USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY15 Final Performance Report
Due date: July 15, 2016

Cover Page

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Fiscal Year:	2015
USDA-ARS Agreement ID:	59-0206-1-114
USDA-ARS Agreement Title:	FHB Resistant Soft Wheat for Michigan and the Eastern Soft Wheat Region.
FY15 USDA-ARS Award Amount:	$ 74,417
Recipient Organization:	Michigan State University Contract & Grant Administration Hannah Administration Building, Room 2 East Lansing, MI 48824-1046
DUNS Number:	193247145
EIN:	38-6005984
Recipient Identifying Number or Account Number:	RC100549
Project/Grant Reporting Period:	04/24/15-04/23/16
Reporting Period End Date:	04/23/16

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
VDHR-NWW	FHB-Resistant Wheat Varieties for Michigan and the Great Lakes Region.	$ 68,270
VDHR-NWW	Male Sterile Facilitated Recurrent Selection for FHB Resistance (MPI-5).	$ 680
VDHR-NWW	Coordinated Phenotyping of Uniform Nurseries and Official Variety Trials.	$ 1,944
VDHR-NWW	Implementing Genomic Selection for FHB Resistance in Soft Winter Wheat (SWW) Adapted to the Corn Belt.	$ 3,523
	FY15 Total ARS Award Amount	**$ 74,417**

Eric P. Olson 7/15/2016

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: *FHB-Resistant Wheat Varieties for Michigan and the Great Lakes Region.*

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

The mission of the Michigan State University Wheat Breeding and Genetics program is to provide Michigan wheat producers with high-yielding, high-quality wheat varieties with exceptional resistance to Fhb and DON. To achieve this mission, breeding populations are developed with parents having high levels of Fhb resistance and stringent phenotypic selection is applied for resistance is applied in segregating populations. Identifying novel sources of Fhb resistance in adapted and exotic wheat genotypes supports long term resistant variety development.

Major project objectives:

A. Develop and apply selection to breeding populations segregating for FHB resistance using a combination of phenotypic and marker-assisted selection strategies.
B. Evaluate resistance levels of breeding yield trial entries in a misted FHB nursery.
C. Perform marker-assisted selection for major resistance QTL.
D. Disseminate resistant germplasm.

2. What was accomplished under these goals?

1) major activities.

A. Selections in breeding populations. Phenotypic selection was applied in ~600 segregating F_2 populations. Populations were inoculated with 30 lb. per acre of infected grain spawn. Spikes of 20 to 30 plants per population were harvested and threshed in bulk. Selections focused on plant height, early flowering and general plant type. Upon threshing of selected seed, color sorting to remove FDKs will follow. Intact, uninfected seed will then be planted in bulk plots and randomly advanced in the greenhouse.

A total of 600 crosses were made in fall 2015 and spring 2016 to develop new breeding populations segregating for Fhb resistance. F_2 seed will planted in the field during fall 2016.

B. Phenotypic evaluation of Fhb resistance in breeding germplasm. A total of 1100 breeding lines were evaluated for Fhb resistance under inoculated conditions. The preliminary yield trial of 1000 lines was evaluated in two replications. The advanced yield trial of 100 lines was evaluated in three replications.

C. Marker assisted selection for major Fhb resistance QTL. A total of 368 genotypes from preliminary yield trials were genotyped for nine Fhb reistance QTL. From these, 229 lines were identified that carry Fhb resistance QTL with carrying up to four resistance QTL.

2) specific objectives

A. Crosses incorporating Fhb resistance. Both molecular marker data and phenotypic data were used to make 600 crosses incorporating Fhb resistance in to breeding populations.

B. Identification advanced breeding lines with Fhb resistance. Phenotypic selection for Fhb resistance was done using an inoculated Fhb nursery.

C. Marker assisted selection for Fhb resistance QTL. MAS was completed on preliminary and advanced breeding lines with pedigrees suggesting resistance QTL may be present.

D. Disseminate resistant germplasm. Lines with high levels of resistance to Fhb were entered in the Uniform Fhb nurseries in order to be made available to other regional breeding programs.

3) significant results

- Two F_4-derivedfull sib lines, MI14R0008 and MI14R0009, were identified to have true type III resistance to DON accumulation. High levels of infection occurred in the 2015 Fhb nursery. Fhb severity in both lines was 66% indicating strong susceptibility. However, MI14R0008 and MI14R0009 had the lowest DON levels of any lines at 1.2 ppm and 2.0 ppm, respectively which are less than 10% of the most susceptible individual in the nursery at 17.0 ppm.
- Among lines tested in preliminary yield trials, 15 lines were identified that carry three or more Fhb resistance QTL and were used in crossing schemes to enrich populations with five or more QTL
- In the Ohio State Uniform Fhb nursery, the MSU breeding line MI14R0182 had a severity score of 4.8, significantly lower than the most resistant check Truman at 15.1%.
- F_1 crosses were made between parents having up to seven unique Fhb QTL present. These plants will selfed to develop segregating populations and used in topcrosses in fall, 2016.

