

Duplication of the dominant *Vrn-A1b.2* allele in *Triticum dicoccum* lineage

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The *Triticum dicoccum* lineage includes domesticated hulled tetraploid wheat of *T. dicoccum* and hexaploid wheat species of *T. spelta*, *T. macha* and *T. vavilovii*, which were derived from hybridisation events between the *T. dicoccum* and free-threshing hexaploid wheat of *T. aestivum*. The dominant *VERNALIZATION-A1* alleles determine spring growth habit (without vernalization requirement) and early flowering of wheat. The *Vrn-A1b.2* allele is frequent in tetraploid wheat of *T. dicoccoides* and *T. dicoccum* as well as in hexaploid wheat of *T. spelta*. In *T. spelta* this allele as well as *Vrn-B1c* are major determinants of the spring phenotype, while *T. macha* and *T. vavilovii*, as a rule, are characterized the strong vernalization requirement (winter type) and carry the recessive *VRN1* genes. The *VRN1*-ratio test, based on end-point qPCR was optimized to estimate the copy number variation (CNV) of *VRN1* in wheat. Applied to the analysed accessions this test showed a two-fold increase in signal for the *VRN-A1* fragments in two accessions of *T. dicoccum* from Israel and Palestine carrying *vrn-A1b.3* and numerous accessions of *T. spelta* from Europe carrying *Vrn-A1b.2* and *vrn-A1b.3*. This difference in amplification of the *VRN-A1* fragments was preserved at different level of the genomic DNA fragmentation, excluding the genomic environment effect, and was confirmed during TaqMan real-time PCR assay with the different endo- and exogenous controls. Duplication of *Vrn-A1b.2* in accessions of *T. spelta* was strongly associated with the *Vrn-A1b.2/Vrn-B1c* genotype and awned spikes, indicating the bottleneck and founder effects. It is known that gene dosage of the dominant *VRN1* alleles positively correlates with early flowering of polyploid wheat. On the other hand, multiplication of the recessive *vrn-A1* is associated with the later flowering. In any case the effect of the *Vrn-A1b.2* duplication on phenotype provides additional advantages in manipulation of the flowering time of wheat.

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