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

Cover Page

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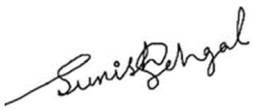
Fiscal Year:	2020
USDA-ARS Agreement ID:	59-0206-0-117
USDA-ARS Agreement Title:	Winter Wheat breeding for Scab Resistance in South Dakota
FY20 USDA-ARS Award Amount:	$ 191,338
Recipient Organization:	South Dakota State University SAD 133, Box 2201 Brookings, SD 57007
DUNS Number:	929929743
EIN:	46-6000364
Recipient Identifying Number or Account Number:	SA2000532
Project/Grant Reporting Period:	5/6/20 - 5/5/21
Reporting Period End Date:	5/4/2021

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
HWW-CP	Developing Winter Wheat Varieties with Enhanced Resistance to FHB and low DON	$ 146,326
HWW-CP	Innovated Selection Plan to Improve the FHB Resistance of Hard Winter Wheat	$ 6,984
GDER	EMS Mutagenized Populations for Characterization of Resistance to FHB in Wheat	$ 38,028
	FY20 Total ARS Award Amount	**$ 191,338**



7/28/21

Principal Investigator Date

* 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: *Developing Winter Wheat Varieties with Enhanced Resistance to FHB and low DON*

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

   The major goal of this project was to successfully address USWBSI – HWW-CP priorities, which are to develop high yielding and high-quality hard winter wheat varieties with improved resistance to FHB and lower DON content. The specific objectives of this proposal are (1) develop FHB resistant and low DON winter wheat varieties for South Dakota and the surrounding regions; (2) pyramiding major and minor genes for FHB resistance by developing phenotypic and genomic selection models for SDSU winter wheat program.

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?
   1) Evaluate Hard Winter Wheat (HWW) cultivars from the region, advanced breeding lines, and germplasm in the mist-irrigated inoculated FHB nursery. Utilization of FHB resistant genotypes as parents in crosses and advance most resistant breeding lines with the lowest disease index, FDK, and DON content.
   2) Participation in multi-location regional screening under the mist-irrigated inoculated FHB nursery (i.e. Regional HWW FHB Nursery).
   3) Marker-assisted selection to enhance FHB resistance in SD germplasm.

   b) What were the significant results?
   1) Data was collected on 10 Elite, 36 Advanced, and 126 Preliminary Yield Trial entries from SDSU winter wheat breeding program in mist irrigated FHB nurseries. Two advanced breeding DH lines SD12DHA01373 and SD12DHA03282 performed well in the state trials and also ranked among the top six in Northern Regional Performance Nursery (NRPN) in 2020. SD12DHA03282 was released as a new variety (SD Andes) with good yield potential and good quality and moderate resistance stripe rust and average FHB tolerance. Another advanced line SD15004-2 shown good yield potential and very good FHB resistance similar to Lyman in 2020. If the line performs well in 2021 and 2022 it may be released in fall 2022.
   2) The FHB disease ratings on regional germplasm in the Northern Hard Winter Wheat FHB Public and Private Nurseries and South Dakota CPT is made available to South Dakota producers, and colleagues at other participating institutions and private industries.
   3) More than 125 crosses were made specifically for FHB resistance and about 40 marker assisted backcrosses were advanced BC1F3 made to incorporate Fhb1 into the South Dakota germplasm and combine with native FHB resistance. Additionally,

promising lines from Lyman x Emerson RILs were identified and being validated in replication in the field in FY21.

c) List key outcomes or other achievements.

The major outcome was the release of 'SD Andes' hard red winter wheat for eastern SD. SD Andes is semi-dwarf wheat (RhtB1b) and is expected to offer the producers a higher-yielding winter wheat variety with excellent straw strength, winter hardiness, and good stripe rust resistance. It has an average tolerance to FHB.

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.

Yes, the SDSU was shut down from mid-March to June 1st, 2020 due to COVID-19. The graduate student experiments and some backcrosses in the greenhouse could not be completed and may cause a minor delay.

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

One graduate student Jinfeng Zhang (partially supported by the project) and two undergraduate and two gradute students got hands-on training/experience in day-to-day operations of the breeding program and FHB screening nursery during this period. Additionally, students assisted with collecting Fusarium damaged kernel (FDK) scores and helped in the preparation of samples for DON analysis.
Jinfeng Zhang also attended the virtual 2020 FHB forum.

