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:	59-0206-0-135
USDA-ARS Agreement Title:	Molecular Genetics Approaches to Developing Scab Resistance
FY20 USDA-ARS Award Amount:	$ 162,190
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:	CON000000086331
Project/Grant Reporting Period:	5/17/20 - 5/16/21
Reporting Period End Date:	5/16/2021

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
BAR-CP	Molecular Genetics Approaches to Developing Scab Resistant Barley	$ 85,575
GDER	Utilizing Genomics Resources to Develop Scab Resistant Wheat	$ 76,615
	FY20 Total ARS Award Amount	**$ 162,190**

Gary J. Muehlbauer

July 26, 2021

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: *Molecular Genetics Approaches to Developing Scab Resistant Barley*

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

The major goal of this project is to develop genetic tools for increasing FHB resistance in barley. There are three major objectives that will be addressed including: (1) characterize the impact of trichothecenes on infection and host responses; (2) identify resistant mutants; and (3) fine map and characterize the chromosome 2H bin8 and chromosome 6H bin7 FHB resistant QTL.

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. Characterize the impact of trichothecenes on infection and host responses. We are examining the infection pathways, host response, and DON and D3G levels of a barley transgenic overexpressing *HvUGT13248* and a *HvUGT13248* mutant inoculated with *F. graminearum*. Our overall goal is to identify resistance genes and mechanisms that can be genetically manipulated and used in breeding programs. We have shown that disease severity is largely governed by whether the rachis node and rachis are infected. We have also shown that HvUGT13248 rapidly conjugates DON with a glucoside group resulting in the nontoxic DON-3-Glucoside (D3G). In addition, we have shown that HvUGT13248 is the primary type II resistance gene in barley. We are in the process of establishing an experiment to examine the host response in plants that do not contain a functional HvUGT13248 and plants that are overexpressing HvUGT13248.

Objective 2. Identify DON and FHB resistant mutants. We are screening a mutagenized population for genes that confer susceptibility or suppressors of resistance. Our hypothesis is that mutations in genes conferring susceptibility or suppressors of resistance will result in increased resistance. We are screening a M3 lines from mutagenized population in the cv. Conlon. In the future we will begin screening M3 lines on DON-containing media.

Objective 3. Fine map and characterize the chromosome 2H bin8 and chromosome 6H bin7 FHB resistant QTL. With previous USWBSI funding we developed populations segregating for the chromosome 6H and 2H FHB QTL regions, genotyped approximately 2,000 individuals from each population with markers that flanked each QTL region, and selected recombinants (Kevin Smith collaboration). The recombinants were further genotyped with markers spanning the QTL region, recombination

breakpoints identified, and phenotyped in the field in 2016-2019 for FHB, heading date and grain protein content. Lines that carry resistance uncoupled from the deleterious traits were identified, and the FHB resistance allele containing regions were reduced to less than 1 cM and 8 cM for the chr 6H and 2H regions, respectively. We submitted a paper to Theoretial and Applied Genetics describing the fine mapping of the 6h bin7 region. We have identified two DON QTL and a FHB QTL in our fine mapping of the 2H bin8 region.

b) What were the significant results?

We have evidence that suggests the rachis and rachis node are the sites important for resistance. We showed that HvUGT13248 conjugated DON to D3G. We have also shown that HvUGT13248 is the primary gene conferring type II resistance in barley. Our mutant screening is just getting started so there are no results to report. We have fine mapped the 6H bin7 and 2H bin8 regions and have identified lines that carry resistance that are uncoupled from deleterious traits. We have also shown that both QTL regions are a complex of QTL for DON and FHB resistance.

c) List key outcomes or other achievements.

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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.

Yes, the work on this project was impacted by the COVID-19 pandemic. Three postdocs were the primary workers on this project and they needed to stagger their schedules to make sure to avoid being in the same space, thus progress on the project was slower than expected.

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

The three postdocs (Gerit Bethke, Sean O'Mara and Yadong Huang) meet with me regularly, and participate and present their work in weekly lab meetings.

