USDA-ARS
U.S. Wheat and Barley Scab Initiative
FY19 Performance Report
Due date: September 30, 2020

Cover Page

Cooperating Principle Investigator (CPI):	Stephen Baenziger
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Fiscal Year:	2019
USDA-ARS Agreement ID:	58-3020-8-027
USDA-ARS Agreement Title:	Breeding Scab Resistant and Low DON Hard Winter Wheat Varieties for the Northern Great Plains
FY19 USDA-ARS Award Amount:	$ 73,094
Recipient Organization:	University of Nebraska Sponsored Programs 312 N 14th, Alexander West Lincoln, NE 68588-0430
DUNS Number:	55-545-6995
EIN:	47-0049123
Recipient Identifying Number or Account Number:	25-6222-0913-001
Agency PI:	Guihua Bai
Project/Grant Reporting Period:	9/1/19 - 8/31/20
Reporting Period End Date:	8/31/2020

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
HWW-CP	Breed Scab Resistant and Low DON Hard Winter Wheat Varieties for the Northern Plains	$ 69,218
HWW-CP	Genomics Selection for Hard Winter Wheat	$ 3,876
	FY19 Total ARS Award Amount	**$ 73,094**

P. Stephen Baenziger

Principal Investigator — 9/14/2020 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

FY19 Performance Report
CPI: Baenziger, P. Stephen
NACA Agreement #: 58-3020-8-027
Reporting Period: 9/1/19 - 8/31/20

Project 1: *Breed Scab Resistant and Low DON Hard Winter Wheat Varieties for the Northern Plains*

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 that accumulate reduced levels of DON following infection. Specifically, our objectives and associated research activities are:

1. *Increase efficiency of individual breeding programs by developing phenotypic and genomic selection models through coordinated efforts of pyramiding major and minor genes leading to the development and release FHB resistant varieties with lower levels of DON,*
2. *Characterize genotype x fungicide "specific" treatment responses for enhancing FHB resistance and the reduction of DON so information can be given to the MGMT group,* and
3. *Enhance communication and end-user education/outreach relating to resistant varieties and effective management practices.*

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

a) What were the major activities? We continued our traditional crossing program (made ~100 directed crosses for FHB tolerance using native and major gene resistance) and six elite line backcrossing populations (BC_2F_2) for *Fhb1*. We genotyped and advanced lines from the F_5 generation [1597 lines] and used markers to identify *Fhb1* in the F_6 generation) onwards. We improved our mist nurseries and increased our ability to locally screen for FHB tolerance. We evaluated 300 preliminary, 60 advanced, 60 elite lines plus our multistate public and private nursery lines in our mist nurseries. We continue to do our fungicide by genotype trials with fungicide applications at flag leaf and flowering stages to control fungal diseases and specifically FHB. We expanded our efforts in describing our lines to growers through a few field days, but mainly via web-based information using virtual field days that can be shared widely during the growing, seed selection, and planting seasons

b) What were the significant results?

Some of the results will be described in the genomic selection aspect of this report. As expected, we continue to see an increase in the level of FHB tolerance/resistance in our material, for example this year 5% of our preliminary lines contain *Fhb1*. Other lines have native or unknown genetic resistance. This year had relatively little fungal disease including FHB at Lincoln (a 6% loss between our fungicide treated and untreated plots; a difference of 3.6 bu/a). The major controlled diseases at Lincoln were leaf rust and FHB. I do not have a way of tracking virtual field day hits, but certainly it must expand our reach beyond our face to face meetings.

c) List key outcomes or other achievements.

