USDA-ARS | U.S. Wheat and Barley Scab Initiative
FY21 Performance Progress Report
Due date: July 26, 2022

Cover Page

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Fiscal Year:	2021
USDA-ARS Agreement ID:	59-0206-0-178
USDA-ARS Agreement Title:	Breeding Scab Resistant and Low DON Winter Wheat and Barley Varieties for the Great Plains
FY20 USDA-ARS Award Amount:	$142,019
Recipient Organization:	University of Nebraska Department of Agronomy and Horticulture 377H Plant Sciences Building, 1875 N 38th St Lincoln, NE 68583-0915
DUNS Number:	55-545-6995
EIN:	47-0049123
Recipient Identifying Number or Account Number, if any:	25-6235-0352-001
Project/Grant Period:	5/15/21 - 5/14/23
Reporting Period End Date:	5/14/2022

USWBSI Individual Project(s)

USWBSI Research Category[*]	Project Title	ARS Award Amount
BAR-CP	Breed Scab Resistant and Low DON Winter Barley Varieties for the Great Plains.	$33,000
HWW-CP	Breed Scab Resistant and Low DON Hard Winter Wheat Varieties for the Great Plains	$102,036
HWW-CP	Innovated Selection Plan to Improve the FHB Resistance of Hard Winter Wheat	$6,983
FY21 Total ARS Award Amount		$142,019

I am submitting this report as an: ☒ Annual Report ☐ 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.

7/20/2022

Principal Investigator Signature   Date Report Submitted

Project 1: Breed Scab Resistant and Low DON Winter Barley Varieties for the Great Plains.

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1.   What are the major goals and objectives of the research project?
Our goal is to develop winter barley cultivars that are resistant to Fusarium head blight and accumulate reduced levels of DON following infection. Our barley program has traditionally developed feed barley cultivars for regions with low scab risk, however, we are seeing more interest in barley production in regions susceptible to scab, and we are also developing winter malting quality cultivars. Therefore, our objectives are to 1- Evaluate and implement new breeding methods to increase resistance to FHB and the accumulation of mycotoxins; 2-Develop new barley varieties with enhanced resistance to FHB and lower mycotoxins; 3-Evaluate chemical, biological and cultural management strategies that reduce FHB and/or mycotoxin accumulation in barley; and 4- Develop and promote best management strategies through integrated disease management that is robust to conditions experienced in barley production fields in diverse geographies.

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?**
       We added our advanced and elite barley to our scab misting nursery in the fall of 2020 and obtained our first results in 2021. We continued our barley efforts in the 2021-2022 growing season and expanded the inoculated barley nursery by planting the Winter Malting Barley trial and the newly organized winter NABSEN.
       We received new germplasm from our collaborators in the barley community to increase our level of FHB tolerance and low DON in the UNL winter barley germplasm. We made 20 crosses designed to improve FHB tolerance in our germplasm.
       We are also continuing to develop best management practices for winter barley in Nebraska.

   b) **What were the significant results?**
       In our first year screening our advanced and elite barley trials for FHB tolerance, we evaluated 40 elite and 45 advanced lines from the UNL program and also screened the 2021 Winter Malting Barley Trial (WMBT, 27 lines). The WMBT had more FHB tolerant lines than both UNL trials, so we identified several lines that could be used as parents in the future, particularly from the Oregon State program. The UNL advanced barley trial averaged 36% for severity and 67% incidence, with the best line NB21406 scoring 10 and 10% for severity and incidence respectively. The UNL elite trial had a severity average of 26% and incidence of 48%, with the best line NB19423 scoring 7 and 13% for severity and incidence respectively. We will validate the performance of these lines in 2022.

c) List key outcomes or other achievements.

The data from collaborators as well as our UNL scab nursery provided enough data that we submitted two F1 crosses (NB17411/2ND38517 and NB15415/2ND38517) to Dr. Pat Hayes at Oregon State University for production of DH populations. These populations will be evaluated for scab resistance and winter hardiness and made available to all interested breeding programs.

