USDA-ARS
U.S. Wheat and Barley Scab Initiative
FY20 Annual Performance Progress Report
Due date: July 29, 2021

Cover Page

Principle Investigator (PI):	Katherine Frels
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Fiscal Year:	2020
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 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:	25-6235-0352-001
Project/Grant Reporting Period:	5/15/20 - 5/14/21
Reporting Period End Date:	5/14/2021

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
	FY20 Total ARS Award Amount	**$ 142,019**

(signature) 7/29/2021

Principal Investigator   Date

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[*] MGMT – FHB Management
  FST – Food Safety & Toxicology
      R- Research
      S – Service (DON Testing Labs)
  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

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

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

   This report for each project was prepared by Dr. P.S. Baenziger, who supervised this project from 5/15/20 until his retirement on 5/3/21. Dr. Katherine Frels is his successor at UNL.

   Our goal is to develop winter barley cultivars that are resistant to Fusarium head blight and accumulate reduced levels of DON following infection. Specifically we will address the following Barley-CP objectives *3. Evaluate and implement new breeding methods to increase resistance to FHB and the accumulation of mycotoxins. 4. Develop new barley varieties with enhanced resistance to FHB and lower mycotoxins. 9. Evaluate chemical, biological and cultural management strategies that reduce FHB and/or mycotoxin accumulation in barley. 10. 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 had our advanced and elite nurseries evaluated at Cornell U. thank to Dr. Mark Sorrells in 2020. We had a few elite lines evaluated by Dr. Christina Cowger in 2020. We added our advanced and elite barley to our scab misting nursery in the fall of 2020 and obtained our first results in 2021. Dr. Sorrells evaluated our advanced lines in 2020-21 and Dr. Cowger evaluated our elite lines in regional nurseries. We collected resistant barley lines from the barley community and began making crosses to enhance the level of FHB tolerance and low DON in winter barley.

   b) **What were the significant results?**
      Based on the 2020 data from Dr. Sorrels, all of the advanced and elite barley lines were susceptible. Based on the data on four lines from Dr. Cowger, a few of our lines were better than susceptible. Now that we have a base line of susceptibility and entries from our misting trials, we can begin submitting lines for DON testing and also begin using fungicides to control FHB.

   c) **List key outcomes or other achievements.**
      NB15420, a new winter barley, was released in 2021. It is a major advance over the previous winter barleys (9% higher yielding than P-845, a popular winter hardy barley) with equivalent or better winter hardiness. NB15420 will be a general release.

(Form – PPR20)

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

   We were fortunate in that our crossing block in 2021 was allowed and we had pretty much full staff. The summer of 2020 and our harvest was extremely difficult due to single person per car and combines unless you were related or a roommate capped by covid-19 infections in one combine crew at the end of harvest. All in all, we survived.

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

   Ms. Fang Wang leads our barley breeding effort. She received hands on breeding experience and is expected to graduate in Dec. 2021. She will be replaced by Ms. Sheryl Sierra who has been working with Fang for the past 10 months. Both students worked with Dr. Wegulo's team to learn plant pathology, specifically FHB. Fang attended the virtual FHB Forum in 2020.

5. **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. Barley is discussed at field days, seed days, with maltsters, and brewers. 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*

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. Specifically we will address the following objectives and associated research activities: Objective 1, associated activities. *Increase efficiency of coordinated project breeding programs to develop and release FHB resistant varieties. 2. Characterize genotype x fungicide "specific" treatment responses for enhancing FHB resistance and the reduction of DON 3. Test and evaluate regional germplasm to include breeding lines from the public and private breeding programs;* Objective 2, associated activity 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* Objective 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?**
      We continued to make crosses to FHB tolerant and low DON accumulating lines (~90 crosses involving line with native FHB tolerance and low DON accumulation and those having known FHB major tolerance genes, e.g. *Fhb1*). We advanced the segregating populations and continue to develop lines with good native and major gene tolerance to FHB and have low DON accumulation. We continue to grow our preliminary, advanced and elite trials with and without fungicides at Lincoln to determine the effect of disease (with a major emphasis on FHB) on our lines. We continue to test the regional trials for FHB and DON accumulation.

