USDA-ARS | U.S. Wheat and Barley Scab Initiative

FY22 Performance Progress Report

Due date: July 26, 2023

Cover Page

USDA-ARS Agreement ID:	59-0206-2-115
USDA-ARS Agreement Title:	Wheat Breeding for Enhanced Fusarium Head Blight (FHB) Resistance in North Dakota
Principle Investigator (PI):	Andrew Green
Institution:	North Dakota State University
Institution UEI:	EZ4WPGRE1RD5
Fiscal Year:	2022
FY22 USDA-ARS Award Amount:	$123,957
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Period of Performance:	May 1, 2022 – April 30, 2026
Reporting Period End Date:	April 30, 2023

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
VDHR-SPR	Developing Improved Cultivars of North Dakota Hard Spring Wheat	$123,957
	FY22 Total ARS Award Amount	$123,957

I am submitting this report as an: ☒ Annual 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.

_____ 25 July 2023 _____

Principal Investigator Signature Date Report Submitted

ǂ 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: Developing Improved Cultivars of North Dakota Hard Spring Wheat

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

A) Developing MR lines of hard spring wheat for North Dakota
Continue to develop new and competitive moderately resistant lines of hard spring wheat for North Dakota and the Northern Plains. Maintain inoculated FHB nurseries to achieve this goal, along with screening the commercial variety trial and uniform nurseries. Selection under natural conditions is conducted when the opportunity occurs.

B) Increasing breeding efficiency for FHB
-Develop prediction models using photographs of grain to estimate Fusarium damage and DON
-Predict entries in FHB nursery using genomic selection to validate genomic selection models

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

Objective A

a) What were the major activities?
Three misted, inoculated FHB nurseries were planted with a total of 8540 plots. One location was abandoned due to lack of FHB pressure and significant Bacterial leaf streak. Data were recorded at the Prosper location 21 days after anthesis, with the majority of experiments being rated by two different individuals. All plots were harvested and FDK was recorded. At the Langdon location, plots were rated once, 21 days after the mean flowering date and around 50% of the plots were harvested with FDK collected. 3000 total samples from both sites were submitted for DON analysis.

b) What were the significant results?
FHB data were sufficient to discard a large number of experimental lines after zero useful FHB phenotyping in 2021. Cuts to program materials were made prior to any quality analysis and around 50% of experimental lines were discarded due to excessively low yield, high FHB infection, or poor straw strength.

c) List key outcomes or other achievements.
Two moderately resistant hard red spring wheat lines were advanced to pre-release with a potential release in 2024. ND Thresher was approved for released on 7/1/2023 during the January release meeting. ND Thresher is an MR line with adaptation to eastern ND and good BLS resistance. It is a cross between ‘Faller’ and ‘Bolles’.

Objective B

a) What were the major activities?
680 samples were analyzed visually for Fusarium damaged kernels (FDK) and by the VIBE seed analyzer and 469 of those were also analyzed for DON. These plots were also visually rated on a 1-9 scale 21 days after anthesis.

Genotyping was completed and selection for major genes (Fhb1, Fhb5) was completed. Genomic prediction was attempted with 2022 entries. Following a year with no FHB data in 2021 due to severe statewide drought, this was challenging.

b) What were the significant results?

680 samples were analyzed visually for Fusarium damaged kernels (FDK) and by the VIBE seed analyzer using an RBG camera and prediction model for detecting shrunken and off-colored kernels which are likely scabby. A linear regression model for predicting FDK using the photographs only had an R^2 of 0.46, but the image detection did a better job of predicting DON on the 469 samples, with R^2 of 0.24 (FDK) and 0.34 (VIBE photos). It was noted that many samples were discolored and that Fusarium was difficult to see on the grain in 2022 and we anticipate that with additional years data, these models will continue to improve.

Implementing genomic prediction models continue to be challenging. Throughout the reporting year we were without a researcher to dedicate attention to this project. Preliminary analysis of FHB traits suggest that a more careful selection of the training population is necessary. We are in the process of optimizing training population and predicting indices rather than per se traits, following the work of Verges et al. (2020), which was funded by USWBSI.

c) List key outcomes or other achievements.

After two years of capturing seed images from Fusarium nurseries, we are confident that our image-based predictions for FDK are as good as the visual assessments we had been recording. This is critical because the FDK assessments are subjective, and require an extensively trained disease rater to collect the data. Utilizing the seed imager saves considerable resources because it is a low skill task.

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

We have trained two undergraduate students on data collection all the way from threshing to seed imaging and then grinding of DON samples. A recently graduated M.S. student (Lucas Batista) also helped to refine the image predictions.

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

ND Heron (PI 699926) is a hard-red spring wheat with very good resistance to DON and FHB infection which was distributed through the ND County Crop Improvement system in Spring 2023.

FHB data are annually provided to stakeholders through the Spring Wheat Variety Trial Results and Selection Guide.

Project leader A. Green speaks at around 8 Summer field days and 2-3 winter meetings annually where FHB data are included and FHB resistance is discussed.

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 FY22 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 May 1, 2022 – April 30, 2023?

☒ Yes, I've included the citation reference in listing(s) below.

☐No, I have nothing to report.

Journal publications as a result of FY22 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).

Green, A. J., Mergoum, M., Frohberg, R., Underdahl, J., Horsley, R., Walz, A., Simsek, S., Otteson, B., Heilman-Morales, A. M., Friskop, A., Ransom, J., Rickertsen, J., Ostlie, M., Schatz, B., Hanson, B., Eriksmoen, E., Pradhan, G., Martin, G., Rasmussen, J., …Acevedo, M. (2022). Registration of 'ND VitPro' hard red spring wheat. Journal of Plant Registrations, 00, 1– 7. https://doi.org/10.1002/plr2.20239
Role: Corresponding Author.

Green, A. J., Mergoum, M., Frohberg, R., Underdahl, J., Walz, A., Selland, T.,Miranda, A., Simsek, S., Otteson, B., Heilman-Morales, A. M., Murillo, D., Friskop, A.,Ransom, J., Rickertsen, J., Ostlie, M., Schatz, B., Hanson, B., Mehlhoff, R., Eriksmoen, G., Martin, G., Fiedler, J., Rasmussen, J., … Gill, U. (2022). Registration of 'ND Frohberg' hard red spring wheat. Journal of Plant Registrations, submitted.
Role: Corresponding Author.

Books or other non-periodical, one-time publications as a result of FY22 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 FY22 award

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

Keene, C., Green, A., Simsek, S., Friskop, A., Friesen, T., Liu, Z., Zhong, S., Rickertsen, J., Eriksmoen, E., Hanson, B., Martin, G., Pradhan, G., and Ostlie, M. (2022) North Dakota Hard Red Spring Wheat Variety Trial Results for 2022 and Selection Guide (vol. A574-21). North Dakota Cooperative Extension Service. Available online https://www.ndsu.edu/agriculture/extension/publications/north-dakota-hard-red-spring-wheat-variety-trial-results-2022-and-selection