USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY15 Final Performance Report
Due date: July 15, 2016

Cover Page

Principle Investigator (PI):	Ruth Dill-Macky
Institution:	University of Minnesota
E-mail:	ruthdm@umn.edu
Phone:	612-625-2227
Fiscal Year:	2015
USDA-ARS Agreement ID:	59-0206-4-016
USDA-ARS Agreement Title:	Management of Fusarium Head Blight in Small Grains.
FY15 USDA-ARS Award Amount:	$ 34,493
Recipient Organization:	Regents of the University of Minnesota Suite 450 Sponsored FIN RPT-P100100001 Minneapolis, MN 55455-2003
DUNS Number:	555917996
EIN:	41 -6007513
Recipient Identifying Number or Account Number:	CON000000048329
Project/Grant Reporting Period:	05/06/15-05/05/16
Reporting Period End Date:	05/05/16

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
MGMT	Developing More Robust Integrated Management Guidelines to Minimize Losses Due to FHB and DON in Wheat and Barley in MN.	$ 17,250
GDER	A Field Nursery for Testing Transgenic Spring Wheat and Barley from the USWBSI.	$ 17,243
	FY15 Total ARS Award Amount	**$ 34,493**

7-15-16

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: *Developing More Robust Integrated Management Guidelines to Minimize Losses Due to FHB and DON in Wheat and Barley in MN.*

1. **What are the major goals and objectives of the project?**
   This project aimed to increase growers' adoption of an integrated management approach for the control of FHB and DON and was is part of a larger collaborative project, aimed to generate the data that will provide a convincing body of evidence to promote the adoption of the best management practices for the control of FHB. The specific technologies being targeted in this project are host resistance and chemic control, encompassing both chemistry and application technology aspects.

2. **What was accomplished under these goals?**
   1) Major activities
   Four experiments (2 HRS wheat and 2 spring barley) were conducted each including three cultivars with different levels of resistance to FHB (a standard susceptible [wheat = Samson; barley = Lacey] and two resistant and/or moderately resistant cultivars - including one recently released line with improved FHB resistance [wheat = SY Soren and Linkert; barley = Conlon (2-row) and Quest (6-row]) and six fungicide treatments (inoculated and non-inoculated untreated checks, application of Prosaro (6.5 fl oz/A + 0.125% Induce) at Feekes 10.5.1 (50% anthesis), and post-anthesis applications of Prosaro at 2, 4, and 6 days after anthesis [daa]). Applications were made using a sprayer equipped with flat fan XR8001 nozzles, mounted at a forward angle and calibrated to deliver 10 to 20 gallons per acre. All but one plot of each cultivar was inoculated (timing of inoculation ca. 24-36 hours after the anthesis timed fungicide treatment is applied) with a spore suspension (100,000 macroconidia/ml) consisting of a mixture of isolates of *F. graminearum* endemic to Minnesota. The experimental design was a randomized complete block, with a split-plot arrangement of cultivar as the whole-plot and fungicide treatment as the sub-plot. There will be four replicate blocks in each experiment. The experiments were established, one each for what and barley, at the University of Minnesota Agricultural Experiment Station in St Paul, MN and Crookston MN on land previously planted with soybeans and managed according to the standard agronomic practices for wheat and barley in Minnesota. FHB, DON, VSK (wheat only), yield, and test weight data were collected in each trial and analyzed to determine the effect of fungicide and resistance. The untreated check and the anthesis treatment served as references for estimating percent control of FHB, DON and VSK for the post-anthesis applications.

   FHB was assessed in each plot at Feekes 11.2 (soft dough). FHB severity was determined visually on 20 spikes per plot, and FHB incidence and FHB index calculated. The presence and flag leaf severity (as a percentage) of any foliar diseases present was also determined. Plots were harvested with a plot combine and yield and test weight determined. Grain from all wheat plots were rated to determine the percentage of Visually Scabby Kernels (VSK, equivalent to FDK). Grain samples from each plot were submitted to the USWBSI-funded DON Testing Laboratories in St Paul, MN for DON analysis. Onsite weather stations were used to collect temperature, relative humidity, surface wetness, rainfall, wind speed, and solar radiation data at regular intervals from Feekes 7 (stem elongation) to harvest.

2) Specific objectives
The specific objectives of these experiments were to evaluate the integrated effects of fungicide and genetic resistance on FHB and DON in hard red spring (HRS) wheat and spring barley, with emphasis on different application timings and new genotypes; 2) provide data to support an economic analysis of the integrated effects of fungicide and resistance on FHB/DON; 3) develop more robust "best-management practices" for FHB and DON; and 4) generate data to advance the FHB and DON risk prediction effort.

