

FY21 Performance Progress Report**Due date:** July 26, 2022**Cover Page**

Principle Investigator (PI):	Clay Sneller
Institution:	The Ohio State University
E-mail:	sneller.5@osu.edu
Phone:	330-263-3944
Fiscal Year:	2021
USDA-ARS Agreement ID:	59-0206-0-149
USDA-ARS Agreement Title:	Improving SRWW Resistance to FHB using Traditional and Molecular Breeding
FY20 USDA-ARS Award Amount:	\$261,797
Recipient Organization:	The Ohio State University Department of Horticulture and Crop Science OARDC, 1680 Madison Ave Wooster, OH 44691
DUNS Number:	07-165-0709
EIN:	31-6401599
Recipient Identifying Number or Account Number, if any:	GRT00060449
Project/Grant Period:	6/6/21 - 6/5/23
Reporting Period End Date:	6/5/2022

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
HWW-CP	Innovated Selection Plan to Improve the FHB Resistance of Hard Winter Wheat	\$16,576
VDHR-NWW	Discovering, Understanding, and Utilizing Wheat Genes for FHB Resistance in Ohio	\$63,212
VDHR-NWW	Coordinated Phenotypes of Soft Wheat Germplasm for the Midwest	\$18,024
VDHR-NWW	Implementing Genomic Selection within the NWW Coordinated Project	\$135,664
VDHR-NWW	Assessing FDK, DON, and Fusarium graminearum Biomass in Soft Winter Wheat Grain	\$28,321
FY21 Total ARS Award Amount		\$261,797

I am submitting this report as an: Annual Report Final Report

I certify to the best of my knowledge and belief that this report is correct and complete for performance of activities for the purposes set forth in the award documents.



Principal Investigator Signature

July 26th, 2022

Date Report Submitted

† BAR-CP – Barley Coordinated Project
 DUR-CP – Durum Coordinated Project
 EC-HQ – Executive Committee-Headquarters
 FST-R – Food Safety & Toxicology (Research)
 FST-S – Food Safety & Toxicology (Service)
 GDER – Gene Discovery & Engineering Resistance
 HWW-CP – Hard Winter Wheat Coordinated Project

MGMT – FHB Management
 MGMT-IM – FHB Management – Integrated Management Coordinated Project
 PBG – Pathogen Biology & Genetics
 TSCI – Transformational Science
 VDHR – Variety Development & Uniform Nurseries
 NWW – Northern Soft Winter Wheat Region
 SPR – Spring Wheat Region
 SWW – Southern Soft Red Winter Wheat Region

Project 1: Innovated Selection Plan to Improve the FHB Resistance of Hard Winter Wheat

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

The major object was to assess the ability of FHB rating obtained in Ohio's high FHB environment to predict the FHB resistance of lines from the Great Plains (NE, SD). The goals were to obtain phenotypic from OH, NE, and SD and genotypic data from SD and NE breeding lines and assess the ability of genomic selection to predict genetic values between the environments.

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?

In 2021 we phenotyped 388 HRW breeding lines from NE (200) and SD (188) in Ohio. These lines were also genotyped by NE and SD. OH performed an analysis of the OH phenotypic data and some preliminary GS analyses.

b) What were the significant results?

As in 2020, we obtained high disease pressure with the "R", MR and S checks having index values of 28%, 31% and 61%. There was significant genetic variation for FHB in OH among both the NE and SD lines. Strong moderate resistance was noted with 4.4% of the HRW having greater FHB resistance than Truman ("R" check) and 7.2% having greater FHB resistance than Freedom (MR check). 28.7% were more susceptible to FHB than Pioneer2545 (S check). These percentages show that the HRW are less resistant to FHB than SRWW.

The GS analysis showed that the correlation of the phenotypes of the SD lines with their predicted value based on OH data was 0.30, similar to the correlation of OH phenotypes and SD GEBVs with SD phenotypes.

List key outcomes or other achievements.

The results show that we can obtain phenotypes in OH that can be used to predict FHB resistance in HRW. We will expand on this once we obtain the phenotypic and genotypic data from NE on the phenotyped lines.

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

The study is being done by Lenin Rodriguez Betancourth, a PhD student at Ohio State.

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

The results will be presented in a poster at the 2022 North American Plant Breeders conference

Project 2: Discovering, Understanding, and Utilizing Wheat Genes for FHB Resistance in Ohio

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

The major goal is to develop FHB resistant germplasm with high yield and other desirable traits

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?

In 2021 we assessed the FHB resistance of 1024 Ohio State University breeding lines. All lines were genotyped using GBS and their value predicted using genomic selection.

b) What were the significant results?

