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:	N/A
USDA-ARS Agreement Title:	Pedigree Based Association Analysis of Novel Sources of FHB Resistance in Durum Wheat
FY20 USDA-ARS Award Amount:	$ 62,512
Project/Grant Reporting Period:	5/1/20 - 4/30/21
Reporting Period End Date:	4/30/2021

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
DUR-CP	Enhancing FHB Resistance by Epigenetic Modification of Durum Cultivars	$ 62,512
	FY20 Total ARS Award Amount	**$ 62,512**

Shahryar Kianian

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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: *Enhancing FHB Resistance by Epigenetic Modification of Durum Cultivars*

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

The specific objectives of this project were to:

1) characterize the stability and inheritance of epigenetic changes in FHB resistant durum lines produced by altering the DNA methylation patterns,
2) profile the transcriptome changes that have occurred as a result of epigenetic modification in resistant durum lines, and
3) validate altered gene expression patterns and characterize candidate genes for use as perfect molecular markers in breeding.

The ultimate objective of this project is to enhance FHB resistance in durum cultivars by removal of persistent suppression mechanism. Through this project we aim to develop lines with enhanced FHB resistance and associated molecular markers that can be incorporated into durum breeding programs.

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?

1. Advancement of backcross lines and testing the stability of resistance
2. Testing the agronomic performance of resistant lines as compared with durum cultivars
3. Additional transcriptome analysis and narrowing the list of candidate genes
4. Validation of altered gene expression patterns

b) What were the significant results?

Field testing of a backcross derived population indicated, as expected, segregation for resistance vs. susceptible phenotype. The top 50 resistant and bottom 50 susceptible lines were selected for further testing in the greenhouse. Greenhouse test confirmed the field measurements further indicating the stability of resistance.

The previous transcriptome comparison between a susceptible check (Ben) and the M4 line (E.25.10) provided significant details on the acquired resistance in the M4 line. We further continued with comparing the transcriptome of the M4 lines with their respective parental lines at two time points, 12h and 48h. We compared E.25 (parent) with the M4 lines E.25.10 and E.25.23 and D0.41708 (parent) vs. 41708.72 (M4). A much stronger response was observed in all of the M4 lines. However, the three M4 lines varied in their gene expression and seem to have some common and different set of genes responsible for FHB resistance.

A total of 25 genes with significantly altered gene expression patterns have been identified that could play a critical role in the resistance mechanism. It is possible that a single gene or multiple genes among these 25 (or an upstream regulator) are acting to enhance the resistance in these lines.

Primers for these genes among others (e.g., controls) have been designed and ordered for further testing of gene expression patterns using quantitative real-time PCR.
We field tested the M4 lines along with selected backcross derived lines and durum checks for agronomic performance. There were no significant difference observed.

c) List key outcomes or other achievements.

Selected group of backcross derived lines were sent to the NDSU durum breeding program for testing. They confirmed the resistance and lines were evaluated in preliminary yield trials (PYTs). However, due to quality issues – realizing that they originated from about 12 years old durum varieties-- NDSU breeding program decided that more backcrosses are needed.

Narrowed the list of candidate genes that are now being confirmed and tested for use as molecular markers

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. Field and greenhouse evaluations were significantly impacted (more than laboratory research) due to shutdowns, social distancing requirements, and limitations on travel. Thus, our field evaluations were limited in number of locations and greenhouse evaluations had to be paired back due to limited number of scientists allowed in the space.

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

Dr. Jitendra Kumar is the postdoctoral scientist on this project. Drs. Muehlbauer and Kianian have been actively advising/mentoring Dr. Kumar as he advances through his career. He has actively participated at various on-campus meeting (e.g., Department of Plant Pathology and Agronomy and Plant Genetics Seminar series). He has made several oral presentations to various groups (e.g., departmental, Cereal Disease Laboratory, and lab groups) and has been active in preparing publications from his research.

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

Through presentations and publication of outcomes.

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY20 award period (5/1/20 - 4/30/21). 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 (5/1/20 - 4/30/21). 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
Backcross derived lines	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 (5/1/20 - 4/30/21**) 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:

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

Journal publications.

Kumar, J., R.M. Krishan, S. Pirseyedi, E.M. Elias, S. Xu, R. Dill-Macky and S.F. Kianian. 2020. Epigenetic regulation of gene expression improves Fusarium head blight resistance in durum wheat. Scientific Reports 10(1): 17610. doi: 10.1038/s41598-020-73521-2
Status: Published
Acknowledgement of Federal Support: YES

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

Nothing to report.

Other publications, conference papers and presentations.

Nothing to report.