4) key outcomes or other achievements

Informed crosses based on molecular marker data have enabled the development of breeding populations segregating for resistance. Valuable phenotypic data from the inoculated Fhb nursery has enabled selection and advancement of wheat genotypes with high levels of resistance to Fhb.

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

This project has provided training and professional development opportunities for *four graduate students, two post-doctoral research associates* and *two breeding program research technicians*.

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

Results from the 2015 project have been communicated to all industry stakeholders. Results were communicated in three talks given to the Michigan Agri-Business Association, Michigan Millers Association and Michigan Crop Improvement Association.

Project 2: *Male Sterile Facilitated Recurrent Selection for FHB Resistance (MPI-5).*

1. **What are the major goals and objectives of the project?**
   Recurrent selection is a breeding procedure with the objective of increasing the frequency of desirable alleles for one or more traits while maintaining a high level of variability in the population. The goal for this project is to develop several adapted breeding populations with genes for FHB resistance derived from multiples sources. Methods employed will rapidly incorporate Fhb resistance into wheat genotypes with adaptation to soft winter wheat growing environments.

2. **What was accomplished under these goals?**
   1) major activities. Inbred lines were extracted from segregating populations in summer, 2015, and were planted in 2016 preliminary yield trials.

   2) specific objectives. The primary objective in this goal was to identify Fhb-resistant lines extracted from segregating populations that have superior agronomic performance and high yield.

   3) significant results. One inbred line derived from segregating populations, MI15R0416 yielded 102.5 bu/Ac, which is significantly higher than the check variety, Ambassador at 97.2 bu/Ac. This result demonstrates success in the development of high yielding genotypes that are resistant to Fhb.

   4) key outcomes or other achievements. The key outcome from this work is the advancement of inbred lines with Fhb resistance and high yield. Lines developed in this work could lead to variety release and at minimum will be used as Fhb resistance donors future crosses.

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

   Nothing to report

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

   Nothing to report

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

1. **What are the major goals and objectives of the project?**
   Selections by breeders and planting decisions by growers affect the amount of wheat acreage planted to resistant varieties. Information on Fhb resistance in breeding germplasm and varieties available to wheat growers is critical to making selection and planting decisions. The goal of this project is to provide wheat breeders, Fhb researchers, extension, members of agri-business and farmers on the levels of resistance present in wheat breeding lines and varieties.

2. **What was accomplished under these goals?**
   1) major activities. In coordination with the breeding program an Fhb nursery was planted to assess levels of resistance in elite breeding lines and varieties available to growers. Disease ratings took place from June 23 through June 28, 2016. A total of 90 entries from the Michigan State Wheat Performance trial were evaluated for Fhb incidence and severity. Other nurseries evaluated include the Preliminary and Northern Uniform Fhb nurseries, the Uniform eastern soft red and soft white winter wheat nurseries. Samples were collected for DON analysis which will take place in the coming months after sample processing.

   2) specific objectives. The objective of this work is to determine the level of Fhb resistance in wheat varieties available to wheat farmers and provide wheat breeders with information on levels of resistance in breeding germplasm.

   3) significant results. Analysis of trial data is currently in progress.

   4) key outcomes or other achievements

   Results of this work will be communicated to cooperating breeding programs to help identify resistant lines as sources of resistance for introgression into the crossing program. Publication of Fhb resistance in Michigan wheat varieties will assist in management decisions and variety selection by growers.

3. **What opportunities for training and professional development has the project provided?**
   This project has provided training and professional development opportunities for *four graduate students, two post-doctoral research associates* and *two breeding program research technicians*.

4. **How have the results been disseminated to communities of interest?**
   Results of this work will communicated to cooperating breeding programs. Variety trial results will be reported in the Michigan State Wheat Performance Trials in print and online at varietytrials.msu.edu.

