USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY19 Performance Progress Report - NCE
Due date: July 29, 2021

Cover Page

Principle Investigator (PI):	Sunish Seghal
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Phone:	605-688-5709
Fiscal Year:	2019
USDA-ARS Agreement ID:	59-0206-8-194
USDA-ARS Agreement Title:	Winter Wheat breeding for Scab Resistance in South Dakota
FY19 USDA-ARS Award Amount:	$ 77,380
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:	3F4627
Project/Grant Reporting Period:	4/6/19 - 4/5/21
Reporting Period End Date:	4/5/2021

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	$ 73,504
HWW-CP	Genomics Selection for Hard Winter Wheat	$ 3,876
	FY19 Total ARS Award Amount	**$ 77,380**

Signature: Sunish Sehgal

7/28/2021

Principal Investigator   Date

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* MGMT – FHB Management
  FST – Food Safety & Toxicology
       R – Research
       S – Service (DON Testing Lab)
  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

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) Mapping and 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 125 Preliminary Yield Trial entries. Further, 600 F3:6 lines from several crosses were also screened in the mist-irrigated nursery. Two advanced breeding lines SD14113-3 and SD14115-5 performed well in the state trials and ranked among the top five in Northern Regional Performance Nursery (NRPN) in 2018 and 2019. SD14113-3 and SD14115-5 were released as new varieties ('Draper and 'Winner', respectively) with good yield potential and good quality and moderate to intermediate tolerance to rust. Both Draper and 'Winner' showed above-average FHB tolerance better than Wesley and Ideal and comparable to Overland. Another advanced line SD13062-2 had shown very good FHB resistance similar to Lyman in 2018 and 2019 with higher yield potential and better resistance to stripe rust, leaf rust, and BLS, however due to less desirable baking quality it was not released.
      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 150 crosses were made specifically for FHB resistance and about 40 backcrosses were 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 under greenhouse conditions.

c) **List key outcomes or other achievements.**
1) Redfield released in 2013 (moderately resistant to FHB) still has 16% winter wheat acreage in the state based on a recent variety survey conducted by South Dakota Wheat Commission and is the second most popular variety in the state. Oahe (2016) (MR to FHB) has also picked up 14% acres in SD and Thompson (2017) should start picking up some acres from 2020. Two new varieties 'Winner' and 'Draper' were released in fall 2019 for certified seed growers. Both Winner and Draper showed above-average tolerance to FHB in the last 3 years. Breeding materials with better scab resistance and superior yield will be moved to the next breeding cycle and parents for new crosses identified.
2) FHB disease ratings were utilized within the breeding program, shared with
3) Colleagues and data pertaining to released cultivars were made available to regional producers.
4) Selections were made from backcross populations using new Fhb1 markers. This will help increase the frequency of Fhb1 in SD breeding material against FHB.
5) Ultimately, these efforts are expected to lead to the release of FHB resistant winter hardy cultivars and result in reducing grower losses due to FHB epidemics across the region.

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 backcrosses in the greenhouse could not be completed and needs to be repeated and may cause a delay in graduation.

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 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 2019 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.

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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 at four farmer field days last year and through articles in appropriate popular press sources, word of mouth, twitter, brochures, and Extension press releases from the Agricultural Experiment Station.

Project 2: *Genomics Selection for Hard Winter Wheat*

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

   The major goal of this project is to increase the 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. **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) Phenotype 200 SDSU HWW lines (training set) in Ohio (Dr. Clay Sneller) in Summer 2020. Also, phenotype the same set in South Dakota.
      2) Build GS models and use the models to predict the FHB resistance of HWW that are not phenotyped (prediction set).
      3) 3) Use the predicted values to select the HWW lines and then validate their resistance by phenotyping them in OH.

   b) **What were the significant results?**
      The training set of 200 HWW lines was planted in Ohio and South Dakota in October 2019. The phenotype data was recorded in summer 2020. The training and prediction set lines were genotyped at USDA, Manhattan, however, due to COVID-19 the genotype data has been delayed. The GEBVs were esteimated in FY20.

   c) **List key outcomes or other achievements.**
      The project is currently ongoing results and outcomes will be shared on completion.

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 from mid-March to June 1st. The genotyping data for the training and prediction arrived late from USDA due to shut down, however, we were able run prediction models before the next cycle.

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

   Jinfeng Zhang was trained in the genome-wide selection and genome-wide association mapping.

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

The project is in the first year and results will be shared through presentations, journal articles, and farmer field days.

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the **FY19 award period (4/6/19 - 4/5/21)**. 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 FY19 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 FY19 award period?**
    ☐Yes   ☒No
    If yes, how many?   Click to enter number here.

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?**
    ☐Yes   ☒No
    If yes, how many?   Click to enter number here.

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?**
    ☐Yes   ☒No
    If yes, how many?   Click to enter number here.

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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 **FY19 award period (4/6/19 - 4/5/21)**. 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
Winner	HRW - Hard Red Winter	MR-MS	5	2019
Draper	HRW - Hard Red Winter	MR-MS	5	2019
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

(Form – FPPR19)

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 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 (4/6/19 - 4/5/21)** 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.

> Halder J, Zhang J, Ali S, Sidhu JS, Gill HS, Talukdar SK, Kleinjan J, Turnipseed B, Sehgal SK, (2019) Mining and genomic characterization of resistance to tan spot, Stagonospora nodorum blotch (SNB), and Fusarium head blight in Watkins core collection of wheat landraces. BMC Plant Biology 19: 480 (2019). Online: https://bmcplantbiol.biomedcentral.com/articles/10.1186/s12870-019-2093-3
> Status: Published
> Acknowledgment of Federal Support: Yes

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

> Nothing to report.

Other publications, conference papers and presentations.

> Release Notice: Release of 'Winner' Hard Red Winter Wheat by South Dakota Agricultural Experiment Station, South Dakota State University. December 13, 2019.
> Status: Published
> Acknowledgment of Federal Support: Yes

(Form – FPPR19)

Release Notice: Release of 'Draper' Hard Red Winter Wheat by South Dakota Agricultural Experiment Station, South Dakota State University. December 13, 2019.

Status: Published

Acknowledgment of Federal Support: Yes

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