L., **R.E. Mason**, A.L. Holder, G. Brown-Guedira, and S.A. Harrison. 2019. Genome wide association analysis and prediction of Fusarium head blight resistance in soft winter wheat. 2019 Gamma Sigma Delta Student Poster and Oral Competition – Arkansas Chapter, Fayetteville, AR. 15 Mar.
Status: Oral presentation
Acknowledgement of Federal Support: Yes

Larkin, D.L., **R.E. Mason**, A.L. Holder, and S.A. Harrison. 2019. Genome wide association analysis and prediction of FHB resistance in soft winter wheat. The international conference on the status of plant and animal genome research. PAG XXVII Conference, San Diego, CA. 12-16 Jan. Poster 1023.
Status: Poster presented
Acknowledgement of Federal Support: Yes

Extension Publication for FY20.

A University of Arkansas Extension publication (Wheat Update) was developed to assist wheat growers on variety selection and provided FHB resistance ratings on commercially available wheat varieties that had been tested in the Official Wheat Variety Testing trials during the 2019-2020 season (published in September 2020). An updated version was also published in August 2021from 2020-2021 growing season data (https://www.uaex.uada.edu/farm-ranch/crops-commercial-horticulture/wheat/
Status: Published
Acknowledgement of Federal Support: No