Project 4: *Implementing Genomic Selection for FHB Resistance in Soft Winter Wheat (SWW) Adapted to the Corn Belt.*

1. **What are the major goals and objectives of the project?**
   The major goal of this project is to quickly incorporate Fhb resistance into elite soft winter wheat breeding lines. Genomic selection enables prediction of Fhb resistance based on marker genotype. Selection candidates can be genotyped and levels of Fhb resistance estimated based on a genome wide SNP marker profile. Selected lines predicted to have high levels of resistance can be inter-mated to develop new populations with progressively higher levels of resistance. The time frame of a selection cycle using genomic selection is on the order of months compared to years of selection using phenotypic selection alone.

2. **What was accomplished under these goals?**
   1) major activities. A total of 47 crosses were made initially followed by 29 crosses among progenies predicted to have high levels of Fhb resistance. Hundreds of DNA isolations took place to genotype individuals and develop predictions of Fhb resistance based on SNP markers.
   2) specific objectives. Objectives in the 2015 cycle were to make crosses among the most Fhb resistant genotypes from a base population. Segregating progeny were developed and genotypes with the highest level of Fhb resistance were selected and intermated. Further selection will take place in the progenies of the second intermating cycle.
   3) significant results. Replicated phenotypic data has been generated on 28 $F_{3:4}$ families predicted to have high levels of Fhb resistance. It is now possible to make correlations between predicted and actual Fhb resistance. Positive results will demonstrate the effectiveness of genomic selection in develop Fhb resistant wheat varieties.
   4) key outcomes or other achievements. Two cycles of selection have taken place. Results from 2015 will provide validation of the effectiveness of GS in rapidly improving Fhb resistance in wheat breeding populations.

3. **What opportunities for training and professional development has the project provided?**
   A post-doctoral research associate at MSU was trained in the practical implementation of genomic selection for FHB resistance in wheat breeding.

4. **How have the results been disseminated to communities of interest?**
   Results of this work were presented by Antonio Cabrera at the 2015 forum to the FHB community. An oral presentation and two posters were presented.

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY15 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.

Nothing to Report

1. **Did any graduate students in your research program supported by funding from your USWBSI grant earn their MS degree during the FY15 award period?**

   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 FY15 award period?**

   If yes, how many?

3. **Have any post docs who worked for you during the FY15 award period and were supported by funding from your USWBSI grant taken faculty positions with universities?**

   If yes, how many?

4. **Have any post docs who worked for you during the FY15 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?

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 FY15 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**

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

Refer to the FY15-FPR_Instructions for listing publications/presentations about your work that resulted from all of the projects included in the FY15 grant. If you did not have any publications or presentations, state 'Nothing to Report' directly above the Journal publications section.

Journal publications.

Brisco E.L., Brown L.K., Olson E.L. 2016. Fusarium head blight resistance in *Aegilops tauschii*. Crop Sci.
Status: Manuscript submitted
Acknowledgement of Federal Support: Yes

Books or other non-periodical, one-time publications. None

Other publications, conference papers and presentations.

Siler L., Brisco E.L., Wiersma A.T., Brown L.K., McCarthy K., Olson E.L. 2015. Michigan State Wheat Variety Performance Trials. 2015. http://www.varietytrials.msu.edu/wheat.
Status: Published
Acknowledgement of Federal Support: Not applicable for this publication.

Olson E.L., Brisco E.L., Brown L.K. 2016. Fusarium head blight resistance in *Aegilops tauschii*. Great Lakes Wheat Workers Meeting. Ridgetown, ON.
Status: Presentation
Acknowledgement of Federal Support: Not applicable for this presentation.

Wiersma A.T., Olson E.L. 2016. A Fusarium head blight resistance QTL from *Aegilops tauschii*. Great Lakes Wheat Workers Meeting. Ridgetown, ON.
Status: Presentation
Acknowledgement of Federal Support: Not applicable for this presentation.

Olson E.L., Siler L., Brisco E.L., Wiersma A.T., Brown L.K., McCarthy K. 2015. Wheat Breeding and Genetics at Michigan State University. Michigan Agri-Business Association. Lansing, MI.
Status: Presentation
Acknowledgement of Federal Support: Not applicable for this presentation.

Olson E.L., Siler L., Brisco E.L., Wiersma A.T., Brown L.K., McCarthy K. 2015. Wheat Breeding and Genetics at Michigan State University. 2015. Michigan Crop Improvement Association Membership meeting. Okemos, MI.
Status: Presentation
Acknowledgement of Federal Support: Not applicable for this presentation.

Olson E.L., Siler L., Brisco E.L., Wiersma A.T., Brown L.K., McCarthy K. 2015. Wheat Breeding and Genetics at Michigan State University. 2015. Michigan State Millers Association Meeting. Mackinaw Island, MI.
Status: Presentation
Acknowledgement of Federal Support: Not applicable for this presentation.