**USDA-ARS**
**U.S. Wheat and Barley Scab Initiative**
**FY18 Performance Report**
**Due date:** September 23, 2019

## Cover Page

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|---|---|
| **Cooperating Principle Investigator (CPI):** | Juliet Marshall |
| **Institution:** | University of Idaho |
| **E-mail:** | jmarshall@uidaho.edu |
| **Phone:** | 208-529-8376 Ext. 115 |
| **Fiscal Year:** | 2018 |
| **USDA-ARS Agreement ID:** | 58-2050-8-013 |
| **USDA-ARS Agreement Title:** | Integrated Management Tools to Reduce FHB Impact in the Intermountain West and the PNW |
| **FY18 USDA-ARS Award Amount:** | $ 51,309 |
| **Recipient Organization:** | University of Idaho<br>Moscow, ID 83844-3020 |
| **DUNS Number:** | 075746271 |
| **EIN:** | 82-6000945 |
| **Recipient Identifying Number or Account Number:** | 846457 |
| **Agency PI:** | Phil Bregitzer |
| **Project/Grant Reporting Period:** | 8/1/18 - 7/31/19 |
| **Reporting Period End Date:** | 07/31/19 |

## USWBSI Individual Project(s)

| USWBSI Research Category* | Project Title | ARS Award Amount |
|---|---|---|
| MGMT | Efficacy of a New Fungicide for FHB and DON Management across Environments and Grain Market Classes. | $ 16,850 |
| BAR-CP | Determining FHB Susceptibility in Barley Cultivars in the Western US. | $ 18,884 |
| VDHR-SPR | Determining FHB Susceptibility in Spring Wheat Cultivars in the Western US. | $ 15,575 |
| | **FY18 Total ARS Award Amount** | $ 51,309 |

Juliet M. Marshall 8/30/19
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

FY18 Performance Report
PI: Marshall, Juliet
USDA-ARS Agreement #: 58-2050-8-013
Reporting Period: 8/1/18 - 7/31/19

**Project 1:** *Efficacy of a New Fungicide for FHB and DON Management across Environments and Grain Market Classes.*

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

FHB damage in spring grain continues to increase in southern and eastern Idaho. Fungicide management tools are being investigated in the irrigated western production region to reduce FHB pressure and DON contamination. Our goals are to participate in the MGMT CP to evaluate the integrated effects of fungicide treatment and genetic resistance on FHB and DON in hard red spring and hard white wheat grown in the Pacific Northwest and Intermountain West region, with emphasis on a new fungicide, Miravis Ace®. We compared the efficacy of Miravis Ace when applied at heading or at anthesis to that of standard anthesis application of Prosaro® or Caramba®. The objective was to generate data to further quantify the economic benefit of FHB/DON management strategies and to develop more robust "*best-management practices*" for FHB and DON and generate data to validate and advance the development of FHB and DON risk prediction models**.** With the expansion of FHB into irrigated production areas of the PNW and intermountain West, and the limits of currently available fungicides, testing of the newly available fungicide Miravis Ace may provide increased choices for the producer.

**Project goals:**
Our objectives for this proposal were to: 1) evaluate fungicide treatments of a new class of fungicides compared to standard applications and 2) test appropriate combinations of fungicides and host resistance for FHB and DON reduction.

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

1) major activities - Two separate experiments were conducted in conjunction with the Management CP. The first was the Uniform Fungicide Trial, and the second was the Integrated Management Trial. Following standard protocol developed for the MGMT CP, we planted the first trial and applied fungicides according to seven different treatments. In the Integrated Management trial, four varieties (susceptible, moderately susceptible and moderately resistant) based on previous screening evaluations were combined with several different fungicide timing combinations to evaluate fungicide effectiveness at reducing FHB and DON.

2) specific objectives – In collaboration with the MGMT CP, The Objectives of this FHB Management Coordinated Project (MGMT_CP) are to:

- Evaluate the integrated effects of fungicide treatment and genetic resistance on FHB and DON in all major grain classes, with emphasis on a new fungicide, Miravis Ace,
- Compare the efficacy of Miravis Ace when applied at heading or at anthesis to that of standard anthesis application of Prosaro or Caramba,
- Generate data to further quantify the economic benefit of FHB/DON management strategies;

- Develop more robust "*best-management practices*" for FHB and DON; and
- Generate data to validate and advance the development of FHB and DON risk prediction models.

3) significant results – Good disease formed in the spring nursery, with significant differences between varieties and fungicide treatments. The plots were rated and harvested (mid-September), but post-harvest analysis has not yet been accomplished.

