USDA-ARS
U.S. Wheat and Barley Scab Initiative
FY20 Annual Performance Progress Report
Due date: July 29, 2021

Cover Page

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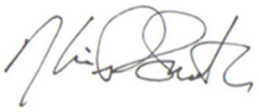
Fiscal Year:	2020
USDA-ARS Agreement ID:	59-0206-0-134
USDA-ARS Agreement Title:	Breeding and Genetics of Fusarium Head Blight Resistance in Barley
FY20 USDA-ARS Award Amount:	$ 197,973
Recipient Organization:	Regents of the University of Minnesota Suite 450 Sponsored FIN RPT-P100100001 Minneapolis, MN 55455-2003
DUNS Number:	555917996
EIN:	41 -6007513
Recipient Identifying Number or Account Number:	CON000000086376
Project/Grant Reporting Period:	5/13/20 - 5/12/21
Reporting Period End Date:	5/12/2021

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	$ 173,087
BAR-CP	Optimizing Parent Combinations to Improve FHB/DON Resistance in Barley	$ 24,886
	FY20 Total ARS Award Amount	**$ 197,973**



7/29/21

Principal Investigator Date

* MGMT – FHB Management
FST – Food Safety & Toxicology
R- Research
S – Service (DON Testing Labs)
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 research project?

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. Our breeding efforts have concentrated on two-row barley in response to industry needs. We have added a winter barley program to explore more sustainable production systems and potential avoidance of FHB.

2. What was accomplished under these goals or objectives? *(For each major goal/objective, address these three items below.)*

a) What were the major activities?

Objective 1. Create new breeding populations by crossing parents that carry resistance to FHB and other desirable traits.

In the fall of 2020, we identified a set of 80 parents from our breeding program to make crosses to develop new breeding populations. Most of these 122 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 2021, we made 39 crosses with lines that should provide better winterhardiness. Many of these sources were outside of our breeding program and we have not yet assessed their FHB resistance. In most cases they were paired with a parent from our program with lower DON compared to ND-Genesis.

Objective 2. Conduct selection for FHB resistance and lower DON concentration in segregating breeding populations using genetic markers and field screening.

In the summer of 2020, we conducted FHB evaluation in misted and inoculated field nurseries at Crookston and St. Paul, MN totaling just over 3,500 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. We genotyped 1,450 F3 breeding lines in the Fall of 2020 with genome-wide markers to produce predictions

for agronomic performance, malting quality, FHB severity, and DON concentration. This genotypic data was used to select 417 new lines to be entered into first year yield and FHB evaluations for the 2021 growing season.

Objective 3. Advance lines to regional testing and industry evaluation that are candidates for new cultivar releases.

Four advanced lines (S2M184, S2M185, S2M186, S2M187) from crop year 2020 were advanced to American Malting Barley industry pilot testing for malting quality.

b) What were the significant results?

Objective 1. Create new breeding populations by crossing parents that carry resistance to FHB and other desirable traits.

These crosses resulted in the advancement and planting of 120 F2 populations in the spring of 2021.

Objective 2. Conduct selection for FHB resistance and lower DON concentration in segregating breeding populations using genetic markers and field screening

Based on re-evaluation of parents, observed phenotype in the New Zealand winter nursery, and marker-based prediction for seven traits including DON, 417 lines were harvested and the seed used to plant preliminary yield trials at three locations and FHB nurseries at two locations in the spring of 2021.

Objective 3. Advance lines to regional testing and industry evaluation that are candidates for new cultivar releases.

One of our advanced line (S2M184) was rated satisfactory in AMBA pilot testing with the 2020 crop. It has lower DON compared to ND Genesis and is earlier, shorter and has better straw strength. It will be evaluated again with the 2021 crop.

c) List key outcomes or other achievements.

Objective 1. Create new breeding populations by crossing parents that carry resistance to FHB and other desirable traits

These activities maintain the steady flow of breeding lines created and advanced to field trials, marker genotyping, and FHB field screening to improve resistance to FHB.

Objective 2. Conduct selection for FHB resistance and lower DON concentration in segregating breeding populations using genetic markers and field screening.

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 3. Advance lines to regional testing and industry evaluation that are candidates for new cultivar releases.

While three of our candidates for release this year were removed from consideration for release due to industry evaluation of malting quality, these lines have been used in crosses and should be good parents for future breeding lines.

3. Was this research impacted by the COVID-19 pandemic (i.e. university shutdowns and/or restrictions, reduced or lack of support personnel, etc.)? If yes, please explain how this research was impacted or is continuing to be impacted.

Due to reduced labor during the pandemic we were not able to collect severity data from all of our trials. In addition, we were slower in getting grain samples to the toxin labs. We were required to grind our samples this year which further slowed processing. This had the impact of not having complete data sets at the time we were making selections for crossing and advancing lines through the breeding program. Fortunately, we were able to plant all of our FHB nurseries as planned for 2021.

