



VRNturing into the unknown: dissecting the role of VERNALIZATION2 (VRN2) in climate adaptation

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Q&A session

Presenter: Dominique Hirsz, Leibniz Institute of Plant Genetics and Crop Plant Research (IPK), Germany

The webinar recording is available on the IWGSC YouTube channel at: <https://youtu.be/UmeoNGXEvU4>

Q: Can the plant undergo vernalization at any age or is there a specific age at which it can undergo vernalization? If there is a specific age then what is the mechanism behind it?

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Q: CCT genes whether interact with Auxin or other hormone signalling pathways to regulate tillering

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Q: Have you found/seen any relationship between vernalization gene (VRN) and frost tolerance (FR) gene as they located very close to each other in chromosome 1H?

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Q: Any specific Post translation modification are reported for this vernalization response in your study?

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Q: Hi, did you perform knock out of VNR2 gene in winter wheat?

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We have not directly performed a knock-out in winter wheat as we used TILLING lines for *VRN2* which are in a Cadenza (facultative spring) background. However, we have crossed the BC₂F₂ TILLING line plants into a few different winter backgrounds which we will use for further phenotyping experiments.

Q: Some genes perform early growth stages but silent at later stages and some genes perform early and later stages. why due to temperature or any other reason

Yes these genes are expressed at different developmental stages with temperature and photoperiod being direct environmental signals which regulate gene expression of several flowering associated genes, including the vernalisation genes.

Q: Your data suggest that VRN2 expression does not always align with the classical role of a vernalization-dependent floral repressor. Could it be hypothesized that VRN2 is involved in a broader regulatory network of growth and development, potentially interacting with abiotic stress signaling pathways such as drought or high temperatures? Are there any studies supporting this connection?

Yes, we hypothesise that *VRN2* is involved in an additional developmental role to vernalisation which we are currently investigating further. We have also identified a connection with frost tolerance, which is another avenue we are researching in more detail in collaboration with some industry partners. This link to cold stress and other abiotic stresses is supported by a couple of other studies included below:

- DIALLO, A., KANE, N., AGHARBAOUI, Z., BADAWI, M. & SARHAN, F. 2010. Heterologous expression of wheat VERNALIZATION 2 (TaVRN2) gene in Arabidopsis delays flowering and enhances freezing

tolerance. *PLoS One*, 5, e8690.

- GULYÁS, Z., BOLDIZSÁR, A., NOVÁK, A., SZALAI, G., PÁL, M., GALIBA, G. & KOCSY, G. 2014. Central role of the flowering repressor ZCCT2 in the redox control of freezing tolerance and the initial development of flower primordia in wheat. *BMC Plant Biol*, 14:91.

Q: What about the Triticum Spearococcum wheat from which were spring types have been originated in India

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We have not specifically looked into this wheat subspecies, but other *Triticaceae* species have shown variable ZCCT gene expression so it would be interesting to see how it compares.

Q: Have you found any effect on drought tolerance?

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Q: Is vernalization is necessary to increase yield?

This is a very interesting question and is dependent on growth habit. For winter habit plants vernalisation is necessary for the floral transition to take place, so by extension vernalisation is necessary for any seed at all. For spring plants, vernalisation is not needed and these cultivars are usually more susceptible to cold temperatures so vernalisation may actually reduce yield. Plants with a facultative habit, which are vernalisation responsive but do not require it to make the floral transition, would therefore be the most interesting to explore regarding the effect of vernalisation on yield. This is something I am actively looking in to, as this growth habit is the least understood but may become increasingly useful to provide more flexibility for drilling date.

Q: Have you performed RNA-seq from transgenic plants or TILLING plants to see alteration in photoperiod or vernalization pathway?

We have not performed RNA-Seq with the transgenic or TILLING germplasm as these have both only been recently developed and have therefore only been included in expression studies using RT-qPCR. However, we are hoping to keep developing this germplasm and doing further phenotyping experiments and expression analysis under different conditions to understand the effect of overexpressing or mutating these genes in more depth.

Q: Are all of these genes expressed in leaves? Is there any difference between old and young leaves?

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Q: Durum wheat has no D genome. Any idea on how the putative role of the ZCCT genes on the D genome could be affected?

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Because of high agronomic performances of Linkert (USA), navruz (Tajikistan) and SLU-Elite (Sweden) cultivars. Since, these are commercial cultivars from different countries so, have own set of characteristics which are useful during population development.