4) key outcomes or other achievements - The results of this study will be presented numerous times at the local, national and international level. Consultants and breeding companies in the area have used previous data to improve fungicide application recommendations, and growers now regularly spray to reduce FHB and DON in susceptible and moderately susceptible 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?**

I have a PhD student that has been working on this project (previously as a technician), whose responsibilities have been to develop inoculum, organize inoculations, analyze data and assist in preparing reports. The PhD project will incorporate weather data to assist in the development of predictive models that are specific to the intermountain West irrigated environment. I also have a postdoctoral fellow training to supervise the nursery following the graduation of the PhD student.

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

As I have a 60% extension appointment (100% cereals), I am responsible for presenting appropriate research to the growers and industry professionals. I regularly present the FHB research results at almost every meeting, incorporating it into presentations as well as into my annual Small Grain Report, which is widely distributed in Idaho and available online. Every year, I encourage my technician (now PhD student) to present at the Idaho Association of Plant Protection, to develop papers and to present at the USWBSI annual meeting and the regional and national American Phytopathological Society meetings.

**Project 2:** *Determining FHB Susceptibility in Barley Cultivars in the Western US.*

1. **What are the major goals and objectives of the project?** In 2015, fields of barley showed signs of the disease and many spring wheat fields tested at >5 ppm DON, even after appropriate treatments with fungicides. Large production areas north of Idaho Falls had barley rejected due to high levels of DON. In 2018, 40,000 bu of barley was rejected from one producer alone near Rupert, Idaho. The majority of the barley varieties that are available to growers in the area are susceptible to FHB and growers need information for FHB management. Breeders need information on advanced lines and breeding material to release selections with reduced vulnerability to FHB damage and DON accumulation. Management practices need to be tested under the unique conditions in the irrigated production regions of the Intermountain West to develop appropriate management practices to reduce FHB and DON.

   **Project goals:**
   Our specific objectives for this proposal were to: 1) determine the degree of susceptibility that exists in currently grown varieties and advanced lines to local *Fusarium graminearum* isolates, 2) provide DON data to local breeders and growers to increase the ability to select the best varieties for breeding and production.

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

   1) major activities - An assessment of released 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. Resistant and susceptible checks were: 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 installed 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 30 grams per square meter. 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 total spore suspension of 100,000 conidia per mL. Plots were inoculated twice (50,000 conidia per mL) 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 for 3 minutes every 30 minutes to 1 hour between 5PM to 10PM and 6AM to 9AM.

FHB was be assessed in each plot at about soft dough (Feekes 11.2). Scab readings were done 21to 28 days after head emergence. 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. Samples will be 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 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 (hopefully) DON levels in harvested grain.

4) key outcomes or other achievements - The results of these studies were and will be 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 spring cultivars. Growers are now aware of the varieties that are less likely to get FHB and suffer high DON, and spray those varieties they know are vulnerable, especially when following corn in their crop rotations.

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

I have a PhD student that has been working on this project (previously as a technician), whose responsibilities have been to develop inoculum, organize inoculations, analyze data and assist in preparing reports. The PhD project will incorporate weather data to assist in the development of predictive models that are specific to the intermountain West irrigated environment. I also have a postdoctoral fellow training to supervise the nursery following the graduation of the PhD student.

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

As I have a 60% extension appointment (100% cereals), I am responsible for presenting appropriate research to the growers and industry professionals. I regularly present the FHB research results at almost every meeting, incorporating it into presentations as well as into my annual Small Grain Report, which is widely distributed in Idaho and available online. Every year, I encourage my technician (now PhD student) to present at the Idaho Association of Plant Protection, to develop papers and to present at the USWBSI annual meeting and the regional and national American Phytopathological Society meetings.

**Project 3:** *Determining FHB Susceptibility in Spring Wheat Cultivars in the Western US.*

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

FHB damage in spring grain continues to increase in southern and eastern Idaho. Several years in a row, fields of spring wheat showed signs of the disease and many spring wheat fields tested at >5 ppm DON, even after appropriate treatments with fungicides. Growers now regularly incorporate fungicide treatments for FHB suppression as standard practices for susceptible varieties. The majority of the wheat varieties that are available to growers in the area are susceptible to FHB. Growers need information on FHB susceptibility of the 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. Management practices need to be tested under the unique conditions in the irrigated production regions of the Intermountain West to develop appropriate management practices to reduce FHB and DON in susceptible cultivars.

**Project goals:**
Our specific objectives for this proposal were to: 1) determine the degree of susceptibility that exists in currently grown varieties and advanced lines to local *Fusarium graminearum* isolates, 2) provide DON data to local breeders and growers to increase the ability to select the best varieties for breeding and production. Awareness of variety reaction to FHB determines need for potential fungicide applications.

