USDA-ARS
U.S. Wheat and Barley Scab Initiative
FY17 Final Performance Report – NCE for FY18
Due date: July 12, 2019

Cover Page

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Fiscal Year:	2017 (NCE for FY18)
USDA-ARS Agreement ID:	59-0206-4-028
USDA-ARS Agreement Title:	Improvement of Soft Winter Wheat that is Resistant to FHB and Adapted to Eastern USA.
FY17 USDA-ARS Award Amount:	$ 73,415
Recipient Organization:	Purdue University AG Spnsored Program Services 615 W. State Street West Lafauette, IN 47907
DUNS Number:	07-205-1394
EIN:	35-6002041
Recipient Identifying Number or Account Number:	107128
Project/Grant Reporting Period:	6/8/18 - 6/7/19
Reporting Period End Date:	06/07/19

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
VDHR-NWW	Genetics of, and Breeding for, Fusarium Head Blight Disease Resistance in Wheat.	$ 70,800
VDHR-NWW	Male Sterile Facilitated Recurrent Selection for FHB Resistance.	$ 678
VDHR-NWW	Coordinated Phenotyping of Uniform Nurseries and Official Variety Trials.	$ 1,937
	FY17 Total ARS Award Amount	$ 73,415

M. Mohammadi July 12, 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

Project 1: *Genetics of, and Breeding for, Fusarium Head Blight Disease Resistance in Wheat.*

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

The major goals of this project were to characterize agronomic traits and the Fusarium head blight responses of the Purdue University's soft red winter wheat germplasm, inherited from Dr. Ohm. We aimed to evaluate grain yield and FHB resistance of nearly 400 lines in two seasons. The 2017-18 season (which was the reporting period for FY17 Final Report) was the first year of this evaluation. Because the PI was new to the program and the germplasm, this two-year plan assured to produce phenotypic data that would help for designing crosses and future breeding populations. The data produced from this project will be used for selecting advance lines as potential varieties or parental lines in crossing program, completing genome-wide association studies to identify QTL controlling FHB resistance, and finally developing breeder's friendly molecular markers.

2. What was accomplished under these goals? *Address items 1-4) below for each goal or objective.*

1) major activities

Activities included planting Purdue panel (n = 336) in a single-replicate yield testing in one location, preliminary yield trial (n = 50) in one location, advanced yield trial (n = 30) in three locations, planting FHB nurseries in row plots, setting up misting system, producing inoculum (using a combination of 9 isolates), and sending grain samples to Minnesota for DON measurements.

2) specific objectives

Objective 1. One of the objectives of 2018-19 funding cycle was to characterize Purdue University's soft red winter wheat germplasm for agronomic traits (grain yield, plant height, and days to heading). In 2017-18 season, we planted the first year study of only 336 lines (due to seed limitation) in a single-replicate trial in West Lafayette, IN. This experiment provided phenotypic data that can be used for genome-wide association studies (GWAS) and for developing training model for evaluation of genomic prediction accuracy. In a multi-PI genomic selection project (which will be submitted in 2020-21 cycle) this data will be used.

Objective 2. Similar to objective 1, we examined the response of Purdue panel against Fusarium head blight disease. We planted the germplasm in row plots and artificially inoculated them under misting system. This experiment allowed us to obtain disease incidence, severity, and Fusarium Damaged Kernels (FDK). We then sent grain samples to University of Minnesota for DON measurement.

Objective 3. As one major goal was performing genome-wide studies and evaluating accuracy of genomic prediction, we produced genome-wide markers using genotyping-by-sequencing for ~436 lines, which resulted in thousands of high quality markers.

Objective 4. The goal of this objective was to conduct yield testing of superior breeding lines in preliminary and advanced nurseries and identify germplasm that can be chosen for regional nurseries.

3) significant results

From breeding experiments we measured grain yield, test weight, plant height, and days to heading. This data was used to advance germplasm for regional nurseries. We had an overall good disease establishment (FHB incidence and severity). The 93 Purdue breeding lines had disease incidence range of 25-95%, with a mean of 66%. The disease severity for these breeding lines ranged 7-40%, with mean of 21%.

