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 FHB resistance genes from wild grass and wheat 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 7H 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?

a) What were the major activities?

- Made crosses of the substitution lines DS 7E(7A), MS 7H(7A), DS 7H(7B), DS 7E(7B), DS 7E(7D), and DS 7H(7D) with CS *ph1b* mutant to produce 7H-7E double monosomics homozygous for *ph1b* mutant (i.e. 7H'+7E'+*ph1bph1b*) by marker and chromosome analysis (FISH and GISH). These special double monosomics genotypes will be used to induce homoeologous recombination between barley chromosome 7H and *Thinopyrum* chromosome 7E carrying *Fhb7*^{The2}. In addition, the specific crosses between DS 7E(7D)-*ph1bph1b* and DS 7H(7D) were made to develop the double monosomics.
- Validated the utility of the 7H-specific PACE markers in the presence of 7E and 7E-specific PACE markers in the presence of 7H. They have been used to select the double monosomics from the progeny of the above crosses.
- Performing FISH and GISH analysis to verify the chromosome compositions of the progenies selected by marker analysis.

b) What were the significant results?

- Developed the intermediate materials 40W+7H'+7W'+*Ph1/ph1b*, 40W+7E'+7W'+*Ph1/ph1b*, DS 7H(7W)+*Ph1/ph1b*, and DS 7E(7W)+*Ph1/ph1b*. They have been crossed to each other to produce the special genotype 40W+7H'+7E'+*ph1b/ph1b* by MAS and chromosome analysis.
- 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.
- Optimized multicolor FISH/GISH procedure for the simultaneous detection of two introgression chromosomes 7H and 7E on the wheat background.

c) List key outcomes or other achievements.

- User-friendly co-dominant PACE markers specifically targeting group 7 chromosomes, including wheat chromosomes 7A, 7B, and 7D, *Th. elongatum* chromosome 7E, and barley chromosome 7H are extremely useful in chromosome engineering and alien introgression involving these chromosomes.

- Multicolor FISH/GISH pipeline developed in this project allows for simultaneous visualization of wheat, barley, and *Th. elongatum* chromosomes, providing an effective method of chromosome identification in various genetic studies and alien introgression.
- Bridging materials for the alien introgression from wheat into barley.

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 them 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 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?

This is 2nd 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 2024 FHB Forum.

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

- Producing 7H-7E double monosomics homozygous for *ph1b* mutant (i.e. 7H'+7E'+*ph1bph1b*) to induce homoeologous recombination between barley chromosome 7H and *Thinopyrum* chromosome 7E carrying $Fhb7^{The2}$.
- Recovering 7H-7E recombinants from the progeny of "7H'+7E'+*ph1bph1b*" using chromosome-specific markers and FISH/GISH.
- Identifying 7H-7E recombinants containing $Fhb7^{The2}$ using $Fhb7^{The2}$-specific markers.
- Making crosses of the 7H-7E recombinants containing $Fhb7^{The2}$ with barley to introduce the 7H-7E recombinant chromosome into barley.