USDA-ARS | U.S. Wheat and Barley Scab Initiative

FY21 Performance Progress Report

Due date: July 26, 2022

Cover Page

Principle Investigator (PI):	Juliet Marshall
Institution:	University of Idaho
E-mail:	jmarshall@uidaho.edu
Phone:	208-529-8376 Ext. 115
Fiscal Year:	2021
USDA-ARS Agreement ID:	59-0206-0-175
USDA-ARS Agreement Title:	Integrated Management Tools to Reduce FHB Impact in the Intermountain West and the PNW
FY20 USDA-ARS Award Amount:	$125,356
Recipient Organization:	University of Idaho Aberdeen Research & Extension Center 1693 S 2700 W, Aberdeen, ID 83210
DUNS Number:	075746271
EIN:	82-6000945
Recipient Identifying Number or Account Number, if any:	AN4786
Project/Grant Period:	6/1/21 - 5/31/23
Reporting Period End Date:	5/31/2022

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
BAR-CP	Determining FHB Susceptibility in Barley Cultivars in the Western US	$43,259
VDHR-SPR	Determining FHB Susceptibility in Wheat Cultivars in the Western US	$61,999
MGMT	Efficacy of a New Fungicide for FHB and DON Management in Idaho Integrated Management Studies	$20,098
	FY21 Total ARS Award Amount	$125,356

I am submitting this report as an: ☒ Annual Report ☐ Final Report

I certify to the best of my knowledge and belief that this report is correct and complete for performance of activities for the purposes set forth in the award documents.

Juliet M. Marshall _____ 7/22/2022_____

Principal Investigator Signature Date Report Submitted

‡ BAR-CP – Barley Coordinated Project
DUR-CP – Durum Coordinated Project
EC-HQ – Executive Committee-Headquarters
FST-R – Food Safety & Toxicology (Research)
FST-S – Food Safety & Toxicology (Service)
GDER – Gene Discovery & Engineering Resistance
HWW-CP – Hard Winter Wheat Coordinated Project
MGMT – FHB Management
MGMT-IM – FHB Management – Integrated Management Coordinated Project
PBG – Pathogen Biology & Genetics
TSCI – Transformational Science
VDHR – Variety Development & Uniform Nurseries
NWW –Northern Soft Winter Wheat Region
SPR – Spring 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?

FHB damage in spring grain continues to increase in southern and eastern Idaho. 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 resulted in rejection of barley for malting 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. 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. 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 or objectives? *(For each major goal/objective, address these three items 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 was conducted in on-station FHB nurseries at the Aberdeen Research and Extension Center. A second location at the USDA-ARS research facility at Kimberly, Idaho was added to increase the number of environments and to include an environment more conducive to infection. Resistant and susceptible checks were: Chevron and Quest were included as the six-row resistant checks; PI383933 and Stander as susceptible checks. 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 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 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.

b) What were the significant results?

Good disease formed in the spring nurseries, allowing us to confirm the level of genetic tolerance or susceptibility of currently produced varieties. DON levels were also obtained with the collaboration of Dr. Yanhong Dong, University of Minnesota. Disease development in barley was less than optimal, but significant differences still developed in both FHB and 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, especially when barley cultivars are rotated behind corn production. Growers are now aware of the varieties that are 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.

3. 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 and field days as well as into my annual Small Grain Report, which is widely distributed in Idaho and available online. Every year, I encourage my technicians and 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 Wheat Cultivars in the Western US

What are the major goals and objectives of the research 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. 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.

1. **What was accomplished under these goals or objectives?** *(For each major goal/objective, address these three items 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. A second location at the USDA-ARS research facility at Kimberly, Idaho was added to increase the number of environments and to include an environment more conducive to infection. Additional breeder material from Montana State University were included for testing. Spring wheat classes of soft white, hard white and hard red spring wheat were tested of 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 60 grams per plot. During and after anthesis, plots were irrigated every other

day for two hours. An irrigation system with sprinkler nozzles every 20 feet is used both for irrigation and increasing humidity in the plant canopy. A misting system 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 (24 days post-heading). 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. Plots were harvested using Wintersteiger Classic small plot combine and weighed for yield and test weight. Harvested samples will be assessed for VSK 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?

Good disease formed in the spring nursery, allowing us to confirm the level of genetic tolerance or susceptibility of currently produced varieties. DON levels were also obtained with the collaboration of Dr. Yanhong Dong, University of Minnesota.

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.

2. 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 and assisting in graduate student training.

3. 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 technicians and students 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 in Idaho Integrated Management Studies

---

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

Management Coordinated Project (MGMT_CP) goals are to:

1) 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,
2) Compare the efficacy of Miravis Ace when applied at heading or at anthesis to that of standard anthesis application of Prosaro or Caramba,
3) Generate data to further quantify the economic benefit of FHB/DON management strategies;
4) 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.

2. What was accomplished under these goals or objectives? *(For each major goal/objective, address these three items below.)*

Efficacy of a Miravis Ace for FHB and DON Management in Idaho Integrated Management Studies (FHB Management Coordinated Project)

a) What were the major activities?

