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:	59-0206-0-123
USDA-ARS Agreement Title:	Development of Hard Spring Wheat Cultivars Resistant to Fusarium Head Blight
Principle Investigator (PI):	Andrew Green
Institution:	North Dakota State University
Institution UEI:	EZ4WPGRE1RD5
Fiscal Year:	2021
FY21 USDA-ARS Award Amount:	$127,539
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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
VDHR-SPR	Development of Hard Spring Wheat Cultivars Resistant to Fusarium Head Blight	$127,539
	FY21 Total ARS Award Amount	$127,539

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.

_____ 24 July 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: Development of Hard Spring Wheat Cultivars Resistant to Fusarium Head Blight

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1. **What are the major goals and objectives of the research project?**
   2. Obj. 1. Continue to develop varieties adapted to the Northern Plains spring wheat region which are at least moderately resistant to Fusarium head blight using traditional methods, marker assisted selection, and genomic prediction.
   3. Obj. 2. Introgress novel germplasm from pre-breeding into adapted spring wheat backgrounds with suitable end-use quality for breeding and cultivar development.
   4. Obj. 3. Characterize non-Fhb1 resistance (i.e. 'Glenn', 'SY Rowyn') present in breeding program through marker-assisted selection and phenotyping.

5. **What was accomplished under these goals or objectives?** *(For each major goal/objective, address these three items below.)*

Objective 1)

a) What were the major activities?

We screened over 11,000 entries in three misted, inoculated FHB nurseries. These included around 5,000 experimental lines, the statewide variety trial, uniform regional nursery (URN), and uniform regional scab nursery (URSN). Our Y3 and Y4 trials were screened for all available FHB markers at the ARS Genotyping Lab in Fargo. We attempted genomic prediction as well as high throughput phenotyping of FHB nurseries in FY21. We also attempted to correlate visual images of seed samples to FDK as well as DON in order to improve phenotyping for genomic prediction.

b) What were the significant results?

Unfortunately, due to historic heat and drought throughout each location, we were able to obtain almost no FHB data in 2021. This is highly unusual to not observe natural disease symptoms in North Dakota, and almost unheard of to not be able to produce FHB in misted, inoculated nurseries. Unfortunately, this set back our genomic prediction work and led to non-significant results from our seed imaging work. We were able to make selections based on Marker Assisted Selection in conjunction with BLUPs from all previous years of phenotypic data, but we are hopeful for better conditions for disease pressure in 2022.

c) List key outcomes or other achievements.

We released "ND Heron", which is an early maturing variety which is MR for FHB and low in DON accumulation, relative to long term checks.

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

Obj. 2.

What were the major activities?

In 2021 we screened 1500 $F_{4:5}$ breeding lines which were advanced through the offseason by single seed descent after starting as F_2 in the field in 2020. The germplasm lines were in a 'Faller' background and were crosses made with 15FAR1157-1-5 and 15FAR1162-2 from Dr. Steven Xu. These carry the novel 5A QTL from PI277012. The NDSU parents were ND VitPro (Glenn based resistance) and ND Frohberg (Fhb1, 5A). Both NDSU parents also carry Lr34 and have good end-use quality, and straw strength. Single rows were evaluated in the field at one location in addition to screening in the FHB nursery. Selections in 2021 were based on plant height, maturity, straw strength, relative yield potential, and FHB reaction in the misted, inoculated nursery. 3 spikes were selected from each selected row in the field. Selected lines were genotyped in the off-season by the ARS Genotyping Lab and lines carrying Lr34 (from ND VitPro and ND Frohberg), Fhb1 (from Faller recurrent parent, ND Frohberg), and the novel 5A QTL (from the two germplasm lines) were advanced for selection as $F_{5:6}$ headrows at one location in 2022, and in the FHB nursery as well.

What were the significant results?
1169 lines were planted in 2022. The lines appeared to have high yield potential, and many were found to carry multiple FHB resistance alleles, plus Lr34. The germplasm lines used the NDSU variety 'Faller' as the recurrent parent, which needed improvement for leaf rust resistance, dough strength, and straw strength, but had extremely high yield potential and good FHB resistance. We hope to identify lines with good leaf rust and Fhb resistance, which have good yield potential and high end-use quality.

List key outcomes or other achievements.
Because of the collaboration with Dr. Xu and the ARS Genotyping laboratory, we were able to make good progress in FHB breeding despite the challenging field conditions we observed. The previous data on these germplasm lines, plus available markers, made the FY21 portion of the project a success.

Obj. 3.

What were the major activities?
Non-Fhb1 resistance was increased by focused selection efforts on phenotypic resistance in lines with Glenn in the pedigree. Additionally, the novel QTL on 5A was selected for in addition to the Sumai-3 resistance from 3B and 5A. Because low cost genotyping is still a barrier for Genome Wide Association analysis in early generations, greater emphasis was placed on Fusarium damaged kernel (FDK) and DON content for Glenn derivatives in the breeding program.

List key outcomes or other achievements.
Genome wide association analysis was unsuccessful with limited genotypic data on experimental lines thought to carry non-Fhb1 resistance. Even though it meant forgoing this objective of the project, we supported and now collaborate with Dr. Fiedler's project on sequencing Glenn and other non-Fhb1 resistant lines because we believe that this is much more conclusive research approach.

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

Undergraduate students were trained in data collection and research methodology. One graduate student (Lucas Batista) began a project which had an FHB component which was unfortunately abandoned due to lack of disease progress.

How have the results been disseminated to communities of interest?

Variety Release, contributions to the Annual Variety Trial Results and Selection Guide

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.