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

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1. **What are the major goals and objectives of the research project?**
   Our objectives fall under the research priorities as follows:
   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 are being evaluated for FHB resistance in 2024.

   Additionally, we planted lines this spring 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.

   Objective 2: We screened over 400 lines in 2023 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 begun the process of evaluating data from 2022 and 2023 to determine if we can use this in order to map potential FHB resistance. This work in ongoing.

   Additionally, we served as another location for a mapping population screening performed by Dr. Juliet Marshall's research group (Univ. of Idaho) in 2023. This screening consisted of 645 hill plots.

   Objective 3: We have identified 350 isolates collected in 2019 and XXX from 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 April 2024 and the work in ongoing.

What were the significant results?

Objective 1: In 2022, we adjusted the timing of our conidia applications from heading to 50% out of the boot and this has resulted in increased disease and DON. Additionally, we moved our nursery to a section of the farm where we could access city water, allowing us to apply more misting which has increased the amount of water that we put on the study. In 2023, we had good disease pressure and significant differences in disease and DON between our promising varieties and barley varieties not bred specifically for FHB resistance. The DON amounts varied from 22.8 ppm in the susceptible variety Stander to 2.63 ppm in the line MT18F00607. All of the lines from the initial crosses first evaluated in the field in 2017, were all below 6.6 ppm. See table 1 for the 2023 results.

Table 1: Barley Variety Reponses to Fusarium Head Blight

Variety	Severity (%)[a]	Incidence (%)[b]	Index[c]	DON (ppm)
Bearpaw	5.8 C-E	68.9 A-K	4.0 CD	6.1 C-F
Buzz	10.7 B-E	75.6 A-J	8.15 B-D	8.1 B-F
Cowgirl	12.6 B-E	84.4 A-F	10.9 B-D	5.9 C-F
Havener	7.2 C-E	78.9 A-H	5.8 CD	6.2 C-F
Haxby	5.5 C-E	63.3 B-L	3.5 CD	8.5 B-F
Haymaker	12.7 B-E	92.2 A-C	11.9 B-D	7.1 B-F
Hockett	5.6 C-E	53.3 F-L	2.5 CD	8.1 B-F
Lavina	19.4 B-D	90.0 A-D	17.5 A-C	6.5 B-F
MT Boy Howdy	10.4 B-E	82.2 A-G	8.5 B-D	7.3 B-F
MT Endurance	9.8 C-E	68.9 A-K	7.3 B-D	10.2 B-F
MT16F01601	26.9 AB	82.2 A-G	23.9 AB	9.2 B-F
MT16M01801	6.4 C-E	68.9 A-K	4.5 CD	3.4 D-F
MT17F02410	16.9 B-E	94.4 A-C	16.1 A-D	6.3 B-F
MT17M01908	10.6 B-E	76.7 A-I	8.63 B-D	11.8 B-D
MT17M05808	5.0 C-E	56.7 E-L	2.9 CD	9.25 B-F
MT18F00507	18.9 B-E	87.8 A-E	17.5 A-C	5.6 C-F
MT18F00607	8.5 C-E	80.0 A-H	6.8 CD	2.6 F
MT18F00803	13.1 B-E	80.0 A-H	10.3 B-D	4.6 C-F
MT18H02702	5.9 C-E	61.1 C-L	3.7 CD	7.8 B-F
MT18M06008	14.8 B-E	88.9 A-E	13.5 B-D	14.7 AB
MT18M06011	14.1 B-E	87.8 A-E	12.5 B-D	10.4 B-F
MT18M10106	9.6 C-E	77.8 A-H	7.5 B-D	6.9 B-F
MT18M11002	7.1 C-E	76.7 A-J	5.5 CD	8.3 B-F
MT18M11004	10.2 B-E	78.9 A-H	8.4 B-D	7.9 B-F
MT18M11103	5.6 C-E	64.4 B-L	3.7 CD	4.9 C-F
MT19_F04_02	21.1 A-C	80.0 A-H	17.4 A-D	5.4 C-F
MT19_H09_09	3.7 DE	57.8 D-L	2.2 CD	5.4 C-F
MT19_H11_03	7.9 C-E	82.2 A-G	6.6 CD	3.3 EF
MT19_H11_04	4.8 C-E	65.6 B-L	3.4 CD	3.6 D-F
MT19_H11_05	9.4 C-E	87.8 A-E	8.4 B-D	7.6 B-F
MT19_H14_11	4.3 C-E	61.7 B-L	2.9 CD	6.7 B-F
MT19_M034_16	5.3 C-E	67.8 A-K	3.7 CD	7.3 B-F
MT19_M046_16	9.1 C-E	85.6 A-F	7.8 B-D	9.6 B-F
MT19_M061_19	7.8 C-E	73.3 A-K	5.8 CD	5 C-F
MT19_M064_04	7.2 C-E	76.7 A-I	5.6 CD	4.5 C-F
MT19_M065_05	8.9 C-E	75.6 A-J	6.8 CD	5.4 C-F
MT19_M067_02	8.9 C-E	77.8 A-H	6.9 CD	7.8 B-F
MT19_M075_23	6.0 C-E	67.8 A-K	4.1 CD	2.9 F
MT19_M095_04	12.3 B-E	85.5 A-F	10.5 B-D	12.5 BC

