

USDA-ARS
U.S. Wheat and Barley Scab Initiative
FY16 Final Performance Report – NCE for FY17
Due date: July 31, 2018

Cover Page

Principle Investigator (PI):	Esten Mason
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Fiscal Year:	2016 (NCE for FY17)
USDA-ARS Agreement ID:	59-0200-3-007
USDA-ARS Agreement Title:	Developing Double Haploids to Expedite Mapping and Enhance FHB Resistance in SRWW.
FY16 USDA-ARS Award Amount:	\$ 72,137 (NCE for FY17)
Recipient Organization:	University of Arkansas 305 Administration Bldg. Fayetteville, AR 72701
DUNS Number:	191429745
EIN:	71-6003252
Recipient Identifying Number or Account Number:	0403-05646-24-0001
Award Reporting Period:	7/1/17 - 6/30/18
Reporting Period End Date:	06/30/18

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
VDHR-SWW	Development of FHB-Resistant Wheat Cultivars for the Midsouth.	\$ 62,706
VDHR-SWW	Developing Double Haploids to Expedite Variety Development in SRWW.	\$ 9,431
	FY16 Total ARS Award Amount	\$ 72,137



Principal Investigator 7/31/18
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

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.

a. 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:
 - i. There were 27 FHB resistant or moderately resistant parents used for crossing, including four parents from the 2017 Uniform Southern Scab Nursery: GA09129-16EL56, KWS095, KWS103 and KWS141.
 - ii. 481 crosses were made this season where at least one parent was resistant or moderately resistant to FHB. This was an increase from 339 in FY16.
 - iii. 275 crosses were made where both parents were moderately resistant or resistant to FHB
 - iv. 60 crosses were made involving a parent with *FHB1*.
 - v. Misted and inoculated nurseries were grown in Newport and Fayetteville.
 - vi. 2,589 breeding lines and varieties (3,987 total plots) were screened for FHB resistance in one or two-row plots.

- vii. 1,515 samples were sent for DON analysis
 - viii. AR06146E-4-1 had the 5th lowest FHB severity, 11th lowest Fusarium damaged kernels and 7th lowest DON content in the 2017 Uniform Southern Scab Nursery. This line contains the FHB_1A_Neuse, FHB_1B_Jamestown and the FHB_6A_Jamestown QTL.
 - ix. ARLA06146E-1-4 (FHB reaction described above) was 11th for grain yield in the Arkansas Official Variety Test in 2016-2017. Unfortunately, it was severely impacted by a late freeze in spring 2018. Foundation seed was produced in 2017-2018. We are currently determining the mechanism of release for this line.
 - x. 64 advanced breeding lines containing *FHB1* were yield tested in FY17. Due to a late spring 2018 freeze, all of these lines will be retested in FY18.
4. Key outcomes or other achievements: Breeding lines with increased levels of FHB resistance and high grain yield continue to be identified at a faster rate since an increased emphasis was put on variety development starting in 2013. ARLA06146E-1-4 is resistant to FHB and close to release. Other advanced breeding lines are superior in terms of grain yield and overall performance compared to germplasm in the program pre-2010. The USWBSI has been vital to this effort.

b. 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:
 - i. Molecular marker data was used to select parents for crossing, with an emphasis on FHB1 and new QTL derived from Jamestown, Neuse and Bess.
 - ii. A population of 360 breeding lines was evaluated for a third season (incidence, severity, FDK and DON) and screened with molecular markers for known FHB resistance QTL. Data was used by a graduate student for a genome wide association analysis study (GWAS, manuscript currently in prep) and is being used by a new graduate student for developing prediction

models for FHB resistance that will be used for increasing breeding efficiency through genomic selection.

- iii. A total of 672 new breeding lines were genotyped this season and FHB prediction models developed from the Uniform Southern Scab Nursery (collaboration with North Carolina State University) were used to select lines for advancement in the absence of extensive field data.
- iv. A recombinant inbred line (RIL) population of 200 lines from the the cross AGS2060/AGS2035 was evaluated for a second season in collaboration with Louisiana State University to map native resistance in AGS2060.