3) Significant results
No single management strategy is fully effective in controlling FHB or preventing the contamination of grain with mycotoxins. The current recommendations for FHB management include the use of fungicides, genetic resistance, and cultural practices targeting residue management, including crop rotation or tillage. This cooperative research effort supports our understanding that integrating the use of cultivar resistance and fungicides provides greater control than either strategy used alone.

4) Key outcomes or other achievements
Data from these trials are still being prepared for submission to the project coordinator for meta-analysis. Based on results from the combined studies we expect to be able to identify management combinations that are effective, yet robust enough to allow growers more flexibility when managing FHB/DON.

3. What opportunities for training and professional development has the project provided?
Nothing to Report

4. How have the results been disseminated to communities of interest?
The data are forwarded to the project coordinator and will be used in a larger analysis and used to identify management combinations that are effective, yet robust enough to allow growers more flexibility when managing FHB/DON. The additional data from these trials thus adds to the body of knowledge that we can use to support our efforts to promote an integrated approach to the management of FHB.

Project 2: *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?**
   1) Major activities
   The 2015 field screening nursery included 9 wheat and 12 barley entries evaluated in side by side experiments. Entries within each species experiment were arranged in a randomized complete block design with four replications in a field located at UMore Park, Rosemount MN. Trial entries and untransformed controls* were submitted by the University of North Texas (9 wheat lines + Bobwhite*) and the USDA (12 barley lines + Conlon* and ND20448*). Lines with known reactions to Fusarium head blight (FHB) were also included as checks. The wheat checks included were the moderately resistant cultivar Alsen and the susceptible cultivars Roblin and Wheaton. The barley checks were the moderately resistant cultivar Quest and the susceptible cultivar Stander. Individual plots were 2.43 m long single rows.
   The trial was planted on June 2, 2015. All plots were inoculated twice with the exception for Wheaton and Stander non-inoculated controls. The first inoculation was applied at anthesis for wheat (July 13-July 22) and at head emergence (July 16-July 20) for barley. The second inoculation was applied three days after the initial inoculation (d.a.i.) for each plot. The inoculum was a composite of 40 *F. graminearum* isolates, applied at a concentration of 100,000 macroconidia.ml^{-1} with Tween 20 (polysorbate) added at 2.5 $ml.L^{-1}$ as a wetting agent. The inoculum was applied using a CO_2-powered backpack sprayer fitted with a SS8003 TeeJet spray nozzle with an output of 10 $ml.sec^{-1}$ at a working pressure of 275 kPa. Mist-irrigation was applied from the first inoculation on July 16 through August 6 to facilitate FHB development. FHB incidence and severity were assessed visually 18-24 d.a.i. for wheat and 17-21 d.a.i. for barley on 20 arbitrarily selected heads per plot. FHB incidence was determined by the percentage of spikes with visually symptomatic spikelets of the 20 heads observed. FHB severity was determined as the percentage symptomatic spikelets of the total of all spikelets observed. Plots were hand harvested at maturity on August 17 (barley) and August 25 (wheat). Approximately sixty heads where harvested from each plot, threshed and the seed cleaned manually. The wheat grain was used to determine the percentage of visually scabby kernels (VSK) and then all samples (wheat and barley) were ground and submitted for deoxynivalenol (DON) analysis.

   2) Specific objectives
   The nursery achieved the stated objective of the project and provided data on the field reaction of both wheat and barley lines to the researchers that submitted materials for testing.

3) Significant results
In 2015 FHB incidence, FHB severity, VSK and DON levels were moderate to high in the susceptible varieties indicating good disease pressure in the nursery. The disease severities were similar to the 2013 nursery and generally lower than the 2014 nursery.
Wheat: The mean FHB severity for the non-inoculated Wheaton control was 19%. Mean FHB severity for the untransformed wheat check Bobwhite was 31%. Mean FHB severities for the standard wheat checks, Alsen, Roblin and Wheaton, were 9, 35 and 38%, respectively. The data indicated that resistance was expressed, in terms of FHB severity, in several wheat entries in the Bobwhite background, when compared to the untransformed check. The mean VSK and DON concentration for the untransformed check Bobwhite was and 30% and 5.3 ppm, respectively.
Barley: The mean FHB severity for the non-inoculated Stander check was 17%, while the untransformed barley check varieties Conlon and ND20448 had mean FHB severities of 25 and 15%, respectively. The barley standard checks, Quest and Stander had mean FHB severities of 8 and 22%, respectively. The FHB severity data indicated that resistance was significantly ($P<0.05$) improved in some transformed barley lines compared to the untransformed checks. The mean DON concentrations for all barley entries ranged from 1.3 to 7.8 ppm.