   b) **What were the significant results?**
      In 2020, the application of fungicides in our elite lines increased grain yield by 6% indicating a relatively low disease year. We continue to identify native resistance in our lines. Approximately one half of our better FHB tolerant and low DON lines have native resistance and the other half have major gene resistance (e.g. *Fhb1*). We have backcrossed *Fhb1* into six very important lines (LCS Valiant (NE10478-1) and five advanced experimental lines). The lines with *Fhb1* are better than their recurrent parent and those without native resistance in the background are marketed better. The regional tests continues to provide data to other programs on their lines and to growers on lines they may grow, as well as, confirms data coming from our program.

c) **List key outcomes or other achievements.**

The major outcome was the release of 'Epoch" (NE15420) hard red winter wheat for irrigated production in Nebraska. It was a general release. Epoch has excellent grain yield, test weight, and protein content under irrigation. Epoch is moderately resistant to stem and stripe rust, and moderately susceptible to leaf rust and FHB. It is moderately high levels of DON accumulation. The backcross lines are being selected for use as parents and potential release.

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

We were fortunate in that our crossing block in 2021 was allowed and we had pretty much full staff. The summer of 2020 and our harvest was extremely difficult due to single person per car and combines unless you were related or a roommate capped by covid-19 infections in one combine crew at the end of harvest. All in all, we survived.

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

Ms. Fang Wang was involved in the backcross population development and has learned breeding and molecular marker techniques, as well as, how to release germplasm from this effort.

5. **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. The combined new marketing strategy should increase wheat's visibility in the Great Plains.

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

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. Specifically we will address the following objectives and associated research activities: 1. *Increase efficiency of coordinated project breeding programs to develop and release FHB resistant varieties; and* Objective 2, associated activity 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?**
       Two hundred lines from Nebraska and 200 lines from South Dakota were sent to Dr. Clay Sneller for phenotyping in 2020. The lines were also phenotyped and genotyped in the respective states. In the fall of 2020 an additional 200 lines from Nebraska and 200 lines from South Dakota were sent to Dr. Clay Sneller for phenotyping in 2021. The lines were also phenotyped and genotyped in the respective states. The 2021 lines included slightly fewer new lines and about 20 lines from the previous year to determine the environmental effects on the phenotyping. Genomic analyses were run on the lines and the first effort to develop genomic selection (GS) algorithms were initiated

    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*. It was impressive to see that the phenotyping identified both sets of lines. Also, while the data from OH was extremely valuable as it has a more consistent FHB infection, the data from NE was actually better for the first attempt at GS, indicated the importance of our local screen with all of its weather related difficulties.

    c) **List key outcomes or other achievements.**
       This is the first year of the project and it is too early to have key outcomes or other achievements beyond what is listed in the significant results

(Form – PPR20)

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

    As this project relied upon Dr. Sneller and OSU for the major phenotyping effort beyond what is listed in our effort to phenotype lines in NE (see previous project), the covid-19 pandemic was relatively minor for NE on this project.

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

    Ms. Fang Wang learned genomic selection protocols which will be a significant part of her dissertation.

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

    It is too early to disseminate results, but Fang will present at the next Scab Forum.

