

USDA-ARS
U.S. Wheat and Barley Scab Initiative
FY19 Performance Report
Due date: September 30, 2020

Cover Page

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Fiscal Year:	2019
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
FY19 USDA-ARS Award Amount:	\$ 51,309
Recipient Organization:	University of Idaho Moscow, ID 83844-3020
DUNS Number:	075746271
EIN:	82-6000945
Recipient Identifying Number or Account Number:	846457
Agency PI:	Kathy Esvelt Klos
Project/Grant Reporting Period:	8/1/19 - 7/31/20
Reporting Period End Date:	7/31/2020

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
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
MGMT	Efficacy of a New Fungicide for FHB and DON Management across Environments and Grain Market Classes	\$ 16,850
	FY19 Total ARS Award Amount	\$ 51,309

Juliet Marshall

9/28/2020

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: Determining FHB Susceptibility in Barley Cultivars in the Western US

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

Increasing risks associated with FHB and DON in Idaho barley production prompted research in screening varieties to FHB-causing fungi. 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 variety 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. Testing under the unique conditions in the irrigated production regions of the Intermountain West was performed 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 spring and winter 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 or objectives? (For each major goal/objective, address items a-b) below.)

a) What were the major activities?

An assessment of released barley cultivars and advanced lines from entries in the University of Idaho Extension Variety trials (EVT) was conducted in on-station FHB nurseries at the Aberdeen Research and Extension Center and at a second location in Kimberly, ID at the USDA-ARS Northwest Irrigation and Soils Research. The second location was added to increase the chances of having a (warmer) conducive environment for FHB development for both spring and winter lines. Spring checks were: 1) six-row resistant checks were Chevron and Quest; 2) the susceptible cultivars were PI 383933 and Stander; 3) the two-rowed susceptible check was ICB 111809; and 4) the 2-row resistant check was Clho 4196. 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 the irrigation needs of the crop was provided separately with standard solid-set irrigation equipment.

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

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mL) with conidial suspension starting at head emergence (Feekes GS 10.5) using a CO₂ 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. A misting system with sprinkler nozzles every 10 feet was used for increasing humidity in the plant canopy. The misters ran for 3 minutes every 30 minutes in the evening (between 5PM to 10PM) and every hour in the morning (between 6AM to 9AM in Aberdeen, and 6AM to 8AM and 10 AM in Kimberly).

FHB was assessed in each plot at about soft dough (Feekes 11.2). Scab readings were done 21 to 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 in the total number of assessed heads. FHB index is calculated using the formula: $FHB\ Index = (\% \text{ severity} \times \% \text{ incidence}) / 100$. 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. 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.

b) What were the significant results?

Enough disease formed in the spring nursery to allow ratings to distinguish the level of genetic tolerance or susceptibility of screened varieties in the EVT. Disease development in barley was less than optimal, but significant differences still developed in both FHB and (hopefully) DON levels in harvested grain.

c) List 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. Was this research impacted by the COVID-19 pandemic (i.e. university shutdowns, reduced or lack of support personnel, etc.)? If yes, please explain how this research was impacted or is continuing to be impacted.

No, this research was not significantly impacted by the COVID-19 pandemic. Yet to be determined is the impact on fall activities in the lab.

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4. 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.

5. 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 extension 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 Spring Wheat Cultivars in the Western US

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

As in barley, increasing risks associated with FHB and DON in Idaho wheat production prompted research in screening varieties to FHB-causing fungi. 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, including screening cultivars in the winter variety trials; 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 or objectives? (For each major goal/objective, address items a-b) below.)

a) What were the 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 and at a second location in Kimberly, ID at the Kimberly R&E Center. The second location was added to increase the chances of having a (warmer) conducive environment for FHB development in spring lines while providing the first screening of the winter wheat cultivars in the EVT. Experiments tested existing varieties and advanced cultivars and were evaluated after inoculation and misting. Caledonia soft white winter line was included as a resistant check in the winter trial. Resistant and susceptible spring checks included: 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.

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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. A supplementary misting system with nozzles every 10 feet provided additional moisture to increase likelihood of infection everyday Monday through Sunday (run intermittently for 5 hours in the evening 5pm-10pm and three hours in the morning 6am-9am).

FHB was 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: $FHB\ Index = (\% \text{ severity} \times \% \text{ incidence}) / 100$. 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.

b) What were the significant results?

Significant differences in disease levels in the spring wheat nursery allowed ratings to distinguish the level of genetic tolerance or susceptibility of currently produced varieties. Significant differences in DON levels in harvested grain will be determined with the cooperation of the USWBSI supported lab at UMN in St. Paul.

c) List 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. Was this research impacted by the COVID-19 pandemic (i.e. university shutdowns, reduced or lack of support personnel, etc.)? If yes, please explain how this research was impacted or is continuing to be impacted.

No, this field research was not significantly impacted by the COVID-19 pandemic. Yet to be determined is the impact on fall activities in the lab.

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4. 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.

5. 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: 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 research project?

Depending on the year, 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. We also are generating 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 or objectives? (For each major goal/objective, address items a-b) below.)

a) What were the 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.

b) What were the significant results?

Good disease formed in the spring nursery, with significant differences between varieties and fungicide treatments. The plots were rated (late July) and harvested (mid-September). In the UFT, fungicide treatments had significant differences in FHB Index, DON, test

weight, FDK but not yield. In the IM trial, both varieties and fungicides had significant effects on DON, FDK, test weight and yield.

