USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY18 Performance Report
Due date: July 12, 2019

Cover Page

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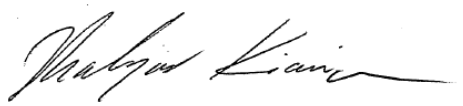
Fiscal Year:	2018
USDA-ARS Agreement ID:	N/A
USDA-ARS Agreement Title:	Pedigree Based Association Analysis of Novel Sources of FHB Resistance in Durum Wheat.
FY18 USDA-ARS Award Amount:	$ 53,140

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
DUR-CP	Enhancing FHB Resistance by Epigenetic Modification of Durum Cultivars.	$ 53,140
	FY18 Total ARS Award Amount	**$ 53,140**



7/12/2019

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

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

Our repeated tests over several years in field nurseries (various locations in ND and MN) and greenhouse screening have identified 5 lines from our epigenetic modification effort, which were significantly more resistant than parental lines and durum checks. These lines also have significantly lower FDK and DON. The specific objectives of this project are to:

1) **characterize the stability and inheritance of epigenetic changes in FHB resistant durum cultivars produced by altering the DNA methylation patterns; and**
2) **profile the transcriptome changes that have occurred as a result of epigenetic modification in resistant durum lines.**

The ultimate objective of this project is to enhance the 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? *Address items 1-4) below for each goal or objective.*

Objective 1: characterize the stability and inheritance of epigenetic changes in FHB resistant durum cultivars produced by altering the DNA methylation patterns.

1) major activities

Develop populations with mutant lines and test for inheritance of FHB resistance.

2) specific objectives

characterize the stability and inheritance of epigenetic changes in FHB resistant

3) significant results

To test the stability of the resistance, we selected two of the most resistant mutant M_4 lines and backcrossed them to the parental cultivars and advanced them for three generations without selection or screening for resistance. The BC_1F_3 plants were evaluated in the greenhouse and under field conditions. Visual scoring for the FHB infection and DON analysis revealed stable inheritance of the resistance in the backcross-derived line (i.e., a number of families showed consistent resistant phenotype similar to or better than that of our resistant check ‘Alsen’.

4) key outcomes or other achievements

The original M_4 lines were sent to ND durum breeding program for inclusion in their crossing program. We intend to, upon further validation, send the most resistant backcross lines to the durum breeding program as well.

Objective 2: profile the transcriptome changes that have occurred as a result of epigenetic modification in resistant durum lines.

1) major activities

Transcriptome profiling of resistant lines to identify genes/pathways that lead to enhanced resistance and identify markers that can be used in the breeding effort

2) specific objectives

profile the transcriptome changes that have occurred as a result of epigenetic modification

3) significant results

Two most resistant lines, along with a susceptible check were inoculated under controlled conditions and tissues were collected at 3 different time points (mock inoculation, 12h and 48h) and from three biological replicates, resulting into 27 samples, and used for RNAseq analysis. Transcriptome analysis (with a mean library size of ≈ 200 bp, quality scores of ≥Q30 and approximate coverage of 32 - 50 million reads per samples) of the selected lines (treated and susceptible check) yielded 34 novel and 43 known genes that showed ≥ 4-fold increase in gene expression levels than controls. Upon validation of these results by real-time quantitative PCR, we plan to use the a) sequenced durum ('Kronos') mutants and b) VIGS or genome editing tools to look for impact of mutations in these genes on FHB resistance.

4) key outcomes or other achievements

These analyses should provide us with a set of markers that tag the critical genes and can be used in the breeding effort. Additionally, this analysis is critical in identifying the gene(s)/pathways in durum wheat that lead to improved FHB resistance.

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

Dr. Jitendra Kumar is the postdoctoral scientist on this project. Drs. Bradeen 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 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.

4. 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 FY18 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 FY18 award period?** NO.

   If yes, how many?

2. **Did any graduate students in your research program supported by funding from your USWBSI grant earn their Ph.D. degree during the FY18 award period?** NO.

   If yes, how many?

3. **Have any post docs who worked for you during the FY18 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 FY18 award period and were supported by funding from your USWBSI grant gone on to take positions with private ag-related companies or federal agencies?** No

   If yes, how many?

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 FY18 award period. 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** (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 FY18-FPR_Instructions for detailed instructions for listing publications/presentations about your work that resulted from all of the projects included in the FY18 grant. Only include citations for publications submitted or presentations given during your award period. If you did not have any publications or presentations, state 'Nothing to Report' directly above the Journal publications section.

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

> Conley, E.J., and J.A. Anderson. 2018. Accuracy of Genome-Wide Prediction for Fusarium Head Blight Associated Traits in a Spring Wheat Breeding Program. In: Proceedings of the XXIV International Plant & Animal Genome Conference, San Diego, CA.
> Status: Abstract Published and Poster Presented
> Acknowledgement of Federal Support: YES (poster), NO (abstract)

Journal publications.

Nothing to Report

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

Nothing to Report

Other publications, conference papers and presentations.

Kumar, J., S. Xu, E.M. Elias, R. Dill-Macky, and S.F. Kianian. Epigenome modification in durum wheat provides FHB resistance. Proceeding of the National Fusarium Head Blight Forum. Dec. 2018 poster #60
Status: Published
Acknowledgement of Federal Support: YES

Kumar, J., S. Xu, E.M. Elias, R. Dill-Macky, and S.F. Kianian. FHB resistance in durum wheat via epigenome modification. International Plant and Animal Genome Conference. Jan. 2019 poster #PE1028
Status: Published
Acknowledgement of Federal Support: YES