USDA-ARS
U.S. Wheat and Barley Scab Initiative
FY17 Final Performance Report
Due date: July 31, 2018

Cover Page

Principle Investigator (PI):	Ruth Dill-Macky
Institution:	University of Minnesota
E-mail:	ruthdm@umn.edu
Phone:	612-625-2227
Fiscal Year:	2017
USDA-ARS Agreement ID:	59-0206-4-016
USDA-ARS Agreement Title:	Management of Fusarium Head Blight in Small Grains.
FY17 USDA-ARS Award Amount:	$ 46,394
Recipient Organization:	Regents of the University of Minnesota Suite 450 Sponsored FIN RPT-P100100001 Minneapolis, MN 55455-2003
DUNS Number:	555917996
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Project/Grant Reporting Period:	5/6/17 - 5/5/18
Reporting Period End Date:	05/05/18

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
GDER	A Field Nursery for Testing Transgenic Spring Wheat and Barley from the USWBSI.	$ 15,696
MGMT	Minnesota Component of the FHB Integrated Management Coordinated Project.	$ 30,698
	FY17 Total ARS Award Amount	$ 46,394

Ruth Dill-Macky

7-31-18

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

Project 1: *A Field Nursery for Testing Transgenic Spring Wheat and Barley from the USWBSI.*

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

This project had the objective of establishing an annual nursery to provide a central field-testing site for transgenic spring wheat and barley lines developed by researchers in the USWBSI.

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

1) Major Activities

Following the discovery of GE wheat plants on an Oregon farm in 2013 the USDA strengthened its oversight of regulated GE field trials for wheat. The increased oversight has resulted in APHIS requiring developers of GE wheat to apply for a permit for field trials involving GE wheat planted on or after January 1, 2016 rather than the notification process employed in the past. The permit application process takes cooperators more time to gain the federal and state approvals for field trials. There was no transgenic field nursery planted in Rosemount in 2017. Post-trial inspection assessment was conducted every 21 days as required during the 2017 growing seasons for GE trials planted in previous years.

In 2018 a nursery was planted that to include 76 wheat and 12 barley entries evaluated in side by side experiments. The trial was planted at UMore Park, Rosemount MN on May 22, 2018. Trial entries and untransformed controls* for wheat were submitted by the University of Minnesota (52 wheat lines + Bobwhite*, Linkert* and Rollag* along with the checks Norm and Sumai 3), Rutgers University (16 wheat lines + Bobwhite*, RB07* and Rollag*) and the USDA (8 1ines and CB037*). All barley lines included in the nursery were provided by the University of Minnesota (12 barley lines + Rasmusson*). Entries within each experiment were planted 2.43 m long single row plots, arranged in a randomized complete block design with four replications. Lines with known reactions to Fusarium head blight (FHB) were also included as checks. The wheat checks included the moderately resistant cultivars Linkert (FHB-5), RB07 (FHB-4), and Rollag (FHB-3) and the susceptible cultivars Norm (FHB-8) and Wheaton (FHB-8). The barley checks were the moderately resistant cultivar Quest (FHB-5) and the susceptible cultivar Lacey (FHB-8).

2) Specific Objectives

The major objective in the 2017 field season involved the ongoing monitoring and site inspections to comply with APHIS obligations for permits issued in and before 2015.

In 2018 the major objectives were getting the information needed to cooperators to facilitate permitting and getting the trial planned and planted.

3) Significant Results

Monitoring of the site for wheat volunteers was conducted at least every 21 days from March 15 till December 1, 2017 and since May 1 2018 till the present. APHIS completed a site inspection on July 14, 2017 and July 25, 2018. Feedback following the APHIS inspections indicate that we had met our monitoring obligations to the satisfaction of APHIS.

Results from the screening of lines in 2018 should be available in time for the USWBSI forum in December 2018.

4) Key Outcomes or Other Achievements

In 2017, none, other than we met all APHIS regulations in 2017 which was a similar amount of work as actually running an inoculated and mist-irrigated FHB nursery, though less rewarding.

In 2018 we have conducted a successful nursery though at the time of writing we have no data analyzed. We anticipate that the PI's submitting entries will have their data ahead of the USWBSI forum and we intend to present the filed data in a poster at that meeting.

