

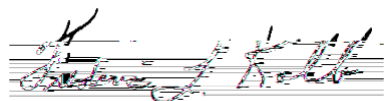
**USDA-ARS**  
**U.S. Wheat and Barley Scab Initiative**  
**FY18 Performance Report**  
**Due date: July 12, 2019**

**Cover Page**

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| <b>Principle Investigator (PI):</b>                    | Fred Kolb  |
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| <b>Fiscal Year:</b>                                    | 2018   |
| <b>USDA-ARS Agreement ID:</b>                          | 59-0206-8-205  |
| <b>USDA-ARS Agreement Title:</b>                       | Scab Research Projects and Development of Scab Resistant Soft Red Winter Wheat Varieties at the University of Illinois.                  |
| <b>FY18 USDA-ARS Award Amount:</b>                     | \$ 126,267   |
| <b>Recipient Organization:</b>                         | The Board of Trustees of the University of Illinois<br>Grants & Contracts Office<br>1901 S. First Street, Suite A<br>Champaign, IL 61820 |
| <b>DUNS Number:</b>                                    | 41544081   |
| <b>EIN:</b>  | 37-6000511   |
| <b>Recipient Identifying Number or Account Number:</b> | AF392  |
| <b>Project/Grant Reporting Period:</b>                 | 6/8/18 - 6/7/19  |
| <b>Reporting Period End Date:</b>                      | 06/07/19   |

**USWBSI Individual Project(s)**

| <b>USWBSI Research Category*</b> | <b>Project Title</b>  | <b>ARS Award Amount</b> |
|----------------------------------|---|-------------------------|
| 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               |
|                                  | <b>FY18 Total ARS Award Amount</b>  | <b>\$ 126,267</b>       |



Principal Investigator

6/20/2019

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

**Project 1:** *Development of Scab Resistant Soft Red Winter Wheat Varieties.*

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

Our major objective is to develop high-yielding, well-adapted soft red winter wheat lines with high levels of scab resistance. This is essential in order to minimize the damage from FHB. Deployment of FHB resistant lines has a major impact on wheat production and increases the stability of wheat yields and economic return from wheat. As more lines with good to excellent scab resistance are identified we are using these parents in crosses, so that in many crosses both parents, or two parents out of three in a three-way cross, are scab resistant. We also believe that it is important to combine several types of resistance rather than rely solely on Type II resistance. We are addressing this by using the ISK index ( $0.3 \times \% \text{ incidence} + 0.3 \times \% \text{ severity} + 0.4 \times \% \text{ shriveled kernels}$ ) to select breeding lines with high levels of scab resistance. Development of varieties with low deoxynivalenol (DON) levels is also crucial; therefore, all breeding lines are evaluated each year for DON level if sufficient scab develops in the scab field nursery. We also beginning to implement genomic selection in the breeding program to enhance selection for scab resistance.

**2. What was accomplished under these goals?** *Address items 1-4) below for each goal or objective.*

1) major activities

In 2018, about 500 breeding lines from the University of Illinois wheat breeding program were evaluated. Scab resistant lines were evaluated for many traits including grain yield, milling and baking quality, standability, and resistance to diseases.

In 2018-19, we produced 372 single crosses, and about 107 three-way and 3 four-way crosses were made involving FHB resistance sources. Forty-four F<sub>3</sub> and F<sub>4</sub> bulks were grown in the inoculated and mist irrigated FHB nursery, and heads were selected.

Soft red winter wheat breeding lines with a high level of FHB resistance and high yield potential were increased for potential release for licensing and potential commercial production. In 2018, eight what breeding lines were released for potential commercial production as brand labelled varieties.

Breeding lines in the preliminary and single plot nursery of the wheat breeding program were genotyped and genomic selection was performed for FHB resistance and other traits using a 273 line association mapping panel and other lines from the breeding program as the training population and phenotypic data collected as part of the breeding program evaluation of breeding lines.

2) specific objectives

1. Continue selection of wheat lines with high levels of FHB resistance.
2. Evaluate all breeding lines for grain yield and test weight, milling and baking quality, standability, and resistance to other diseases.
3. Make crosses involving elite FHB resistant parents.

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4. Implement genomic selection in the breeding program.

3) significant results

- All breeding lines in the program were evaluated for FHB resistance in the inoculated, mist irrigated field evaluation nursery.
- Breeding lines were evaluated for many traits in addition to FHB resistance in order to combine FHB resistance with high grain yield and test weight, milling and baking quality, standability, and resistance to other diseases.
- Genomic data for lines in the Preliminary Yield Trials and in the single plot Augmented Nursery arrived too late for use in the selection of lines to advance for 2018-19 planting, but will be useful for future selection decisions.