4) Key outcomes or other achievements
Wheat: None none of the transformed lines performed significantly better than Bobwhite for either VSK or DON concentration.
Barley: Three of the barley transformations, 82ND2-2, 82Q3-6 and 321Q3, performed significantly better than the untransformed Conlon check in terms of FHB severity. None of the transformed lines performed significantly better than Conlon for DON concentration.

3. What opportunities for training and professional development has the project provided?
Nothing to Report.
[Transgenic nurseries are conducted under federal and state permits and with institutional oversight. The strict regulations associated with this nursery means that we limit access to the field site to trained personnel. As a consequence this nursery is not used for training or professional development.]

4. How have the results been disseminated to communities of interest?
Individual submitting entries to the nursery were provided data files upon completion of the nursery. A poster presenting the results of this project was prepared and presented at the USWBSI Forum in St Louis in December 2015.

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY15 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 FY15 award period?**
   No
   If yes, how many?
   n/a

2. **Did any graduate students in your research program supported by funding from your USWBSI grant earn their Ph.D. degree during the FY15 award period?**
   No
   If yes, how many?
   n/a

3. **Have any post docs who worked for you during the FY15 award period and were supported by funding from your USWBSI grant taken faculty positions with universities?**
   No
   If yes, how many?
   n/a

4. **Have any post docs who worked for you during the FY15 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?
   n/a

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 FY15 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

Refer to the FY15-FPR_Instructions for listing publications/presentations about your work that resulted from all of the projects included in the FY15 grant. If you did not have any publications or presentations, state 'Nothing to Report' directly above the Journal publications section.

Journal publications.

Anderson, J.A., Wiersma, J.J., Linkert, G.L., Reynolds, S., Kolmer, J.A., Jin, Y., Dill-Macky, R., and Hareland, G.A. 2015. Registration of 'Rollag' spring wheat.
Journal of Plant Registrations, 9:201-207.
Status: Published
Acknowledgement of Federal Support: YES

Garvin, D.F., Porter, H., Blankenheim, Z.J., Chao, S., and Dill-Macky, R. 2015. A spontaneous segmental deletion from chromosome arm 3DL enhances Fusarium head blight resistance in wheat.*Genome*, 58:479-488.
Status: Published
Acknowledgement of Federal Support: YES

Li, X., Shin, S., Heinen, S.J., Dill-Macky, R., Berthiller, F., Nersesian, N., Clemente, T.E., McCormick, S.P., and Muehlbauer, G.J. 2015. Transgenic wheat expressing a barley UDP-glucosyltransferase detoxifies deoxynivalenol and provides high levels of resistance to *Fusarium graminearum*. *Molecular Plant-Microbe Interactions*, 28:1237-1246.
Status: Published
Acknowledgement of Federal Support: YES

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

Other publications, conference papers and presentations.

Dill-Macky, R., Samuels, P.L., Elakkad, A.M., and Zargaran, B. (2015). The influence of pre-anthesis moisture on Fusarium head blight of wheat. In: *Book of Abstracts of the 13th European Fusarium Seminar*, Martina Franca, ITALY, May 10-14, 2015, p. 148.
Status: Abstract Published and poster presented
Acknowledgement of Federal Support: YES

Dill-Macky, R., Van Sanford, D.A., De Wolf, E.D., and Paul, P.A. (2015). *Fusarium* head blight of wheat: progress and challenges. In: *Program and Abstracts of the 9th International Wheat Conference*, Sydney, AUSTRALIA, September 20-25, 2015, pp. 41-42.
Status: Abstract Published and oral presentation delivered
Acknowledgement of Federal Support: YES

Dill-Macky, R., Elakkad, A.M., Shah, J., Trick, H.N., Sarowar, S., Alam, S., Dahleen, L.S., Skadsen, R.W., and Bregitzer, P.P. (2015). Testing transgenic spring wheat and barley lines for reaction to Fusarium head blight: 2015 field nursery report. In: *Proceedings of the 2015 National Fusarium Head Blight Forum*, St. Louis, Missouri, USA, December 6-8, 2015, pp. 45-46.
Status: Abstract Published and poster presented
Acknowledgement of Federal Support: YES

Salgado, J.D., Ames, K., Bergstrom, G., Bradley, C., Byamukama, E., Cummings, J., Chapara, V., Chilvers, M., 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. (2015). Robust management programs to minimize losses due to FHB and DON: a multi-state coordinated project. In: *Proceedings of the 2015 National Fusarium Head Blight Forum*, St. Louis, Missouri, USA, December 6-8, 2015, pp. 24-26.
Status: Abstract Published and poster presented
Acknowledgement of Federal Support: YES