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

None. Given the nature of the monitoring work access to the site was restricted to project personnel with considerable experience in running transgenic nurseries.

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

Quarterly reports, documenting all monitoring activities have been provided as required to APHIS. All USWBSI-funded PI's with wheat and barley entries in the nurseries have been copied on all communications with APHIS regarding site monitoring.

Project 2: *Minnesota Component of the FHB Integrated Management Coordinated Project.*

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

Sub-project 1: Minnesota Component of the FHB Integrated Management Coordinated Project.

For years the recommended fungicide program for FHB and DON management has been a single well-timed application at anthesis. In this project we tested the value of late (post-anthesis) applications of fungicides following an anthesis application, used in combination with genetic resistance, will be more effective at reducing FHB and DON than an application at anthesis alone, resistance alone, or even resistance combined with an anthesis-only application. We hypothesize that the benefit of such a program will be large enough to offset application costs of a second fungicide application. These hypotheses were tested in experiments in Minnesota and will contribute to a large collaborative effort to provide a body of data relevant to all major grain market classes, under a range of weather conditions and baseline levels of FHB and DON.

Sub-project 2: Risk-based Fungicide Decision-making for FHB and DON Management in Wheat

The goal of this project was to facilitate the practical utilization of the web-based FHB risk assessment system. The results of this study will add to those of studies at other locations to provide a range of environments where risk scenarios will vary based on whether the fungicide application is made when FHB risk is low, moderate, or high.

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

Sub-project 1: Minnesota Component of the FHB Integrated Management Coordinated Project.

1) Major Activities

Four field experiments were conducted in 2017, with hard red spring wheat and spring barley, to investigate the effects of cultivar resistance and fungicide application programs on FHB and DON accumulation. Experiments were established for both wheat and barley at two locations (St. Paul and Crookston). The sites were previously planted with a crop that was representative of the typical cropping sequence in Minnesota. We followed the standard experimental design and treatment arrangement developed by the USWBSI integrated management working group. The design was a randomized complete block, with a split-plot arrangement (cultivar as the whole-plot and fungicide treatment program as the sub-plot) and four replicate blocks in each of the trials. We used four hard red spring wheat cultivars; a FHB susceptible variety Samson (FHB-8, DTH-64.7), the moderately susceptible variety Knudson (FHB-6, DTH-66.1) and two moderately resistant varieties RB07 (FHB-4 , DTH-64.4) and LG Albany (FHB-4, DTH-68.5). In the

spring barley trials we examined the four cultivars; the six-rowed varieties Lacey (FHB-8) and Quest (FHB-5) and the two-rowed varieties Conlon (FHB-6) and Pinnacle (FHB-9).

FHB incidence and severity were rated as described (Stack and McMullen 1998) on 60 spikes per plot at the soft dough growth stage (Feekes 11.2). The presence and flag leaf severity (as a percentage) of foliar diseases was also rated. Plots were harvested with a plot combine and yield and test weight determined. A 50 g subsample of the harvested grain from each wheat plot was used to determine the percentage of visually scabby kernels (VSK; equivalent to Fusarium damaged kernels (FDK)). Following the assessment of VSK all grain samples were sent to the USWBSI-funded DON testing laboratories in St. Paul (Yanhong Dong) for DON analysis.

2) Specific Objectives

In the Minnesota component of this project we conducted inoculated field experiments, using four cultivars of hard red spring wheat and four cultivars of spring barley, respectively, with different levels of resistance to FHB and at least six fungicide treatments at each of two locations. The fungicide treatments examined included: 1) an untreated check; 2) Prosaro at anthesis; 3) Prosaro at anthesis and Caramba 4 days later; 4) Caramba at anthesis and tebuconazole 4 days later; 5) Proline at anthesis and tebuconazole (Folicur) 4 days later; and 6) an untreated, non-inoculated check. FHB incidence and severiuty, VSK (wheat only), DON, foliar diseases severity, yield, and test weight data was collected in all trials. Our objective was to demonstrate that management programs utilizing anthesis and post-anthesis fungicide applications in addition to cultivar resistance, will consistently provide higher levels of FHB and DON reduction than the single-application program or cultivar resistance used.

