Project FY22-BA-012: Fusarium Head Blight Resistance for Montana Barley

Note: Report must cover the *entire* duration of the project period of performance, May 1, 2022-July 30, 2026.

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

1) Continue crossing resistant material from other programs and identified in this program into lines adapted to Montana; field screen resulting progeny in different environments (VDHR objective #1).
2) Continue to pyramid resistant lines and screen for resistance in the field for future genotype mapping (VDHR objective #3).
3) Phenotype resistance in four 2-row NAM families in the field (VDHR objective #3).
4) Collect and identify Fusarium species in the Montana FHB disease complex (PBG objective #12).

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

What were the major activities?

Objective 1: In Fall 2023, Dr. Sherman made 7 crosses related to scab resistance. These crosses will be evaluated in the field as F4 rows in 2025 and will be evaluated for both agronomic characteristics and FHB resistance. In summer of 2023, 7 families consisting of 100-200 were grown as head rows and visually selected for agronomics. A total of 22 families of 10-20 lines each were evaluated agronomically as F5s. The most agronomically adapted of the 56 families were evaluated for FHB resistance in 2024. We have harvested these plots, evaluated for DON, and are currently analyzing agronomic data. Additionally, we planted lines in 2024 that have shown promise at the EARC screening nursery in previous years at three locations: Sidney, Langdon, and Fargo in order to evaluated them for disease severity, incidence, index, FKD, and DON. We have planted these lines for evaluation at other locations in 2025.

Objective 2 and 3: We screened over 400 lines in 2024 and 215 lines in 2025 produced from pyramiding different sources of resistance in small hill plots in our nursery and included a subset of the 2-row nested association mapping (NAM) panel. We sent in seed for DON analysis for many of these lines. Dr. Sherman's graduate student has evaluated the data from 2022 and 2023 to determine if we can use this to map potential FHB resistance. In 2024, we collected plant tissue from the mapping population and sent it to Fargo for genotyping. We used the results to evaluate our 2023 severity and DON results from these lines.

Objective 4: We have identified 350 isolates collected in 2019 and 2022 from two regions in Montana. We have completed chemotyping the *F. graminearum* isolates, and for the second time identified 3-ADON isolates in Northeast MT on durum. Montana Wheat and Barley Committee has funded an experiment in which we are testing these lines in the field on durum to determine if there is any difference in virulence, DON, and fungicide sensitivity in the field between the 15-ADON and 3-ADON isolates. This experiment was planted in 2024 and the work is ongoing. We will explore these isolates along with other species identified over the last few years for barley in a field experiment in 2027.

What were the significant results?

During this project, we performed 5-7 crosses per year and screened over 1120, 645, 430, and 645 lines in 2022, 2023, 2204, and 2025, respectively in our Sidney FHB nursery. We identified several lines that have decreased DON production in multiple years and locations from a cross with material from the Minnesota program. We have made crosses with Montana adapted lines and observed some improvement in DON. Beginning in 2024,

we began testing material resulting from crosses between two of the lines in Table 1. This material had significant reduction in DON levels over single crosses which was confirmed in 2025. If low DON is confirmed in 2026, we will begin testing agronomics and quality. In Table 1, the green highlight indicates lines used for breeding prior to 2024, yellow highlight indicates that the line was in the top 10 evaluated for low DON production that year, L indicates Langdon screening nursery, M indicates Minnesota screening nursery, and F indicates Fargo screening nursery. All lines in Table 1 were used for crosses in 2025.

Table 1: Average DON amounts in promising barley lines from the MSU Breeding Program.

Line	2019	2020	2022	2023	2024	2025	2021 L	2021 M	2023 L	2023 F	2024 L	2024 F
2017-40-17	1.2	1.8	6.6			33.4	49.4	12.8				
2017-41-16	1.7	0.9				10.7	32.3	2.65				
2017-41-6	1.1	0.7	5.7	6.6		14.1	43.9	3	41.1			
2017-69-13	1.9	1.4					56	4.45				
2019-27-46		1.8	5.9			20	64.9					
2017-40-10	1.8	1.9	7.1		11.9	27.6	50.7	7.3			44.55	7.5
2017-42-18	1.5	0.8	2.5	4.6		12.1	62.7	1.4	22.2		22.2	2.7
2017-42-2	1.7	1.1				19.8	27.7	0.08				
2017-43-18	1.7	1.5	2.9	3.7		16.2	37.7	3.2	38.05	15.65	43.85	2.1
2017-43-19	1.3	0.6				8.8	31.1	2.3				
2017-43-20	1.3	0.6	2.1	4.9		7.6	23.4	3.1	22.15	12.9	30.8	2.1
2017-43-22	0.9	1.2	3.4	4.3	7.9	13.3	54.3	0.865	26.8	21.7		5.8
2017-44-18	0.8					12.3	21.6	0.65				
2017-44-23	1.1					18.9	27.5	3.85				
2017-46-10	1.8		3.3	6.5	14.3	17.2					41.2	9
2017-46-19	1.4	2.1	3	3.5		18.2	52.2	3.54	63.95	26.95		7.65
2017-47-6	1.5	1.2	4.2	4.8		12.4	38.2	2.15	25.1	9.75		
2019-23-22			2	4.3		10.9						
2021-45-7			3.1	4.1		22.1			28.75			
2021-45-11			2.5	6.1		21.9						
MT18F00607			1.9	2.6		12.4			33.35	38.9		
MT19_H11_03			2.1	3.3		29.9				23.5		
MT22_Y076_16											77	4.9
MT22_Y079_10						24.7					57.15	6.33
MT22_Y080_15											62.75	6.8
MT23_042_08						11.8						
MT23_042_03						12.6						
Stander		6.1	16.8	22.8	30.6	29.4	62	13.05			70.45	23.1
Bearpaw		2.3	3	6.1	14.1	43.2	31.3		20	35.25		
Pinnacle		1.5	8.7	8		24.5	36.2	1.9			34.3	10.35
Hockett		3.2	2.3	8.1	18.9	29.9	42.2				44.75	17.5
Conlon					11.9	20.6		4.7			34.1	5.9
Chevron		1.1				13.1	53.2					
Synergy						31.9						