A good level of resistance was noted with 35% of the OSU lines having greater FHB resistance than Truman ("R" check) and 52% having greater FHB resistance than Freedom (MR check). Just 6% were more susceptible to FHB than Pioneer2545 (S check). We found 63% of the OSU lines had less DON than Truman.

We predicted the FHB Index of all OSU lines using data from past trials (eg pre-2021) as the training population. The average correlation of observed and predicted values was 0.33. Of the 224 OSU with the lowest 25% of the index values, 52% were also predicted to be in the lowest 25%

c) List key outcomes or other achievements.

The OSU lines continue to show a high prevalence of acceptable FHB resistance, included low levels of DON. This contributed to the release of six OSU breeding lines in July of 2021. One of these, OH15-191-52, had exceptional yield, possessed the resistant allele at Fhb1, and had lower index, FDK and DON levels than Freedom. OH15-131-31 possessed the resistant allele at Fhb1 and was also released due to its good yield and that its DON level was lower than that of Truman.

We also increased the seed of OH16-184-77 which has good yield and very good FHB resistance with DON levels that are 24% lower than those of Truman.

Our results with GS show that GS can be useful at eliminating the most FHB susceptible lines from further trialing.

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

All four OSU PhD students work on this project including packaging, planting, irrigating, rating, and harvesting. The students also produce the GS predictions.

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

The information on the new release was presented at the December 2021 Norgrains meeting.

Project 3: Coordinated Phenotypes of Soft Wheat Germplasm for the Midwest

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

The objective is to evaluate the FHB resistance of elite SRWW lines and commercial varieties and to use the data to develop new cultivars and to inform growers of the FHB resistance in available commercial cultivars.

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?

The major activities are 1) conducting a uniform trial of the FHB resistance of 97 breeding lines from 10 programs and 2) phenotyping the FHB resistance of all entries in the Official Variety Trials (OVT) of each state.

b) What were the significant results?

The 97 entries in the P+NUWWSN were tested in 7-9 locations. In the NUWWSN, the % of lines with greater resistance than Truman was 6% for IND, and 24% DON. In the NUWWSN, the % of lines with greater resistance than Freedom was 26% for IND and 37% for DON. In the PNUWWSN, the % of lines with greater resistance than Truman was 7% for IND and 47% DON. In the PNUWWSN, the % of lines with greater resistance than Freedom was 28% for IND and 35% for DON. In general, the level of resistance in the 2021 trials was not as great as in past years. The frequency of the resistant allele at *Fhb1* was 0.42 among the 50 breeding lines (checks excluded) in the NUWWSN and 0.21 among the 39 breeding lines in the PNUWWSN.

The entries in the OVT were assessed for the IL, KY, MI, OH, and NY trials: IN does not conduct an OVT. In addition, the entries in the 5_state, Uniform Eastern SRWW, Uniform Eastern SWW, and the Mason-Dixon trials were assessed for FHB resistance by at least one program from the NWW-CP.

c) List key outcomes or other achievements.

The main outcome is the dissemination of information on FHB resistance of nearly all current commercial varieties in the upper Midwest as well as most of the advanced breeding lines. This information is vital to breeders as it provides robust, multi-environments data to use in their selection. It is vital to growers so they can choose high yield cultivars with excellent FHB resistance so they can produce a crop with low DON levels.

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

All four OSU PhD students work on this project including packaging, planting, irrigating, rating, and harvesting.

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

The preliminary and full report on the P+NUWWSN is distributed directly to all participants and is posted on the USWBSI website. The results from the OVT is disseminated via state extension service via field days, newsletters, and websites and to grower via Scabsmart.

Project 4: Implementing Genomic Selection within the NWW Coordinated Project

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

The benefits of genomic selection can be increased by implementing GS across multiple programs and coordinating our efforts. Our goal was to genotype all breeding lines from IL, IN, KY, OH, MI, and NY with a common set of markers and then use the markers in genomic selection predictions.

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?

Major activities included 1) placing phenotypic data from 2021 and earlier trials in the T3 data base, 2) preparing T3 to receive data from the 2022 trials, 3) genotyping 5,440 breeding lines using Genotyping-by-sequencing, 4) using the data to make predictions pre- and post-harvest (or assisting individual programs in making predictions), 5) predict the FHB resistance of all entries in the 2020-2021 P+NUWWSN, and 6) performing bioinformatics support in developing an Allegro genotyping platform for SRWW.

b) What were the significant results?

The yield, TW, and FHB resistance was predicted on all genotyped lines within each program. OSU also predicted the value of all breeding lines from all programs, whether grown in OH or not, using phenotypic data from Ohio trials. The GEBV of other lines from other programs were predicted using their own phenotypic data. The GEBVs were very useful in making selection and advancement decisions.

