USDA-ARS | U.S. Wheat and Barley Scab Initiative

FY22 Performance Progress Report

Due date: July 26, 2023

Cover Page

USDA-ARS Agreement ID:	59-0206-2-150
USDA-ARS Agreement Title:	Breeding Fusarium Head Blight Resistant Spring and Winter Barley
Principle Investigator (PI):	Kevin P. Smith
Institution:	University of Minnesota
Institution UEI:	KABJZBBJ4B54
Fiscal Year:	2022
FY22 USDA-ARS Award Amount:	$153,466
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Period of Performance:	May 1, 2022 – April 30, 2026
Reporting Period End Date:	April 30, 2023

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
BAR-CP	Developing Barley Varieties with Enhanced FHB Resistance and Lower DON	$153,466
	FY22 Total ARS Award Amount	$153,466

I am submitting this report as an: ☒ Annual Report

I certify to the best of my knowledge and belief that this report is correct and complete for performance of activities for the purposes set forth in the award documents.

7/25/2023

Principal Investigator Signature — Date Report Submitted

ǂ BAR-CP – Barley Coordinated Project
DUR-CP – Durum Coordinated Project
EC-HQ – Executive Committee-Headquarters
FST-R – Food Safety & Toxicology (Research)
FST-S – Food Safety & Toxicology (Service)
GDER – Gene Discovery & Engineering Resistance
HWW-CP – Hard Winter Wheat Coordinated Project
MGMT – FHB Management
MGMT-IM – FHB Management – Integrated Management Coordinated Project
PBG – Pathogen Biology & Genetics
TSCI – Transformational Science
VDHR – Variety Development & Uniform Nurseries
NWW –Northern Soft Winter Wheat Region
SPR – Spring Wheat Region
SWW – Southern Soft Red Winter Wheat Region

Project 1: Developing Barley Varieties with Enhanced FHB Resistance and Lower DON

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

1) Implement a breeding pipeline that includes evaluation and selection for lower DON and FHB severity at multiple stages to generate variety candidates with improved disease resistance and acceptable agronomic and quality performance.

2) Coordinate with other breeding programs by exchanging germplasm, participating in the regional NABSEN trial, and depositing breeding data into the T3 database.

3) Utilize high-density marker genotyping to implement marker assisted selection and genomic selection for parent selection and early generation selection.

2. What was accomplished under these goals or objectives? *(For each major goal/objective, address these three items below.) May 1, 2022 – April 30, 2023*

Objective 1) Implement a breeding pipeline that includes evaluation and selection for lower DON and FHB severity at multiple stages to generate variety candidates with improved disease resistance and acceptable agronomic and quality performance.

a) What were the major activities?

In the summer of 2022, we conducted FHB evaluation in misted and inoculated field nurseries at Crookston and St. Paul, MN totaling 1,917 plots. We evaluated FHB severity and harvested selected plots for DON. These nurseries included trials from first year yield trial entries, advanced breeding lines, and varieties from our spring and winter (facultative) two-row breeding programs. This data was used to select parents and advance lines in our breeding program.

In the fall of 2022, we identified a set of 35 spring and 40 winter (facultative) parents from our breeding program to make crosses to develop new breeding populations. Most of these 102 new crosses have at least one parent that is lower in DON concentration compared to ND Genesis or is predicted based on genomic selection modeling to have progeny that are lower in DON compared to ND Genesis.

In the winter greenhouse of 2023, we selected 28 parents and made an additional 31 crosses with lines that should provide better winterhardiness. In most cases these crosses included a parent from our program with lower DON compared to ND-Genesis.

b) What were the significant results?

Our field screening has been very successful with both of our locations (St. Paul and Crookston) producing disease and DON levels that are useful for selection. In 2022, 262 of 297 (88%) spring lines from first year testing evaluated for DON had lower levels compared to ND-Genesis.

c) List key outcomes or other achievements.
We successfully met our target of generating new first year breeding lines for evaluation and evaluating advanced breeding lines for industry evaluation and consideration as new variety candidates.

Objective 2) Coordinate with other breeding programs by exchanging germplasm, participating in the regional NABSEN trial, and depositing breeding data into the T3 database.

a) What were the major activities?
We submitted 10 entries to the NABSEN trial in the summer of 2022 and evaluated the nursery in two misted and inoculated nurseries (St. Paul and Crookston, MN). We harvested the nursery and submitted grain samples (bulked 3 replications) for DON analysis. We uploaded all data collected from the NABSEN to T3 and shared the data with the NABSEN coordinator to assemble the annual report.

b) What were the significant results?
Five of the 10 entries submitted from our program had lower DON levels then the dominant variety check AAC Synergy. These lines are also advanced breeding lines currently in the American Malting Barley Association (AMBA) Quality Evaluation Program.

c) List key outcomes or other achievements.
Multi-location testing of advanced breeding lines provides more robust evaluation of breeding line performance and helps guide decisions related to cultivar release. We also use this data to select breeding lines from other breeding programs to add to our crossing block.