4) key outcomes or other achievements

- Over 148,000 units of seed of scab resistant lines from the University of Illinois program were purchased by producers for the 2018-19 planting season.
- Eight new breeding lines were released for potential commercial production. Most of these lines combine very strong FHB resistance with high yield. Several of the lines are also quite early.

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

One graduate student completed her MS during this period.

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

Data from cooperative nurseries were distributed to other wheat breeders.

**Project 2:** *Male Sterile Facilitated Recurrent Selection for FHB Resistance.*

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

The cooperative male sterile facilitated recurrent selection (MSFRS) populations were developed as a way to generate FHB resistant breeding lines and facilitate the combination of FHB resistant genes from different sources. Recurrent selection has the objective of increasing the frequency of desirable alleles for one or more traits while maintaining a high level of variability in the population. Intermating among selected parents each generation allows recombination to occur thus combining genes from different sources. Male sterility provides a mechanism to easily allow recombination among FHB resistance sources. The dominant male-sterile gene was utilized to create recurrent selection populations segregating for FHB resistance because the progenies of the male-sterile plants always segregate 1:1 for sterility and a generation of selfing is not required to obtain true-breeding fertile genotypes. Our objective was to create four populations with FHB resistance adapted to different regions of the eastern U.S. Seed from the sterile heads were planted, and their sterile offspring were tagged for harvest to repeat the process. These populations were developed over several seasons at the Ohio Agricultural Research and Development Center in Wooster, Ohio. Breeding programs in the eastern U.S. contributed FHB resistant lines to serve as pollinators. Sterile plants were selected; those highly susceptible to FHB were discarded.

**2. What was accomplished under these goals?** *Address items 1-4) below for each goal or objective.*

1) major activities

In 2018 the male-sterile population was grown in the field at Urbana, IL. Sterile heads were identified and tagged. Sterile heads that were very susceptible to *Fusarium graminearum* were removed. After being harvested and threshed, *Fusarium* damaged kernels were removed by aspiration, removing approximately 50% of the kernels. Remaining seed was space planted in the fall of 2018. A mixture of FHB resistant lines from the University of Illinois breeding program was planted as pollinators in adjacent rows. Additional MS plants were identified in headrows selected from the main population. Additional cycles of mating and selection for FHB resistance will be carried out.

In the fall of 2018 seed from the Illinois MSFRS population was offered to other breeders in the Eastern soft wheat region, and seed was distributed to five programs requesting seed including Purdue, U KY, NCSU, U of GA and MU.

2) specific objectives

Continue to develop male-sterile facilitated recurrent selection populations in the eastern soft wheat region that can be used with local FHB resistant breeding lines as pollinators to further develop recurrent selection populations as a source of potential FHB resistant

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breeding lines with resistance from different sources and begin to extract fertile lines from the population.

3) significant results

We have maintained the MS gene in the population and through pollination with locally adapted FHB resistant lines we are continuing to change the population to shorter, earlier and higher level of FHB resistance. We have extracted lines from the population.

4) key outcomes or other achievements

- Selection and crossing to locally adapted FHB resistant lines is resulting in improvement in the adaptation of the population.
- In the fall of 2018 we shared seed of the Illinois population with five other breeding programs.

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

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

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

In the 2018 and 2019 field seasons a large number of male-sterile plants were identified in headrows from the MSFRS population. These heads were harvested (or will be harvested) and a moderately large amount of seed should be available for distribution to other breeders.

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

**1. What are the major goals and objectives of the 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?** *Address items 1-4) below for each goal or objective.*

1) major activities

In 2018 and 2019 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.

2019 Experiments:

- 103 entries in the Illinois Variety Trial
- 42 entries in the Uniform Eastern Soft Red Winter Wheat Nursery
- 33 entries in the Advanced Six State Nursery
- 33 entries in the Preliminary Six State Nursery
- 61 entries in the Northern Uniform Winter Wheat Scab Nursery
- 49 entries in the Preliminary Northern Uniform Winter Wheat Nursery
- 63 entries in the Southern Uniform Winter Wheat Scab Nursery

2) specific objectives

- 1) Provide data on OVT entries to seedsmen and producers.
- 2) Collect data on FHB resistance of entries in uniform cooperative nurseries and distribute data to cooperators.

