

Inheritance of the type growth and maturity in *Aegilops squarrosa*, a donor of the D hexaploid wheat genome

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Wheat is one of the main food crops of mankind. In conditions of global and impending change, the impact on a favorable environment to changing environmental conditions has an impact on the genes that control precocity. According to some estimates, the genes of the *Vrn* system (response to vernalization), which determine not only the type, but also the rate of development of wheat plants, make the main contribution to the characterization. All diploid species of *Triticum* L., with the exception of *T. sinskajae*, appear mainly as winter forms. The growth of most spring forms of these species is late-ripening. The last remark also applies to diploid species of the genus *Aegilops* L. The only exception is the species *Ae. squarrosa* L. (syn. *Ae. tauschii*), which are the most early maturing forms not only for the genera *Triticum* and *Aegilops*, but also for the wheat tribe as a whole. Vegetation period of accessions K-1954 and K-992 *Ae. squarrosa* in the conditions of Novosibirsk, on average for three years, the study did not exceed 60 days. The type of development (spring vs. wintering) and precocity in hexaploid ($2n = 6x = 42$) common wheat *Triticum aestivum* L. determine for *VRN-1*, *VRN-2*, *VRN-3* loci. One of the donors of the main genomes of common wheat is *Ae. tauschii* ($2n = 2x = 14$) is the object present study. The paper presents the results of the determination of allelic variants of the *Vrn-1D* gene and the established nucleotide sequences of the *ZCCT-1D* and *ZCCT-2D* genes of the *Vrn-2D* locus. Total DNA was isolated from 28 spring and winter accessions of *Ae. tauschii*, PCR amplification of the region of the first intron of the *Vrn-1D* gene was carried out. In this development, which, as demonstrated in previous studies [4, 5], is manifested by the presence of the trait "loss of the vernalization requirement". In 6 samples, there was no deletion in the intron, which is found to be the presence of an intact gene in them. Thus, the sign of "loss of the vernalization requirement" in this accessions of *Ae. tauschii* does not disrupt the *Vrn-1D* gene. In this samples, nucleotide sequences were established for the sections of the *ZCCT-1D* and *ZCCT-2D* genes, structural changes in which (deletions of 24 and 1 bp respectively), as described in the description [1–3, 6], disrupt the functionality of genes. According to the results of the study, all 6 samples did not reveal published deletions, which reveals the presence of other alleles in them, which determine the sign of "loss of the vernalization requirement". They probably have other, previously undetectable, disorders within the *ZCCT-1D* and *ZCCT-2D* genes or changes in traces upstream of the *Vrn-3D* gene promoter, already described *Vrn-3B* for cv. Hope. Also, one should not exclude the possibility of disruption of the association of sites with the TaGRP2 protein in the first region of the *Vrn-1D* intron without availability a large deletion. The presence of such an allele was going to help clarify the specific binding sites and complement the already observed literature data, however, the study of changes in the sequences of the *Vrn-1D* and *Vrn-3D* genes will be developed in the future.

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References

1. Distelfeld A., Tranquilli G., Li C., Yan L., Dubcovsky J. Genetic and molecular characterization of the *VRN2* loci in tetraploid wheat. *Plant Physiol.* 2009;149:245-257.
2. Dubcovsky J., Loukoianov A., Fu D., Valarik M., Sanchez A., Yan L. Effect of photoperiod on the regulation of wheat vernalization genes *VRN1* and *VRN2*. *Plant Mol Biol.* 2006;60:469-480.
3. Kippes N., Chen A., Zhang X. et al. Development and characterization of a spring hexaploid wheat line with no functional *VRN2* genes. *Theor Appl Genet.* 2016;129:1417-1428.
4. Shigeo T., Kayoko K., Kensuke F., Fuminori K. Identification of a large deletion in the first intron of the *Vrn-D1* locus, associated with loss of vernalization requirement in wild wheat progenitor *Aegilops tauschii* Coss. *Genes Genet Syst.* 2011;86(3):183-195.
5. Xiao J. et al. O-GlcNAc-mediated interaction between *VER2* and *TaGRP2* elicits *TaVRN1* mRNA accumulation during vernalization in winter wheat. *Nat Commun.* 2014;5:4572.
6. Yan L. et al. The wheat *VRN2* gene is a flowering repressor down-regulated by vernalization. *Science.* 2004;303:1640-1644.