The yield testing, FHB phenotyping, and genotyping of the Purdue panel, resulted in phenotypic and genotypic datasets that can be used for genome-wide analyses. We repeated this experiment in 2018-19 season for the second year. Analysis of the first year data resulted in presentation of two posters in the USWBSI meeting in St Luis MO, 2018. Briefly, for grain yield we did not detect major QTL, reinforcing the need for genomic selection. For FHB traits, we observed a range of 24-100% and average of 77% for disease incidence and a range of 3.2-100% and average of 44% for disease severity. Preliminary GWAS analysis on one year data showed a large effect QTL on chromosome 2B for both disease incidence and severity. We received the DON data from the University of Minnesota on March 4, 2019. DON showed a range of 0.13-11.4 ppm, with a mean and median of 2.58 and 2.20 ppm, respectively. When we used this data in the GWAS analysis, we detected a QTL on chromosome 2B for DON content.

4) key outcomes or other achievements

Promising preliminary data and identification of high yielding and FHB resistant germplasm.

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

A postdoctoral research associate (funded by USWBSI) and a PhD student (funded by startup grant) worked on FHB related projects.

Dr. Sintayehu Daba's postdoctoral employment was funded by the USWBSI funding. This project has provided an opportunity for Dr. Daba to improve field based plant breeding skills.

In addition, Dr. Daba improved his skills in genome-wide marker development and applications in plant breeding.

Mr. Rupesh Gaire is a PhD student funded by startup grant. His PhD research involves genome-wide analyses of grain yield and FHB resistance of Purdue panel. Mr. Gaire worked in various aspects including yield testing, FHB phenotyping, and molecular marker development.

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

Two posters, first-authored by the PhD student, from this project were presented in USWBSI annual meeting in St Luis MO.

Gaire R, Brown-Guedira G, Ohm H, and Mohammadi‡ M. 2018. Genome-wide Analysis of Grain Yield in Purdue Wheat Germplasm: Protecting Germplasm during Tenure Transition. 2018 National Fusarium Head Blight Forum. December 2-4, Hyatt Regency St. Louis, MO, USA.

Gaire R, Brown-Guedira G, Ohm H, and Mohammadi‡ M. 2018. Genome-wide association study for Fusarium head blight resistant in Purdue soft red winter wheat population. 2018 National Fusarium Head Blight Forum. December 2-4, Hyatt Regency St. Louis, MO, USA.

Project 2: *Male Sterile Facilitated Recurrent Selection for FHB Resistance.*

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

The goal of this project was to utilize male-sterility in wheat to facilitate hybridization without laborious manual emasculation and pollination. This is helpful for pyramiding resistance genes against FHB disease.

2. What was accomplished under these goals? *Address items 1-4) below for each goal or objective.*

1) major activities

During FY16 one cycle of male sterile based hybridization was achieved, where the bulk of male sterile was fertilized by four local elite lines. However, during the 2017-18 season, too much rain resulted in severe lodging and loss of the row plots.

2) specific objectives

We planted each male sterile row in between two high yielding and moderately FHB resistant experimental accessions. The four germplasm were 0762A1-2-8, 0722A1-1-1-7, 05247A1-7-7-3-1, and 0762A1-2-8.

3) significant results.

We lost this experiment due to rain resulted in severe lodging.

4) key outcomes or other achievements.

See #3.

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

No postdoc or student was specifically devoted to this project.

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

Because we lost the row plots, we informed the coordinator and requested another batch of male sterile seed.

Project 3: *Coordinated Phenotyping of Uniform Nurseries and Official Variety Trials.*

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

Coordinated Phenotyping of Uniform Nurseries and Official Variety Trials are used to evaluate advanced breeding germplasm across a wide range of environments. The ultimate goal of this project is to provide the breeders with a multi-environment yield data that is necessary for selection and variety release.

