

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:	59-0206-0-121
USDA-ARS Agreement Title:	Identify and Develop Durum Wheat Resistant to Fusarium Head Blight
Principle Investigator (PI):	Elias Elias
Institution:	North Dakota State University
Institution UEI:	EZ4WPGRE1RD5
Fiscal Year:	2021
FY21 USDA-ARS Award Amount:	\$177,889
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Period of Performance:	5/5/21 - 5/4/23
Reporting Period End Date:	5/4/2023

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
DUR-CP	Develop Durum Wheat Resistant to Fusarium Head Blight	\$145,520
DUR-CP	Identify Sources of Resistance to Fusarium Head Blight in Durum Wheat	\$32,369
FY21 Total ARS Award Amount		\$177,889

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.

E. Elias

7/6/2023

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: Develop Durum Wheat Resistant to Fusarium Head Blight

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

The relevance of the project's objectives to the goals and research priorities of the USWBSI are as follows:

- a) Breeding FHB-resistant durum wheat (Action VDHR goals 1-3 and CP priority 3-4);
- b) Screen durum populations/experimental lines for FHB resistance in greenhouses and irrigated field nurseries (Action VDHR goal 2 and CP priority 1);
- c) Evaluate experimental lines for DON (Action VDHR goal 2 and CP priority 4);
- d) Use marker assisted selection at the USDA-ARS Genotyping Center in Fargo, ND for selection of valuable loci (Action VDHR goal 2-3 and CP priority 2);
- e) Evaluate identified FHB resistant lines for quality (Action VDHR goal 2 and CP priority 3-4); and
- f) Develop new populations by crossing adapted germplasm to newly identified sources of resistance (Action VDHR goal 1-3 and CP priority 3-4).

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?

- 2 lines were evaluated in the Uniform Regional Durum Nursery
- 49 lines were evaluated in the Elite Advanced Yield Trial
- 90 lines were evaluated in the Advanced Yield Trials
- 1,162 lines were evaluated in the Preliminary Yield Trials
- 57 populations were screened in the field and greenhouses
- 65 new populations were developed
- 1,000 lines were tested for DON
- 4,900 lines were evaluated in the FHB nursery in Prosper, ND
- 2,000 lines were evaluated in the FHB nurseries at Langdon, ND

b) What were the significant results?

- All material listed in major activities above was successfully screened in FHB field irrigated nurseries and the greenhouse.
- All experimental lines in yield trials were evaluated for agronomic and quality traits.
- Several experimental lines from yield trials were evaluated for low cadmium uptake.
- Several experimental lines with moderate resistance combined with low cadmium uptake were selected and advanced for evaluation in 2022.

c) List key outcomes or other achievements.

In 2017, we released a new moderately resistant cultivar ND Riveland. ND Riveland has the lowest disease severity when compared to all cultivars grown in ND. It also has lower DON than all the cultivars with the exception of Joppa. In 2022, ND Riveland was grown on 38.9% of the durum acreage in ND because of its high yield potential, excellent quality, lower FHB severity and low cadmium uptake. Divide and Joppa, the moderately FHB-resistant cultivars, continue to rank in the top three in durum planted acreage. In 2022, collectively Divide, Joppa, and ND Riveland were planted on 63.9% of the acreage in North Dakota. Based on FHB resistance, yield advantage, and the current planted acreage, the three cultivars will generate millions of dollars into the state economy.

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

Two students rated scab nurseries.

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

Gave presentations at Field Days hosted by NDSU Research Centers and to trade teams through the ND Wheat Commissions.

Project 2: Identify Sources of Resistance to Fusarium Head Blight in Durum Wheat

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

The relevance of the project's objectives to the goals and research priorities of the USWBSI are as follow:

- 1) Screen diverse durum accessions from ICARDA for reaction to FHB in an FHB screening nursery located at the Jiangsu Academy of Agricultural Sciences in Nanjing, China (Action VDHR goals 1-3 and CP priority 1);
- 2) Re-evaluate the accessions exhibiting high levels of resistance in the preliminary screening test in the greenhouse and field screening nurseries in North Dakota (Action VDHR goals 1-3 and CP priority 1);
- 3) Determine whether the new sources of resistance carry novel resistant loci by marker haplotyping using the existing markers associated with known resistance QTL (Action VDHR goals 3 and CP priority 2);
- 4) Make crosses using the resistant lines and distribute them to durum wheat breeders (Action VDHR goals 1-3 and CP priority 3).

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?

- 48 lines were tested in elite yield trials from crossing adapted germplasm with various sources of un-adapted moderately resistant accessions, including 5 from crosses with *Triticum dicoccum*, 1 from crosses with PI 277012, and 1 from crosses with ICARDA accessions.
- 90 lines were tested in advanced yield trials from crossing adapted germplasm with various sources of un-adapted moderately resistant accessions.
- 31 populations with 1167 lines were tested in preliminary yield trials from crossing adapted lines to various sources of un-adapted moderately resistant accessions, including 1 population with 80 lines from a cross with *Triticum dicoccum*.
- 6 F₆ populations with 315 lines were advanced in New Zealand winter nursery from crossing adapted lines to various sources of un-adapted moderately resistant accessions.
- 23 F₅ populations made of 558 lines were advanced in New Zealand from crossing adapted lines to various sources of un-adapted moderately resistant accessions.
- 20 F₄ populations were advanced from crossing adapted lines to various sources of un-adapted moderately resistant accessions, including 5 from crossing with ICARDA accessions.
- 23 F₃ populations were advanced from crossing adapted lines to various sources of un-adapted moderately resistant accessions, including 12 from crossing with ICARDA accessions.

- 16 F₂ populations were advanced from crossing adapted lines to various sources of un-adapted moderately resistant accessions, including 2 from crossing with ICARDA accessions.
- 33 crosses were made and advanced from crossing adapted lines to various sources of un-adapted moderately resistant accessions, including 2 from crossing with ICARDA accessions.

b) What were the significant results?

Several experimental lines with FHB resistance from wild relatives and Tunisian sources of resistance were evaluated in yield trials for agronomic and quality traits

c) List key outcomes or other achievements.

Using wild relatives and unadapted germplasm is normally associated with linkage drag. However, from crossing adapted lines to various sources of un-adapted moderately resistant accessions, several experimental lines with lower linkage drag were selected and evaluated in yield trials.

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

Two students rated scab nurseries.

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

Gave presentations at Field Days hosted by NDSU Research Centers and to trade teams through ND Wheat Commissions.

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).

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).

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.

Runhao Wang, Jason Axtman, Evan Salsman, Justin Hegstad, Jason Fiedler, Steven Xu, Shaobin Zhong, Elias Elias, and Xuehui Li. (2022) Recurrent Selection for Fusarium Head Blight Resistance in a Durum Wheat Population In: USWBSI Networking & Facilitation Office (Eds). *Proceedings of the 2022 National Fusarium Head Blight Forum*. Tampa, FL, December 4-6: U.S. Wheat & Barley Scab Initiative. p.103.

Status: Abstract Published and poster presented.

Acknowledgement of Federal Support: YES