

USDA-ARS
U.S. Wheat and Barley Scab Initiative
FY19 Performance Report
Due date: July 24, 2020

Cover Page

Principle Investigator (PI):	Jessica Rutkoski
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Fiscal Year:	2019
USDA-ARS Agreement ID:	59-0206-8-205
USDA-ARS Agreement Title:	Scab Research Projects and Development of Scab Resistant Soft Red Winter Wheat Varieties at the University of Illinois
FY19 USDA-ARS Award Amount:	\$ 126,267
Recipient Organization:	The Board of Trustees of the University of Illinois Grants & Contracts Office 1901 S. First Street, Suite A Champaign, IL 61820
DUNS Number:	41544081
EIN:	37-6000511
Recipient Identifying Number or Account Number:	AF392
Project/Grant Reporting Period:	6/8/19 - 6/7/20
Reporting Period End Date:	6/7/2020

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
VDHR-NWW	Development of Scab Resistant Soft Red Winter Wheat Varieties	\$ 108,027
VDHR-NWW	Male Sterile Facilitated Recurrent Selection for FHB Resistance	\$ 1,163
VDHR-NWW	Coordinated Phenotyping of Uniform Nurseries and Official Variety Trials	\$ 17,077
FY19 Total ARS Award Amount		\$ 126,267



July 24, 2020

Principal Investigator

Date

* MGMT – FHB Management
FST – Food Safety & Toxicology
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: *Development of Scab Resistant Soft Red Winter Wheat Varieties*

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

The major goals of this research project are to 1) develop and release soft red winter wheat varieties that are resistant to FHB and competitive with other commercial varieties in terms of yield and all other traits of interest to farmers in the region, 2) introgress FHB resistance into breeding germplasm, and 3) develop and map markers for sources of FHB resistance.

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

a) What were the major activities?

For the first major objective, the major activities included making crosses involving FHB resistant parents, advancing segregating populations to develop stable lines, testing lines for FHB resistance as well as other traits that are critical for variety adoption including grain yield, days to heading, test weight, and height. Other major activities include analyzing data across multiple locations and years, making selection decisions and designing new trials.

For the second major objective, the major activities included making crosses involving non-Illinois lines with high levels of FHB resistance, deriving lines from these populations, and evaluating their progeny for FHB resistance and all other important traits.

For the third major objective, the major activities have shifted away from identifying molecular markers linked to FHB resistance genes in favor of using molecular markers to predict FHB resistance in Genomic Selection (GS) models. These activities included genotyping at least 1000 breeding lines per year with genome-wide markers and validating genomic selection models.

b) What were the significant results?

One significant result of this work is that we see improved levels of FHB resistance in the breeding germplasm over time in combination with improved yields, and earlier maturity. We also find that Illinois derived wheat varieties tend to have higher levels of FHB resistance non-Illinois derived wheat lines in our region. However, some our scab resistant lines were developed using parental lines from other breeding programs in the region, especially from Missouri and Purdue. This germplasm exchange was made possible by cooperative nurseries, including the Northern Uniform Scab Nursery and Preliminary Northern Uniform Scab Nursery.

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c) List key outcomes or other achievements.

A key outcome of this objective is that during FY19, more than 10 wheat lines with at least moderate resistance to FHB has been licensed to a seed company for marketing. Foundation seed is being produced for 5 of these lines and we expect that at least 3 lines will be in commercial production in 2022. Another key outcome is that we developed GS models that can predict Deoxynivalenols and Fusarium damaged kernels with an accuracy of 0.64 and 0.82 respectively with will greatly improve our ability to improve FHB resistance in the future in an efficient manner.

3. Was this research impacted by the COVID-19 pandemic (i.e. university shutdowns, reduced or lack of support personnel, etc.)? If yes, please explain how this research was impacted or is continuing to be impacted.

This research has been impacted by COVID-19 significantly because 1) genotyping labs are not allowed to operate at full capacity and genome-wide-marker data that we use for genomic selection are arriving at least 6 months after their scheduled arrival date, and 2) the PI of this project did not have childcare for three months' and is behind on hiring students, writing papers, and releasing varieties.

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

This project has contributed to providing University of Illinois and Parkland college students with summer internships where they have learned about wheat breeding and FHB resistance and we have trained them on different technical aspects of plant breeding and on phenotyping procedures. The student interns have been instrumental in the FHB resistance phenotyping process.

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

Data on FHB resistance of wheat varieties for sale in Illinois has been disseminated on the Illinois state variety testing website and on Scabsmart. The PI has also communicated to Illinois wheat growers about this research and its outcomes at the Summer Wheat Forum, Okawville IL, August 2019, and at a grower meeting at the Siemer Milling Company, Teutopolis IL, January 2020.

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Project 2: Male Sterile Facilitated Recurrent Selection for FHB Resistance

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

The goal of this project is to develop several breeding populations adapted to the eastern U.S. with genes for FHB resistance derived from multiple sources

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

a) What were the major activities?

The major activities of this project include planting male sterile populations in the field along with elite male pollinators, selecting male sterile plants prior to or at anthesis, culling scab-susceptible plants just prior to maturity, selection and harvest of fertile spikes, and selection of a new set of male pollinators prior to planting. Seed from each of the fertile spikes as is planted as headrows, the best headrows are advanced to Stage-1 testing. The lines that enter Stage-1 testing then advance to Stages 2 and 3 if they are among the best in their cohort. The exact details of how the activities are performed vary by cooperator.

b) What were the significant results?

At the University of Illinois, one of the lines derived from the Illinois male-sterile population is among the best performers in terms of both resistance to FHB and grain yield across multiple locations. This line, as well as other male-sterile population derived lines will be tested again next year to evaluate their potential as varieties.