3) Significant Results

We generated useful levels of FHB and subsequently obtained useful data from all experiments. The final toxin analyses were completed a couple of months ago and data files are currently being compiled ahead of submission to the project coordinators.

4) Key Outcomes or Other Achievements

Results of these experiments will allow us to determine whether the integrated approach tested here is equally consistent across locations, and if not, which local conditions affect the degree of disease control. The data will be used to demonstrate whether the overall efficacy of each fungicide program is enhanced by genetic resistance and whether the two-treatment programs are consistently or equally effective across cultivars, environments, and grain market classes. Ultimately the results will allow us to tailor management recommendations to environments and provide producers with additional options for managing FHB.

Sub-project 2: Risk-based Fungicide Decision-making for FHB and DON Management in Wheat

1) Major Activities

Field experiments were conducted in 2017 to investigate the efficacy of fungicide treatments applied in relation to the FHB forecasting model predictions. In 2017 we planted field experiments at two locations, St. Paul in central Minnesota and Crookston in the northern part Minnesota and located in the center of the Red River Valley. Plots of three cultivars; Samson, FHB-8 susceptible, DTH-57.6 (mid-season); Linkert, FHB-5 moderately resistant, DTH-58.2 (mid-season); and Prosper, FHB-7 moderately resistant, DTH 61.1 late] were included in the study. The trials were established on university research farms and managed according to standard agronomic practices for each location. The dimensions of the plots were at least 5 ft x 20 ft. at any location. Half of each plot of each cultivar was treated with Prosaro at 6.5 fl. oz/acre at early anthesis (Feekes 10.5.1) and the other half or the plots were left untreated. Fungicide applications were made using a sprayer equipped with paired Twinjet or flat fan XR8001 or XR8002 nozzles, mounted at an angle (30-45^{o} from the horizontal) forward and backward (or forward only) and calibrated to deliver at a rate of 10 to 20 gallons per acre. Scab risk was evaluated at the time of each application, and each 'cultivar x flowering date x location' combination was assigned a code (A, B, C, or D) based on the predicted risk of FHB. The risk of scab, and code assigned to each treatment, was evaluated separately for each cultivar at each location. FHB incidence and severity was rated in each plot at the soft dough growth stage (Feekes 11.2). The presence and flag leaf severity (as a percentage) of foliar diseases was also assessed. The flowering date of each cultivar and GPS coordinates of each location were recorded. Plots were harvested, and grain yield and test weight determined. Subsamples of the harvested grain from each plot were used to determine the percent visually scabby kernels (VSK aka FDK), and sent to the USWBSI-funded DON testing laboratories in St. Paul (Yanhong Dong's lab) for DON analysis.

2) Specific Objectives

In the Minnesota component of this project we conducted inoculated field experiments, using three cultivars of hard red spring wheat at two locations with the intent of providing useful data for the meta-analysis following the completion of similar experiments by others.

3) Significant Results

We generated useful levels of FHB and subsequently obtained useful data from the two locations where the experiments were established. The toxin analyses for the 2017 trial were completed in 2018 and the data files are currently being compiled ahead of submission to the project coordinator.

4) Key Outcomes or Other Achievements

Results of these experiments will be used to advance the development of FHB and DON risk assessment models.

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

In both sub-projects undergraduate researchers utilized the project to gain experience in field-based research techniques.

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

Summary results from these studies will be published on SCABSMART as part of a national publication on integrated management guidelines for FHB and DON. In Minnesota, results will be delivered to growers, county extension educators and others in the wheat and barley industry, largely through Madeleine Smith's extension program. In addition, data from these trials will be used to advance the development of FHB and DON risk assessment models.

The data collected from these trials, along with trials conducted by other colleagues as part of the integrated management coordinated project funded by the USWBSI, will ultimately be used in a meta-analysis that will be published in peer-reviewed scientific journals. The outcome of this large collaborative research effort will ultimately provide information of the efficacy of fungicide treatments for FHB that would not be obtainable by any individual scientist.

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY17 award period. 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 FY17 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 FY17 award period?**
   No

   If yes, how many?