### 3) significant results

- Data from the 2018 Illinois Variety Trial were summarized and distributed. Data on FHB resistance of lines in the 2019 Illinois Variety Trial will be summarized and distributed.
- Data collected on cooperative nurseries will be made available to cooperators in each nursery to facilitate selection of FHB resistant breeding lines.
- Lines from the Univ. 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. All five University of Illinois breeding lines in both the 2018 NUWWN and PNUWWN had low FDK and DON scores indicating that these lines have very strong FHB resistance. Genomic estimated breeding values (GEBVs) for these lines were also very good indicating that these lines will be useful as parents in breeding for FHB resistance.

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

A graduate student has gotten extensive experience in the collection of FHB resistance evaluation data.

### **4. 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>). Handouts summarizing the 2018 data and data over multiple years were prepared, discussed and distributed at several producer/seedsmen meetings

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## **Training of Next Generation Scientists**

**Instructions:** Please answer the following questions as it pertains to the FY18 award period.

id 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 FY18 award period?**

Yes.

**If yes, how many?** One, Deanna Michels completed her MS in May, 2019.

- 2. Did any graduate students in your research program supported by funding from your USWBSI grant earn their Ph.D. degree during the FY18 award period?**

No.

**If yes, how many?**

- 3. Have any post docs who worked for you during the FY18 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 FY18 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?**



### 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 FY18 award period. All columns must be completed for each listed germplasm/cultivar. Use the key below the table for Grain Class abbreviations.

| Name of Germplasm/Cultivar | Grain Class | FHB Resistance<br>(S, MS, MR, R,<br>where R represents<br>your most resistant<br>check) | Inc.<br>(%) | Sev.<br>(1-9) | FHB<br>index<br>(0-100) | Year<br>Released |
|----------------------------|-------------|---|-------------|---------------|-------------------------|------------------|
| IL12-8512                  | SRW         | R/MR  | 1.0         | 3.3           | 0.4                     | 2018             |
| IL12-26004                 | SRW         | MR/MS   | 23.0        | 2.3           | 27.8                    | 2018             |
| IL14-11830                 | SRW         | R   | 0.0         | 0.0           | 0.0                     | 2018             |
| IL14-28462                 | SRW         | R/MR  | 2.0         | 2.7           | 2.9                     | 2018             |
| IL14-DC-64-95-118          | SRW         | MR  | 1.0         | 4.7           | 0.6                     | 2018             |
| IL15-2639                  | SRW         | R   | 3.0         | 0.7           | 1.4                     | 2018             |
| IL15-23803                 | SRW         | MR  | 9.0         | 4.7           | 5.8                     | 2018             |
| IL15-30529                 | SRW         | R   | 0.0         | 0.3           | 0.5                     | 2018             |
|                            |             |   |             |               |                         |                  |
| IL07-4415 (R Check)        | SRW         | R   | 2.0         | 0.3           | 0.0                     | --               |
| Bess (MR Check)            | SRW         | MR/MS   | 28.0        | 4             | 15.5                    | --               |
| Pioneer 25R47 (S Chk)      | SRW         | S   | 53.0        | 4.7           | 61.4                    | --               |

*NOTE: Leave blank if you have nothing to report or if your grant did NOT include any VDHR-related projects.*  
 Add rows if needed.

**NOTE:** List the associated release notice or publication under the appropriate sub-section in the

**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 FY18-FPR\_Instructions for detailed instructions for listing publications/presentations about your work that resulted from all of the projects included in the FY18 grant. Only include citations for publications submitted or presentations given during your award period (6/8/18 - 6/7/19). If you did not have any publications or presentations, state

**NOTE:** Directly below each reference/citation, you must indicate the Status (i.e. published, submitted, etc.) and whether acknowledgement of Federal support was indicated in publication/presentation. See example below for a poster presentation with an abstract:

Conley, E.J., and J.A. Anderson. 2018. Accuracy of Genome-Wide Prediction for Fusarium Head Blight Associated Traits in a Spring Wheat Breeding Program. In: Proceedings of the XXIV International Plant & Animal Genome Conference, San Diego, CA.  
Status: Abstract Published and Poster Presented  
Acknowledgement of Federal Support: YES (poster), NO (abstract)

### **Journal publications.**

Krill, A.M., N. J. Smith, E. A. Handal, and F. L. Kolb. 2018.  
Winter Wheat. J. of Plant Registrations 13:58-62. doi:10.3198/jpr2018.04.0025crc  
Status: Published, Jan 2019  
Acknowledgement of Federal Support: YES

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

Nothing to Report.

### **Other publications, conference papers and presentations.**

Nothing to Report.