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

Cover Page

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Fiscal Year:	2017
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.
FY17 USDA-ARS Award Amount:	$ 41,644
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:	6/1/17 - 5/31/18
Reporting Period End Date:	05/31/18

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
EC-HQ	Determining FHB Susceptibility in Barley and Wheat Cultivars in the Western US.	$ 29,932
MGMT	Integrated Management of FHB and DON in Spring Wheat in Idaho.	$ 11,712
	FY17 Total ARS Award Amount	$ 41,644

Juliet Marshall 8/1/18

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

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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 are susceptible to FHB. Over the previous ten years, FHB infections have been occurring with greater frequency and severity under irrigated production. A few varieties of hard red spring wheat and soft white spring have some level of resistance associated with the presence of the Fhb1 gene. Soft white spring wheat and spring 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) For 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 lower 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 (susceptible check), and Rollag hard red spring (resistant check). For barley, Chevron and Quest were included as the six-row resistant checks, PI383933 and Stander as susceptible. ICB111809 was the two-rowed susceptible check, and Clho4196 was the 2-row resistant check. Experimental units consisted of two row plots with two replications using a randomized complete block design. Plots were 5-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 (100,000 conidia per L) with conidial suspension 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 occurred 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. A supplementary misting system with nozzles every 10 feet was also used for the barley screening nursery. The misters ran every 3 minutes every 2 hours between 9PM to 3AM and 9AM to 11AM.

FHB was assessed in each plot at about soft dough (Feekes 11.2). Scab readings were done 21 days after 50% flowering (24 days post-heading). Barley was rated 20-22 days after 50% heading (first spray inoculation). Twenty 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. Plots were harvested using Wintersteiger Classic small plot combine, and weighed for yield and test weight. Subsamples of harvested grain per plot were rated for Fusarium-damaged kernels (FDK) then submitted to the USWBSI-funded DON testing laboratories in St. Paul, MN for DON analysis

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 irrigated 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 formed in the spring 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 and breeding companies 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, assisted other researchers in the setup of additional nurseries in the west, and have helped other extension pathologists disseminate information of resistance and disease epidemiology.

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 3 and 4.)
   3) Goal 3, determine management practices to reduce FHB disease, FDK, and DON levels under western irrigated production systems using susceptible, moderately susceptible and moderately resistant wheat 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 integrated management coordinated study was conducted at the University of Idaho Aberdeen Research and Extension Center in Aberdeen, ID in the summer of 2017 with four wheat varieties, Diva (moderately susceptible), IDO1202S (moderately susceptible), IDO851 (moderately resistant), and Klasic (susceptible) planted on 8 May 2017. This was the second year of the study. Varieties were selected based on 2015 FHB varietal screening performed at Aberdeen. The experimental design was a 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 randomly selected heads per plot was rated at soft dough (FGS 11.2) 23-24 days after anthesis. FHB severity ratings were 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.

   2) specific objectives
   The specific objectives were to test the combination of variety and fungicide treatments 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, DON levels, yield and test weight were found among varieties. Similar to 2016 data, IDO851 had the lowest FHB ratings and highest yield. Diva and IDO1202S (both moderately susceptible) responded similarly to fungicide treatment. Klasic also had a higher FHB index than Diva and IDO1202S, the highest FDK, DON, and lowest yield and test weight among varieties. Klasic is an earlier maturing variety, and reached anthesis one week earlier than other varieties.

Fungicide applications significantly reduced FHB ratings and FDK as well as significantly increased yield and test weight compared to the untreated checks in all but the resistant line. Inoculated and non-inoculated untreated checks did not significantly differ in yield, and test weight varied only with Klasic, where the untreated control had higher test weight than the untreated and non-inoculated treatment. Treatments with the added post-anthesis fungicide applications (Prosaro and Caramba) significantly reduced FHB index, DON and FDK in Klasic and Diva. No significant differences in FHB index were detected among fungicide treatments in IDO1202S and IDO851. There were no significant difference between yield and test weight of fungicide treated varieties. The effectiveness of additional post-anthesis fungicide applications is positive only on very susceptible varieties in environments with highly conducive conditions.

Overall, FHB index ranged from 2 to 64%, and DON levels ranged from 0.13 to 22 PPM.

4) key outcomes or other achievements
This result of this study were 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 moderately susceptible 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 (Washington State University, Montana State University, Miller Research in Rupert, ID) in protocol development and nursery establishment.

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 (IAPP), state, national (APS) and international level (ICPP). I have received invitations to talk at many meetings, assisted other researchers in the setup of additional nurseries in the west, and have helped other extension pathologists disseminate information of resistance and disease epidemiology.

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 (6/1/17 - 5/31/18). 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.
These three publications were from previous work but directly applicable to FHB research and my project:

Bissonnette, K., Wharton, P., Chen, J., Marshall, J.M. 2018. Survey of *Fusarium* species associated with Fusarium head blight in southeastern Idaho. Plant Health Progress.19:125-127. https://doi.org/10.1094/PHP-10-17-0066-S
Status: Published
Acknowledgement of Federal Support: No

Marshall, J.M., Arcibal, S., Jackson, C.A., Shelman, T. 2018. Foliar fungicides for control of Fusarium head blight in irrigated Klasic hard white spring wheat, Bingham Co, ID, 2017. Plant Disease Management Report (Field, Cereal and Forage Crops) CF210.
Status: Published
Acknowledgement of Federal Support: No

Marshall, J.M., Arcibal, S., Jackson, C.A., Shelman, T. 2018. Foliar fungicides for control of Fusarium head blight in irrigated Idagold spring barley, Bingham Co, ID, 2017. Plant Disease Management Report (Field, Cereal and Forage Crops)CF211.
Status: Published
Acknowledgement of Federal Support: No

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

Other publications, conference papers and presentations.

