Project FY22-DU-011: Integration of Major FHB-resistant QTL into Modern Durum Wheat Varieties

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

The objective of this project is to continue developing elite durum germplasm with improved FHB resistance derived from diploid, tetraploid and hexaploid wheat accessions.

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

What were the major activities?

- Planted and evaluated 167 new durum lines (BC_1F_5) carrying Fhb1, PI277012-derived 5A QTL, and Cdu1 and 23 lines without Fhb1 and 5A QTL as checks in FHB nurseries at Fargo and Prosper, ND during the summer seasons of 2023 and 2024. These lines were previously selected by genotyping over 2,500 BC2F2 plants derived from backcrossing durum lines 15Entry 104, 15Entry 111, 15Entry 129, 15Entry 269, 15Entry 271, and 15Entry 295 with durum variety 'ND Riveland'. Four lines with increased FHB resistance were identified.

- Conducted a yield trial for 37 breeding lines for the 2nd and 3rd year at Prosper and Langdon during the summer seasons of 2023 and 2024. These lines were selected from the 212 lines derived from backcrossing durum line D151343 (15Entry 255) to ND Riveland and breeding lines Carpio_Cdu1 and Joppa_Cdu1 and three varieties (Carpio, Joppa, and ND Riveland). The data from the yield trail in Prosper in 2022 showed that 10 elite durum lines had higher grain yields than check varieties Carpio and Joppa and four lines also had similar yields compared to ND Riveland. The data from the Langdon 2023 trial showed that 12 had higher grain yields than Carpio.

- Selected five of the 37 breeding lines with higher grain yields than check varieties (Carpio, Joppa) to be included in the elite yield trials in multiple locations in the NDSU (North Dakota State University) durum wheat breeding programs in the summer of 2023.

- Developed BC_4F_1 populations by backcrossing a wheat-*Thinopyrum ponticum* 7D/7el2 introgression line RWG52 (591) with durum Divide and Divide *ph1b* line to transfer *Fhb7* from chromosome 7D to 7A or 7B in durum wheat.

- Produced BC_3F_1 hybrids between ND Riverland and a wheat-*Th. elongatum* 7B/7E introgression line XWC14-255-13-1 (WGC002) carrying new *Fhb7* allele $Fhb7^{Th2}$.

- Developed BC_3F_1 population by backcrossing Chinese wheat landrace 'Wangshuibai' with ND Riverland to simultaneously transfer major FHB resistance QTL *Fhb1*, *Fhb2*, *Fhb4*, and *Fhb5*.

What were the significant results?

- A large number elite durum germplasm lines carrying *Cdu1*, *Fhb1* and/or two PI277012-derived 5A QTL in the backgrounds of modern durum germplasm have been developed. These lines have a high potential for developing new durum varieties and adapted germplasm with FHB resistance combined with good agronomic performance, high yield, and accepted end-use quality.

- The BC_3F_1 and BC_4F_1 populations have been developed for introgression of *Fhb7* into modern durum wheat varieties, and they are currently be used for developing BC_4F_1 and BC_5F_1 populations.

- The BC_3F_1 population from backcrossing Chinese wheat landrace 'Wangshuibai' with ND Riverland to simultaneously transfer major FHB resistance QTL *Fhb1*, *Fhb2*, *Fhb4*, and *Fhb5* have been developed.

List key outcomes or other achievements.

A total of 205 breeding lines carrying *Cdu1*, *Fhb1,* and/or two PI277012-derived 5AS/5AL QTL were provided to the NDSU durum wheat breeding program and they were evaluated in a preliminary yield trial and about 60 lines showed similar or higher yield than the current durum varieties used in the checks in the summer of 2022. Five of the lines have been included in the 2023 Elite Yield Trial (EYT) in four locations (Langdon, Minot, Prosper, and Williston, North Dakota) in NDSU Durum Wheat Breeding Program. All five lines had higher grain yield than check variety Divide, and three lines had higher grain yield than check varieties Carpio and ND Riveland. Two of lines were selected by NDSU Durum Wheat Breeding Program for further testing in the EYT in 2024.

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

Nothing to Report.

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

The results have been disseminated through publications and presentations at various workshops and seminars and communications with breeders and collaborators.

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

- Evaluate new BC_1F_7 and BC_2F_7 lines with *Fhb1* pyramided with the two PI277012-derived 5A QTL in the background of ND Riveland in FHB nurseries and yield trial.

- Produce BC_5F_1 populations by backcrossing the heterozygous BC_3F_1 plants to ND Riveland from backcrossing *Fhb7* introgression lines with ND Riveland using markers for *Fhb7*.

- Produce BC_5F_1 populations by backcrossing Wangshuibai with ND Riveland using markers for *Fhb1, Fhb2*, *Fhb4*, and *Fhb5*.