Following standard protocol developed for the MGMT CP, we planted the and applied fungicides according to six different treatments to evaluate the efficacy of Miravis Ace in soft white spring wheat and hard red spring wheat of various resistance classes (susceptible, moderately susceptible and moderately resistant). Fungicides were applied at early anthesis with one treatment having an additional application 4-6 days after the first. There were two checks, one untreated and not inoculated and the other inoculated. Rating of disease occurred 21-24 days after inoculation, plots were harvested at maturity, and FDK and DON was determined from harvested grain samples.

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 in July and early August and harvested in early

September. Greater disease suppression and significantly less DON was reported in moderately susceptible and moderately resistant varieties. Greater levels of DON were found in susceptible varieties even with appropriate timing and concentrations of fungicides. Fungicide efficacy of Miravis Ace was slightly better but not statistically different than Prosaro. Two fungicides provided better control than a single treatment, but not significantly enough to warrant two fungicide applications in practice.

c) List key outcomes or other achievements.

The results of this study have been and 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.

Uniform Fungicide Trials

a) What were the major activities?

The Uniform Fungicide Trial followed standard protocol developed for the MGMT CP, designed to compare the efficacy of Miravis Ace when applied at early heading or at anthesis to that of standard anthesis application of Prosaro or Caramba. Trial establishment and general management including irrigation and misting treatments were reported previously in the proposal. Plots of a single susceptible cultivar was planted in a randomized complete block, with 4 replicate blocks, and subjected to at least ten fungicide treatments. Plots were harvested and DON levels in grain were measured in collaboration with Dr. Yanhong Dong and University of Minnesota.

b) What were the significant results?

Good disease formed in the spring nursery, with significant differences between fungicide treatments. The plots were rated in July and early August and harvested in early September. Performance of fungicides in reducing FHB and DON were comparable, including the newer fungicides Miravis Ace and Sphearex. The most effective application of Miravis Ace was at the standard application timing of all fungicides (early anthesis), however there was a reduction of disease and DON when applied at early heading in comparison to the treatment applied at anthesis. Two fungicide treatments were not significantly lower in DON and FHB incidence below the standard application timing.

c) List key outcomes or other achievements.

The results of this study have been and 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 and fungicides needed to reduce FHB and suffer high DON.

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

I have a PhD and a new master's student that have been working on this project, 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 supervising 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 students and post-docs 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.

Publications, Conference Papers, and Presentations

Please include a listing of all your publications/presentations about your FHB work that were a result of funding from your FY21 grant award. Only citations for publications published (submitted or accepted) or presentations presented during the **award period** should be included.

Did you publish/submit or present anything during this award period?

☒ Yes, I've included the citation reference in listing(s) below.

☐ No, I have nothing to report.

Journal publications as a result of FY21 grant award

List peer-reviewed articles or papers appearing in scientific, technical, or professional journals. Include any peer-reviewed publication in the periodically published proceedings of a scientific society, a conference, or the like.

Identify for each publication: Author(s); title; journal; volume: year; page numbers; status of publication (published [include DOI#]; accepted, awaiting publication; submitted, under review; other); acknowledgement of federal support (yes/no).

Books or other non-periodical, one-time publications as a result of FY21 grant award

Report any book, monograph, dissertation, abstract, or the like published as or in a separate publication, rather than a periodical or series. Include any significant publication in the proceedings of a one-time conference or in the report of a one-time study, commission, or the like.

Identify for each one-time publication: Author(s); title; editor; title of collection, if applicable; bibliographic information; year; type of publication (book, thesis or dissertation, other); status of publication (published; accepted, awaiting publication; submitted, under review; other); acknowledgement of federal support (yes/no).

Other publications, conference papers and presentations as a result of FY21 grant award

Identify any other publications, conference papers and/or presentations not reported above. Specify the status of the publication.

Marshall, J.M. Presentation to growers associated with Bingham Ag Services. Foliar and Seed treatments for disease control in wheat and barley. 63 growers, March 9, 2022. Invited.

Marshall, J.M. 2022. US Wheat and Barley Scab Initiative FHB "Scabinar". Organizing committee and Panel Member for 1) *Fusarium graminearum* Pathogen Perspective and 2) FHB Management. March 15, 2022. https://scabusa.org/scabinar 177 attending

Marshall, J.M., Yimer, B., Shelman, T., Jones, L., Hatch, J., Moll, M., and Windes, S.M. Cereal Variety Trial Results for 2021. University of Idaho Cereal Schools, Online Feb 2, 2022. 128 attending. 1 hour

Marshall, J.M., Yimer, B., Shelman, T., Jones, L., Hatch, J., Moll, M., and Windes, S.M. Cereal Disease Update and integrated approaches to common cereal diseases in Idaho. University of Idaho Cereal Schools, Online Feb 2, 2022. 128 attending. 0.5 hour

Baldwin, S.A., Yimer, B., Baldwin, T., Dong, Y., Marshall, J.M. 2021. Determining Fusarium Head Blight resistance of spring barley in Idaho. *Proceedings of the 2021 National Fusarium Head Blight Forum*; Virtual. December 6-7, 2021. Retrieved from: https://scabusa.org/forum/2021/2021NFHBForumProceedings.pdf