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

I have one post-doc and one graduate student (both not paid from the USWBSI) that are currently gaining experience with barley breeding and FHB by working with materials and data from this project.

5. 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 on the USWBSI website. We report the FHB rating for all varieties grown in Minnesota in the MAES Minnesota Field Crop Trials extension publication and in Prairie Grains Magazine. I also discuss FHB breeding research at field days in Minnesota. We provide annual updates to Scab Smart with current variety information.

Project 2: *Optimizing Parent Combinations to Improve FHB/DON Resistance in Barley*

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

   The major goal was to directly compare the performance, in our breeding program, of those breeding lines that trace back to crosses informed by a new cross selection procedure to those breeding lines from cross combinations designed conventionally.

2. **What was accomplished under these goals or objectives?** *(For each major goal/objective, address these three items below.)*

   a) **What were the major activities?**

   Evaluate parent selection based on genome-wide marker effects to increase genetic variance and reduce unfavorable trait correlations.

   We generated 42 crosses in the fall of 2020 that were among a set of parents that had undergone 2 years of testing. About half of these crosses were designed based on marker-based predictions of parent combinations that should produce progeny with lower DON or reduced correlation of DON with heading date and plant height. The other half were used to produce a set of populations based on traditional parent selection.

   b) **What were the significant results?**

   We have successfully designed and carried out crosses that are based on genomic estimates of genetic variance and trait correlations and another set based on traditional methods in 2019 and 2020. The crosses made in 2019 were F2's in the summer of 2020 and entered into first year yield trials and FHB evaluation trials in 2021. The crosses made in 2020 are following one year behind. No results yet, but analyzing the 2021 data will provide preliminary results from this selection experiment.

   c) **List key outcomes or other achievements.**

   Progressing as planned

3. **Was this research impacted by the COVID-19 pandemic (i.e. university shutdowns and/or restrictions, reduced or lack of support personnel, etc.)? If yes, please explain how this research was impacted or is continuing to be impacted.**

   Going forward getting DON data in a timely manner may be affected by COVID.

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

None

5. 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. A manuscript entitled "Multi-Trait Improvement by Predicting Genetic Correlations in Breeding Crosses" was published in the journal G3 in 2019.

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY20 award period (5/13/20 - 5/12/21). 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 FY20 award period?**
   ☐Yes ☒No
   If yes, how many? Click to enter number here.

2. **Did any graduate students in your research program supported by funding from your USWBSI grant earn their Ph.D. degree during the FY20 award period?**
   ☐Yes ☒No
   If yes, how many? Click to enter number here.

3. **Have any post docs who worked for you during the FY20 award period and were supported by funding from your USWBSI grant taken faculty positions with universities?**
   ☒Yes ☐No
   If yes, how many? 1

4. **Have any post docs who worked for you during the FY20 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 ☐No
   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 FY20 award period (5/13/20 - 5/12/21). 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	FHB Rating (0-9)	Year Released
Nothing to report.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
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Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year

NOTE: List the associated release notice or publication under the appropriate sub-section in the 'Publications' section of the FPR.

Publications, Conference Papers, and Presentations

Instructions: Refer to the PR_Instructions for detailed more instructions for listing publications/presentations about your work that resulted from all of the projects included in the FY20 grant award. Only citations for publications published (submitted or accepted) or presentations presented during the **award period (5/13/20 - 5/12/21**) should be included. If you did not publish/submit or present anything, state 'Nothing to Report' directly above the Journal publications section.

NOTE: Directly below each citation, you **must** indicate the Status (i.e. published, submitted, etc.) and whether acknowledgement of Federal support was indicated in the publication/ presentation. See example below for a poster presentation with an abstract:

> Winn, Z.J., Acharya, R., Lyerly, J., Brown-Guedira, G., Cowger, C., Griffey, C., Fitzgerald, J., Mason R.E., and Murphy, J.P. (2020, Dec 7-11). Mapping of Fusarium Head Blight Resistance in NC13-20076 Soft Red Winter Wheat (p. 12). In: Canty, S., Hoffstetter, A. and Dill-Macky, R. (Eds.), *Proceedings of the 2020 National Fusarium Head Blight Forum*. https://scabusa.org/pdfs/NFHBF20_Proceedings.pdf.
> Status: Abstract Published and Poster Presented
> Acknowledgement of Federal Support: YES (Abstract and Poster)

Journal publications.

Nothing to report

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

Nothing to report

Other publications, conference papers and presentations.

Neyhart, J.L., Gutierrez Chacon, L. and Smith, K.P. 2021. Using Environmental Similarities to Design Training Sets for Genomewide Selection. Crop Science, 61(1), 396-409. https://doi.org/10.1002/csc2.20303
Status: Published
Acknowledgement of Federal Support: YES