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:	59-0206-7-005
USDA-ARS Agreement Title:	Development of FHB-Resistant Wheat Cultivars for the Midsouth.
FY18 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:	6/1/18 - 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 Cultivars for the Midsouth.	$ 79,657
VDHR-SWW	Developing Doubled Haploids to Expedite Variety Development in Soft Red Winter Wheat.	$ 10,125
	FY18 Total ARS Award Amount	$ 89,782

7/10/19

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 Cultivars for the Midsouth.*

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

The overarching goal is the development of high-yielding and *Fusarium* head blight (FHB) resistant wheat cultivars adapted to Arkansas and the mid-south soft red winter wheat growing region of the U.S. The specific objectives include:

1) Develop and release high yielding, FHB resistant cultivars adapted to Arkansas and the mid-south.
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? *Address items 1-4) below for each goal or objective.*

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

1) 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.
2) Specific objectives
   a. Develop new breeding populations using FHB resistant parents.
   b. Screen breeding material in misted and inoculated nurseries.
   c. Yield test advanced breeding lines that are resistant to FHB.
3) Significant results for the granting period included:
   - There 761 crosses made in 2018, the majority of which contained at least one parent with moderate resistance FHB.
   - Eleven lines were included from the 2018 Uniform Southern Scab Nursery including lines from North Carolina, Louisiana, Georgia, Virginia and Limagrain.
   - 13 parents that possess FHB1 were used for crossing.
   - Misted and inoculated nurseries were grown in Newport and Fayetteville.
   - 4,684 breeding lines and varieties (5,776 total plots) were screened for FHB resistance in Newport and Fayetteville
   - 1,960 samples were harvested for FDK and sent for DON analysis

- 27 advanced breeding lines and 272 observation level breeding lines containing *FHB1* were yield tested in FY18.

4) Key outcomes or other achievements: Breeding lines with increased levels of FHB resistance and high grain yield continue to be identified. AR01040-4-1 was licensed as a soft red winter wheat variety in FY18 and is consistently moderately resistant to FHB (Severity range from 10-25%, tested from 2010-2016). ARLA06146E-1-4 is resistant to FHB (Severity range from 10-20%, tested from 2015-2019) and will be licensed in Fall 2019. Other advanced breeding lines are superior in terms of grain yield and overall performance compared to germplasm in the program pre-2010.

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

1) Major activities: The major activities of this objective include genotyping of new breeding lines with markers for known QTL, whole genome genotyping of new breeding lines for determining genomic estimated breeding values (GEBV) for FHB traits and screening of genetic populations for molecular marker development in a collaborative manner.

2) Specific objectives

   a. Develop and utilize genomic selection prediction models for FHB resistance

   b. Develop new molecular markers for FHB resistance QTL

   c. Genotype new breeding lines for known QTL and for determining GEBV.

3) Significant results for the granting period included:

   - Molecular marker data was used to select parents for crossing, with an emphasis on FHB1 and new QTL derived from Jamestown, Neuse and Bess.
   - A total of 768 new breeding lines were genotyped this season and FHB prediction models developed from the Uniform Southern Scab Nursery (collaboration with North Carolina State University) and in-house were used to select lines for advancement in the absence of extensive field data. GEBVs will be validated on data collected in FY18 and FY19.
   - Molecular marker data for FHB1, FHB_1B_Jamestown, FHB_1A_Neuse, and FHB_4A_Neuse was generated on 768 breeding lines in collaboration with the Eastern Genotyping Lab and used to select lines for advancement.
   - A manuscript describing the characterization of an Arkansas FHB training population and development of genomic prediction models for FHB resistance traits was drafted and will be submitted in FY19
   - Two review manuscripts were submitted related to genomic selection methodology, including its utility for improving FHB were drafted and will be submitted in FY189

4) Key outcomes or other achievements: The use of molecular markers and genomic selection is increasing in the program, both in collaboration with the USDA regional genotyping lab and in house. This is allowing us to identify FHB resistant lines earlier in the breeding cycle and at higher frequency. In our genomic selection dataset, low GEBVs for DON and FDK were correlated with higher GEBVs for grain yield. This indicates that we are able to select for both resistance and higher grain yield simultaneously.

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

1) Major activities: For this objective, the major activities included evaluating multiple SunGrains, USDA and commercial nurseries for reaction to FHB in misted and inoculated nurseries in both Fayetteville and Newport. The cooperative (non-UA) nurseries evaluated included: Uniform Southern Scab Nursery, The Uniform Southern Nursery, Uniform Eastern, SunWheat, Gulf-Atlantic Wheat Nursery (GAWN), and the Arkansas Wheat Cultivar Performance Test

2) Specific objectives

   a. Screen breeding and cooperative germplasm in misted and inoculated nurseries.

   b. Report FHB reaction for the lines entered into the Official Variety Test.

3) Significant results for the granting period included:

   - Misted and inoculated nurseries were grown in Newport and Fayetteville.
   - 4,684 breeding lines and varieties (5,776 total plots) were screened for FHB resistance in Newport and Fayetteville.
   - 1,960 samples were harvested for FDK and sent for DON analysis, including all cooperative nurseries.
   - 96 entries in the Official Variety Trial were screened for FHB including field severity, *Fusarium* damaged kernels (FDK), and DON.