Arcibal, S.S. and Marshall, J.M. 2017. Assessing Spring Wheat for FHB Susceptibility Idaho. (Abstr.) Phytopathology 107:S5.76. http://dx.doi.org/10.1094/PHYTO-106-12-S5.76 (APS Annual Meeting, San Antonio, TX. August 4-8, 2017.)
Status: Abstract Published
Acknowledgement of Federal Support: YES (poster), NO (abstract)

Arcibal, S.S. and Marshall, J.M. 2017. Uniform integrated approach for management of FHB and DON in wheat. Idaho Association of Plant Protection. November 2, 2017. Burley, ID.
Status: Presented
Acknowledgement of Federal Support: Yes

Marshall, J.M. and Arcibal, S.S. 2017. Utilization of fungicides and host resistance in reducing FHB. Idaho Association of Plant Protection. November 2, 2017. Burley, ID.
Status: Presented
Acknowledgement of Federal Support: Yes

Arcibal, S.M., Jackson, C.A., Shelman, T. and Marshall, J.M. 2017. Abstract. Integrated FHB management of spring wheat in Idaho. Proceedings of the 2017 National Fusarium Head Blight Forum. Dec 3-5, 2017. Page 3. https://scabusa.org/pdfs/NFHBF17_Proceedings_PF_Web.pdf
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: YES (poster), NO (abstract)

Arcibal, S.M., Jackson, C.A., Shelman, T. and Marshall, J.M. 2017. Abstract. Screening for resistance to Fusarium Head Blight in spring wheat and barley in Idaho. Proceedings of the 2017 National Fusarium Head Blight Forum. Dec 3-5, 2017. p78. https://scabusa.org/pdfs/NFHBF17_Proceedings_PF_Web.pdf
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: YES (poster), NO (abstract)

Baldwin, T., Arcibal, S.M., Bregitzer, P.P., Marshall, J.M. 2017. Abstract. Deletion of FgNAT1 reveals a potential role of benzoxazinoids in suppression of DON accumulation. Proceedings of the 2017 National Fusarium Head Blight Forum. Dec 3-5, 2017. Page 43. https://scabusa.org/pdfs/NFHBF17_Proceedings_PF_Web.pdf
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: YES (poster), NO (abstract)

Salgado, J.D., Bergstrom, G., 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., Negelkirk, M., Stevens, J., Smith, D., Smith, M., Wegulo, S., Wise, K., Yabwalo, D., Young-Kelly, H.M., Paul, P.A. 2017. Efficacy of two-treatment fungicide programs for FHB Management: A multistate coordinated project. Proceedings of the 2017 National Fusarium Head Blight Forum. Dec 3-5, 2017. Page 20. https://scabusa.org/pdfs/NFHBF17_Proceedings_PF_Web.pdf
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: YES (poster), NO (abstract)

Marshall, J.M. Disease Management in Cereal Grains. Far West Conference, Boise, ID. Dec 12, 2017.
Status: Presented
Acknowledgement of Federal Support: Yes

Marshall, J.M. Disease Management in Cereal Grains. Western Ag Expo. Caldwell, ID. Jan 23, 2018.
Status: Presented
Acknowledgement of Federal Support: Yes

Marshall, J.M. Disease Management in Cereal Grains. Cereal Schools. Burley, ID. Feb 6, 2018.
Status: Presented
Acknowledgement of Federal Support: Yes

Marshall, J.M. Disease Management in Cereal Grains. Cereal Schools. Pocatello, ID. Feb 7, 2018.
Status: Presented
Acknowledgement of Federal Support: Yes

Marshall, J.M. Disease Management in Cereal Grains. Cereal Schools. Idaho Falls, ID. Feb 8, 2018.
Status: Presented
Acknowledgement of Federal Support: Yes

Marshall, J.M. Disease Management in Cereal Grains. Cereal Schools. Ashton, ID. Feb 8, 2018.
Status: Presented
Acknowledgement of Federal Support: Yes

Marshall, J.M. Disease Management in Cereal Grains. Cereal Schools. Preston, ID. Feb 9, 2018.
Status: Presented
Acknowledgement of Federal Support: Yes

Marshall, J.M. Disease Management in Cereal Grains. Grower meeting in Shoshone, ID. Feb 16, 2018.
Status: Presented
Acknowledgement of Federal Support: Yes

Marshall, J.M. Disease Management in Barley. Anheuser Busch Agronomist Training. Idaho Falls, ID. March 13, 2018.
Status: Presented
Acknowledgement of Federal Support: Yes

Marshall, J.M. USWBSI Update: FHB Management in Wheat and Barley. Bozeman, MT. March 14, 2018.
Status: Presented
Acknowledgement of Federal Support: Yes