ND24388	7.7 C-E	71.1 A-K	5.4 CD	10.7 B-F
Odyssey	15.7 B-E	98.9 A	15.6 A-D	11.4 B-E
Pinnacle	12.2 B-E	74.4 A-J	9.5 B-D	7.9 B-F
Stander	37.3 A	81.1 A-G	30.5 A	22.8 A
2017-41-6	5.7 C-E	63.3 B-L	3.7 CD	6.6 B-F
2017-42-18	5.2 C-E	56.7 E-L	3.2 CD	4.6 C-F
2017-42-3	2.3 E	33.3 L	0.8 D	5.7 C-F
2017-43-18	6.0 C-E	66.7 A-K	4.0 CD	3.7 D-F
2017-43-20	10.2 B-E	68.9 A-K	7.0 CD	4.9 C-F
2017-43-22	4.1 DE	50.0 G-L	2.2 CD	4.3 C-F
2017-46-10	4.1 DE	47.8 H-L	2.1 CD	6.5 B-F
2017-46-19	2.8 DE	41.1 KL	1.2 CD	3.5 D-F
2017-47-6	3.2 DE	43.3 J-L	1.4 CD	4.8 C-F
2019-23-22	9.9 B-E	81.1 A-G	8.4 B-D	4.3 C-F
2019-23-26	12.3 B-E	87.8 A-E	11.1 B-D	6.3 B-F
2019-25-55	9.4 C-E	75.6 A-J	7.7 B-D	5.4 C-F
2020-27-1	5.0 C-E	60.0 C-L	3.1 CD	6.2 C-F
2021-45-11	6.4 C-E	73.3 A-K	4.8 CD	6.1 C-F
2021-45-7	3.3 DE	44.4 I-L	1.5 CD	4.1 C-F
Mean	9.6	72.3	7.7	6.9
% CV	76.8	22.5	90.9	55.8
HSD (0.05)	17	32.8	16.7	8.5
P-value	<.0001	<.0001	<.0001	<.0001

Letters in common did not differ significantly according to a Tukey's HSD test at a significance level of 5%.
[a]Pest Severity: Average percent area of head covered by disease. Thirty heads were evaluated for each plot.
[b]Pest Incidence: Percent of thirty plants per plot that had visible FHB symptoms.
[c]Index: Severity X Incidence / 100
[d]Grain yield adjusted to 12.0% moisture.

Objective 2: We have completed two years of screening NAM populations in the nursery and the data is currently being evaluated for its usefulness in resistance mapping. This work is ongoing.

Objective 3: We have identified 3-ADON isolates for the first time in Montana and have been screening them to compare them with 15-ADON isolates.

List key outcomes or other achievements.
The MSU barley breeding program released the following varieties in 2023 that were screened for disease resistance as part of this work.
- MT Endurance (MT16M02201) considered to be susceptible
  https://www.montana.edu/barleybreeding/learning-center/barley-variety-dictionary/two-row/endurance.html
- MT Boy Howdy (MT17M02507) considered to be susceptible
  https://www.montana.edu/barleybreeding/learning-center/barley-variety-dictionary/feed/boy-howdy.html

3. **What opportunities for training and professional development has the project provided?** A graduate student named Janaki Mahat has been working with the disease data we collected in Sidney on the NAM populations. She will be presenting her research results at the 2024 FHB Forum.

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

   Dr. Crutcher presented results from the nursery and educated growers on the current goals of the USWBSI projects to breed resistant varieties at the following grower education events:

   Malt Barley and Sugar Beet Symposium. Billings, MT Jan 9, 2024. Fusarium head blight management (150 attendees).

   Northeastern Montana Women's Conference. Sidney, MT Mar 31, 2023. EARC tour and discussion of plant pathology research program (12 attendees).

   Pro Coop Presentation Series. Plentywood, MT Feb 17, 2023. Plant disease management in northeastern Montana (22 attendees).

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

   So far, we have gotten disease severity that shows differences between varieties in the testing nursery at the Sidney EARC for 2024. Within the next month we will harvest our plots and begin cleaning them, measuring agronomic characteristics, and sending them out for DON measurements.

   A graduate student with Dr. Sherman has been working on the two years of disease data for the NAM populations to determine if it can be used for resistance mapping. We anticipate that this will be completed in the next couple of months.

   We have sent in leaf samples from 508 lines for genotyping using a 3K chip to Dr. Jason Fiedler at the USDA ARS this spring and anticipate evaluating the results once completed.