

USDA-ARS
U.S. Wheat and Barley Scab Initiative
FY19 Performance Report
Due date: July 24, 2020

Cover Page

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Fiscal Year:	2019
USDA-ARS Agreement ID:	59-0206-8-200
USDA-ARS Agreement Title:	Development of Hard Spring Wheat Cultivars Resistant to Fusarium Head Blight
FY19 USDA-ARS Award Amount:	\$ 122,465
Recipient Organization:	North Dakota State University Office of Grant & Contract Accounting NDSU Dept 3130, PO Box 6050 Fargo, ND 58108-0650
DUNS Number:	80-388-2299
EIN:	45-6002439
Recipient Identifying Number or Account Number:	FAR0028564
Project/Grant Reporting Period:	5/5/19 - 5/4/20
Reporting Period End Date:	5/4/2020

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	\$ 122,465
FY19 Total ARS Award Amount		\$ 122,465



16 July 2020

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: *Development of Hard Spring Wheat Cultivars Resistant to Fusarium Head Blight*

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

- 1) Continue to develop varieties adapted to the Northern Plains spring wheat region which are at least moderately resistant to Fusarium head blight.
- 2) Screen breeding lines, varieties, and uniform nurseries in misted, inoculated nurseries, and test those entries for DON accumulation.
- 3) Characterize non-Fhb1 resistance present in breeding program through marker-assisted selection and phenotyping.
- 4) Identify germplasm which is low in DON accumulation in addition to having a low visual rating score for disease presence.
- 5) Introgress novel germplasm from pre-breeding into adapted spring wheat backgrounds with suitable end-use quality for breeding and cultivar development.
- 6) Utilize marker assisted selection for FHB resistance in cooperation with the USDA-ARS genotyping facility.

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

1 - a) What were the major activities? Successful phenotyping at three misted, inoculated nurseries.

b) What were the significant results - include major findings, developments, or conclusions?

We had a very successful year for phenotyping in 2019, allowing us to cut MS/S lines from the program. A selection index using FDK, visual score, and DON was used.

c) List or state key outcomes or other achievements. Include a discussion of stated goals not met.

We released 'ND Frohberg', which is moderately resistant to FHB.

2- a) What were the major activities?

We conducted three successful inoculated nurseries in 2019. We phenotyped every entry for FDK for the first time and were able to screen all fixed breeding lines, entries in the variety trial, and uniform nurseries.

b) What were the significant results - include major findings, developments, or conclusions? The most significant result was a streamlined DON sample preparation process which allowed us to receive DON data in time for breeding advancement decisions, despite harvest being significantly delayed.

c) List or state key outcomes or other achievements. Include a discussion of stated goals not met.

3- a) What were the major activities?

Preliminary genome-wide association analysis was conducted, and we genotyped an additional 250 individuals with the Illumina 90k SNP array. Our goal is to identify selectable markers for non-Fhb1 based resistance in our program. We are phenotyping

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a large training population this summer (2020) to develop models to use for predictions going forward.

b) What were the significant results - include major findings, developments, or conclusions?

Preliminary results suggest that at least 40% of MR lines for FHB in our program share the 'Glenn' based (non-Fhb1) resistance. This underscores our need for developing selectable markers from this resistance.

c) List or state key outcomes or other achievements. Include a discussion of stated goals not met.

Marker assisted selection won't be possible until loci are identified which are contributing to the non-Fhb1 resistance in our program. While it doesn't show in this project, the PI submitted a proposal as a Co-PI for the most recent funding cycle for deep sequencing of 'Glenn' resistance. Between our approach of Genome wide association analysis as well as whole genome prediction plus the results of the sequencing work, we hope to have selectable markers soon.

4- a) What were the major activities?

As was mentioned, we were able to incorporate DON data into our annual selection, which is not always possible when data take a long time to generate. A selection index favoring DON and FDK was used with multi-location visual scores to make breeding advancements.

b) What were the significant results - include major findings, developments, or conclusions

Disease pressure was very high in 2019. This made it difficult to separate many lines which performed similarly for FHB on a visual basis. Our program only started submitting DON samples from our inoculated nurseries in 2016, and FDK wasn't collected until 2018. Having the "whole picture" has improved our phenotypic data for this important disease.

c) List or state key outcomes or other achievements. Include a discussion of stated goals not met.

We identified a number of lines across multiple generations which showed lower DON accumulation and FDK than the most resistant checks. We hope to confirm this resistance in 2020.

5- a) What were the major activities?

We developed approximately 50 populations to introgress novel resistance stemming from PI 277012. These backcross lines were developed by Steven Xu.

b) What were the significant results - include major findings, developments, or conclusions?

Preliminary screening of the new parental lines in 2019 suggest that they are moderately

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resistant to other foliar diseases, and were among the most resistant FHB lines in our nurseries. These are backcross lines that are highly adapted. We expect to recover many lines from these populations with the new resistance.

c) List or state key outcomes or other achievements. Include a discussion of stated goals not met.

