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:	59-0206-4-040
USDA-ARS Agreement Title:	Integrated Approaches to Reduce FHB and DON in Irrigated Grain Production of the Arid West.
FY16 USDA-ARS Award Amount:	$ 41,735
Recipient Organization:	University of Idaho Moscow, ID 83844-3020
DUNS Number:	075746271
EIN:	82-6000945
Recipient Identifying Number or Account Number:	BJKN14
Project/Grant Reporting Period:	6/1/16 - 5/31/17
Reporting Period End Date:	05/31/17

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
VDHR-SPR	Determining FHB Susceptibility in Barley and Wheat Cultivars in the Western US.	$ 30,000
MGMT	Integrated Management of FHB and DON in Spring Wheat in Idaho.	$ 11,735
	FY16 Total ARS Award Amount	**$ 41,735**

Juliet Marshall 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: *Determining FHB Susceptibility in Barley and Wheat Cultivars in the Western US.*

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

The majority of the grain varieties that are available to growers in the intermountain west area are susceptible to FHB, especially the hard white spring wheat and durum varieties. A few varieties of hard red spring wheat have some level of resistance associated with the presence of the Fhb1 gene. Soft white spring wheat and barley have shown the lowest vulnerability to FHB infection in the field, but high levels of DON are being reported even in soft white spring wheat. Due to increasing FHB pressure in the PNW and mountain west, growers need information on FHB susceptibility of the wheat and barley varieties that currently are being grown and those newly released. Breeders need information on advanced lines and breeding material to release selections with reduced vulnerability to FHB damage and DON accumulation.

The research priorities being addressed include Plan Goals 1and 4.
1) Goal 1, we screened for FHB resistance in advanced lines and widely grown cultivars of wheat and barley that are grown under irrigation in order to identify low risk lines. Screening of breeding material and segregating populations was offered to western breeders of both wheat and barley and to private breeding programs. 4) For Goal 4, Enhancing communication with other FHB researchers through participation in collaborative research and attending the annual meeting is also critical to increasing PI's ability to improve end user education and outreach (Goal 4) including, but not limited to, producers, agricultural advisors, the research community, and grain processors.

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

1) major activities - An assessment of released wheat and barley cultivars and advanced lines from entries in the University of Idaho Extension Variety trials was conducted in on-station FHB nurseries at the Aberdeen Research and Extension Center. Two experiments (spring wheat and spring barley) tested existing varieties and advanced cultivars. Resistant and susceptible checks were (for wheat) Klasic hard white spring is the susceptible check, and Volt hard red spring is the resistant check. For barley, ND20943 was included as the two-row resistant check, Quest as the 6-row resistant check, Conlon as the two-rowed susceptible check, and Goldeneye as the 6-row susceptible check. Experimental units consisted of two row plots with two replications using a randomized complete block design. Plots were 8-foot long rows planted with a Hege 1000 headrow planter. Special irrigation systems were designed and purchased to provide an environment conducive for FHB infection while simultaneously meeting the irrigation needs of the crop.

Autoclaved corn was inoculated with *F. graminearum* and allowed to grow for three weeks before drying. Corn spawn was spread in the field approximately three weeks prior to anthesis (wheat) or head emergence (barley) of the earliest lines at 60 grams per plot. Barley plots were inoculated with a spore suspension of macroconidia of *F. graminearum* at head emergence. Barley symptom development has been more difficult to induce and has responded best after inoculation with both corn spawn and a spore suspension of 100,000 conidia per L. Plots were inoculated twice with conidial suspension (80,000 macroconidia/ml) starting at head emergence (Feekes GS 10.1, June 9) using a CO_2

backpack sprayer with three 8003 VS nozzles at a ground speed of 1 sec/ft at 40 psi. A second inoculation of each barley plot occured one week after the first. An irrigation system with sprinkler nozzles every 20 feet was used both for irrigation and increasing humidity in the plant canopy. After inoculation, plots were irrigated every other day for two hours.

FHB was assessed in each plot at about soft dough (Feekes 11.2). Scab readings were done 21 days after flowering (24 days post-heading). Barley was rated 20-22 days after spray inoculation. Thirty spikes per plot were rated for percent disease severity. Percent incidence was determined by calculating the proportion of infected and the total number of assessed heads. FHB index is calculated using the formula: FHB Index = (% severity x % incidence) /100. On-site weather stations were used to collect temperature and humidity data. Ten heads per plot were collected prior to harvest, hand threshed and assessed VSK prior to testing for DON. Samples were submitted to the USWBSI-funded DON testing laboratories in St. Paul, MN for DON analysis. Plots were harvested using Wintersteiger Classic small plot combine, and weighed for yield and test weight.