A winter feed barley cultivar, NB10425, was released. It has excellent winter hardiness and yield potential, however, it is susceptible to scab. It is recommended that production be focused in areas with low risk of scab.

3. **What opportunities for training and professional development has the project provided?**
Dr. Fang Wang lead the barley breeding effort from 2020 to May 2022 when she graduated with her Ph.D. Dr. Wang's expertise is in genetic improvement for FHB, so she initiated selection schemes for FHB resistance in barley. Ph.D. student Sheryl Sierra is continuing the barley breeding efforts and made approximately 20 crosses dedicated to improving FHB resistance in our winter barley program in FY21. Both students attended the virtual FHB Forum in 2021.

4. **How have the results been disseminated to communities of interest?**
We continue to use twitter and university outreach publications to reach our growers. In addition, our variety development and release committee is evaluating how to improve marketing of UNL barley varieties. Barley is discussed at UNL field days and seed days and was a particular focus of the High Plains Ag Lab Field Day in 2022. While barley is grown on approximately 60,000 acres in the Southern Great Plains which is smaller than the triticale acreage (estimated to be 400,000+ acres) and the wheat acreage, the combined new marketing strategy should increase barley's visibility in the Great Plains.

Project 2: Breed Scab Resistant and Low DON Hard Winter Wheat Varieties for the Great Plains

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

Our goal is to develop hard winter wheat cultivars that are resistant to Fusarium head blight and accumulate reduced levels of DON following infection. Our objectives are 1- Increase efficiency of coordinated project breeding programs to develop and release FHB resistant varieties by evaluating regional germplasm for FHB tolerance and DON levels; 2- Enhance selection efficiency through technologies such as genomic selection, marker-assisted selection, doubled haploid production and/or high throughput phenotyping leading to pyramiding of major and minor genes for FHB resistance; and 3- Enhance communication and coordination to increase the impact of our research beyond the region.

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?

Obj 1- In FY 21, we tested the regional trials, the UNL preliminary, advanced, and elite yield trials, as well as the UNL state variety trial for FHB and DON accumulation in an inoculated misted nursery.

Obj 2- We continue to grow our preliminary, advanced and elite trials with and without fungicides at Lincoln to determine the effect of disease (primarily FHB and stripe rust) on our lines. In FY 21 the major disease was stripe rust with very little FHB present in non-inoculated trials, therefore, fungicide x genotype interactions are not meaningful for the breeding trials in the 2020-2021 growing season.

Doctoral student Fang Wang continued to develop and evaluate methods for genomic selection of improved FHB tolerance in the Nebraska wheat breeding program.

We continue to advance several segregating populations with Fhb1 and native resistance. We are beginning to evaluate the yield potential of the most advanced lines from these populations and are using them as parents to increase FHB tolerance in our germplasm. In early 2022, we designed a crossing block to target the combination of native resistance with major gene resistance (primarily Fhb1) and agronomic characteristics necessary for production in the Nebraska regions most susceptible to scab. We anticipate that these planned crosses will result in more efficient delivery of FHB tolerance to Nebraska producers.

Obj 3- Doctoral student Fang Wang presented her research to the USWBSI at the 2021 Forum. She also successfully defended her dissertation in a public defense.

b) What were the significant results?

Obj 1- The regional FHB trial location at Lincoln continues to provide data to other programs on their lines and confirms data coming from our program. Approximately one half of our better FHB tolerant and low DON lines have native resistance and the other half have major gene resistance.