2. What was accomplished under these goals? *Address items 1-4) below for each goal or objective.*

1) major activities

The five state trials and the uniform eastern trial were planted in four replicates in the Agronomy Center for Research and Education (ACRE), West Lafayette, IN. Plot size was 4ft x 12ft, trimmed to 4ft x 10ft later. Experiments were planted by a standard 7-row small grain yield planter and harvested by a Wintersteiger plot combine. We measured days to heading (DH), days to maturity (DM), and plant height (PLH) before harvest. We reported grain yield (bu/acre), hectoliter weight (lb/bu), and 1000 kernel weight (g) to the nursery coordinators.

For PNUWWSN and NUWWSN trials, the 55 NUWWSN and 55 PNUWWSN entries were planted in single replicate. Plot size was 4ft x 4ft. We planted them in the FHB evaluation field at ACRE, West Lafayette, IN. For inoculum, we prepared the conidia from 9 isolates of *Fusarium graminearum* in mung bean extraction. The inoculum was sprayed during anthesis to only a quarter portion of each plot. FHB incidence was measured from each plot. The result was communicated with the nursery coordinator.

2) specific objectives

Conducting:

- Five-state preliminary trials (n= 25 lines)
- Five-state advanced trials (n= 25 lines)
- Uniform eastern trial (n = 30 lines)
- PNUWWSN and NUWWSN trials (n = 110 lines)

3) significant results

In the uniform eastern trial, the average yield was 91.2 bu/acre with a minimum of 66 bu/acre. M14R1140 showed the maximum yield of 112 bu/acre. CV for this experiment was 12.2%.

In the 5-state preliminary trial, the average yield was 101.2 bu/acre with a minimum of 85.4

bu/acre. The maximum yield of 114.2 bu/acre was observed in 05247A1-7-7-3-1. The CV for this experiment was 7.2%.

In the 5-state advanced trial, the average yield was 97.4 bu/acre with a minimum of 76.9 bu/acre. OH14216-47 showed the maximum yield of 114.8 bu/acre. CV for this experiment was 10%.

One hundred and ten entries from different programs (55 in NUWWSN nursery and 55 in PNUWWSN nursery) were evaluated for resistance against FHB disease under misting system. In NUWWSN, the mean incidence was 70%, with a range of 30-100%. The mean severity was 26%, with a range of 4-82%. In PNUWWSN, the mean incidence was 68.4%, with a range of 30-95%, while the mean severity was 16.5%, with a range of 7.2-36.5%.

4) key outcomes or other achievements

The results of these experiments helped breeders to perform an informed selection.

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

A postdoc funded by this project had the opportunity to work on these trails.

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

The results were communicated after harvest with nursery coordinators.

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY17-NCE 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 FY17-NCE 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 FY17-NCE period?** No.

   If yes, how many?

3. **Have any post docs who worked for you during the FY17-NCE 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 FY17-NCE 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 FY17-NCE 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**

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 FY17-FPR_Instructions for detailed instructions for listing publications/presentations about your work that resulted from all of the projects included in the FY17-NCE grant period. Only include citations for publications submitted or presentations given during your award period (6/8/18 - 6/7/19). If you did not have any publications or presentations, state 'Nothing to Report' directly above the Journal publications section.

Journal publications.

No.

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

No.

Other publications, conference papers and presentations.

Gaire, R., Brown-Guedira, G, Ohm, H., and Mohammadi, M. 2018. Genome-wide Analysis of Grain Yield in Purdue Wheat Germplasm: Protecting Germplasm during Tenure Transition. 2018 National Fusarium Head Blight Forum. December 2-4, Hyatt Regency St. Louis, MO, USA.
Status: Presented as poster in the USWBSI conference.
Acknowledgement of Federal Support: Yes

Gaire, R., Brown-Guedira, G., Ohm, H., and Mohammadi, M. 2018. Genome-wide association study for Fusarium head blight resistant in Purdue soft red winter wheat population. 2018 National Fusarium Head Blight Forum. December 2-4, Hyatt Regency St. Louis, MO, USA.
Status: Presented as poster in the USWBSI conference.
Acknowledgement of Federal Support: Yes