Yellow highlight indicates that the line was in the top 10 evaluated for low DON production that year.
L indicates Langdon, ND screening nursery
M indicates Minnesota screening nursery
F indicates Fargo screening nursery.

There have been three Montana FHB surveys in 2016, 2019, and 2022 which identified *F. graminearum* as the predominant species in the fields sampled; however, *F. sporotrichioides* also made up a large proportion of the isolates collected from a barley field in Hysham, MT. *F. sporotrichioides* is predominantly found in the FHB disease complexes surveyed in the United States; however, it has been identified in large proportions in Canada (Fernandez et al. 2005; Pearse et al. 2006). We screened these lines in the greenhouse against barley lines with differing FHB resistance and are currently working to evaluate this data.

Additionally, we found 3-ADON isolates in Sheridan Co. in durum in 2022 (Crutcher et al. unpublished). These isolates made up 45% of the *F. graminearum* collected and is the first time 3-ADON isolates were detected in Montana. In 2024, we conducted a field experiment in which hill plots of durum were treated with different 3-ADON and 15-ADON isolates both with and without fungicide application. This study still needs to be replicated, however unlike what has been observed in spring wheat, there was no difference between chemotypes for DON production. So far, 3-ADON isolates have only been detected in NE Montana however it is important that we continue to monitor the movement of the 3-ADON chemotype throughout the state and measure the response to fungicide applications and resistant barley varieties.

List key outcomes or other achievements.

1) We have identified parental material with measurable resistance to FHB and DON accumulation that has been confirmed at different site years.
2) We have crossed this material into Montana adapted elite lines. Further work will screen these lines for agronomics and FHB resistance in order to develop a resistant variety for release (release of a new variety may take up to 10 years).
3) We identified 3-ADON isolates in Montana for the first time and determined that resistance to *F. graminearum* is also consistent with resistance to other *Fusarium* spp. such as *F. avenaceum*.

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

We have high school and undergraduate students that work with us each summer to learn about agricultural research. Each one spends some time in our FHB nursery and we discuss how to identify the disease, why it is important, and what the nursery is for as part of their work experience. Two graduate students did work on this project and one presented results at the FHB Forum as a poster.

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

Results of each year's screenings have been included in the regional MonDak research report that reaches approximately 2500 people in Montana and North Dakota annually. Additionally, results have been presented to stakeholders at field days, commodity meetings, and advisory meetings. These events are listed below:

1) 2022 EARC Field Day. Sidney, MT Jul 12. Fusarium head blight management (56 attendees).
2) 2023 Northeastern Montana Women's Conference. Sidney, MT Mar 31. EARC tour and discussion of plant pathology research program (12 attendees).
3) 2023 Pro Coop Presentation Series. Plentywood, MT Feb 17. Plant disease management in northeastern Montana (22 attendees).
4) 2023 Montana Agricultural Business Association Conference. Virtual, Jan 26. Management of fungal pathogens in Eastern Montana: Challenges, opportunities, and updates (450 attendees).
5) 2024 Malt Barley and Sugar Beet Symposium. Billings, MT Jan 9. Fusarium head blight management (157 attendees).
6) 2024 EARC Field Day. Sidney, MT Jun 27. Fusarium head blight management and screening varieties for resistance (69 attendees).
7) 2024 EARC MAES Advisory Committee Meeting. Sidney, MT Dec 18. Plant pathology research program objectives and results (30 attendees). Note: Fusarium head blight resistance screening in our nursery was discussed at length.
8) 2025 EARC Field Day. Sidney, MT Jul 9. Fusarium head blight management and research update (84 attendees).

5. What do you plan to do during the next reporting period to accomplish the goals and objectives?

Not applicable, this is the final report for the agreement.