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

FHB resistance ratings collected on released cultivars are made available to growers as a part of the annual South Dakota Crop Performance Testing Hard Winter Wheat report. Additionally, data collected from Northern Hard Winter Wheat FHB Public and Private Nurseries is shared back with the colleagues from both public and private breeding programs. The results from this project were shared through virtual field day in 2020 and through articles in appropriate popular press sources, word of mouth, twitter, brochures, and Extension press releases from the Agricultural Experiment Station.

Project 2: *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?**

   200 lines from South Dakota phenotyped both in Ohio (Dr. Clay Sneller) and South Dakota. The lines were also genotyped. In the fall of 2020 an additional 200 lines have been submitted for phenotyping at OSU (Dr. Sneller) along with 200 lines from UNL. These include a small set of lines selected based on 2020 genomic predictions for validation. Genomic prediction models will be evaluated and updated in 2021.

   b) **What were the significant results?**

   Of the SDSU lines evaluated in OSU, 24.8% of the lines had scores similar to or better than Truman (R), whereas 62% of the lines had scores similar to or better than Freedom (MR) demonstrating SDSU material has native resistance. GP prediction using data from multiple years (2018, 2019, and 2020) from South Dakota evaluations showed promise.

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

   First year of project too early for outcomes

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.**

   The project relied on Dr. Sneller (OSU) for phenotyping and had a minor effect of Covid-19, however, the genotyping of the samples was delayed at USDA genotyping center due to restricted access. Overall we have a minor impact of Covid-19 on this project.

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

One graduate student Jinfeng Zhang (partially supported by the project) and another graduate student Harsimardeep Gill (not supported by this grant) got hands-on training in genomic data analysis and genomic prediction.
Jinfeng Zhang attended the virtual 2020 FHB forum.

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

The manuscript from multiple years of South Dakota data in under writing and results will be presented at the next Scab Forum.

Project 3: *EMS Mutagenized Populations for Characterization of Resistance to FHB in Wheat*

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

   The goals of the project are a) development of EMS mutagenized wheat population and b) TILLING resource to characterize gene(s) and understand pathways involved in FHB resistance/susceptibility in bread wheat.

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?**
      1) We are developing EMS mutagenized populations in two wheat cultivars RB07 (MR) and Berkut (S) to identify FHB resistant and susceptibility mutants. Further we are developing a TILLING resource in these two wheat cultivars.

   b) **What were the significant results?**
      Preliminary screening on 750 M4 RB07 and 80 M4 Berkut mutants (M4 lines with enough seed available) were evaluated for FHB under a mist irrigated nursery. RB07 was moderately resistant (Disease Index: 17%) whereas Berkut was susceptible (Disease Index: 41%). Two M4 lines (in RB07 background) highly susceptible to FHB were identified and crossed RB07 (wild type) to develop a mapping population. A small set of Berkut M4 lines were evaluated, one line showed lower disease index as compared to Berkut and is being validated in greenhouse. All promising lines will be re-evaluated in greenhouse and additional lines are being screened in 2021. Generation of TILLING populations is also underway.

   c) **List key outcomes or other achievements.**
      FHB susceptible mutants in RB07 backgorund has been identified.

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.**

   Yes, the SDSU was shut down from mid-March to June 1st, 2020 due to COVID-19. The greenhouse screening and growing of mutant lines could not be performed so there is some delay.

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

   One graduate student got hands on training in mutagenesis and FHB screening.

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

It is the first year of the project so too early to disseminate results.

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY20 award period (5/6/20 - 5/5/21). 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? Click to enter number here.

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 (5/6/20 - 5/5/21). 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
SD ANDES	HRW - Hard Red Winter	MS - Moderately Susceptible	6	2020
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
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 (5/6/20 - 5/5/21**) 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.

Nothing to report.

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

Nothing to report.

Other publications, conference papers and presentations.

Release Notice: Release of 'SD Andes' Hard Red Winter Wheat by South Dakota Agricultural Experiment Station, South Dakota State University. December 15, 2020.
Status: Published
Acknowledgment of Federal Support: Yes