USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY16 Final Performance Report
Due date: July 28, 2017

Cover Page

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Fiscal Year:	2016
USDA-ARS Agreement ID:	59-0206-4-016
USDA-ARS Agreement Title:	Management of Fusarium Head Blight in Small Grains.
FY16 USDA-ARS Award Amount:	$ 46,484
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:	5/6/16 - 5/5/17
Reporting Period End Date:	05/05/17

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.	$ 15,726
MGMT	Minnesota Component of the FHB Integrated Management Coordinated Project.	$ 30,758
	FY16 Total ARS Award Amount	**$ 46,484**

Ruth Dill-Macky

7-28-17

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: *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 single 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. The principle advantage for establishing a cooperative nursery was to provide independent testing for transgenic lines produced by different researchers funded by the USWBSI and thus to provide comparative data across programs allowing researchers to establish the merit of individual transgenes they are testing.

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

1) major activities

A field screening nursery was conducted in 2015 that included 9 wheat and 12 barley entries evaluated in side by side experiments. Previous wheat and barley nurseries have been conducted at this same location since 2008. In the Fall of 2015 APHIS raised concerns over the presence of wheat plants that had volunteered from the non-transgenic wheat border planted surrounding this nursery, and issued an Emergency Action Notification (EAN) for the site.

APHIS concerns over wheat volunteers had been heightened following the identification of GE wheat plants on an Oregon farm in mid-2013. Following this discovery the USDA has strengthened its oversight of regulated GE field trials. As part of this increased oversight APHIS is requiring developers apply for a permit for field trials involving GE wheat planted on or after January 1, 2016. The permit process is likely to take considerable more time to be processed and approved. The decision to require the more stringent permit process, rather than the notification process employed in the past, was undertaken to provide greater certainty that GE wheat will remain confined during field trials.

The EAN mandated, amongst other restrictions, visual inspection of the site for wheat volunteers for the three subsequent growing seasons. FY16 represented the first of these post-trial inspection years. While barley was not impacted by the EAN we decided it would also be prudent to skip a year of field testing both wheat barley in 2016 and for this reason there was no transgenic field nursery planted in 2016.

2) specific objectives

The major objective in 2016 involved the inspection for wheat volunteers to meet the obligations of the EAN.

3) significant results

Monitoring of the site for wheat volunteers was conducted at least every 21 days from March 15 till December 1, 2016. As luck would have it, 2016 was the longest growing season on record and thus site monitoring involved 15 trips to the field site. APHIS also

completed a site inspection on July 14. A small number of wheat volunteers were observed at the site early in the 2016 growing season and these were devitalized with a herbicide. No wheat volunteers were observed later in the 2016 growing season and no barley volunteers were observed at the site in 2016. Feedback following the July APHIS inspection indicated that we had met our monitoring obligations under the EAN to the satisfaction of APHIS.

4) key outcomes or other achievements
None, other than we met all APHIS regulations which was about as much work as actually running an inoculated and mist-irrigated FHB nursery, though it was rather less rewarding.

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 transgenic nurseries.

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

Quarterly reports, documenting all monitoring activities have been provided as required under the EAN to APHIS. All USWBSI-funded PI's with wheat and barley entries in the 2014 and 2015 nurseries were also copied on all communications with APHIS regarding the EAN.

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.

We hypothesized that at moderate to high levels of FHB, a "late" or "post-anthesis" application of a fungicide following an anthesis application, coupled 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 further hypothesized that the benefit of such a program in terms of disease and toxin reduction and yield and test weight increase will be large enough to offset application costs and losses associated with damage caused by wheel tracks. 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. This study, in conjunction with studies at other locations, will provide data from a range of environments where risk scenarios will vary. Data from all trials will be compiled using meta-analysis. Based on findings from these studies, we anticipate being able to identify combinations of management techniques that are effective, yet robust enough to allow growers more flexibility when managing FHB and DON.

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

Field experiments were conducted for 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 on university research stations in areas previously planted with a crop that was representative of the typical cropping sequence in Minnesota. We largely followed the standard experimental design and treatment arrangement as agreed. The design was a randomized complete block (RCBD), with a split-plot arrangement of cultivar as the whole-plot and fungicide treatment program as the sub-plot. There were four replicate blocks in each of the Minnesota trials. We used the hard red spring wheat cultivars; a standard 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 was 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 plot was used to determine the percentage of visually scabby kernels (VSK; equivalent to Fusarium damaged kernels (FDK)). Following the assessment of VSK the 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, DON, VSK, foliar diseases severity, yield, and test weight data will be collected in these 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 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

We planted plots of three cultivars (Samson, FHB-8 susceptible, DTH-57.6 (mid-season); Linkert, FHB-5 moderately resistant, DTH-58.2 (mid-season); Prosper, FHB-7 moderately resistant, DTH 61.1 late) at each of four locations (Saint Paul- central MN, Foxhome - southern Red River Valley (RRV), Crookston - central RRV, Strathcona - northern RRV) across Minnesota. The plots, established on university research farms or in farmers' fields, were managed according to standard agronomic practices for each location. The dimensions of the strips 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 will be left untreated. 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 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 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) 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 four 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 two of the four locations where experiments were established. The final toxin analyses were completed for those two locations (St Paul and Foxhome) a couple of months ago and 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.

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY16 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 FY16 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 FY16 award period?** No

   If yes, how many?

3. **Have any post docs who worked for you during the FY16 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 FY16 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 FY16 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 FY16-FPR_Instructions for detailed instructions for listing publications/presentations about your work that resulted from all of the projects included in the FY16 grant. Only include citations for publications submitted or presentations given during your award period (5/6/16 - 5/5/17). If you did not have any publications or presentations, state 'Nothing to Report' directly above the Journal publications section.

Journal publications.

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

Other publications, conference papers and presentations.

Dill-Macky, R. and Van Sanford, D. (2016). (2016). Managing Fusarium head blight: successes and future challenges. In: *Proceedings of the 8th Canadian Workshop on Fusarium Head Blight*, Ottawa CANADA, November 20-22, 2016, p. 34.
Status: Abstract Published and Oral Presentation Given
Acknowledgement of Federal Support: No (abstract), Yes (oral presentation)

Moraes, W.B., Anderson, K.F., Cowger, C., Dill-Macky, R., Madden, L.V., and Paul, P.A. (2016). Effect of pre-anthesis rainfall patterns on Fusarium head blight and deoxynivalenol: a multi-state study. (APS Annual Meetings, Tampa FL, July 30-Aug 3, 2016) *Phytopathology*, **106**: S4.131.
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: No (abstract), Yes (poster)

Dill-Macky, R. (2016). Pre-harvest management strategies for mycotoxins in cereals in the USA: adapting to change. In: *Book of Abstracts of the 9th conference of the World Mycotoxin Forum and the XIVth IUPAC International Symposium on Mycotoxins*, Winnipeg, CANADA, June 6-9, 2016. p. 54.
Status: Abstract Published and Oral Presentation Given
Acknowledgement of Federal Support: No (abstract), Yes (oral presentation)