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 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 separate experiments (spring wheat and spring barley) tested existing varieties and advanced cultivars. Resistant and susceptible checks were: (for wheat) Jefferson hard red spring (susceptible check), and Rollag hard red spring (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 installed 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 of the earliest lines at 30 grams per square meter. An irrigation system with sprinkler nozzles every 20 feet is used both for irrigation and increasing humidity in the plant canopy. A supplementary misting system misting system with nozzles every 10 feet provided additional moisture to increase likelihood of infection every day Monday through Sunday

(run intermittently for 5 hours in the evening 5pm-10pm and three hours in the morning 6am-9am).

FHB was be assessed in each plot at about soft dough (Feekes 11.2). Scab readings were done 21 days after flowering (at least 24 days post-heading). 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. Harvested samples will be assessed for FDK prior to testing for DON. Samples will be 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 - Good disease formed in the spring nursery, allowing us to confirm the level of genetic tolerance or susceptibility of currently produced varieties.

4) key outcomes or other achievements
The results of the previous FHB experiments and this study was/will be 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 moderately susceptible spring wheat cultivars. Growers are now aware of the varieties that are less likely to get FHB and suffer high DON, and spray those varieties they know are vulnerable, especially when following corn in their crop rotations.

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

I have a PhD student that has been working on this project (previously as a technician), whose responsibilities have been to develop inoculum, organize inoculations, analyze data and assist in preparing reports. The PhD project will incorporate weather data to assist in the development of predictive models that are specific to the intermountain West irrigated environment. I also have a postdoctoral fellow training to supervise the nursery following the graduation of the PhD student.

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## Training of Next Generation Scientists

**Instructions:** Please answer the following questions as it pertains to the FY18 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 FY18 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 FY18 award period?** Yes

   **If yes, how many?** One

3. **Have any post docs who worked for you during the FY18 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 FY18 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 FY18 award period. All columns must be completed for each listed germplasm/cultivar. Use the key below the table for Grain Class abbreviations.

*NOTE: 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** |
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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 FY18-FPR_Instructions for detailed instructions for listing publications/presentations about your work that resulted from all of the projects included in the FY18 grant. Only include citations for publications submitted or presentations given during your award period (8/1/18 - 7/31/19). 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. See example below for a poster presentation with an abstract:

> Conley, E.J., and J.A. Anderson. 2018. Accuracy of Genome-Wide Prediction for Fusarium Head Blight Associated Traits in a Spring Wheat Breeding Program. In: Proceedings of the XXIV International Plant & Animal Genome Conference, San Diego, CA.
> Status: Abstract Published and Poster Presented
> Acknowledgement of Federal Support: YES (poster), NO (abstract)

**Journal publications.**

Baldwin, T.T., Arcibal, S.M., Klos, K., Bregitzer, P., Marshall, J.M. 2019. Deletion of the benzoxazinoid detoxification gene NAT1 in *Fusarium graminearum* reduces deoxynivalenol in spring wheat. *Accepted 03/19* PloS 14(7): e0214230. https://doi.org/10.1371/journal.pone.0214230
Status: Published
Acknowledgement of Federal Support: YES

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

'Nothing to Report'

**Other publications, conference papers and presentations**.

**Conference Abstracts and Presentations:**

Arcibal, S.S., T. Baldwin, P. Bregitzer, and J.M. Marshall. 2018. FHB Susceptibility of spring barley and wheat cultivars in the Intermountain West. Proceedings of the 2018 National Fusarium Head Blight Forum (p. 100).
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: YES (poster), YES (abstract)

Arcibal, S.S., C.A. Jackson, Y. Dong, and J.M. Marshall. 2018. Efficacy of a new fungicide (Miravis Ace) for managing FHB and DON in Southern Idaho. Proceedings of the 2018 National Fusarium Head Blight Forum (p. 7).
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: YES (poster), YES (abstract)

Arcibal, S. and Marshall, J.M. 2018. Expansion of Fusarium head blight coordinated projects in Idaho wheat and barley. Idaho Association of Plant Protection Meeting, Twin Falls, ID.
Status: Presented
Acknowledgement of Federal Support: YES

Marshall, J.M. 2018. FHB Now Westward Bound, and New Struggles to Keep DON Down. Abstract. Invited presentation to USWBSI National Fusarium Head Blight Forum, St. Louis, MO. Dec 2 – 4, 2018.
Status: Abstract Published and Presented
Acknowledgement of Federal Support: YES (poster), YES (presentation)