3. **Have any post docs who worked for you during the FY17 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 FY17 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 FY17 award period. All columns must be completed for each listed germplasm/cultivar. Use the key below the table for Grain Class abbreviations. *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**

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

Publications, Conference Papers, and Presentations

Instructions: Refer to the FY17-FPR_Instructions for detailed instructions for listing publications/presentations about your work that resulted from all of the projects included in the FY17 grant. Only include citations for publications submitted or presentations given during your award period (5/6/17 - 5/5/18). If you did not have any publications or presentations, state 'Nothing to Report' directly above the Journal publications section.

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.

Journal publications.

Anderson, J.A., Wiersma, J.J., Linkert, G.L., Reynolds, S.K., Kolmer, J.A., Jin, Y., Rouse M., Dill-Macky, R., Hareland G.A., and Ohm, J.-B. 2018. Registration of 'Norden' hard red spring wheat. *Journal of Plant Registrations, **12:**90-96.*
Status: *Published online: 07 December 2017, doi:10.3198/jpr2017.07.0045crc*
Acknowledgement of Federal Support: YES

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

Other publications, conference papers and presentations.

Salgado, J.D., Bergstrom, G.C., Bradley, C., Bowen, K., Byamukama, E., Byrne, A., Collins, A., Cowger, C., Cummings, J., Chapara, V., Chilvers, M.I., Dill-Macky, R., Darby, H.M., Friskop, A., Kleczewski, N., Madden, L.V., Marshall, J., Mehl, H., Nagelkirk, M., Stevens, J., Smith, D., Smith M., Wegulo, S., Wise, K., Yabwalo, D., Young-Kelly, H.M., and Paul, P.A. (2017). Efficacy of two-treatment fungicide programs for FHB management: a multi-state coordinated project. In: *Proceedings of the 2017 National Fusarium Head Blight Forum*, St. Louis, Missouri, USA, December 3-5, 2017, pp. 20-25.
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: YES (poster), NO (abstract)

Salgado, J.D., Ames, K., Bergstrom, G.C., Bradley, C., Byamukama, E., Cummings, J., Chapara, V., Chilvers, M.I., Dill-Macky, R., Friskop, A., Gautam, P., Kleczewski, N., Madden, L.V., Milus, E., Nagelkirk, M., Ransom, J., Ruden, K., Stevens, J., Wegulo, S., Wise. K., Yabwalo, D. and Paul, P.A. (2017). Robust management programs to minimize losses due to Fusarium Head Blight and deoxynivalenol in wheat. In: *Proceedings of the 2017 National Fusarium Head Blight Forum*, St. Louis, Missouri, USA, December 3-5, 2017, pp. 26-27.
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: YES (poster), NO (abstract)

Kumar, J., Xu, S., Elias, E.M., Dill-Macky, R., and Kianian, S.F. (2017). FHB resistance in durum wheat by means of epigenetic modification. In: *Proceedings of the 2017 National Fusarium Head Blight Forum*, St. Louis, Missouri, USA, December 3-5, 2017, p. 47.
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: YES (poster), NO (abstract)

Bakker, M.G., McCormick, S.P., and Dill-Macky, R. (2017). Microbial correlates of *Fusarium* biomass and deoxynivalenol content in individual wheat seeds. In: *Proceedings of the 2017 National Fusarium Head Blight Forum*, St. Louis, Missouri, USA, December 3-5, 2017, p. 59.
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: YES (poster), NO (abstract)

Salgado, J. D., Paul, P.A., Ames, K., Bergstrom, G.C., Bradley, C., Byamukama,E., Cummings, J.A., Chapara, V., Chilvers, M., Dill-Macky, R., Friskop, A.J., Gautam, P., Kleczewski, N.M., Madden, L.V., Milus, E.A., Nagelkirk, M., Ransom, J., Ruden, K.R., Stevens, J., Wegulo, S.,N. and Wise. K.A., and Yabwalo, D. (2017). A multi-state coordinated project to evaluate integrated management strategies for Fusarium head blight and deoxynivalenol in wheat. In: Abstracts of Presentations, 2017 APS Annual Meeting, San Antonio, TX, August 5-9, 2017, *Phytopathology* 107: S5.6.
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: YES (poster), NO (abstract)