Project FY22-BA-002: Transferring Fusarium Head Blight Resistance Gene Fhb7 to Barley

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

The major goal of this project is to incorporate wild species *Thinopyrum elongatum*-derived FHB resistance gene *Fhb7*^{The2} into barley for germplasm/variety development using genomics-enabled chromosome engineering. The objectives of this research project are: 1) Induce meiotic recombination of *Thinopyrum* chromosome 7E (*Fhb7*^{The2}) with its homoeologue in barley using wheat *ph1b* mutant; 2) Recover 7H-7E recombinants containing *Fhb7*^{The2} using molecular markers and fluorescent in situ hybridization (FISH)/genomic in situ hybridization (GISH); and 3) Develop barley germplasm/varieties containing *Fhb7*^{The2}.

2. What was accomplished under these goals or objectives?

What were the major activities?

1) Developed the bridging materials for the homoeologous recombination-based *Fhb7*^{The2} introgression from *Th. elongatum* chromosome 7E to barley chromosome 7H, including 40W+7H'+7W'+*Ph1/ph1b*, 40W+7E'+7W'+*Ph1/ph1b*, DS 7H(7W)+*Ph1/ph1b*, and DS 7E(7W)+*Ph1/ph1b* by FISH and molecular marker analysis (Note: "W" refers to wheat A-, B-, and D-genome chromosomes).
2) Intercrossed the bridging materials to each other to produce the special genotypes "40W+7H'+7E'+*ph1b/ph1b*" by marker and chromosome analyses. Meiotic 7H-7E homoeologous recombination will be induced in the special genotypes that are monosomic for *Th. elongatum* chromosome 7E containing *Fhb7*^{The2} and barley chromosome 7H under the homozygous *ph1bph1b* condition.
3) Developed co-dominant SNP-based PACE markers specific for *Th. elongatum* chromosome 7E containing *Fhb7*^{The2} and barley chromosome 7H. They are useful in recovering and detecting 7E-7H recombinants for *Fhb7*^{The2} introgression into barley.
4) Optimized multicolor FISH/GISH procedure for the simultaneous detection of two introgression chromosomes 7H and 7E in the wheat background.
5) Developed large 7E-7H recombination populations derived from the special genotypes "40W+7H'+7E'+*ph1b/ph1b*" for the recovery of 7E-7H recombinants using chromosome-specific marker and FISH/GISH analyses.

What were the significant results?

1) Produced large homoeologous 7E-7H recombination populations from the special genotypes "40W+7H'+7E'+ph1b/ph1b". 7E-7H recombinants will be recovered from the populations using chromosome-specific markers and FISH/GISH.
2) Developed DNA markers and FISH/GISH probes specific for chromosomes 7E and 7H. They are very helpful for the detection and recovery of 7E-7H recombinants in the large recombination populations.

List key outcomes or other achievements.

1) Produced special wheat bridging materials to induce meiotic homoeologous recombination of barley chromosome 7H with *Th. elongatum* chromosome 7E containing FHB resistance gene *Fhb7*^{The2} and enabled *Fhb7*^{The2} introgression from *Th. elongatum* into the barley genome.

2) Developed SNP-based PCR markers and effective FISH probes highly diagnostic for barley chromosome 7H with *Th. elongatum* chromosome 7E. They will dramatically increase the throughput and efficacy of *Fhb7*^{The2} transfer from 7E to 7H.

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

One postdoc has been hired to work on this research project. This research project has offered him a great opportunity to learn the procedure and principles of FISH/GISH and chromosome-specific marker development from reference genomes and cDNA sequences. In addition, the postdoc has received training in genetic analysis, chromosome engineering, genomics, and bioinformatics. These learning and research experience have facilitated their career development in plant genetics and breeding.

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

This is 3rd year of this new research project. We have not presented/published the results we have obtained. We expect to present the progress/results we have obtained in the 2025 FHB Forum.

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

1) Identifying and recovering 7H-7E recombinants involving the 7E segments containing *Fhb7*^{The2} from the large homoeologous 7H-7E recombination populations using chromosome-specific markers and FISH/GISH.
2) Inducing secondary homoeologous recombination of the primary 7H-7E recombinants to shorten the 7E segments containing *Fhb7*^{The2} if needed.
3) Evaluating the 7H-7E recombinants containing *Fhb7*^{The2} for FHB resistance in the greenhouse if they are produced by then.