2) specific objectives – The specific objectives were to screen currently grown varieties to determine degree of susceptibility and assess risk of DON under intermountain west production conditions, and to select for increased resistance in breeding lines of wheat and barley to improve FHB resistance and reduce DON in newly released varieties.

3) significant results – Excellent disease resulted in the spring wheat nursery, allowing us to confirm the level of genetic tolerance or susceptibility of currently produced varieties. Disease development in barley was less than optimal, but significant differences still developed in both FHB and DON levels in harvested grain.

4) key outcomes or other achievements - This results of this study was presented numerous times at the local, national and international level. Consultants in the area have used this data to improve variety recommendations, and growers now regularly spray to reduce FHB and DON in susceptible and more resistant spring wheat cultivars. Growers are now aware of the varieties that are less likely to get FHB and suffer high DON.

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

Professional collaborations have expanded with the USDA-ARS researchers at Aberdeen. The PI and staff members have learned from the expertise of other researchers, (especially Drs. Ruth Dill-Macky, Pierce Paul, and Brian Steffenson) on the detailed field requirements to successfully conduct this research and to obtain specific checks to improve results and standardization with other programs.

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

The results have been presented at numerous grower meetings, and professional meetings at the regional, state, national and international level. I have received invitations to talk at many meetings, even at the North American Barley Workers Workshop in Canada.

Project 2: *Integrated Management of FHB and DON in Spring Wheat in Idaho.*

1. **What are the major goals and objectives of the project?**
   (The research priorities being addressed include Plan Goals 1, 3 and 4.)
   1) Goal 1, we screened for FHB resistance in advanced lines and widely grown cultivars of wheat and barley that are currently grown under irrigation in order to identify low risk lines, in concert with appropriate fungicide treatments to reduce DON in harvested grain.
   3) Goal 3, determine management practices to reduce FHB disease, FDK, and DON levels under western irrigated production starting with less susceptible varieties, fungicide application and irrigation management.
   4) Enhance communication with other FHB researchers through participation in collaborative research and attending the annual meeting. The PI improved end user education and outreach (Goal 4) including, but not limited to, producers, agricultural advisors, the research community, and grain processors.

2. **What was accomplished under these goals?** *Address items 1-4) below for each goal or objective.*
   1) major activities - The coordinated study was conducted at the University of Idaho Aberdeen Research and Extension Center in Aberdeen, ID in the summer of 2016 with four wheat varieties, Diva (moderately susceptible), IDO1202S (moderately susceptible), IDO851 (moderately resistant), and Klasic (susceptible) on 20 April 2016. Varieties were selected based on 2015 FHB screening performed at Aberdeen. The experimental design was complete randomized block with a split-plot arrangement in 6 replications, with cultivars as main plots and treatments as sub-plots. Fungicide applications were at anthesis (Feekes growth stage 10.5.1) and anthesis + 4 days post-anthesis (A+4). Fungicide treatments were Prosaro (6.5 fl. oz /A) at anthesis, Prosaro + Caramba (6.5 + 14 fl. oz/A) at A+4, Caramba + Folicur (14 + 4 fl. oz/A) at A+4 and Proline + Folicur (5.7 + 4 fl. oz/A) at A+4. Fungicides were applied with a CO_2 sprayer using 8001 VS nozzles at a rate of 10 gallons per acre. Conidial suspensions (100,000 macroconidia/L) were sprayed a day following the anthesis fungicide application with a CO_2 backpack sprayer with Teejet 8003 VS nozzles at a ground speed of 1 second per foot at 40 psi. Severity (percent blighted spikelets per head) of 100 heads per plot was arbitrarily rated at soft dough (FGS 11.2) specifically 23-24 days after anthesis. FHB severity was used to calculate FHB incidence (incidence= number of blighted heads/100 sampled heads) and FHB index (FHB Index= Severity x Incidence / 100). Plots were harvested on 7 September using a Harvestmaster plot combine. Fusarium-damaged kernels (FDK) were assessed as a percentage of harvested kernels visibly affected by FHB out of the harvested grain from each plot. Data were analyzed using the generalized linear mixed model procedure (PROC GLIMMIX) in SAS (version 9.4). Subsamples were sent to Dr. Yanhong Dong of University of Minnesota for DON analysis and data will be provided on a later date.

