Research Highlights

Identification of gene *Vrn-D4* for enabling wheat to adapt to areas with warm winters

Wheat is widely cultivated under diverse climatic conditions around the world. Vernalization plays an important role for avoiding injury from cold in winter, through suppressing precocious spike development before or during winter. In contrast, vernalization negatively affects adaptation in places with warm winter climates, and gene mutation so that vernalization is not needed could benefit wheat cultivation in such areas. Four genes, *Vrn-1*, *Vrn-2*, *Vrn-3*, and *Vrn-4*, are known to control vernalization in wheat, but until recently only the first three genes had been identified.

Kenji Kato and colleagues at the University of California, Davis, USA, identified the fourth vernalization gene *Vrn-D4* located on the 5DS chromosome. *Vrn-D4* proved to be the copy of gene *Vrn-A1* on chromosome 5AL, which was duplicated and inserted into 5DS. Comparisons with *Vrn-A1*, revealed nucleotide substitution in exon 4 (A367C) and introns. Among them, two SNPs (Single Nucleotide Polymorphisms) in intron 1 were within the RIP-3 (RNA immunoprecipitation-3) motif and caused no requirement of vernalization through the interaction with TaGRP2.

Vrn-D4 was mostly found in common wheat (*T. aestivum*) of South Asian origin. All accessions of *T. sphaerococcum* endemic to Pakistan and India proved to have *Vrn-D4* by which they don't need vernalization, and successfully adapted to warm conditions in South Asia. It was therefore suggested that *Vrn-D4* is closely related with the origin of *T. sphaerococcum*, which is specifically adapted to areas with warm winter climates.

Now, all of the four vernalization genes have been identified, providing important information for understanding vernalization in wheat and winter cereals. This finding significantly

Figure 1: Spring-type wheat normally headed without exposure to low temperatures (vernalization) in the seedling stage, while winter-type wheat stayed in a vegetative growth state.

Figure 2: Seeds of common wheat (left, *T. aestivum* cv. Triple Dirk) and *T. sphaerococcum* (right, KU-161).

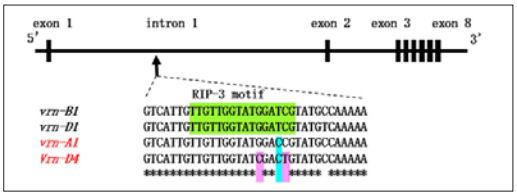

Figure 3: Schematic representation of the structure and RIP-3 sequence of *Vrn-1* and *Vrn-D4*.

contributed to the breeding of new wheat cultivars with stable production, even under changing climates, by fine-tuning the flowering time.

Reference:

- Authors: Nestor Kippes, Juan M. Debernardi, Hans A. Vasquez-Gross, Bala A. Akpinar, Hikment Budak, Kenji Kato, Shiaoman Chao, Eduard Akhunov, and Jorge Dubcovsky
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