Absence of warm temperature spikes revealed as driver for vernalisation

February 14 2018, by Adrian Galvin

Flowering Arabidopsis. Credit: Photo by Andy Davies Multiple factors discovered for vernalisation in arabidopsis. Credit: Andy Davis

A new study has uncovered multiple new factors that contribute to the important phenomenon of vernalisation in plants.

The John Innes Centre researchers carried out field experiments in Norwich and Sweden to investigate how plants interpret and act on varying temperature signals to accurately align their flowering with spring, in a process called 'vernalisation'.

The results are outlined in a paper published in the journal *Nature Communications*, in which the authors warn of "deleterious consequences" for vernalisation in the face of a more variable global climate.

In arabidopsis, vernalisation involves the epigenetic (or environmentally-related) silencing of a gene called FLOWERING LOCUS C (FLC). FLC acts like a brake to flowering: by silencing FLC, flowering is induced.

Previous studies show that silencing is triggered by a particular conserved protein called Polycomb Repressive Complex 2 (PRC2) in combination with PHD proteins, including the cold-induced VERNALISATION INSENSITIVE3 (VIN3).

Under controlled conditions vernalisation can occur at constant temperatures between 0 and 15 °C. But in the field temperatures are often far more variable with daily temperature fluctuations that in some cases exceed the difference in seasonal average temperatures.

Experiments, to date, indicate that plants are able to extract a reliable signal from such "noisy" and variable temperature profiles. But how they integrate these signals over timescales of many weeks to judge the passing of winter has not been clear.

Previous analyses have developed cumulative measures of cold exposure over time, including photothermal units or 'degree days', used to plan the harvest dates of crops. However, the molecular mechanisms underlying these measures are unknown.

This study, carried out by the teams of Professor Caroline Dean and Professor Martin Howard, finds that as winter continues, expression of VERNALISATION INSENSITIVE 3 (VIN3), is upregulated by at least two independent thermosensory processes. One integrates long-term cold temperatures, while the other requires the absence of daily temperatures above 15 °C.

The key factor, the study reveals, is that the lack of spikes of high temperature (above 15 °C), not just prolonged cold, is the major driver for vernalisation.

The findings have implications due to an increasingly unpredictable climate. The study concludes: "Monitoring of peak daily temperature [by plants] is an effective mechanism to judge seasonal progression, but is likely to have deleterious consequences for vernalisation as the climate becomes more variable."

More information: Jo Hepworth et al. Absence of warmth permits epigenetic memory of winter in Arabidopsis, *Nature Communications* (2018). DOI: 10.1038/s41467-018-03065-7

Provided by John Innes Centre