

# Insights into the genetic control of flowering time based on a worldwide series of field trials with the barley NAM population HEB-25



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## Background

The decision to initiate flowering is maybe the most critical switch during plant development. The plant has to perceive and respond to key environmental factors to ensure that flowering does not occur under adverse and detrimental conditions. In the present study we investigated flowering time of the large wild barley nested association mapping (NAM) population HEB-25 in worldwide field trials to determine both environment-dependent and environment-independent genes controlling flowering time by means of GWAS. For this purpose, seven eco-geographically different locations were chosen: Dundee (UK, SCO), Halle (Germany, GER), Merchouch (Morocco, MOR), Gilat (Israel, ISR), Dubai (United Arab Emirates, UAE), Amlaha (India, IND) and Charlick (Australia, AUS). They mainly differed for day length and temperature regime during the vegetation period (Fig. 1).

## Results and discussion

Flowering time varied strongly between locations, ranging from an average flowering time of 69 days after sowing in Germany to 114 days in Australia. Correcting flowering time for temperature resulted in a harmonization of flowering time, separating the locations based on the photoperiod into long-day (SCO and GER) and short-day conditions (Fig. 2).

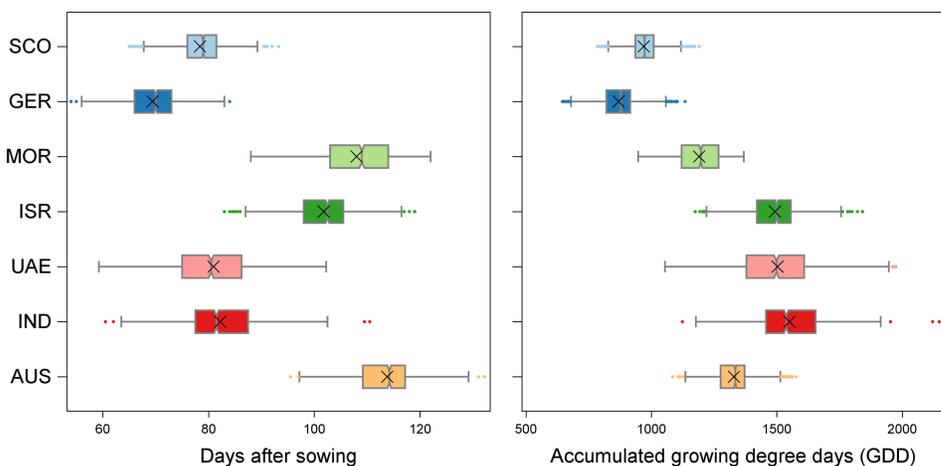


Fig. 2) Distribution of flowering time across the seven trial sites.

The genome-wide association study (GWAS) revealed five major QTL with worldwide relevance. While *HvCEN*, *GA20ox<sub>2</sub>* (*sdw1/denso*) and *HvFT1* (*Vrn-H3*) were detected with similar effects in all locations, *Ppd-H1* was exclusively found in long-day locations (SCO, GER), while *Vrn-H1* had the largest impact in heat-prone locations (UAE, IND) (Fig. 3).

The knowledge gained will assist to fine-tune flowering time of barley in regions severely affected by climate change.

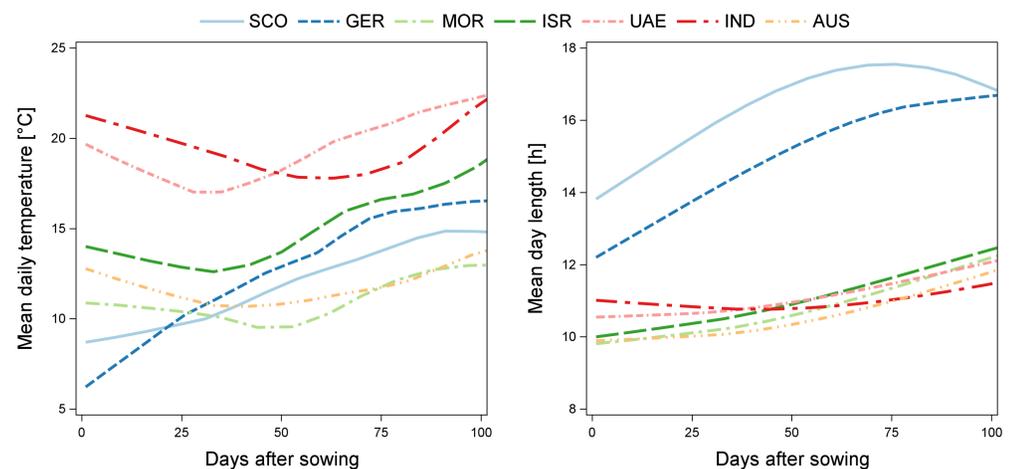


Fig. 1) Temperature and day length profiles of the seven trial sites.

