USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY19 Final Performance Progress Report
Due date: August 31, 2021

Cover Page

Principle Investigator (PI):	Frankie Crutcher
Institution:	Montana State University
E-mail:	frankie.crutcher@montana.edu
Phone:	406-433-2208
Fiscal Year:	2019
USDA-ARS Agreement ID:	59-0206-9-119
USDA-ARS Agreement Title:	Fusarium Head Blight Resistance for Montana Barley
FY19 USDA-ARS Award Amount:	$ 32,338
Recipient Organization:	Montana State University Office of Sponsored Programs Montana State University PO Box 172470 Bozeman, MT 59717-2470
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Recipient Identifying Number or Account Number:	W7919
Project/Grant Reporting Period:	5/6/19 - 8/5/21
Reporting Period End Date:	8/5/2021

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
BAR-CP	Fusarium Head Blight Resistance for Montana Barley	$ 32,338
	FY19 Total ARS Award Amount	**$ 32,338**

Frankie Crutcher

8/31/2021

Principal Investigator Date

* MGMT – FHB Management
FST – Food Safety & Toxicology
R – Research
S – Service (DON Testing Lab)
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: *Fusarium Head Blight Resistance for Montana Barley*

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

   Objective 1: We will continue to make crosses of barley lines that have shown resistance with high performing Montana varieties and field screen the resulting progeny in different environments.

   Objectives 2 and 3: Progeny from new crosses along with progeny developed from 2015-2017, the 2-row NAM population, and progeny from pyramiding multiple forms of resistance will be screened at the MSU Eastern Ag Research Center, which has sufficient field space to evaluate a large number of barley lines. Promising progeny will be sent to North Dakota for additional screening. This should improve the likelihood of identifying resistance and developing cultivars adapted to local weather and cultivation practices.

   Objective 4: This screening will involve the collection and use of *Fusarium graminearium* isolates from Montana barley fields.

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?**

   Objective 1: From previous screening of Montana germplasm, NDSU found Bearpaw to be somewhat resistant. We have been crossing Bearpaw with other germplasm reported to be resistant by NDSU and UM. We will continue this as new material is identified and other breeders are willing to share. In fall of 2019, we crossed Bearpaw to lines from the world core collection with some resistance including PI094790, PI234846, PI357314, and PI361609.

   In 2021, we field screened progeny that has performed well the last three years in Sidney, North Dakota, and Minnesota. In total, we have included 35 lines in the off-station screening. We have also added commonly grown varieties of barley in Montana to the nursery screening this year. Additionally, we are growing lines that have shown promise in the Bozeman Post Farm to test for agronomic and malting characteristics.

   Objective 2 and 3: In 2019, more than 800 progeny from earlier crosses performed by Dr. Sherman were screened at the EARC nursery in Sidney, MT in hill plots. These plots were assessed for disease severity (1-7 scale) and DON. Approximate heading dates were also noted so that lines with the later planting dates could be eliminated. Of these progeny, 19 lines showing promise were planted as 10 ft 2-row plots and 154 were repeated as hill plots in 2020. Additionally, 36 lines that have been screened since 2017 were planted in 2-row plots and the 2-row NAM population consisting of 352 lines were planted as hill plots. As of mid-July, some of the later lines have yet to

flower, but once that occurs an application of *F. graminearum* conidia will be performed. Disease evaluations will begin in late July and harvest in mid-August.

We had no DON measurements in 2020 due to severe bird damage. In 2021, early generation lines from the pyramiding were rescreened as hill plots at Sidney. In total, we are screening 1008 lines including controls as hill plots this year. Our antibird equipment that we added this year appears to be working well.

Objective 4:
In 2019, several incidences of FHB occurred both in the northeast and south central parts of Montana. We either traveled to these areas for plant collection, or samples were sent by collaborators. Some of the sampled fields had DON accumulation as high as 22 ppm. We isolated 252 Fusarium spp. from these samples, single spored them for purity, and are currently identifying them both morphologically and by gene sequencing.

In 2021 because of the severe drought in our state this year, no FHB was identified. However, we have completed the morphological and most of the molecular identification of isolates from 2016. We intend to start screening F. gram isolates for chemotype before the end of the year.

b) What were the significant results?

Objective 1: Dr. Sherman has performed several crosses that have resulted in progeny with different characteristics including maturity rate and morphology. DON measurements from 2019 also indicate that these crosses have resulted in progeny with similar DON accumulation and disease severity within the cross, indicating that we may be looking at a difference in genetics. We were able to eliminate any resistance that might be due to a later maturity rate. In 2021, we were able to obtain disease in a field season with the most severe drought in over 100 years.