At Cornell university, 19 lines derived from the Cornell male-sterile population were found to have higher levels of resistance than a FHB resistant check from Illinois, and 59 were found be more resistant than the most resistant experimental line originating from the conventional breeding program at Cornell.

c) List key outcomes or other achievements.

Male sterility in the populations is successfully being maintained through careful selection. We have also been successful in developing lines derived from the male-sterile population which have short stature and average maturity, which is one of the main challenges to using a male-sterile recombination system.

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- 3. Was this research impacted by the COVID-19 pandemic (i.e. university shutdowns, reduced or lack of support personnel, etc.)? If yes, please explain how this research was impacted or is continuing to be impacted.**

No, this research was not impacted by COVID-19

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

Undergraduate students have learned to identify male sterile wheat heads and have gained experience in selection of male sterile heads.

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

Seed from the IL male sterile population have been shared with other breeders. Male sterile derived lines currently in stage 2 testing will be made available to private seed companies for licensing within the next 2 years.

Project 3: *Coordinated Phenotyping of Uniform Nurseries and Official Variety Trials*

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

Objectives: 1) Phenotype advanced breeding lines that are candidates for release: 2) place FHB and other agronomic, disease resistance, and quality data in database: 3) provide FHB resistance data for lines and varieties in the OVT to producers and seedsmen.

Data on FHB resistance collected from the OVT entries provide information to seedsmen and producers that can be used in making decisions about which wheat varieties to produce. These data are important because they allow seedsmen and producers to use FHB resistance as one criterion in their variety selection decisions.

Coordinated evaluation of breeding lines among the programs in the NWW provides all breeding programs in the CP with FHB resistance data from multiple locations in a single season. This coordinated evaluation of breeding material plays an important role in the identification of breeding lines with high levels of FHB resistance. Our objective is to cooperatively obtain information on breeding lines from various programs within the CP and the SWW CP to allow the breeders involved to make better decisions about which breeding lines to advance and release.

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

a) What were the major activities?

In 2019 and 2020 field seasons an inoculated, mist irrigated field evaluation nursery at Urbana, IL was used to evaluate the Fusarium Head Blight resistance of entries from the following trials by collecting data on % incidence, % severity, % Fusarium damaged kernels (FDK) and deoxynivalenol (DON) level.

2020 Experiments:

- 86 entries in the Illinois Variety Trial
- 29 entries in the Uniform Eastern Soft Red Winter Wheat Nursery
- 25 entries in the Advanced Five State Nursery
- 25 entries in the Preliminary Six State Nursery
- 61 entries in the Northern Uniform Winter Wheat Scab Nursery
- 50 entries in the Preliminary Northern Uniform Winter Wheat Nursery
- 48 entries in the Southern Uniform Winter Wheat Scab Nursery

b) What were the significant results?

Data from the 2019 Illinois Variety Trial were summarized and distributed. Data on FHB resistance of lines in the 2020 Illinois Variety Trial has been summarized and will be made available to growers as soon as possible online.

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Data collected on cooperative nurseries has been made available to cooperators in each nursery to facilitate selection of FHB resistant breeding lines.

Lines from the University of Illinois program were submitted for all of the cooperative nurseries, thus, breeding lines with FHB resistance were made available to other breeding programs for use as germplasm. Lines submitted from University of Illinois showed high levels of resistance both in 2019 and in 2020. Several breeders requested permission to cross with our breeding lines.

b) List key outcomes or other achievements.

- FHB resistance data collected from the Illinois Variety Trial were made available to producers and seedsmen.
- Data collected on cooperative nurseries will be made available to cooperators in each nursery to facilitate selection of FHB resistant breeding lines.

3. Was this research impacted by the COVID-19 pandemic (i.e. university shutdowns, reduced or lack of support personnel, etc.)? If yes, please explain how this research was impacted or is continuing to be impacted.

No

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

Undergraduate students have gained experience evaluating FHB resistance

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

FHB resistance data collected from the Illinois Variety Trial were summarized and the data made available in the annual Variety Trial Report and on the Illinois Variety Trial website (<http://vt.cropsci.illinois.edu/wheat.html>). These results are also reported on the scabsmart website.

Cooperative testing data has been made available to cooperators over email and also through the T3 database which is open access.

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Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY19 award period (6/8/19 - 6/7/20). 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?**

No

If yes, how many?

- 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?**

No

If yes, how many?

- 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?**

No

If yes, how many?

- 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?**

No

If yes, how many?

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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 FY19 award period. 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 (S, MS, MR, R, where R represents your most resistant check)	FHB Rating (0-9)	Year Released
IL14-28444	SRW	MR	4	2019
IL14-28468	SRW	R	2	2019
IL14-28307	SRW	MR	4	2019
IL15-4957	SRW	MR	3	2019

Add rows if needed.

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

Abbreviations for Grain Classes

- Barley - BAR
- Durum - DUR
- Hard Red Winter - HRW
- Hard White Winter - HWW
- Hard Red Spring - HRS
- Soft Red Winter - SRW
- Soft White Winter - SWW

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Publications, Conference Papers, and Presentations

Instructions: Refer to the FY19-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 (6/8/19 - 6/7/20)** 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:

De Wolf, E., D. Shah, P. Paul, L. Madden, S. Crawford, D. Hane, S. Canty, R. Dill-Macky, D. Van Sanford, K. Imhoff and D. Miller. 2019. “Impact of Prediction Tools for Fusarium Head Blight in the US, 2009-2019.” In: S. Canty, A. Hoffstetter, H. Campbell and R. Dill-Macky (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum* (p. 12), Milwaukee, WI; December 8-10. University of Kentucky, Lexington, KY.

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