

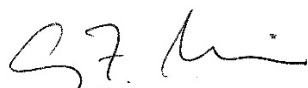
**USDA-ARS**  
**U.S. Wheat and Barley Scab Initiative**  
**FY20 Annual Performance Progress Report**  
**Due date: August 31, 2021**

**Cover Page**

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<b>Fiscal Year:</b>	2020
<b>USDA-ARS Agreement ID:</b>	59-0206-0-160
<b>USDA-ARS Agreement Title:</b>	Transfer of FHB Resistance to NDSU Hard Red Winter Wheat Breeding Material
<b>FY20 USDA-ARS Award Amount:</b>	\$ 58,437
<b>Recipient Organization:</b>	North Dakota State University Office of Grant & Contract Accounting NDSU Dept 3130, PO Box 6050 Fargo, ND 58108-0650
<b>DUNS Number:</b>	80-388-2299
<b>EIN:</b>	45-6002439
<b>Recipient Identifying Number or Account Number:</b>	FAR0031913
<b>Project/Grant Reporting Period:</b>	7/10/20 - 7/9/21
<b>Reporting Period End Date:</b>	7/9/2021

**USWBSI Individual Project(s)**

<b>USWBSI Research Category*</b>	<b>Project Title</b>	<b>ARS Award Amount</b>
HWW-CP	Transfer of FHB Resistance to NDSU Hard Red Winter Wheat Breeding Material	\$ 58,437
<b>FY20 Total ARS Award Amount</b>		<b>\$ 58,437</b>



Principal Investigator

08/18/2021

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

**Project 1: Transfer of FHB Resistance to NDSU Hard Red Winter Wheat Breeding Material**

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

- 1) Increase (annually) the frequencies of FHB resistance genes *Fhb1*, *Qfhs.ifa-5A/Qfhb.rwg-5A1*, *Qfhb.rwg-5A.2* and *Fhb6* within the NDSU breeding population through careful planning and execution of new convergent crosses coupled with marker screening and agronomic evaluation of the segregating progenies.
- 2) Hasten the selection of high yielding, FHB resistant inbred lines in each of three 2-year selection studies. Specific, well-chosen crosses will be employed and large numbers of progeny will be extensively evaluated.
- 3) Initiate (annually, greenhouse) the development of 300-600 new (near-random) single seed descent (SSD) inbred lines from 25-45 select crosses that each segregate for one or more FHB resistance QTL (plus resistance to the wheat rusts). In the next year, the F<sub>4</sub> will be grown in the field for resistance selection and pure line development.
- 4) Conduct an annual Winter Wheat x Fungicide performance trial (field) to evaluate the response of advanced breeding lines and controls to fungicide application for the reduction of DON content.

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

**FY20 - Summary of Progress  
(Answer questions below)**

**a) What were the major activities?**

Objective 1: F2 from 569 crosses (made in 2020) were planted in September 2020 for field evaluation in the summer of 2021. 663 new crosses were made in February 2021 of which 95 aimed to introduce novel FHB and stripe rust resistance. 60 parents were identified from among field planted routine breeding program material. Marker and available data from the Northern FHB Screening Nursery were used to identify parents with known resistance and to plan crosses such that 75-80% will involve at least one parent with FHB resistance.

Objective 2. Study (i): Transfer of the resistance QTL *Qfhb.rwg-5A.1* and *Qfhb.rwg-5A.2* from PI277012 (in GP80) to HRWW produced two B2F3 (GP80/Novus-4//Monument/3/ND Noreen) plants that appeared to be homozygous for the resistance (based on SNP haplotype data). These plants were used to make further backcrosses to HRWW: ND Noreen (132 seeds), 17Nord-96 (12 seeds), 18Nord-103 (13 seeds) and 19Nord-122 (18 seeds). The B3F1 were analyzed with the Infinium 90K SNP platform for continued integration and the plants were tested for FHB Type II

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resistance (greenhouse). Study (ii): An attempt was made to produce high yielding winter wheat lines from eight crosses that involve *Fhb1*, *Qfhs.ifa-5A*, and resistance to leaf-, stem- and stripe rust. Following modified SSD inbreeding, F3-derived F4 families were selected for winter-survival, plant type, and disease resistance in an un-replicated trial (summer of 2021). Study (iii): A double cross made in 2016 was subjected to modified SSD inbreeding. From a large F1 population, 141 near-random F3:4 inbred lines were derived and planted in an un-replicated yield trial. The 40 best F3:5 lines were planted in a replicated yield trial (evaluated in the summer of 2020). The nine highest yielding selections were analyzed with markers and four promising inbred lines were established.

