

## **Project FY22-DU-002: Introgression and Understanding of Hexaploid-derived FHB Resistance Genes in Durum**

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

This project aims to understand the complex inheritance and epistatic effects of hexaploid-derived FHB resistance genes in durum by molecular mapping, QTL analysis, and genomics-enabled chromosome engineering, and to deploy FHB resistance genes in adapted spring and winter durum genotypes for germplasm/variety development by targeted chromosome recombination and marker-assisted selection. The specific objectives of this project are to: 1) Characterize inheritance of the hexaploid-derived FHB resistance genes in durum background and understand the effect of D-genome chromosomes on FHB resistance; 2) Incorporate hexaploid wheat-derived FHB resistance genes into durum for germplasm development; and 3) Develop and validate the molecular markers tagging FHB resistance QTL in durum.

### **2. What was accomplished under these goals or objectives?**

#### **What were the major activities?**

- Advanced two generations of the progeny from the crosses of adapted durum varieties with hexaploid FHB-resistant sources for RIL population development using a modified single-seed descent procedure.
- FHB resistance evaluation of the resistant RILs and other durum introgression lines in the Lincoln (NE) and Fargo (ND) FHB nurseries.
- Evaluated a large set of winter durum breeding lines (n=630) for FHB resistance and other agronomic traits in Mead, NE.
- Phenotyped one durum RIL population (n=203) derived from the “Divide x PI 277012” cross for FHB resistance in a replicated greenhouse experiment (2<sup>nd</sup> greenhouse screening season).
- Performed *Fhb7<sup>The2</sup>* introgression in spring and winter durum for germplasm/variety development through a marker-assisted backcrossing breeding pipeline.
- Verified the *Fhb7<sup>The2</sup>*-specific STS and KASP markers for MAS in different durum genotypes.
- Performed backcrosses and marker/chromosome analysis for chromosome substitution-mediated FHB resistance gene introgression from hexaploid into durum for epistatic analysis and germplasm development.

#### **What were the significant results?**

- Obtained two greenhouse seasons of FHB phenotyping data for a RIL population and identified FHB-resistant RILs that could be developed as FHB-resistant durum germplasm.
- Constructed linkage maps of all 14 durum chromosomes in the RIL population and identified seven FHB resistance QTL with 3.7% to 10.6% phenotypic variation on 5A, 4A, 2B and 5B.
- Detected epistatic effects of the FHB resistance QTL and durum A and B genome-chromosomes from our preliminary analyses.
- Developed durum BC3F1 introgression lines containing *Fhb7<sup>The2</sup>*.

### List key outcomes or other achievements.

- Developed FHB-resistant durum introgression lines, including RILs and those containing *Fhb7<sup>The2</sup>*. After validation of their resistance in the field evaluation at multiple locations, they can potentially be released as FHB-resistant germplasm for variety development in breeding. This will allow durum wheat to gain significant resistance to fight against the FHB disease.
- This work has facilitated a better understanding of the epistatic effects of hexaploid wheat-derived FHB resistance genes in durum. This will be helpful in the deployment FHB resistance genes in durum wheat.

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

One undergraduate student and one postdoc have been hired to work on this research project. This research project has offered them a great opportunity to learn the procedure and principles underlying FHB inoculum preparation, inoculation, and disease development and evaluation. In addition, the postdoc has received trainings in genetic analysis, chromosome engineering, genomics, and bioinformatics. These learning and research experience have facilitated their career preparation in plant genetics and breeding.

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

Research results from this project were presented in the 2023 FHB Forum and will be published in the peer-reviewed journal.

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

- Advancing generation of the two populations derived from the durum x common wheat crosses by single seed decent.
- Making additional backcrosses and performing MAS for *Fhb7<sup>The2</sup>* introgression into adapted spring and winter durum genotypes.
- Performing FHB evaluation of the *Fhb7<sup>The2</sup>* introgression lines in the FHB nurseries in Lincoln, NE and Fargo, ND.
- Conducting backcrosses and marker/chromosome analyses to continue chromosome substitution-mediated FHB resistance gene introgression from hexaploid into durum for epistatic analysis and germplasm development.
- Evaluating another durum RIL population for FHB resistance with shared parent with the previous tested RIL population in the greenhouse.
- Performing epistatic analysis in the RIL population(s) with phenotyping and genotyping data.
- Increasing seed of FHB-resistant RILs to validate their resistance in the field conditions (Lincoln, NE and Fargo, ND).