- c) List 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. Was this research impacted by the COVID-19 pandemic (i.e. university shutdowns, reduced or lack of support personnel, etc.)? If yes, please explain how this research was impacted or is continuing to be impacted.**

No, this research was not significantly impacted by the COVID-19 pandemic. Yet to be determined is the impact on fall activities in the lab.

- 4. 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.

- 5. 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.

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY19 award period (8/1/19 - 7/31/20). 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 FY19 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 FY19 award period?**

No

If yes, how many?

- 3. Have any post docs who worked for you during the FY19 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 FY19 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?

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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 FY19 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

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 FY19-FPR_Instructions for detailed more instructions for listing publications/presentations about your work that resulted from all of the projects included in the FY19 grant award. Only citations for publications published (submitted or accepted) or presentations presented during the **award period (8/1/19 - 7/31/20)** should be included. If you did not publish/submit or present anything, state ‘Nothing to Report’ directly above the Journal publications section.

NOTE: Directly below each citation, you **must** indicate the Status (i.e. published, submitted, etc.) and whether acknowledgement of Federal support was indicated in the publication/presentation. See example below for a poster presentation with an abstract:

De Wolf, E., D. Shah, P. Paul, L. Madden, S. Crawford, D. Hane, S. Canty, R. Dill-Macky, D. Van Sanford, K. Imhoff and D. Miller. 2019. “Impact of Prediction Tools for Fusarium Head Blight in the US, 2009-2019.” In: S. Canty, A. Hoffstetter, H. Campbell and R. Dill-Macky (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum* (p. 12), Milwaukee, WI; December 8-10. University of Kentucky, Lexington, KY.

Status: Abstract Published and Poster Presented

Acknowledgement of Federal Support: YES (Abstract and Poster)

Journal publications. Nothing to report

Books or other non-periodical, one-time publications. Nothing to report

Other publications, conference papers and presentations.

Yimer, B., Arcibal, S., Dong, Y. and Marshall, J.M. 2019. Management of FHB and DON Using Fungicides and Host Resistance in Hard Spring Wheat in Idaho. In: S. Canty, A. Hoffstetter, H. Campbell and R. Dill-Macky (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum* (p. 12), Milwaukee, WI; December 8-10. University of Kentucky, Lexington, KY.

Status: Abstract Published and Poster Presented

Acknowledgement of Federal Support: YES (Abstract and Poster)

Mndolwa, E., Griffey, C., Kress, E., Fitzgerald, J., Marshall, J.M., Sorrells, M.E., Baldwin, S.A., Baldwin, T., Bregitzer, P., Klos, K.E. 2019. Evaluation of Aberdeen Barley (*Hordeum Vulgare*) Germplasm for Fusarium Head Blight Resistance. In: S. Canty, A. Hoffstetter, H. Campbell and R. Dill-Macky (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum* (p. 12), Milwaukee, WI; December 8-10. University of Kentucky, Lexington, KY.

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Acknowledgement of Federal Support: YES (Abstract and Poster)

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Baldwin, T., S.A. Baldwin, E. Kress, E. Mndolwa, K.E. Klos, J. Marshall, and P. Bregitzer. 2019. High vs. low DON accumulating lines of barley evaluated by dip inoculation of Fusarium head blight. In: S. Canty, A. Hoffstetter, H. Campbell and R. Dill-Macky (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum* (p. 43), Milwaukee, WI; December 8-10. University of Kentucky, Lexington, KY.

Status: Abstract Published and Poster Presented

Acknowledgement of Federal Support: YES (Abstract and Poster)

Baldwin, T., Baldwin, S.A., Kress, E., Dill-Macky, R., Sorrells, M.E., Gross, P., Brueggeman, R., Griffey, C., Fitzgerald, J., Marshall, J.M. and Bregitzer, P. 2019. Fusarium head blight biomass measurements in barley from 2018 U.S. nurseries. In: S. Canty, A. Hoffstetter, H. Campbell and R. Dill-Macky (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum* (p. 12), Milwaukee, WI; December 8-10. University of Kentucky, Lexington, KY.

Status: Abstract Published and Poster Presented

Acknowledgement of Federal Support: YES (Abstract and Poster)

Paul, P., et al., 2019. Fusarium head blight management coordinated project: Uniform fungicide trials 2018-2019. In: S. Canty, A. Hoffstetter, H. Campbell and R. Dill-Macky (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum* (p. 12), Milwaukee, WI; December 8-10. University of Kentucky, Lexington, KY.

Status: Abstract Published and Poster Presented

Acknowledgement of Federal Support: YES (Abstract and Poster)

Presentations:

Marshall, J.M. 2019. Fusarium Head Blight Management and Other Cereal Diseases. (1 hour)
Crop and Pest Management School. Montana State University. Invited. January 16, 2019.

Status: Presentation

Acknowledgement of Federal Support: YES

Arcibal Baldwin, S. and J.M. Marshall 2019. Integrated Management of Fusarium Head Blight and Deoxynivalenol in Hard Red and Hard White Spring Wheat. Nov 8, 2019 at the Idaho Association of Plant Protection, Twin Falls, ID.

Status: Abstract Published and Poster Presented

Acknowledgement of Federal Support: YES