Objective 3: In 2020, a new cycle of SSD inbreeding was initiated from the F2 of 40 crosses ( $\pm$  3,800 plants) to combine significant FHB, leaf and stem rust resistance genes. F2 seedlings were screened with mixed leaf and stem rust inoculum and during inbreeding the plants were selected (greenhouse) for height and fertility. In 2021, a second SSD population is being established from 44 crosses made in February.

Objective 4: A variety X fungicide evaluation trial was planted at Casselton. Twenty-two varieties/inbred lines were either left untreated or sprayed with Prosaro. Corn spawn was put out to encourage disease development.

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

Objective 1: The presence of resistance QTL *Fhb1* and *Qfhs.ifa-5A* was increased in the breeding population. Segregating populations and inbred lines were evaluated for multiple adaptive (ND) traits to raise the possibility to develop inbred lines with broad disease resistance. *Fhb6* and *Qfhb.rwg-5A.2* were introduced on a limited scale.

Objective 2. Study (i): Back- and foreground selection identified the most promising backcrosses. Homozygotes for one or both resistance genes were increased and planted in a replicated greenhouse trial that will aim to confirm that the targeted resistance has actually been transferred. Intermediates that were either homozygous or heterozygous for the resistance markers were involved in 35 crosses (February 2021) with routine program breeding parents. Early indications are that *Qfhb.rwg-5A.1* (previously transferred and also present in the breeding line Novus-4) provides significant resistance that is improved by the presence of *Qfhb.rwg.5A.2*. Study 2: Within superior F4 families, plants were selected based on phenotype. F5 seeds from the best selections (yield, cold-hardiness) will now be marker screened to identify individual plants with superior resistance gene pyramids. The latter plants will be harvested to establish inbred lines for continued evaluation. Study (iii): An F6-derived plant, 16M10-143-2-12; selected from the highest yielding line was the single, most

promising plant with a resistance gene pyramid that contained markers for *Fhb1*, *Qfhs.ifa-5A*, *Lr46/Yr29*, *Lr37/Sr38/Yr17*, and *Lr56*. Three additional plants with *Fhb1* and *Qfhs.ifa-5A* included in lesser pyramids were also identified. The four selections were used for making 39 new crosses with routine breeding parents (February 2021) and were also included in preliminary yield trials destined for field planting in September 2021.

Objective 3: The 2020 SSD population contains about 500 F4 lines that will be field-planted in the fall of 2021.

Objective 4: Due to very hot, dry summer conditions, the variety X fungicide trial was free of FHB and other foliar diseases; therefore, no FHB scores or DON analyses were possible.

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

- (i) In 2020, breeding line 14Nord-01 was released as the variety ND Noreen. Based on 2016 Northern FHB Nursery results obtained by Dr. Bill Bockus, KSU; ND Noreen performed similar to the control, Emerson.
- (ii) Indications are that the very promising resistance gene combination *Ofhb.rwg-5A.1* and *Qfhb.rwg-5A.2* have been incorporated into our winter germplasm

**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.**

Not significantly affected

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

Dylan Barry (MS thesis: Early generation selection for high yield, winter-hardiness, rust- and FHB-resistance in a HRWW cross) graduated in December 2020.

Venkata Ganaparthi (MS thesis: Transfer and pyramiding of Wheat Scab Resistance in Hard Red Winter Wheat) graduated in December 2020.

Sagar Adhikari (MS thesis subject: Combining diverse disease resistance and agrotypes genes for the improvement of hard red winter wheat germplasm). First year of study.

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Bipin Neupane (MS thesis subject: A diallel study - Evaluation of winter wheat lines for FHB genetic background resistance) joined the project in June 2021.

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

Promising breeding material was entered in regional nurseries such as NRPN, RGON, Northern Scab Nursery; USDA stem rust, leaf rust and stripe rust nurseries and variety trials. The results of the Variety X Fungicide trial of 2020/21 will be incorporated in the NDSU annual publication “North Dakota Hard Red Winter Wheat Trial Results and Selection Guide” (available at <https://www.ag.ndsu.edu/publications/crops>).

### Training of Next Generation Scientists

**Instructions:** Please answer the following questions as it pertains to the FY20 award period (7/10/20 - 7/9/21). 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     Not Applicable

**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 FY19 award period?**

Yes     No     Not Applicable

**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     Not Applicable

**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     Not Applicable

**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 full or partial support through the USWBSI during the FY20 award period (7/10/20 - 7/9/21). 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
ND Noreen	HRW - Hard Red Winter	MR - Moderately Resistant	2.8	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
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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

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

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## 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 (7/10/20 - 7/9/21)** 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/NFHB20\\_Proceedings.pdf](https://scabusa.org/pdfs/NFHB20_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.

Nothing to report