Objective 2 and 3: We were able to greatly expand our screening capability in 2019 by planting early generation material in hill plots. This has allowed for an earlier evaluation that permits us to eliminate material without resistance or with resistance related to other factors such as maturity rate.

Objective 4: We have collected 252 *Fusarium* isolates from two different regions in Montana that have had the greatest impact from FHB: northeast and south central Montana. Northeast Montana grows primarily durum and spring wheat under dryland, no-till conditions in rotation with pulse crops and oilseeds. Corn is usually only grown in this part of the state when irrigation is available. In south central Montana, both barley, spring wheat, and winter wheat are grown, though all of our samples from this region came from barley. Cereals are typically grown under overhead irrigation in

rotation with corn and sugar beets. Several of the fields we sampled contained barley planted in corn residue. This survey should give us a good idea of how both the spatial and agronomic factors will affect the *Fusarium* populations in these two regions.

c) List key outcomes or other achievements.

Objective 1: We have been able to perform a large number of crosses between different resistant lines in order to pyramid potential resistance genes.

Objective 2: We have been able to screen the large numbers of progeny from Objective 1, which has allowed us to better focus our breeding efforts. Using a hill plot system, in 2020 we have been able to screen both the earlier progeny and the 2-row NAM population. Additionally, we have started a second site to perform seed increases for promising progeny. This site is grown without irrigation and with multiple fungicide applications in order to produce healthy seed for use in future screening both onsite and at other screening nurseries. Here we are also producing seed for CP approved check varieties that will better help us with evaluating our screening.

Objective 3: The large number of isolates we were able to collect in 2019 from several fields in two different regions of the state should allow us to better understand how common agronomic practices effect head blight fungal populations and how this in particular effects barley production in Montana.

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

In 2020, our research was impacted by COVID-19 in that we were unable to get seed to the two nurseries in North Dakota for evaluation this year due to staffing issues. We were able to get the entire nursery planted in Sidney, but without the other locations, screening of the more advanced material may require an additional season.

In 2021, our research was minimally impacted. Like other universities, we are under specific hiring restrictions that have decreased the number of our support personnel but this had a minimal impact on the program this year.

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

This project is training one graduate student on Fusarium head blight management and understanding pathogen communities and mycotoxins.

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

Unfortunately, most of the farmer education events in 2020 were cancelled due to COVID-19. For our field day this summer, we are having a virtual event that will have videos produced by different researchers made available on YouTube. Our program has produced a video outlining FHB research in our state, including the FHB nursery in Sidney. In this video, we go through the nature of the disease, best management practices, and how we perform varietal screening in our nursery.

Our work on Fusarium head blight has been presented at three field days and plot tours to Montana stakeholders in 2021. This includes the Eastern Ag Research Center field day, the Southern Ag Research Center field day, and the Swank plot tour.

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the **FY19 award period (5/6/19 - 8/5/21)**. 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?**
   ☐Yes ☒No ☐ Not Applicable
   If yes, how many? Click to enter number here.

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?**
   ☐Yes ☒No ☐ Not Applicable
   If yes, how many? Click to enter number here.

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?**
   ☐Yes ☒No ☐ Not Applicable
   If yes, how many? Click to enter number here.

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?**
   ☐Yes ☒No ☐ Not Applicable
   If yes, how many? Click to enter number here.

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 (5/6/19 - 8/5/21)**. 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	FHB Rating (0-9)	Year Released
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
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Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
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Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year

NOTE: List the associated release notice or publication under the appropriate sub-section in the 'Publications' section of the FPR.

Publications, Conference Papers, and Presentations

Instructions: Refer to the 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 (5/6/19 - 8/5/21**) 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:

Z.J. Winn, R. Acharya, J. Lyerly, G. Brown-Guedira, C. Cowger, C. Griffey, J. Fitzgerald, R.E. Mason and J.P. Murphy. 2020. "Mapping of Fusarium Head Blight Resistance in NC13-20076 Soft Red Winter Wheat." In: S. Canty, A. Hoffstetter, and R. Dill-Macky (Eds.), *Proceedings of the 2020 National Fusarium Head Blight Forum (*p. 12.), Virtual; December 7-11. Online: https://scabusa.org/pdfs/NFHBF20_Proceedings.pdf.
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: YES (Abstract and Poster)

Journal publications.

Peluola, C., Hoesel S., and F. Crutcher. 2020. Chlorine gas in an effective alternative to sterilize carnation leaves for *Fusarium* spp. identification. Journal of Microbiological Methods 170: 105841.
Status: Published
Acknowledgement of Federal Support: YES

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

None.

Other publications, conference papers and presentations.

None.