The key outcome of this project is new cultivars with improved FHB tolerance. LCS Valiant (developed as NE10478-1 and licensed to LCS in 2018) which has FHB tolerance just slightly below Overland continues to do well in the FHB prone areas (southeastern and southcentral Nebraska where it ranked 2nd and 6th in the 3-year regional averages, respectively). LCS Valiant has excellent test weight, end-use quality, leaf and stem rust and wheat soilborne mosaic virus resistance, but is susceptible to stripe rust. One advantage of LCS Valiant is that it is earlier than most Nebraska wheat varieties, hence provides the opportunity for growers growing multiple varieties to reduce their risk of FHB by having their varieties flower at different times. One of the *Fhb1* backcross populations is for LCS Valiant. A second line, NW13493, has been recommended for release and is being licensed to a milling company. NW13493 also has good native FHB tolerance (Overland > LCS Valiant > NW13493> Overley) and also has excellent test weight, end-use quality, leaf, stripe, and stem rust and wheat soilborne mosaic virus resistance. NW13493 ranked 3rd in the 3-year averages in both the southeast and southcentral NE trials.

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.

In general, this was a difficult year, but we were able to complete all our objectives, though under stress and it was slow. We were fortunate with our harvest weather.

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

Ms. Fang Wang continues to be an outstanding student on this project and has worked hard to develop our backcross populations and lead our FHB marker assisted selection and genomic selection (discussed below). Another graduate student, Emre Karahan, and a visiting scientist, Mr. Mujahid Alam, assisted Dr. Wegulo's FHB pathology project and learned the rudiments of FHB mist screening. Fang attended the National Scab forum and all three attended the 2020 NAPB virtual meeting.

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

We use multiple methods: emails, extension circulars, twitter, seed and field days, and now virtual tours to provide information to our growers.

Project 2: *Genomics Selection for Hard Winter Wheat*

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

Collectively, screening HWW in the Great Plains and the Eastern USA (Wooster, OH) and using genomic selection (GS) should greatly improve the efficiency of breeding HWW with good FHB resistance. Our Objectives are:

1) Phenotype 400 HWW (200 lines from NE and 200 lines form SD) lines in Ohio. These lines are concurrently being phenotyped in South Dakota or Nebraska.
2) Build GS models and use the models to predict the FHB resistance of HWW that were not phenotyped
3) Use the predicted values to select HWW lines and then validate their resistance by phenotyping them in OH.

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

a) What were the major activities?

400 lines (200 lines from the 2020 NE preliminary yield trial and 200 lines from SD) were phenotyped in OH and the relevant lines were evaluated in NE (200 lines) and in SD (200 lines). All of the lines were genotyped using genotype by sequencing (GBS). The data were shared and genomic selection (GS) models were developed in NE using OSU and NE data and in SD using OSU and SD data. Validation populations and new lines were developed and have been sent to OSU

b) What were the significant results?

As expected, the FHB data from OSU were higher than from NE. 12% of the UNL lines had scores similar to or better than the "resistant" check Truman at OSU. 40% of the UNL lines were equal to or better than the moderately resistant check Freedom at OSU. For the SDSU set, 24.8% of the lines had scores similar to or better than Truman, whereas 62% of the lines had scores similar to or better than Freedom in OSU evaluations. Interestingly the data from OSU and NE were similar in that the more tolerant lines were tolerant in both locations and susceptible lines were susceptible in both locations. Among the most tolerant NE lines were lines that contained *Fhb1* or native resistance. The validation population from UNL that will be screened in 2021 includes 180 new lines from the 2021 preliminary yield trial, 10 previously screened resistant and 10 susceptible lines from the 2020 preliminary yield trial (to document the reliability of our assays), 10 additional lines that are predicted to have good tolerance from the 70 lines not tested at OSU in the 2020 preliminary observation nursery. From SDSU, 224 lines including an approximately 24-line validation set (predicted tolerant or susceptible) will be evaluated at OSU in 2021.

c) List key outcomes or other achievements.