The Allegro platform has been further refined and could be implemented in 2022. The work has focused on reducing the volume of the reaction to reduce costs, identifying markers that are compatible with a high level of multiplexing and cover the wheat genome, and getting the markers for major genes to operate in the Allegro system. The team has identified large sets of SRWW that have been genotyped with GBS, phenotyped, and used in GS. These sets will be genotyped with the Allegro system to prove the value of the new markers in MAS and in GS.

Nearly all data from 2021 trials has been entered into T3. This includes yield, test weight and other agronomic data from the breeding trials of all six programs. That data is now being used in various predictions and evaluation of breeding lines.

c) List key outcomes or other achievements.

The GEBV for yield, TW, FHB resistance and other traits were obtained for > 5,000 lines and were used to making advancement decisions. For example, the OSU program predicted the value of >4000 lines from IL, IN, KY and OH and selected lines from all programs to the 2022 OSU trials.

The new Allegro system will greatly simplify the bioinformatics for calling SNPs. The current GBS system is overwhelmed as we now have > 35,000 lines genotyped and SNP need to be recalled after each new genotyping run.

In addition, the new system will be more flexible in terms of scheduling. We currently submit all samples from all programs at one time for genotyping as that gives us the lowest price. The allegro can be done on smaller batches and would allow programs to perhaps submit samples multiple time per year.

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

The coordinator is a research scientist. He has worked with graduate students at OSU, Purdue and the University of Illinois. We held an in-person meeting in December of 2021. It was attended by graduate students and staff from IL, IN, MI, and OH. Students from KY and VA zoomed in.

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

Marker data and phenotypic data are disseminated vis the T3 database and other means.

Project 5: Assessing FDK, DON, and Fusarium graminearum Biomass in Soft Winter Wheat Grain

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

Our goal is to assess the relationship between FHB index, FDK, DON and the level of fungal infection. We will use these relationships to characterize the level of resistance to toxin accumulation (RTA) in SRWW. Here, RTA is defined as a low accumulation of DON for a particular level of fungal infection as determined by rtPCR.

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?

The major activities include 1) assessing IND, FDK, and DON on lines in the 2020-21 P+NUWWSN using data and grain from four locations. This was also done on 100 breeding lines from the OSU program. 2) Develop a working rtPCR protocol for both fungal and wheat DNA and 3) then perform rtPCR on the ~400 samples collected above.

b) What were the significant results?

Data on field and grain phenotypes (IND, FDK, and DON) were collected in 2021 and more will be collected in 2022. rtPCR has been completed for the 2021 samples in June 2022 though the data has not been analyzed at this time. The level of RTA is expressed as a residual from regressing DON onto an estimate of fungal biomass. Lines with a large negative residual have less DON than expected based on their level of infection. Lines with large positive residuals have accumulated more toxin than expected. Across environments we have identified eight SRWW lines that consistently had negative residuals when regressing DON onto FDK (FDK is acting as a surrogate for the level of infection) and six that consistently had positive residuals.

c) List key outcomes or other achievements.

The results to date indicate that RTA, as defined, appears to be repeatable. Variation in the levels of RTA may explain why some lines that have relatively low IND, or FDK still have high DON and vice versa. The lines with the best and worst RTA were also in 2022 trials to see if the results can be repeated. We will also soon do a similar analysis using the rtPCR estimate of infection levels.

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

The project is part of the PhD program of Lenin Rodriguez Betancourth

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

The results have not been disseminated.

Publications, Conference Papers, and Presentations

Please include a listing of all your publications/presentations about your FHB work that were a result of funding from your FY21 grant award. Only citations for publications published (submitted or accepted) or presentations presented during the **award period** should be included.

Did you publish/submit or present anything during this award period?

- Yes, I've included the citation reference in listing(s) below.
- No, I have nothing to report.

Journal publications as a result of FY21 grant award

List peer-reviewed articles or papers appearing in scientific, technical, or professional journals. Include any peer-reviewed publication in the periodically published proceedings of a scientific society, a conference, or the like.

Identify for each publication: Author(s); title; journal; volume: year; page numbers; status of publication (published [include DOI#]; accepted, awaiting publication; submitted, under review; other); acknowledgement of federal support (yes/no).

Books or other non-periodical, one-time publications as a result of FY21 grant award

Report any book, monograph, dissertation, abstract, or the like published as or in a separate publication, rather than a periodical or series. Include any significant publication in the proceedings of a one-time conference or in the report of a one-time study, commission, or the like.

Identify for each one-time publication: Author(s); title; editor; title of collection, if applicable; bibliographic information; year; type of publication (book, thesis or dissertation, other); status of publication (published; accepted, awaiting publication; submitted, under review; other); acknowledgement of federal support (yes/no).

Other publications, conference papers and presentations as a result of FY21 grant award

Identify any other publications, conference papers and/or presentations not reported above. Specify the status of the publication.