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

Posters describing the transgenic and mutation work, and the fine mapping work were presented at the National Scab Forum in December 2020. A talk was presented at the Forum describing the role HvUGT13248 plays in resistance in barley.

Project 2: *Utilizing Genomics Resources to Develop Scab Resistant Wheat*

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

   The major goal of this project is to develop genetic tools for increasing FHB resistance in barley. There are two major objectives that will be addressed including: **(**1) Identify and characterize mutations for increased trichothecene and FHB resistance in wheat; and (2) Identify mutants with increased trichothecene and FHB resistance in wheat.

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. Identify and characterize mutations for increased trichothecene and FHB resistance in wheat. Our plan is to use the mutagenized Kronos population (Krasileva et al., 2017) and identify mutations in candidate susceptibility genes and test plants carrying those mutations for FHB and trichothecene resistance. Kronos is a tetraploid exhibiting susceptibility to FHB. This objective is a targeted approach to identify susceptibility genes that when mutated result in resistant plants. We are in the beginning stages of identifying a set of genes that will be our targets to identify mutations.

   Objective 2. Identify mutants for increased tricothecene and FHB resistance in wheat. We will phenotypically screen a random selection of 500 individuals from the Kronos population. To date, we have screened 100 M3 lines in the greenhouse and 100 lines in the field. Although we do not have the complete set of results, the disease severity in the field is very low so it is difficult to discriminate between susceptible and more resistant lines. To date, from the greenhouse screen we have identified five lines that exhibit reduced severity compared to the controls. We will rescreen these lines along with additional lines in the greenhouse in the fall and spring.

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

   We have set up the screening methodology and are in the process of identifying mutant that exhibit reduced severity. Fives lines have been identified that exhibit reduced severity.

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

   We identified five lines that exhibited reduced severity.

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.**

   Yes, the work on this project was impacted by the COVID-19 pandemic. The postdoc working on this project needed to stagger his schedule to make sure to avoid being in the same space with other staff, thus progress on the project was slower than expected.

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

   The postdoc (Sean O'Mara) meets with me regularly, and he participates and presents their work in weekly lab meetings.

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

   We do not have any results to disseminate yet.

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY20 award period (5/17/20 - 5/16/21). 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? Click to enter number here.

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? Click to enter number here.

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 (5/17/20 - 5/16/21). 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
N/A	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
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
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
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 (5/17/20 - 5/16/21**) 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.

Huang, Y., L. Yin, A.H. Sallam, S. Heinen, L. Li, K. Beaubien, R. Dill-Macky, Y. Dong, B.J. Steffenson, K.P. Smith, and G.J. Muehlbauer. Genetic dissection of a pericentromeric region of barley chromosome 6H associated with Fusarium head blight resistance, grain protein content and agronomic traits.
Status: Submitted to Theoretical and Applied Genetics
Acknowledgement of Federal Support: Yes

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

Nothing to report.

Other publications, conference papers and presentations.

Bethke, G.,Y. Huang, G. Hensel, S. Wyant, X. Li, P. Morrell, J. Kumlehn, S. Salvi, F. Berthiller and Gary Muehlbauer. 2020. The barley glucosyltransferanse UGT13248 is required for deoxynivalenol conjugation and type 2 resistance to Fusarium head blight. National Fusarium Head Blight Forum Abstracts 2020 (Online meeting).
Status: Abstract published and poster presented
Acknowledgement of Federal Support: Yes

Huang, Y., L. Yin, A. Sallam, S. Heinen, L. Li, K. Beaubien, R. Dill-Macky, Y. Dong, B.J. Steffenson, K.P. Smith and G.J. Muehlbauer. 2020. Genetic dissection of quantitive trait loci associated with Fusarium head blight resistance, grain protein content and agronomic traits in the pericentromeric region of chromosome 6H in barley. National Fusarium Head Blight Forum Abstracts 2020 (Online meeting).

Status: Abstract published and poster presented

Acknowledgement of Federal Support: Yes

Muehlbauer, G.J. 2020. HvUGT13248 is required for type II resistance in barley. National Fusarium Head Blight Forum Talk 2020 (Online meting)

Status: Talk presented in the Barley CP session

Acknowledgement of Federal Support: Yes