The most important outcome for NE was that our assay when not severely limited by weather (extreme heat, drought or wind during misting) was similar to, though lower than OSU (better lines were better in both assays and poorer lines were poor in both assays) and that we have begun developing genomic selection indices and validation populations for FHB tolerant lines. Furthermore, our lines carrying the marker for *Fhb1* were consistently among the better lines for FHB tolerance. Marker assisted selection for major FHB genes and genomic selection will be critical tools for selecting FHB tolerant lines once we have validated the genomic selection models.

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.

In general, this was a difficult year, but we were able to complete all our objectives, though under stress and it was slow. We were fortunate with our harvest weather.

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

Ms. Fang Wang is using these data as part of her Ph.D. dissertation and learning genomic selection tools. A visiting scientist at OSU helped score the field data.

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

As this is the first year of the project and we only just completed this year's analyses and predictions, it is too early to communicate our results to communities of interest.

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY19 award period (9/1/19 - 8/31/20). 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?**
   Yes

   If yes, how many? 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?**
   Yes

   If yes, how many? 1

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?**
   No

   If yes, how many?

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?**
   No

   If yes, how many?

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**
NW13493	HWW	MR-MS	5.7	Pending licensing

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

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 (9/1/19 - 8/31/20**) 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.

Journal publications.

Bakhsh, A., P. S. Baenziger, G. Bai, and W. Berzonsky. 2019. Agronomic performance of hard red winter wheat lines introgressed with the Fhb1 gene. Pak. J. Agri. Sci., Vol. 56(3), 623-628.
Status: Published
Acknowledgement of Federal Support: YES

Easterly, A. C., N. Garst, V. Belamkar, A. M. H. Ibrahim, J. C. Rudd, J.-B. Sarazin, and P. S. Baenziger. 2020. Evaluation of Hybrid Wheat (*Triticum aestivum* L.) Yield in Nebraska. Crop Science 60:1-13 . https://doi.org/10.1002/csc2.20019.
Status: Published
Acknowledgement of Federal Support: YES

Bolanos-Carriel, C., S. N. Wegulo, P. S. Baenziger, K. M. Eskridge, D. Funnel-Harris, N. McMaster, D. G. Schmale III and H. E. Hallen-Adams. 2020. *Tri5* gene expression analysis during postharvest storage of wheat grain from field plots treated with a triazole and a strobilurin fungicide. Can. J. Plant Pathol. https://www.tandfonline.com/doi/pdf/10.1080/07060661.2019.1700169?needAccess=true
Status: Published.
Acknowledgement of Federal Support: YES

Bolanos-Carriel, C., S. N. Wegulo, H. Hallen-Adams, P. S. Baenziger, K. M. Eskridge, D. Funnel-Harris, N. McMaster and D. G. Schmale III. 2020. Effects of field-applied fungicides, grain moisture, and time on deoxynivalenol during postharvest storage of winter wheat grain. Can. J. Plant Sci. 100: 304-313. https://www.nrcresearchpress.com/doi/pdf/10.1139/CJPS-2019-0075
Status: Published.
Acknowledgement of Federal Support: YES

Bolanos-Carriel, C., S. N. Wegulo, P. S. Baenziger, D. Funnel-Harris, H. E. Hallen-Adams and K. M. Eskridge. 2020. Effects of fungicides, fungicide application timing, and environment on Fusarium head blight in winter wheat. Eur. J. Plant Pathol. https://link.springer.com/article/10.1007/s10658-020-02109-3?wt_mc=Internal.Event.1.SEM.ArticleAuthorOnlineFirst

Status: Published.
Acknowledgement of Federal Support: YES

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

Other publications, conference papers and presentations.

Wang, F., V. Belamkar, S. Wegulo, D. Hyten, K. Eskridge and P.S. Baenziger. 2019. "Genomic Selection for Fusarium Head Blight (Scab) Resistance in Nebraska Winter Wheat." In: S. Canty, A. Hoffstetter, H. Campbell and R. Dill-Macky (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum* (p. 122), Milwaukee, WI; December 8-10. University of Kentucky, Lexington, KY.

Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: YES (Abstract)