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

Cover Page

Principle Investigator (PI):	James Anderson
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Fiscal Year:	2020
USDA-ARS Agreement ID:	59-0206-0-133
USDA-ARS Agreement Title:	Breeding and Genomic Selection for Fusarium Head Blight Resistance in Spring Wheat
FY20 USDA-ARS Award Amount:	$ 144,876
Recipient Organization:	Regents of the University of Minnesota Suite 450 Sponsored FIN RPT-P100100001 Minneapolis, MN 55455-2003
DUNS Number:	555917996
EIN:	41 -6007513
Recipient Identifying Number or Account Number:	CON000000086283
Project/Grant Reporting Period:	5/13/20 - 5/12/21
Reporting Period End Date:	5/12/2021

USWBSI Individual Project(s)

USWBSI Research Category[*]	Project Title	ARS Award Amount
VDHR-SPR	Breeding and Genomic Selection for Fusarium Head Blight Resistance in Spring Wheat	$ 144,876
	FY20 Total ARS Award Amount	**$ 144,876**

James A. Anderson July 14, 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: *Breeding Fusarium Head Blight Resistant Spring Wheat*

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

1) Develop Fusarium head blight resistant wheat germplasm and varieties adapted for commercial production in Minnesota and the surrounding region.
2) Characterize the level of FHB resistance of all wheat varieties grown in the region.
3) Utilize genomic selection to improve the efficiency of identifying and discarding FHB susceptible lines.

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?

Objectives 1-2: Scab nurseries were established at two field sites, Crookston and St. Paul, in 2020. A total of 1,480 genotypes were evaluated in 1 to 3 replications for a total of 4,660 plots across the two locations. We evaluated the FHB reaction of external germplasm from the 2020 Uniform Regional Scab Nursery (30 lines) and 2020 Regional Performance Nursery (28 lines) and 38 named varieties in our statewide performance trials. We completed Visual Scabby Kernel (VSK) assessment of all materials from these nurseries and received DON data from select materials, predominantly the most advanced nurseries. FHB ratings (1-9 scale) were assigned to all the named varieties.

Objective 3: We genotyped 2,735 F_5 lines using GBS. Genomic predictions were formulated from a training population of a subset of 502 lines and parents that were phenotyped for field disease severity, VSK and test weight. Marker-assisted selection was also used to characterize parental lines (all done in-house) and the F_5 lines (in cooperation with the USDA-ARS Small Grains Genotyping Center in Fargo). We routinely use DNA markers to screen for genes that provide resistance to Fusarium head blight, leaf rust, Ug99 stem rust resistance, semi-dwarfing, and high molecular weight glutenins that are necessary for good baking quality. The Genotyping Center provided data on 8 gene-specific markers on 2,575 F_5 (almost the full set of 2,735 but some were missing or had bad DNA) lines and 51 parents of F_5 materials, generating 21,008 marker data points. We used the MAS data from the 8 markers, genomic predictions for FHB, and observations from our winter nursery in New Zealand, including seed size measurements to select a set of 504 lines for entry into preliminary yield trials in spring 2021. In addition, since Fall 2020 we screened 1,167 individual F_1 plants from topcrosses and backcrosses and 51 parents from Fall 2020 and Spring 2021 crossing blocks for as many as 48 markers in-house, generating a total of 16,665 datapoints.

b) What were the significant results?

- Both the Crookston and St. Paul FHB screening nursery were excellent, providing highly discriminatory data. From the 2020 FHB nursery data and results from previous years, the FHB resistance of 36 spring wheat cultivars was assessed and reported.
- We used genomic selection at the F_5 stage for FHB to help select lines to advance to preliminary yield trials. This data was more critical this year because in-person evaluation of our pre-yield trial lines in our New Zealand winter nursery was not possible to COVID-10 restrictions.
- Experimental line MN15005-4 was approved for seed increase and will be a candidate for public release January 2022. MN15005-4 (Prosper/MN08301-6//Norden) has a good combination of yield and protein and has straw strength almost as good as Linkert which is the main reason for its 5-yr. reign as the most popular variety in Minnesota. Disease resistance is acceptable and will be rated as a 4 or 5 on 1-9 scale for FHB.

c) List key outcomes or other achievements.