   2) specific objectives – The specific objectives were to test the combination of variety and fungicide treatment to demonstrate the efficacy of combining resistant varieties and appropriate fungicides to control FHB in the field and DON in harvested grain. While this

is not specifically a new objective, the fact that these studies had never been performed under irrigation in the intermountain west made this research very relevant and significant.

3) significant results - Significant differences in FHB ratings, yield and test weight were found among varieties. IDO851 had the lowest FHB ratings and highest yield. Only FHB severity and test weight were significantly different between Diva and IDO1202S. Klasic also had lower FHB than Diva and IDO1202S but had the highest FDK, and lowest yield and test weight among varieties. Klasic reached anthesis one week earlier than other varieties, which resulted to earlier and possibly lower FHB ratings.

Despite the moderately low disease pressure, fungicide applications significantly reduced FHB ratings and FDK as well as significantly increased yield and test weight compared to the untreated checks. Inoculated and non-inoculated untreated checks significantly differ in test weight only. Although treatments with post-anthesis fungicide applications significantly reduced FHB severity and FDK, no significant differences in FHB index and yield were detected among fungicide treatments. The effectiveness of additional post-anthesis fungicide applications cannot be determined in this trial but may be effective in environments with highly conducive conditions.

Overall, FHB index ranged from 2 to 32 %. Moderately susceptible varieties Diva and IDO1202S with fungicide treatments had significant FHB reduction but yields did not differ. However, test weights of fungicide-treated IDO1202S plots were significantly higher than the untreated checks. When treated with fungicides, the susceptible variety Klasic had significantly increased yield and test weight. Only Prosaro application at anthesis resulted to significantly higher yield and test weight of the moderately resistant ID0851. The 2016 growing season was very dry and under these conditions, split fungicide applications did not improve disease control compared to one application. Current recommendation of one fungicide application at anthesis remains the most cost effective method to reduce FHB under irrigation in southern Idaho.

4) key outcomes or other achievements – This results of this study was presented numerous times at the local, national and international level. Consultants in the area have used this data to improve fungicide recommendations, and growers now regularly spray to reduce FHB and DON in susceptible and more resistant spring wheat. Growers are now aware of the varieties that are less likely to get FHB and suffer high DON.

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

The PI and staff members have learned from the expertise of other researchers, (especially Drs. Ruth Dill-Macky, Pierce Paul, and Brian Steffenson) on the detailed field requirements to successfully conduct this research. We have also assisted other researchers (Montana State University, Miller Research in Rupert, ID) in protocol development and nursery

establishment. One staff member in particular should be able to apply and accomplish PhD level work as a result of these studies, and I hope to recruit her to participate in my program.

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

The results have been presented at numerous grower meetings, and professional meetings at the regional, state, national and international level. I have received invitations to talk at many meetings, even at the North American Barley Workers Workshop in Canada.

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

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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 (6/1/16 - 5/31/17). If you did not have any publications or presentations, state 'Nothing to Report' directly above the Journal publications section.

Journal publications.
None

Books or other non-periodical, one-time publications.
None

Other publications, conference papers and presentations.

Marshall, J.M., Jackson, C.A., Shelman, T., Jones, L., Arcibal, S., and O'Brien, K. 2017. 2016 Small Grains Report, Southcentral and Southeast Idaho Cereals Research and Extension Program. Idaho Agricultural Experiment Station. UI Research Bulletin 191. 143 pp. http://www.cals.uidaho.edu/edComm/pdf/RES/RES189.pdf
Status: Published
Acknowledgement of Federal Support: YES

Arcibal, S.M., Baldwin, T.T., Jackson, C.A., Shelman, T., and Marshall, J.M**.** 2016. Integrated FHB Management of Spring Wheat in Idaho. In: Proceedings of the 2016 USWBSI meeting, St. Louis, MO.
Status: Abstract and Proceedings Published and poster Presented.
Acknowledgement of Federal Support: YES (poster), NO (abstract)

Marshall, J.M. 2016. New Disease Pressures in Western Cereal Production. Logan, UT. USU Plant Sciences Seminar Series.
Status: Presented
Acknowledgement of Federal Support: YES

Arcibal. S.M., and J.M. Marshall. 2016. Screening and Managing Fusarium Head Blight in Wheat and Barley. Idaho Association of Plant Protection. Nov. 3, 2016, Jerome, Idaho.
Status: Presented
Acknowledgement of Federal Support: YES

Webinar:
2016 (recorded 1/19/16) Managing Fusarium Head Blight Webinar (Updated for the Idaho Wheat Commission). 187 views as of May 31, 2016. https://vimeo.com/152646122
Status: Published
Acknowledgement of Federal Support: YES