

**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:	59-0206-4-020
USDA-ARS Agreement Title:	Breeding and Genetics of Fusarium Head Blight Resistance in Barley.
FY15 USDA-ARS Award Amount:	\$ 167,095
Recipient Organization:	Regents of the University of Minnesota Suite 450 Sponsored FIN RPT-P100100001 Minneapolis, MN 55455-2003
DUNS Number:	555917996
EIN:	41 -6007513
Recipient Identifying Number or Account Number:	CON000000048320
Project/Grant Reporting Period:	05/13/15-05/12/16
Reporting Period End Date:	05/12/16

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
BAR-CP	Developing Six-rowed Malting Barley Varieties with FHB Resistance and Low DON.	\$ 89,223
BAR-CP	Genomic Selection for FHB Resistance in Midwest Six-row Barley.	\$ 77,872
	FY15 Total ARS Award Amount	\$ 167,095

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: *Developing Six-rowed Malting Barley Varieties with FHB Resistance and Low DON.*

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

Fusarium Head Blight (FHB) or scab, caused by the fungus *Fusarium graminearum*, is the major factor limiting barley production in the Midwestern United States. The overall goal of this project is to develop malting barley varieties with enhanced resistance to FHB and lower concentration of the mycotoxin deoxynivalenol (DON). To accomplish this goal, we propose a comprehensive FHB breeding effort utilizing greenhouse for crossing and single-seed advance, extensive field trials for FHB evaluation, various uses of markers to improve selection, regional yield and quality testing, and collaborative regional nurseries to evaluate elite breeding lines.

2. What was accomplished under these goals?

1) Major Activities

We conducted FHB evaluation in misted and inoculated field nurseries at Crookston and St. Paul, MN for totaling over 5,000 plots. We evaluated FHB severity and harvested selected plots for DON. These nurseries included trials for a genetic mapping study of a complex locus on chromosome 6H, a second year evaluation of three cycles of genomic selection for lower DON and higher yield, a second year evaluation of a genomic selection training population for spring two-row barley, first year yield trial entries, and advanced breeding lines and varieties. We initiated new crosses in our spring six-row, spring two-row, and winter two-row breeding programs.

2) Specific Objectives

- 1) Develop breeding populations segregating for FHB resistance.
- 2) Evaluate breeding lines in replicated field disease nurseries. Field disease trials will be conducted at two locations in Minnesota that utilize overhead mist irrigation and inoculum applied as either grain spawn or as a suspension of conidia with backpack sprayers.

3) Significant Results

Variety candidate, M160, has lower DON and higher yield than the current varieties Quest and Lacey. In addition it has lower beta-glucan compared to Quest making it more favorable for maltsters and brewers. M160 was rated satisfactory in first year testing with the 2014 crop. Unfortunately, it was rated unsatisfactory with the 2015 crop.

4) Key Outcomes or Other Achievements

It is unlikely that AMBA members will want to advance M160 to plant scale testing without an additional satisfactory year. If it performs well with the 2016 crop we will submit it for consideration of plant-scale testing and begin increases for release. SM166 was a first year entry into the AMBA pilot evaluation and was rated satisfactory with the 2015 crop.

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

All of my undergraduate and graduate students participate in FHB research and learn about the breeding challenges and approaches that we use thus contributing to their training and development as scientists.

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

All of our raw data is uploaded to the public database, T3 Barley, and is freely available to researchers. Results of the North American Barley Evaluation Nursery (NABSEN) are posted online. We report the FHB rating for all varieties grown in Minnesota in the Variety Trials Bulletin and in the publication Prairie Grains. I also discuss FHB breeding research at field days in Minnesota.

Project 2: *Genomic Selection for FHB Resistance in Midwest Six-row Barley.*

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

The overall goal of this project will be to conduct two cycles of GS within the two year funding cycle to generate breeding lines that will be available for testing in the springs of 2015 and 2016. We will also complete a study evaluating the effectiveness of GS on the first three cycles of selection.

2. What was accomplished under these goals?

1) major activities

The major tasks to be carried out will be crossing of selected parents, advancing populations to the F2 and F3 generations, and GS prediction of breeding values.

2) specific objectives

The specific objectives for this project are to (1) generate data sets to be used in GS model training; (2) make selections based on GS predictions; and (3) carry out experiments to assess prediction accuracy and gain from selection.

