Allelic diversity of genes regulating growth habit and photoperiod response in temperate cereals maintained at the VIR germplasm collection

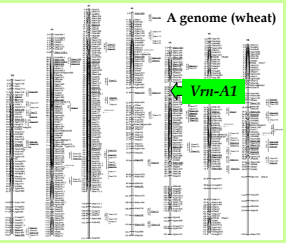
N.I. Vavilov Research Institute of Plant Industry (VIR)

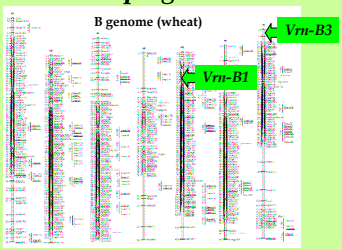
Elena Potokina*, Nikolai Dzjubenko

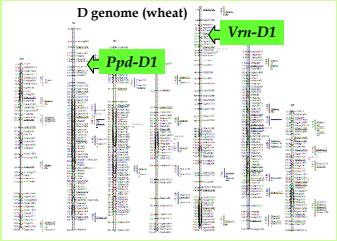
* e.potokina@vir.nw.ru

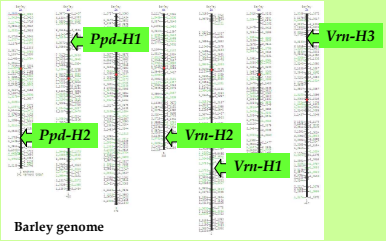
Among the key traits that have been involved in wheat and barley domestication was the adaptation of flowering time to different areas. Migration of the cereal crops to regions outside its place of origin was accelerated through mutations in genes regulating growth habit (***Vrn*** genes) and photoperiod response (***Ppd*** genes). Allelic diversity of the genes is a valuable source for breeders to develop new cultivars with improved adaptive properties to address the issue of climate change.

Several ***Vrn*** and ***Ppd*** genes have been recently cloned in wheat and barley genomes:



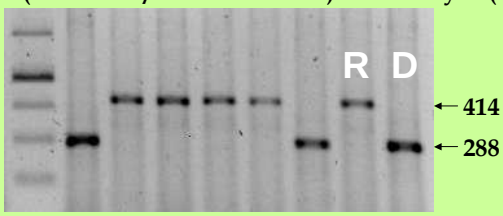




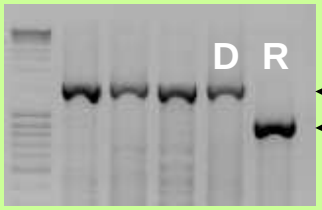


For the cloned ***Ppd*** and ***Vrn*** genes the gene-specific (functional) markers are available (also known as perfect or diagnostic markers). These markers provide a unique opportunity to screen large collections of wheat and barley germplasm for allelic diversity at the ***Ppd*** and ***Vrn*** genes, as in the example below:

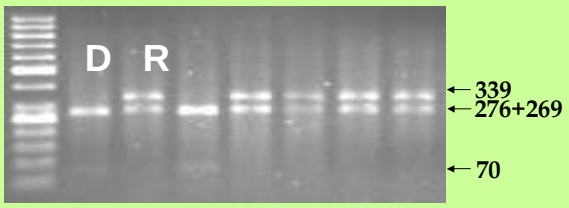
Wheat *Ppd-D1* (dominant / recessive allele) PCR assay



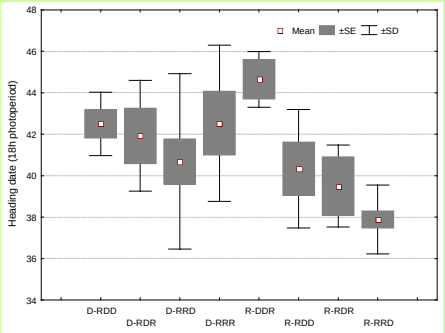
Wheat *Vrn-D1* (dominant / recessive allele) PCR assay