3) Utilize high-density marker genotyping to implement marker assisted selection and genomic selection for parent selection and early generation selection.

a) What were the major activities?
In the Fall of 2022, we genotyped 1,309 F3 breeding lines with genome-wide markers to produce predictions for agronomic performance, malting quality, FHB severity, and DON concentration. This genotypic data was used to select 362 new lines that were entered into first year yield and FHB evaluations for the 2023 growing season.

b) What were the significant results?
Our genomic selection for DON has had some mixed results over the past year. Conducting simple cross-validation within the training populations, we obtained prediction accuracies of 0.45 for 2022. This is reasonably good. However, validation based on predicting lines that are not part of the training population from different years (and locations) in the breeding program is a more realistic assessment of practical accuracy. In this case we have achieved accuracies ranging from 0.02 to 0.19 in past years, but accuracies of 0.43 and 0.40 this year. It is encouraging that the accuracies for the 2022 training population predicting lines from 2019 and 2021 were better. So, it is

possible that our predictions are getting better as we add more genotype and phenotype data from relevant germplasm.

c) List key outcomes or other achievements.

We continue to refine our genomic predictions for DON and explore various combinations of training data sets that will improve accuracy. Because we can predict other traits, we can use this information to increase the likelihood that lines we advance with lower DON also meet expectations for other traits.

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

None

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

Every March we submit a research progress report to the American Malting Barley Association. This report is made available to AMBA members from the malting and brewing industries. We also submit annual reports (this report) to the USDA USWBSI. We have submitted several short reports and abstracts for inclusion in the annual FHB Forum proceedings. Every year I present the status of varieties and progress in the breeding program at field days in Crookston and St. Paul, MN. I presented a talk at the combined North American Barley Researchers Workshop and Barley Improvement Conference in 2022. I presented information on our winter barley program and the potential for winter barley production to reduce DON contamination at a growers meeting in 2023. I discussed similar topics on a webinar sponsored by the Practical Farmers of Iowa in 2022. I meet each year with individuals from Rahr Malting to discuss recent progress in breeding and the status of FHB resistance in varieties.

Publications, Conference Papers, and Presentations

Please include a listing of all your publications/presentations about your FHB work that were a result of funding from your FY22 grant award. Only citations for publications published (submitted or accepted) or presentations presented during the **award period** should be included.

Did you publish/submit or present anything during this award period May 1, 2022 – April 30, 2023?

X Yes, I've included the citation reference in listing(s) below.

☐ No, I have nothing to report.

Journal publications as a result of FY22 award

List peer-reviewed articles or papers appearing in scientific, technical, or professional journals. Include any peer-reviewed publication in the periodically published proceedings of a scientific society, a conference, or the like.

Identify for each publication: Author(s); title; journal; volume: year; page numbers; status of publication (published [include DOI#]; accepted, awaiting publication; submitted, under review; other); acknowledgement of federal support (yes/no).

Books or other non-periodical, one-time publications as a result of FY22 award

Report any book, monograph, dissertation, abstract, or the like published as or in a separate publication, rather than a periodical or series. Include any significant publication in the proceedings of a one-time conference or in the report of a one-time study, commission, or the like.

Identify for each one-time publication: Author(s); title; editor; title of collection, if applicable; bibliographic information; year; type of publication (book, thesis, or dissertation, other); status of publication (published; accepted, awaiting publication; submitted, under review; other); acknowledgement of federal support (yes/no).

Other publications, conference papers and presentations as a result of FY22 award

Identify any other publications, conference papers and/or presentations not reported above. Specify the status of the publication.

Presentations:

Smith, K.P. 2022. Practical Farmers of Iowa Shared Learning Call – Winter Barley, Online, Sept 2, 2022.

Smith, K.P. 2022. Frozen Promise: Toward winter barley for the Bold North. North American Barley Researchers Workshop, Davis, CA, Sept 22-24, 2022

Smith, K.P. 2022. Shedding deoxynivalenol with naked barley. North American Barley Researchers Workshop, Davis, CA, Sept 22-24, 2022

Smith, K.P. 2022. Barley Research Update, Northwest Research and Outreach Center's (NWROC) annual Crops and Soils Day, July 20, 2022

Smith, K.P. 2021 Barley U. Field Day on the University of Minnesota Saint Paul Campus, June 28, 2022.

Minnesota Agriculture Experiment Station

Barley. Varietal Trials Results. MAES 2022

Conference Abstracts

Kevin P. Smith, Ed Schiefelbein, Guillermo Velasquez and Yanhong Dong. (2022.) Reducing DON Concentration with Naked Barley. Proceedings of the 2022 National Fusarium Head Blight Forum: Tampa, FL. December 4-6, 2022. Retrieved from: https://scabusa.org/forum/2022/2022NFHBForumProceedings.pdf