3) significant results

We completed a two year study evaluating three cycles of GS for lower DON and higher yield in spring six-row malting barley.

4) key outcomes or other achievements

Our GS evaluation experiment showed that we had made significant gains in lowering DON and simultaneously increasing yield over three cycles. This result is significant because these two traits are unfavorably correlated and it has been difficult to make gains in both traits.

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

Tyler Tiede was partially funded from this project and completed his PhD in the spring of 2016. He is currently a post-doctoral research associate in my research group.

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

All of our raw data is uploaded to the public database, T3 Barley, and is freely available to researchers. We are preparing a manuscript to describe the GS evaluation results. We have also presented these results at the FHB forum and Plant and Animal Genome conferences.

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.

- 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? No

- 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? Yes. 2

- 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? No

- 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? No

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

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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.

Sallam, A. and K.P. Smith. 2016 Genomic selection performs similarly to phenotypic selection in barley. *Crop Sci.* (in press).

Status: In Press

Acknowledgement of Federal Support: Yes

Huang Y., L. Lia, K.P. Smith and G.J Muehlbauer. 2016. Differential transcriptomic responses to *Fusarium graminearum* infection in two barley quantitative trait loci associated with Fusarium head blight resistance. *BMC Genomics* 17:387. DOI: 10.1186/s12864-016-2716-0

Status: Published

Acknowledgement of Federal Support: Yes

Tiede, T. Kumar, L., Mohamadi, M., and Smith, K.P. 2016. Predicting genetic variance in bi-parental breeding populations is more accurate when explicitly modeling the segregation of informative genomewide markers. *Mol. Breed.* doi:10.1007/s11032-015-0390-6

Status: Published

Acknowledgement of Federal Support: Yes

Lorenz, A. and K.P. Smith. 2015. Adding genetically distant individuals to training populations reduces genomic prediction accuracy in barley. *Crop Sci.* doi: 10.2135/cropsci2014.12.0827

Status: Published

Acknowledgement of Federal Support: Yes

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

Other publications, conference papers and presentations.

Tiede, T., E. Schiefelbein, K. Beaubian G. Velasquez, S. Chao, and K.P. Smith. 2016. Optimizing the Training Population Composition to Improve Genomic Prediction Accuracy across Selection Cycles of a Barley Breeding Population. Plant and Animal Genome Conference XXIV, January 9-13, 2016, San Diego, CA.

Status: Published

Acknowledgement of Federal Support: Abstract: No; Poster: yes

Huang, Y., S. Heinen, B. Steffenson, K.P. Smith and G.J. Muehlbauer. 2015. Coarse and Fine Mapping of Quantitative Trait Loci for FHB in Barley. In: S. Canty, A. Clark, S. Vukasovich,

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and D. Van Sanford (Eds.) *Proceedings of the 2015 National Fusarium Head Blight Forum*. East Lansing, MI/Lexington, KY: U.S. Wheat and Barley Scab Initiative. P.47

Status: Abstract Published and Poster Presented

Acknowledgement of Federal Support: Abstract: No; Poster: yes

Falcon C.M and K.P. Smith. 2015. Characterization of FHB Resistance in Six-Row, Winter Barley Germplasm. In: S. Canty, A. Clark, S. Vukasovich, and D. Van Sanford (Eds.) *Proceedings of the 2015 National Fusarium Head Blight Forum*. East Lansing, MI/Lexington, KY: U.S. Wheat and Barley Scab Initiative. P.83.

Status: Abstract Published and Poster Presented

Acknowledgement of Federal Support: Yes for both Abstract and Poster, but for a NIFA funded grant agreement.

Tiede, T., L. Kumar, M. Mohammadi and K.P. Smith. 2015. Predicting Genetic Variance in Breeding Populations: Using Historical Breeding Records to Empirically Evaluate Six Prediction Methods. In: S. Canty, A. Clark, S. Vukasovich, and D. Van Sanford (Eds.) *Proceedings of the 2015 National Fusarium Head Blight Forum*. East Lansing, MI/Lexington, KY: U.S. Wheat and Barley Scab Initiative. P.111.

Status: Abstract Published and Poster Presented

Acknowledgement of Federal Support: Abstract: No; Poster: yes