Left: Mean daily temperature during vegetation period in the respective environment. IND and UAE are characterized by high temperatures throughout the vegetation period, while the remaining environments show a certain increase over time. Right: Comparison of mean day length clearly distinguishes long-day environments (SCO and GER) from short-day environments.

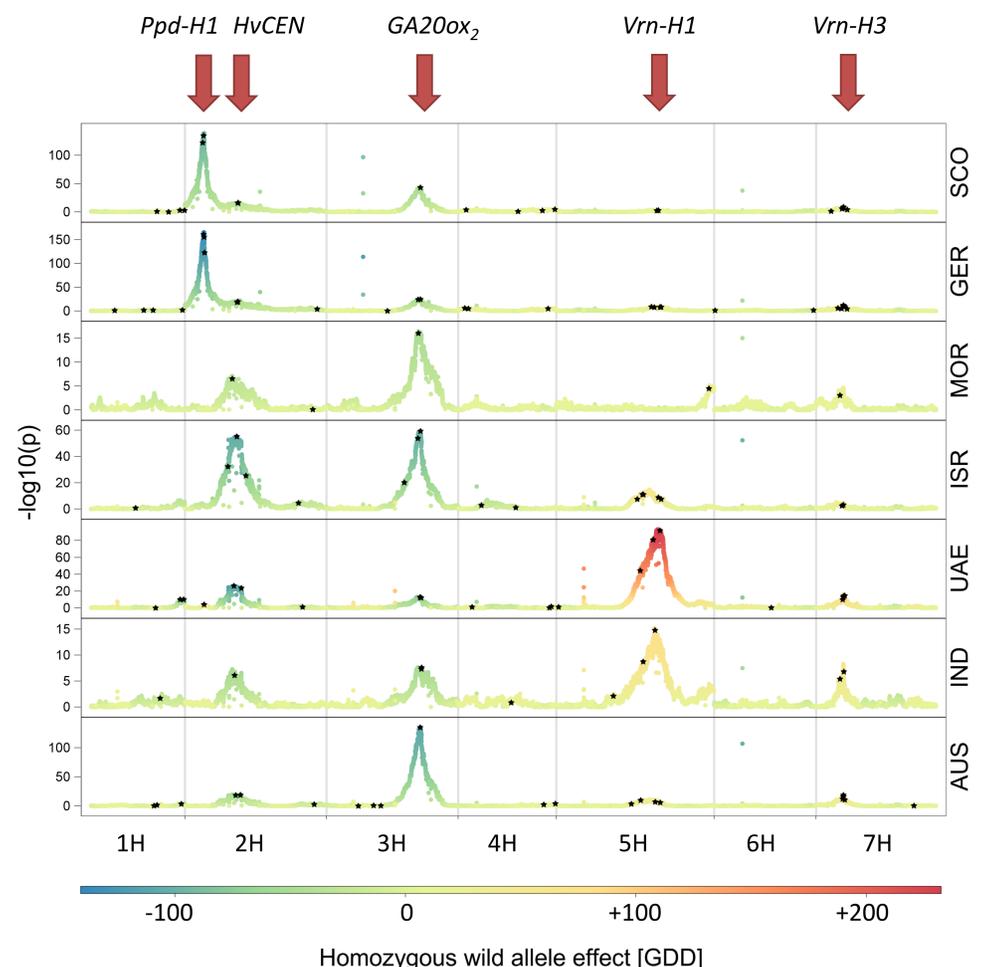


Fig. 3) Comparison of GWAS results across trial sites.

The height of the peaks indicates the strength of the marker trait association in each of the seven environments. Significant marker trait associations determined through repeated random subsampling are highlighted by black asterisks. The wild allele effect at each locus is color-coded with blue indicating strong flowering time accelerating effects and red indicating strong flowering time delaying effects.

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