

USDA-ARS | U.S. Wheat and Barley Scab Initiative
FY21 FINAL Performance Progress Report

Due date: July 26, 2023

Cover Page

USDA-ARS Agreement ID:	59-0206-0-161
USDA-ARS Agreement Title:	Genetic Characterization and Selection for Fusarium Head Blight Resistance in Durum Wheat
Principle Investigator (PI):	Xuehui Li
Institution:	North Dakota State University
Institution UEI:	EZ4WPGRE1RD5
Fiscal Year:	2021
FY21 USDA-ARS Award Amount:	\$39,468
PI Mailing Address:	North Dakota State University, Department of Plant Sciences NDSU Dept # 7670, PO Box 6050 Fargo, ND 58108-6050
PI E-mail:	xuehui.li@ndsu.edu
PI Phone:	701-231-7574
Period of Performance:	6/1/21 - 5/31/23
Reporting Period End Date:	5/31/2023

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
DUR-CP	Genomics-Assisted Recurrent Selection to Enhance FHB Resistance in Durum Wheat	\$39,468
FY21 Total ARS Award Amount		\$39,468

I am submitting this report as a: FINAL 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.

Xuehui Li

7/2/2023

Principal Investigator Signature

Date Report Submitted

* 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: Genomics-Assisted Recurrent Selection to Enhance FHB Resistance in Durum Wheat

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

Objective 1. Develop durum wheat germplasm with improved FHB resistance through recurrent phenotypic selection.

Objective 2. Explore genomics-assisted recurrent selection to accelerate genetic improvement.

Objective 3. Develop new durum wheat lines with improved FHB resistance through introgression of resistance genes from hard red spring 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?

Towards Objective 1

Three cycles of phenotypic selection were conducted from 2019 to 2022, one year per cycle.

Towards Objective 2

The 15 founders, Cycle2, and Cycle3 populations were genotyped using 90K SNP array. Initial prediction models for FHB severity, plant height, and days-to-flowering were developed and validated.

Towards Objective3

Top 2-5 FHB resistance families from the hard red spring wheat recurrent selection Cycle1 and Cycle2 populations were crossed to durum wheat cultivar ND Riveland. A total of 1,010 BC1F1 progenies, 2,400 BC1F2 progenies, and 1020 BC1F3 progenies were screened for FHB severity in greenhouse; a total of 190 BC1F3:4 lines were evaluated in field nurseries.

b) What were the significant results?

Objective 1

Three cycles of phenotypic selection effectively improved FHB resistance in the durum wheat population, but did not change plant height and days-to-flowering. One $S_{0:1}$ line from the Cycle2 and five $S_{0:1}$ lines from the Cycle3 population showed significant lower FHB severity than the check cultivar ND Riveland.

Objective 2

Analysis of 2,700 SNP markers for the 15 founders, Cycle2, and Cycle3 populations indicated that recurrent phenotypic selection did not reduce genetic diversity. Genomic prediction models were developed and validated with accuracies of 0.51, 0.69, 0.61 for FHB severity, plant height, and days to flowering, respectively.

Objective 3

A total of six BC1F3:4 lines were identified with significant lower FHB severity than the check variety ND Riveland.

c) List key outcomes or other achievements.

Objective 1

Of the five $S_{0:1}$ lines from the Cycle3 population with lower FHB severity than ND Riveland, four did not taller than ND Riveland nor flower later than ND Riveland. Screening their progenies is promising to develop desirable inbred lines with improved FHB resistance.

Objective 2

Moderate prediction accuracy was obtained for FHB severity. The Cycle4 population is being evaluated in field nurseries and will be used to update prediction model. Recurrent genomic selection will be applied starting from the Cycle5 population in 2024 to accelerate genetic improvement of FHB resistance.

Objective 3

The six BC1F3:4 lines with significant lower FHB severity than the check variety ND Riveland is being evaluated in field nurseries for further validation. The top lines will be added in the durum wheat recurrent selection population to enrich genetic diversity.

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

Graduate students and hourly students have been involved in inoculation and disease scoring in greenhouse and field nurseries. This provided them a training opportunity for phenotypic evaluation of FHB resistance. Graduate students were also trained for molecular marker genotyping and genomic prediction modeling.

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

The results of recurrent selection for FHB resistance and germplasm derived from this study were shared with wheat breeders and research scientists through personal communication and the annual National FHB Forum. A manuscript is submitted to the journal Crop Science.

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 FY21 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?

- Yes, I've included the citation reference in listing(s) below.
 No, I have nothing to report.

Journal publications as a result of FY21 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).

None

Books or other non-periodical, one-time publications as a result of FY21 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).

None

Other publications, conference papers and presentations as a result of FY21 award

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

Wang, R., J. Axtman, E. Salsman, J. Hegstad, J. Fiedler, S. Xu, S. Zhong, E. Elias, and X. Li. (2021). Recurrent Selection to Develop Fusarium Head Blight Resistance Germplasm for Durum Wheat. *Proceedings of the 2021 National Fusarium Head Blight Forum*; Virtual, December 6-7, 2021. Retrieved from: <https://scabusa.org/forum/2021/2021NFHBForumProceedings.pdf>