USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY16 Final Performance Report
Due date: July 28, 2017

Cover Page

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Fiscal Year:	2016
USDA-ARS Agreement ID:	59-0206-4-020
USDA-ARS Agreement Title:	Breeding and Genetics of Fusarium Head Blight Resistance in Barley.
FY16 USDA-ARS Award Amount:	$ 156,204
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:	5/13/16 - 5/12/17
Reporting Period End Date:	05/12/17

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
BAR-CP	Developing Malting Barley Varieties with Enhanced FHB Resistance and Lower DON.	$ 89,132
BAR-CP	Investigating Genomic Selection for Fusarium Head Blight Resistance in Barley.	$ 67,072
	FY16 Total ARS Award Amount	**$ 156,204**

7/28/17

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 Malting Barley Varieties with Enhanced FHB Resistance and Lower 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 are conducting 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. We have recently added two-rowed and winter barley programs to our long-time spring six-row breeding program with the aim of increasing the tools available to manage disease risk in barley production.

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

   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 6Hassociated with DON and other triats, a third year evaluation of a genomic selection training population for spring two-row barley, first year yield trial entries for our spring two-row and spring six-row, and winter six-row breeding programs, 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 FHB trials were 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
      Two variety candidates that were rated satisfactory with the 2015 crop were advanced in 2016. S6M164 was rated unsatisfactory as it had slightly high barley protein and beta-glucan and slightly low extract and is not recommended for further testing. S6M166 was also rated unsatisfactory as it had good extract, and slightly high S/T and beta-glucan. This line is similar in DON compared to Quest with better lodging resistance and yields equal to Lacey. In our spring two-row program, we had ten 2nd year yield testing lines that were lower in DON compared to Conlon. Similarly, we had 10 2nd year entries with lower DON compared to Quest in our spring six-row program.

4) key outcomes or other achievements
SM166 is a promising line with one satisfactory and one unsatisfactory year of testing in AMBA pilot program. It is currently in a third year of testing and continues to be evaluated in multi-state yield trials and FHB nurseries.

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: *Investigating Genomic Selection for Fusarium Head Blight Resistance in Barley.*

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

The overall goal of the project is to empirically evaluate the effectiveness of genomic selection to improve the breeding of FHB resistant varieties and to develop and evaluate methods to improve prediction accuracy.

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

1) major activities

We have advanced crosses designed to test whether our models are accurate in predicting the variance of breeding populations for FHB severity and other traits. Forty populations were planted in two FHB nurseries in spring of 2016. We are now evaluating lines to determine the FHB severity and will use that data to calculate population variance to compare with our model predictions.

We are also continuing our simulation work to predict the effect of various training population design strategies on prediction accuracy and long term gain from selection.

2) specific objectives

a) Characterize the effects of GS parameters on prediction accuracy and the identification of superior crosses, where a superior cross is one with high progeny mean and variance.
b) Contribute to the optimization of GS of FHB resistance through better training population design.

3) significant results

In our published study, we showed that several methods of optimizing the composition of a GS training population were better than using a random set of lines. It also appears that updating the training population with the best perform was the best method or equal to the other best methods for maintaining prediction accuracy. Keeping the most recent lines from the breeding program and dropping older lines from the training population was also more accurate then leaving lines in the training population over time.

4) key outcomes or other achievements

The most interesting result was that using the best lines to update your training population was optimal. This means that breeders can use data that they already routinely generate to update the training population and do not need to conduct addition experiments solely for the purpose of training GS prediction models.

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. The simulation study was presented at several scientific conferences in posters and published in the journal G3.

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 award period?** yes

   If yes, how many? 1

2. **Did any graduate students in your research program supported by funding from your USWBSI grant earn their Ph.D. degree during the FY16 award period?** no

   If yes, how many?

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

   If yes, how many? 1

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**

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 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 (5/13/16 - 5/12/17). If you did not have any publications or presentations, state 'Nothing to Report' directly above the Journal publications section.

Journal publications.

Neyhart, J.,T. Tiede, A. J. Lorenz, and K. P. Smith. 2017. Evaluating Methods of Updating Training Data in Long-Term Genomewide Selection. G3 May 2017 7:1499-1510; early online March 17, 2017. doi:10.1534/g3.117.040550.
Status: Manuscript published
Acknowledgement of Federal Support: YES

Sallam, A. and K.P. Smith. 2016. Genomic selection performs similarly to phenotypic selection in barley. Crop Sci. 56(6) DOI: 10.2135/cropsci2015.09.0557.
Status: Manuscript published
Acknowledgement of Federal Support: YES

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

None

Other publications, conference papers and presentations.

Evaluating Methods of Updating Training Data in Long-Term Genomic Selection. 2017. Neyhart, JL, Tiede, T, Lorenz, AJ and Smith, KP. Plant and Animal Genome Conference XXV, January 14-18, 2017, San Diego, CA.
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: YES (poster), NO (abstract)

Huang, Y., K.P. Smith and G.J. Muehlbauer. 2016. "Characterization of small RNAs from *Fusarium*-inoculated barley spike tissues." In S. Canty, K. Wolfe and D. Van Sanford (Eds.), *Proceedings of the 2016 National Fusarium Head Blight Forum.* East Lansing, MI/Lexington, KY: U.S. Wheat and Barley Scab Research Initiative. P.50.
Status: Abstract Published and Poster (#20) Presented
Acknowledgement of Federal Support: YES (poster), NO (abstract)

Neyhart, J., T. Tiede, A. Lorenz and K.P. Smith. 2016. "Evaluating Methods of Updating Training Data in Long-Term Genomic Selection for Fusarium Head Blight Resistance in Barley." In S. Canty, K. Wolfe and D. Van Sanford (Eds.), *Proceedings of the 2016 National Fusarium Head Blight Forum.* East Lansing, MI/Lexington, KY: U.S. Wheat and Barley Scab Research Initiative. P.86-90.
Status: Paper Published
Acknowledgement of Federal Support: YES

Yin, L., E.L. Schiefelbein, G.V. Rodrigiez, K.A. Beaubien, A.H. Sallam and K.P. Smith. 2016. Fine mapping coincident QTL for multiple traits linked with gpc1 on chromosome 6H of barley. 12th International Barley Genetics Symposium, Minneapolis, MN, June 26-30, 2016.
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: YES (poster), NO (abstract)

Neyhart, J.L. and K.P. Smith. 2016. Predicting genetic variance in barley using genotyping-by-sequencing and population sequencing. 5th International Conference on Quantitative Genetics, Madison, WI, USA, June 12-17, 2016.
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: YES (poster), NO (abstract)

Neyhart, J. and K.P. Smith. 2016. Applying Genotyping-by-Sequencing (GBS) and Population Sequencing (POPSEQ) to Predict Genetic Variance in Two-Row Barley Breeding. 12th International Barley Genetics Symposium, Minneapolis, MN, June 26-30, 2016.
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: YES (poster), NO (abstract)

Huang, Y., L. Li, K.P. Smith, and G.J. Muehlbauer. 2016. Two barley quantitative trait loci associated with Fusarium head blight resistance exhibit differential resistance mechanisms to *Fusarium graminearum* infection. 12th International Barley Genetics Symposium, Minneapolis, MN, June 26-30, 2016.
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: YES (poster), NO (abstract)