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 at a faster rate and at higher frequency.

c. 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:
 - i. Misted and inoculated nurseries were grown in Newport and Fayetteville.
 - ii. 2,589 breeding lines and varieties (3,987 total plots) were screened for FHB resistance in one or two-row plots.
 - iii. 1,515 samples were sent for DON analysis
 - iv. 96 entries in the Official Variety Trial were screened for FHB including 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.

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

During the granting period, five graduate students (2 Ph.D. and 5 M.S.) were trained in the rating and breeding for FHB resistance, the use of molecular markers and genomic selection.

In July 2017, Amanda Holder, an M.S. student studying FHB and partially funded through the USWBSI attended a summer course titled Diagnosis of Plant Diseases through Aarhus University in Flakkebjerg, Denmark. The course focused on diagnosing diseases of wheat and barley in the field and confirming field diagnosis using molecular methods.

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

A field tour of our misted nursery in Newport was hosted on May 24 for the Arkansas Wheat Promotion Board and other attendees.

A presentation was given at the Arkansas Seed Dealers meeting discussing the wheat breeding program and the USWBSI.

My graduate student Amanda Holder gave one presentation on FHB at the Annual Tri-Society Meeting Tampa, FL. October 25, 2017.

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Project 2: *Developing Double Haploids to Expedite Variety Development in SRWW.*

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 F₁ 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, 542 new double haploids produced through the scab initiative were evaluated in misted and inoculated nurseries in FY17. All 542 were harvested for seed increase, marker screening and reevaluation in 2018-2019. There were 242 double haploids in observation level yield testing and 43 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 542 double haploid lines increased for observation level testing in FY18.
- Yield data was collected on 285 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, five graduate students (2 Ph.D. and 3 M.S.) were trained in the rating and breeding for FHB resistance, the use of molecular markers, GWAS and genomic selection.

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Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY16 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 FY16-17 award period? Yes**

If yes, how many? 2

- 2. Did any graduate students in your research program supported by funding from your USWBSI grant earn their Ph.D. degree during the FY16-17 award period? Yes**

If yes, how many? 2

- 3. Have any post docs who worked for you during the FY16-17 award period and were supported by funding from your USWBSI grant taken faculty positions with universities?**

If yes, how many? 0

- 4. Have any post docs who worked for you during the FY16-17 award period and were supported by funding from your USWBSI grant gone on to take positions with private ag-related companies or federal agencies?**

If yes, how many? 0

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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 FY16 award period. All columns must be completed for each listed germplasm/cultivar. Use the key below the table for Grain Class abbreviations. *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
Nothing to report				

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

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Publications, Conference Papers, and Presentations

Instructions: Refer to the FY16-FPR_Instructions for detailed instructions for listing publications/presentations about your work that resulted from all of the projects included in the FY16 grant. Only include citations for publications submitted or presentations given during your award period (7/1/17 - 6/30/18). 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.

Journal publications.

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

Mason R.E. *, Miller R.G. †, Moon, D.E., Kelley J.P. 2017. Arkansas Wheat Cultivar Performance Tests 2016-2017. Arkansas Agriculture Experiment Station Research Series 645.

Status: Published online and in print

Acknowledgement of Federal Support: Yes

Other publications, conference papers and presentations.

1. Holder, A.L., **Mason, R.E.**, Moon, D.E. Genome Wide Association Study for Resistance to Fusarium Head Blight in Southern Soft Red Winter Wheat. Annual Tri-Society Tampa, FL. October 25, 2017.

Status: Abstract Published and Oral Presentation

Acknowledgement of Federal Support: YES (presentation), NO (abstract)

2. **Mason, R.E.** Update on Arkansas wheat breeding program. Arkansas Wheat Promotion Board Meeting, Aug 20, 2017 Stuttgart, AR

Status: Oral presentation

Acknowledgement of Federal Support: YES

3. **Mason, R.E.** Update on the Arkansas Wheat Breeding and Variety Testing Programs. Arkansas Seed Dealers Summer Meeting, Aug 3-4, 2017, Rogers AR.

Status: Oral presentation

Acknowledgement of Federal Support: YES

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4. **Mason, R.E.** Tour of USWBSI inoculated FHB nursery. Arkansas Wheat Promotion Board Meeting, May 24, 2018, Newport AR.

Status: Oral presentation

Acknowledgement of Federal Support: YES