4) Key outcomes or other achievements: Results of the Official Variety Test were published in print and online (http://www.arkansasvarietytesting.com/) and are accessible through ScabSmart. Data for the USDA nurseries was published by the nursery organizers.

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

During the granting period, seven graduate students (3 Ph.D. and 4 M.S.) were trained in the rating and breeding for FHB resistance, the use of molecular markers and genomic selection.

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

The results of this research were presented to stakeholders in a variety of ways, including both written and electronic. 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 and the American Society of Agronomy meeting. Material was also available online through the state of Arkansas Variety Testing website (http://www.arkansas-variety-testing.com/) and through the SunGrains website (http://www.agronomy.lsu.edu/sungrains/sungrains.html) which are easily accessible to researchers, seedsmen and others. Specific outputs are listed in the Publications, Conference Papers, and Presentations section of this report.

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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 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? *Address items 1-4) below for each goal or objective.*

1) Major activities: Eight F_1 top-cross plants were sent to Heartland with a target of producing 250 double haploid lines. Based on molecular marker screening, all were positive for *FHB1*. In total, 365 new double haploids produced through the scab initiative were evaluated in misted and inoculated nurseries in FY18 with a select number harvested for future evaluation. There were 900 double haploids (including USWBSI and other sources) in observation level yield testing and 70 double haploid lines in advance yield testing.

2) Specific objectives

1. Crossing parents which contain favorable loci for FHB resistance
2. Development of double haploid lines from these crosses
3. Evaluation for FHB resistance, including genotyping for known resistance loci, grain yield and other important traits
4. Cooperative distribution of these lines to other regional programs

3) Significant results

- There were ~250 double haploid lines harvested for observation level testing in FY19.
- Yield data was collected on 970 double haploids for advancement (selection still in process).
- Selected double haploids were sent to other breeders for cooperative testing.

4) Key outcomes or other achievements

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

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

During the granting period, seven graduate students (3 Ph.D. and 4 M.S.) were trained in the rating and breeding for FHB resistance, the use of molecular markers and genomic selection.

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

The results of this research were presented to stakeholders in a variety of ways, including both written and electronic. 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 and the American Society of Agronomy meeting. Material was also available online through the state of Arkansas Variety Testing website (http://www.arkansas-variety-testing.com/) and through the SunGrains website (http://www.agronomy.lsu.edu/sungrains/sungrains.html) which are 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 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?** Yes

   If yes, how many? 7

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?** Yes

   If yes, how many? 2

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**
AR01040-4-1 (Marketed through Stratton Seed)	SRW	MR/MS	2-3	2018

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.

Mason, R.E.[*], Johnson, J. W., Mergoum, M., Miller, R.G. [†], Moon., D.E. [†], Carlin, J., Harrison, S.A., Babar, M.A., Murphy, P., Ibrahim, A.M.H., Sutton, R., and Blount, A.R. 2018. AR11LE24 is a soft red winter wheat adapted to the mid-south region of the United States. Journal of Plant Registrations. doi: 10.3198/jpr2017.09.0060crc
Status: Published online and in print
Acknowledgement of Federal Support: Yes

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

Mason R.E. [*], Miller R.G. [†], Moon, D.E., Kelley J.P. 2018. Arkansas Wheat Cultivar Performance Tests 2017-2018. Arkansas Agriculture Experiment Station Research Series 653.
Status: Published online and in print
Acknowledgement of Federal Support: Yes

Other publications, conference papers and presentations.

Mason, R.E., Larkin, D., Harrison, SA. Genome Wide Association Analysis and Prediction of FHB Resistance in Soft Winter Wheat. United States Wheat and Barley Scab Initiative Meeting, Dec 2-4, 2018 St. Louis, MO.
Status: Abstract Published and Oral Presentation
Acknowledgement of Federal Support: YES (presentation), NO (abstract)

Winn Z.J., **Mason, R.E.**, Moon, D.E., Larkin D.L., Brown-Guedira G., Evaluation of Hybrid Vigor in Soft Red Winter Wheat. 2018 ASA, CSSA Annual Meeting November 3-8, 2018, Baltimore, MD.
Status: Abstract Published and Oral Presentation
Acknowledgement of Federal Support: YES (presentation), NO (abstract)

[Invited] **Mason, R.E.** Breeding Program Update. Board Meeting for AG South Genetics. Jan 4-5, 2018 Stuttgart, AR
Status: Oral presentation
Acknowledgement of Federal Support: YES

[Invited] **Mason, R.E.** Vulnerabilities of U.S. Wheat Germplasm. Global Wheat Germplasm Conservation Working Group Meeting. Nov 28-29, 2018, Cambridge, U.K.
Status: Oral presentation
Acknowledgement of Federal Support: YES

Mason, R.E. Update on Arkansas wheat breeding program. Arkansas Wheat Promotion Board Meeting, May 23, 2018. Newport, AR.
Status: Oral presentation
Acknowledgement of Federal Support: YES

Mason, R.E. Update on Arkansas wheat breeding program. Virtual Arkansas Wheat Promotion Board Meeting, Aug 28, 2018.
Status: Oral presentation
Acknowledgement of Federal Support: YES