High yielding wheat varieties with high grain protein content, good straw strength and good FHB resistance are in demand by wheat growers because they greatly increase the profitability of wheat production in Minnesota. Recent releases include ‘Linkert’ (2013), ‘Bolles’ (2015), ‘Shelly’ (2016), ‘Lang-MN’ (2017), ‘MN-Washburn’ (2019), and ‘MN-Torgy’ (2020). University of Minnesota developed spring wheat varieties accounted for an estimated 34.5% of Minnesota’s 1.43 million spring wheat acres in 2020, including ‘Linkert’ which was the no. 1 variety for the 5th consecutive year. More than 507,000 acres of MN-developed spring wheat varieties also were grown in North Dakota in 2020. Germplasm from our breeding program is being used as parents by private and public breeding programs in the region. Our goal is to continue to release high yielding, disease resistant varieties with good end-use quality. In addition, we coordinate the testing of ~40 public and private released hard spring wheat varieties per year in statewide trials to assess their performance in yield nurseries, end-use quality assessments, and reactions to important diseases. This information is critical to growers to make informed choices among varieties.

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.

Minimal impact on activities. We did our normal winter nursery seed increase and advancement in New Zealand but I was not allowed to go there to make selection. Selections were made virtually (from photos) and from genomic predictions and other

DNA marker data. As a result, I selected more lines than typical. Our 2021 preliminary yield trials are 29% larger, containing 504 lines instead of the normal 360.

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

All members of my project, regardless of what species they work on (wheat, intermediate wheatgrass, or field pennycress) help with inoculation and scoring of our FHB nurseries. This provides them with knowledge of the importance of this disease and our screening methodologies.

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

Wheat cultivar performance, including FHB reaction, of 38 spring wheat cultivars was assessed and reported to growers via print media, web-accessible publications, winter meetings, and field day presentations. We routinely enter five lines in the regional FHB nursery and a variety candidate performance nursery. The data of these nurseries is publicly available and other participants in the nursery have access to cross with this germplasm.

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY20 award period (5/13/20 - 5/12/21). 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? Click to enter number here.

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? 1

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? 1

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? Click to enter number here.

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 FY20 award period (5/13/20 - 5/12/21). 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
Nothing to report.	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
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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
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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 (5/13/20 - 5/12/21)** 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:

> Z.J. Winn, R. Acharya, J. Lyerly, G. Brown-Guedira, C. Cowger, C. Griffey, J. Fitzgerald, R.E. Mason and J.P. Murphy. 2020. "Mapping of Fusarium Head Blight Resistance in NC13-20076 Soft Red Winter Wheat." In: S. Canty, A. Hoffstetter, and R. Dill-Macky (Eds.), *Proceedings of the 2020 National Fusarium Head Blight Forum (*p. 12.), 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)

Journal publications.

Anderson, J.A., J.J. Wiersma, S.K. Reynolds, E.J. Conley, R. Caspers, G.L. Linkert, J.A. Kolmer, Y. Jin, M.N. Rouse, R. Dill-Macky, M.J. Smith, L. Dykes, and J.-B. Ohm. 2021. Registration of 'Lang-MN' hard red spring wheat. J. Plant Registrations. **https://doi.org/10.1002/plr2.20099**
Status: Published
Acknowledgement of Federal Support: YES

Anderson, J.A., J.J. Wiersma, S.K. Reynolds, E.J. Conley, R. Caspers, G.L. Linkert, J.A. Kolmer, Y. Jin, M.N. Rouse, R. Dill-Macky, M.J. Smith, L. Dykes, and J.-B. Ohm. 2021. Registration of 'MN-Washburn' Hard Red Spring Wheat Containing Barley Yellow Dwarf Virus Resistance Gene *bdv2*. J. Plant Registrations. **https://doi.org/10.1002/plr2.20130**
Status: Published
Acknowledgement of Federal Support: YES

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

Nothing to report.

Other publications, conference papers and presentations.

Adeyemo, E., P. Bajgain, and J.A. Anderson. 2020. Leveraging consecutive breeding populations to train genomic prediction models for Fhb resistance in wheat. In: S. Canty, A. Hofstetter, and R. Dill-Macky (Eds.), *Proceedings of the 2020 National Fusarium Head Blight Forum*. East Lansing, MI/Lexington, KY: U.S. Wheat & Barley Scab Initiative.
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: YES (Poster)

Hay, W.T., S.P. McCormick, M.P. Hojila-Evangelista, M. J. Bowman, R.O. Dunn, M.A. Berhow, J.A. Anderson and M.M. Vaughan. 2020. Rising CO_2 more Severely Impacts FHB Moderately Resistant HRSW Compared to Susceptible Cultivars. In: S. Canty, A. Hofstetter, and R. Dill-Macky (Eds.), *Proceedings of the 2020 National Fusarium Head Blight Forum*. East Lansing, MI/Lexington, KY: U.S. Wheat & Barley Scab Initiative.
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: YES (Poster)