(Form – PPR20)

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY20 award period (5/15/20 - 5/14/21). 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 FY20 award period?**
    ☒Yes   ☐No
    If yes, how many?   2

2. **Did any graduate students in your research program supported by funding from your USWBSI grant earn their Ph.D. degree during the FY20 award period?**
    ☒Yes   ☐No
    If yes, how many?   4

3. **Have any post docs who worked for you during the FY20 award period and were supported by funding from your USWBSI grant taken faculty positions with universities?**
    ☐Yes   ☒No
    If yes, how many?   0

4. **Have any post docs who worked for you during the FY20 award period and were supported by funding from your USWBSI grant gone on to take positions with private ag-related companies or federal agencies?**
    ☐Yes   ☒No
    If yes, how many?   0

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Release of Germplasm/Cultivars

Instructions: In the table below, list all germplasm and/or cultivars released with <u>full or partial</u> support through the USWBSI during the <u>FY20 award period (5/15/20 - 5/14/21)</u>. 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	FHB Rating (0-9)	Year Released
NB15420	BAR - Barley	S - Susceptible	8	2021
Epoch (NE15420)	HRW - Hard Red Winter	MS - Moderately Susceptible	6	2021
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year

NOTE: List the associated release notice or publication under the appropriate sub-section in the 'Publications' section of the FPR.

Publications, Conference Papers, and Presentations

Instructions: Refer to the PR_Instructions for detailed more instructions for listing publications/presentations about your work that resulted from all of the projects included in the FY20 grant award. Only citations for publications published (submitted or accepted) or presentations presented during the **award period (5/15/20 - 5/14/21**) 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:

> Winn, Z.J., Acharya, R., Lyerly, J., Brown-Guedira, G., Cowger, C., Griffey, C., Fitzgerald, J., Mason R.E., and Murphy, J.P. (2020, Dec 7-11). Mapping of Fusarium Head Blight Resistance in NC13-20076 Soft Red Winter Wheat (p. 12). In: Canty, S., Hoffstetter, A. and Dill-Macky, R. (Eds.), *Proceedings of the 2020 National Fusarium Head Blight Forum*. https://scabusa.org/pdfs/NFHBF20_Proceedings.pdf.
> Status: Abstract Published and Poster Presented
> Acknowledgement of Federal Support: YES (Abstract and Poster)

Journal publications.

Baenziger, P.S., R.A. Graybosch, D.J. Rose, L. Xu, M.J. Guttieri, T. Regassa, R. N. Klein, G. R. Kruger, D. K. Santra, G. W. Hergert, S. M. Wegulo, Y. Jin, J. Kolmer, G. L. Hein, J.Bradshaw, M.-S. Chen, G. Bai, R. L. Bowden, I. El-Basyoni, and A. Lorenz. 2020. Registration of 'NE10589' (Husker Genetics Brand Ruth) hard red winter wheat. J. Plant Regist. 14(3): 388–397. doi: 10.1002/plr2.20068.
Status: Published
Acknowledgement of Federal Support: Yes

Bolanos-Carriel, C., S.N. Wegulo, P.S. Baenziger, D. Funnell-Harris, H.E. Hallen-Adams, and K. M. Eskridge. 2020. Effects of fungicide chemical class, fungicide application timing, and environment on Fusarium head blight in winter wheat. Eur. J. Plant Pathol. 158(3): 667–679. doi: 10.1007/s10658-020-02109-3.
Status: Published
Acknowledgement of Federal Support: Yes

Bolanos-Carriel, C., S.N. Wegulo, P.S. Baenziger, K.M. Eskridge, D. Funnell-Harris, N. McMaster, D. G. Schmale, 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. 42: 547-559. doi: 10.1080/07060661.2019.1700169.

Status: Published
Acknowledgement of Federal Support: Yes

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

Nothing to report

Other publications, conference papers and presentations.

Wang, F., S. Wegulo, J. Stevens, V. Belamkar, and P.S. Baenziger. 2020. Breeding for Fusarium Head Blight Resistance of wheat (*Triticum aestivum*) by Marker-Assisted Selection and Genomic Selection (p. 12). In: Canty, S., Hoffstetter, A. and Dill-Macky, R. (Eds.), Proceedings of the 2020 National Fusarium Head Blight Forum.), Virtual; December 7-11. Online: https://scabusa.org/pdfs/NFHBF20_Proceedings.pdf.

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