Obj 2- We continue to identify native resistance in our lines led by former student Dr. Fang Wang. We have backcrossed Fhb1 into six very important lines (LCS Valiant (NE10478-1, released 2019) and five advanced UNL breeding lines). The lines with Fhb1 are better than their recurrent parent and those lines without native resistance in the recurrent parent are significantly better with the addition of Fhb1. We have also developed preliminary strategies for developing wheat lines with improved FHB tolerance via genomic selection. Dr. Wang explored different size and content of training population and found that for both severity and incidence, larger training populations tended to work better and including lines grown in the same environment in both the training and testing population produced the best results. This demonstrates the impact of environment on FHB severity and incidence and suggests that if we are to use historical data in our genomic selection models successfully, we will need to include a small training population in each year's inoculated nursery.

Obj 3- Dr. Wang continues to share the results of her research and is preparing a manuscript for peer review.

c) **List key outcomes or other achievements.**
We did not release a wheat variety in FY 21.

3. **What opportunities for training and professional development has the project provided?**
Dr. Fang Wang developed the five backcross populations and developed genomic selection models for FHB tolerance selection. She has continued her career working as a postdoc on wheat/barley FHB tolerance with Drs. Frels (UNL) and Cai (USDA-ARS Lincoln, NE).

4. **How have the results been disseminated to communities of interest?**
We continue to use twitter and university outreach publications to reach our growers. In addition, our release system in undergoing revision and we expect better communication with seed dealers and growers in the future. Winter wheat is discussed at field days, seed days, and at the Wheat Quality Council and Nebraska Crop Improvement Days. Our FHB data is presented with every new cultivar to allow seed dealers, growers, millers, and bakers to be better able to select lines for their region.

(Form – PPR21)

Project 3: Innovated Selection Plan to Improve the FHB Resistance of Hard Winter Wheat

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

Our goal is to develop HWW cultivars that are resistant to FHB and accumulate reduced levels of DON following infection. This project is a collaborative work between University of Nebraska, South Dakota State University, and Ohio State University. We have the following objectives: 1- Increase efficiency of coordinated project breeding programs to develop and release FHB resistant varieties; 2- Enhance selection efficiency through technologies such as genomic selection, marker-assisted selection, doubled haploid production and/or high throughput phenotyping leading to pyramiding of major and minor genes for FHB resistance.

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?

200 lines from Nebraska and 200 lines from South Dakota were sent to Dr. Clay Sneller for phenotyping in the 2020-2021 growing season. The lines were also phenotyped and genotyped in the respective states. The 2021 lines included 20 lines from the 2020 cycle to determine the environmental effects on FHB tolerance. All data was provided to Dr. Sneller for a graduate student to test genomic selection models for predicting FHB tolerance across breeding programs.

b) What were the significant results?

Based upon the phenotyping in NE and OH, the best FHB tolerant and low DON lines had either native resistance or Fhb1. Development of genomic selection models is ongoing.

c) List key outcomes or other achievements.

Not applicable at this time.

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

This project is providing an opportunity for an OSU graduate student to develop, test, and validate genomic selection models using germplasm from diverse breeding programs.

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

This results of this project will be disseminated in posters, presentations, and eventually a manuscript.

Publications, Conference Papers, and Presentations

Please include a listing of all your publications/presentations about your <u>FHB work</u> that were a result of funding from your FY21 grant award. Only citations for publications <u>published</u> (submitted or accepted) or presentations <u>presented</u> 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 grant 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 grant 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).

Fang Wang. 2022. "BREEDING FOR FUSARIUM HEAD BLIGHT RESISTANCE OF NEBRASKA WHEAT BY MARKER-ASSISTED SELECTION AND GENOMIC SELECTION." Dissertation.
Status: Deposited
Acknowledgement of Federal Support: Yes

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

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

F. Wang, S. Wegulo, J. Stevens, V. Belamkar, P.S. Baenziger, K. Frels. (2021). Breeding for *Fusarium* Head Blight Resistance of wheat (*Triticum aestivum*) by Marker-Assisted Selection and Genomic Selection. *Proceedings of the 2021 National Fusarium Head Blight Forum,* Virtual; December 6-7. Retrieved from: https://scabusa.org/forum/2021/2021NFHBForumProceedings.pdf

(Form – PPR21)