

Project FY22-BA-009: Developing Barley Varieties with Enhanced FHB Resistance and Lower DON

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

- 1) Create new breeding populations by crossing parents that carry resistance to FHB and other desirable traits.
- 2) Conduct selection for FHB resistance and lower DON concentration in segregating breeding populations using genetic markers and field screening.
- 3) Advance lines to regional testing and industry evaluation that are candidates for new cultivar releases.

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

- 1) **Create new breeding populations by crossing parents that carry resistance to FHB and other desirable traits.**

What were the major activities?

In our spring breeding program, we selected 10 entries from our 3rd year yield trials, 10 entries from our 2nd-year trials, and 30 entries from our first-year trials as parents in our 2023 fall crossing block. A total of 38 crosses were made and advanced as F1's in our winter greenhouse. We planted F2's from 37 crosses this spring on the St. Paul campus that will be harvested this summer to advance as F3's in our Fall greenhouse.

In our winter breeding program, we selected 15 entries from our 1st year trials, 11 entries from our second year trials, and 10 entries from advanced trials and materials from other breeding programs as parents in our 2023 fall crossing block. A total of 43 crosses were advanced as F2's this spring on the St. Paul campus that will be harvested this summer to advance as F3's in our Fall greenhouse.

What were the significant results?

Approximately 6,000 and 7,000 F2s were planted for our spring and winter breeding programs, respectively, from which new breeding populations will be developed this year.

List key outcomes or other achievements.

We attained our goals for initiating new populations this year from our spring and winter breeding programs.

- 2) **Conduct selection for FHB resistance and lower DON concentration in segregating breeding populations using genetic markers and field screening.**

What were the major activities?

Summer 2023 Trials

In the summer of 2023, we evaluated 362 first year, 40 2nd year, 22 3rd year breeding lines and 40 entries in the North American Scab Evaluation Nursery (NABSEN) in misted and

inoculated FHB nurseries in St. Paul and Crookston, MN. The nurseries were observed for symptom development and severity ratings were taken from some trials. All rows were harvested, and the grain samples were cleaned and ground and sent to the toxicology labs at St. Paul, MN and Fargo, ND. A total of 1271 samples were sent, and the DON data received was used to advance lines in the breeding program and select parents for future crossing (Objective 1).

Summer 2024 Trials

We modified our spring breeding pipeline to replace our PYT using F3:5 seed from a winter nursery to advancing one more year of single seed descent in the greenhouse, genotyping those plants, and planting F4 derived head rows in St. Paul and Crookston. We generated genomic predictions for DON and other traits using the marker data for 1,333 F4:5 breeding lines. We advanced 63 and 18 breeding lines into our second-year and third-year spring barley yield trials, respectively, and planted them at our FHB nurseries in St. Paul and Crookston.

In our winter breeding program, we advanced 2,069 lines to the F4 generation in the greenhouse and planted a single F4:5 head row in St. Paul this spring. We are delaying genotyping these lines until fall and will be generating our first genomic predictions for DON this year. We advanced 17 breeding lines into third-year spring barley yield trials and planted them at our FHB nurseries in St. Paul and Crookston.

What were the significant results?

We observed substantial variation in DON concentration from our trials in FHB nurseries in 2023. Based on the average of the two locations in the spring 1st year trial, the range in the was 4.7 ppm to 23.6 ppm. In this trial 108 out of 361 breeding lines were lower in DON compared to the currently most popular variety ND-Genesis (8.9 ppm). Likewise in our 2nd and 3rd year trials, 31 of 37 and 16 of 23 breeding lines were lower in DON compared to ND-Genesis, respectively, based on the two location average.

DON levels in the winter breeding line trials were higher in general compared to the spring lines. In the 3rd year trial, only three of the 24 entries were lower in DON compared to spring variety ND-Genesis (13.3 ppm) and only two lower in DON compared to our recent winter variety release MN-Equinox (8.6 ppm).

List key outcomes or other achievements.

Our prediction accuracies for DON are still low, but have improved somewhat. The cross-validation accuracy this past year was 0.53. However, when we use previous data with independent genotypes and environments to predict the current genotypes evaluated in current environments the accuracy drops to 0.24. We expect prediction accuracy to improve as we continue to add more data to the model training data set.

3) Advance lines to regional testing and industry evaluation that are candidates for new cultivar releases.

What were the major activities?

In the 2023 crop year, 2 and 5 lines from our spring breeding program were advanced to American Malting Barley Association (AMBA) Quality Evaluation Program (QEP) for the 1st

and second year of testing, respectively. We have not yet selected any winter two-rowed advanced breeding lines for AMBA QEP.

What were the significant results?

We received the results of our entries from crop year 2023 to the American Malting Barley Association (AMBA) Quality Evaluation Program (QEP) in April of 2023 and all five lines submitted were rated unsatisfactory. Several of these lines had DON reductions of 30-50% compared to the dominant varieties ND-Genesis and AAC Synergy.

List key outcomes or other achievements.

Our most advanced line, S2M184, was rated satisfactory in the second year of pilot testing and is eligible for plant scale evaluation. This line is similar to ND-Genesis for yield, but is earlier maturing, shorter in height, and has better stem strength. S2M184 has about 20% lower DON based on the mean of seven inoculated nursery trials. It is also a GN non-producer, a trait that is important to the distilling industry. We contracted a 40 acre increase of this line and the seed produced from that production will be used for Foundation Seed and by Rahr to contract acres in 2025 for plant scale testing.

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

A Postdoc in my group, Adenike Ige, has been working with DON and SNP marker data to evaluate and optimize genomic predictions.

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

The PI presented a talk entitled “Breeding for Lower Deoxynivalenol in Barley” at the 2023 National FHB Forum. Research reports were also provided at the annual Barley U Field Day on the St. Paul campus and the NW Regional Outreach Center Field Day in Crookston, MN. The PI presented a talk at the Barley Improvement Conference entitled “Winter Barley: Why, Where, How”. We published barley variety performance information in the Minnesota Agricultural Experiment Station Variety Trials Report. The NABSEN Report is published on the USWBSI website.

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

We will conduct each of the stages of the breeding pipeline as described in our proposal for both the spring and winter barley programs. We will be proposing spring breeding line S2M184 for variety release in December to our Crop Variety Review Committee.