Populations from these crosses are being expedited through winter nursery and rapid inbreeding in the breeding program.

6- a) What were the major activities?

Our project had access to some data points from a private collaboration during this funding year and decided to use that for major gene MAS this year. We focused our work with the ARS Genotyping lab on 90k SNP genotyping, which we are currently using to develop genomic prediction models for FHB.

b) What were the significant results - include major findings, developments, or conclusions?

Because of the prevalence of 'Glenn' based resistance in our program, which isn't mapped, we expect genome wide prediction to be a superior breeding strategy for FHB genotyping. Preliminary results suggest that a good deal of our resistance is different from major QTL that have been mapped.

c) List or state key outcomes or other achievements. Include a discussion of stated goals not met.

The ARS genotyping lab has never refused any project that we have ever initiated. We currently collaborate with them on multiple marker assisted backcrossing projects, in addition to MAS on all fixed lines in the program. We also performed multiple 90k projects this year. In an effort to use this valuable resource wisely, we took advantage of the MAS datapoints from another source. The lab is working hard to identify new markers from more sources of FHB resistance, which will continue to make it a valuable resource in the future.

3. Was this research impacted by the COVID-19 pandemic (i.e. university shutdowns, reduced or lack of support personnel, etc.)? If yes, please explain how this research was impacted or is continuing to be impacted.

We are leasing more vehicles from state fleet to comply with a one person per vehicle rule. Our locations planted and maintained have not been impacted.

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

We train undergraduate labor on all aspects of data collection that they assist with in our program. Our research technician in charge of FHB research also attended the annual forum and has collaborated with other scientists on campus doing FHB research to better understand his role.

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

Field day presentations have been done virtually this year, but the PI gave general presentations at 4 field days, and detailed presentations including interpretation of FHB data at three locations. The main way that this information is disseminated is through the annual Variety Trial Results and Variety Selection Guide, which is used by extension officials, crop consultants, faculty and staff when communication about variety resistance ratings. The nurseries, visual ratings, kernel data, and DON data are compiled and (0-9) ratings are given. These data are widely used throughout the region.

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Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY19 award period (5/5/19 - 5/4/20). 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 FY19 award period?**

If yes, how many? Yes, 1

- 2. Did any graduate students in your research program supported by funding from your USWBSI grant earn their Ph.D. degree during the FY19 award period?**

If yes, how many? No.

- 3. Have any post docs who worked for you during the FY19 award period and were supported by funding from your USWBSI grant taken faculty positions with universities?**

If yes, how many? N/A

- 4. Have any post docs who worked for you during the FY19 award period and were supported by funding from your USWBSI grant gone on to take positions with private ag-related companies or federal agencies?**

If yes, how many? N/A

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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 FY19 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
ND Frohberg	HRS	MR	5	2020

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

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Publications, Conference Papers, and Presentations

Instructions: Refer to the FY19-FPR_Instructions for detailed more instructions for listing publications/presentations about your work that resulted from all of the projects included in the FY19 grant award. Only citations for publications published (submitted or accepted) or presentations presented during the **award period (5/5/19 - 5/4/20)** should be included. If you did not publish/submit or present anything, state ‘Nothing to Report’ directly above the Journal publications section.

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

De Wolf, E., D. Shah, P. Paul, L. Madden, S. Crawford, D. Hane, S. Canty, R. Dill-Macky, D. Van Sanford, K. Imhoff and D. Miller. 2019. “Impact of Prediction Tools for Fusarium Head Blight in the US, 2009-2019.” In: S. Canty, A. Hoffstetter, H. Campbell and R. Dill-Macky (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum*, Milwaukee, WI; December 8-10. University of Kentucky, Lexington, KY. p. 12.
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: YES (Abstract and Poster)

Journal publications.

Leier, J., Daba., S., Friskop, A., Johnson, B., Rasmussen, J., Simsek, S., and A. Green. 2020. Fusarium head blight resistance in F₁ hybrid spring wheat. *Can. J. Plant Pathol.*
<https://doi.org/10.1080/07060661.2020.1777207>
Status: Accepted (5/28/20) Submitted 12/2019.
Acknowledgement of Federal Support: Yes (Publication).

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

Ransom J, Green A, Simsek S, Friskop A, Breiland M, Friesen T, Liu Z, Zhong S, Rickertsen J, Eriksmoen E, et al. 2019. *North Dakota hard red spring wheat variety trial results for 2019 and selection guide*. NDSU Extension Service & NDAES. Available online:
<https://www.ag.ndsu.edu/publications/crops/north-dakota-hard-red-spring-wheat-variety-trial-results-for-2019-and-selection-guide/a574-hrs-w-19.pdf>
Status: Published
Acknowledgement of Federal Support: No

Other publications, conference papers and presentations.

Nothing to report.