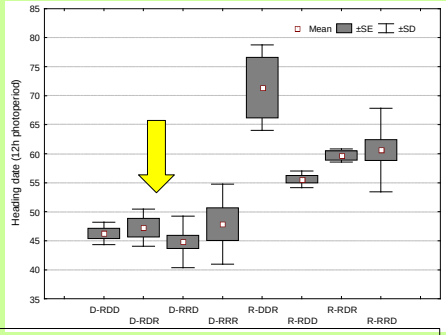


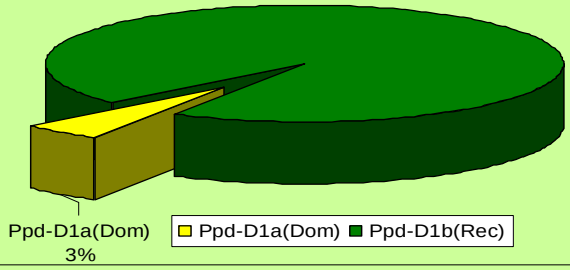
Barley *Ppd-H1* (dominant / recessive allele) PCR assay



The combination of ***Ppd*** and ***Vrn*** alleles has significant influence on the development pattern of wheat cultivars. Below we compared heading date of 57 wheat varieties carrying different allele combinations of the genes under long (18 h) and short (12 h) photoperiod conditions: D-RDD means dominant/recessive allele combination for genes: (*Ppd-D1*)-(*vrn-A1*)-(*Vrn-B1*)-(*Vrn-D1*)



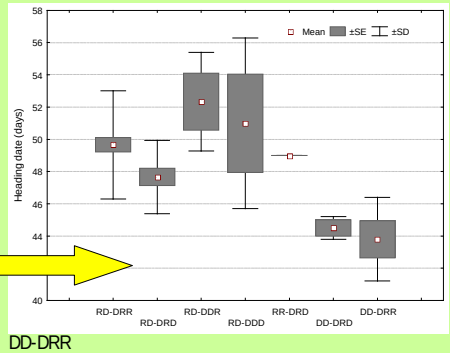




Wheat genotypes carrying dominant *Ppd-D1a* allele are the «champions» in heading date under short day conditions. However, only 3% out of 160 Russian spring wheat varieties carry the *Ppd-D1a* allele

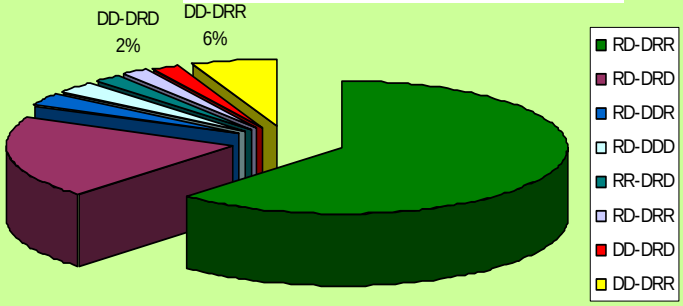
Gene-specific markers currently available for ***Ppd*** and ***Vrn*** genes in wheat and barley allow breeders to manipulate consciously the original material and to select the allele combinations that would be optimal for specific conditions of cultivation.

Allele combinations of *Ppd-H1*, *Ppd-H2* and *Vrn-H1*, *Vrn-H2*, *Vrn-H3* genes (DD-DDD) were investigated among 91 cultivars and breeding lines of Russian barley germplasm using gene-specific primers. Significant association between the allele combinations and heading date of the lines was detected. Barley varieties that carry the dominant allele of *Ppd-H1* transit to flowering much faster comparing to other genotypes under long day conditions. Donors of the dominant *Ppd-H1* allele are valuable source for breeding of ultra-early barley varieties for the Northern areas of Russia.



Resume:

- **Molecular marker assay was employed to assess the vernalization and photoperiod response of wheat and barley cultivars included in Recommended List Varieties for Russia.**
- **Restricted allelic variation was detected in wheat and barley varieties currently recommended for commercial propagation in Russia.**
- **The severe deficiency of dominant alleles of *Vrn* and *Ppd* genes in the domestic cereal germplasm could be replenished by involving in breeding programs new donors of the beneficial alleles of the adaptation-responsive genes.**



The dominant *Ppd-H1* allele was detected only for 8% of cultivars included in Recommended List Varieties for Russia