Hot and Cold: Mathematical Modeling of Temperature Sensing in Arabidopsis and Wheat

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Plants have sophisticated strategies to perceive environmental stimuli and adapt their development accordingly. Specifically, temperature is one of the main cues that impact plant development and, as such, various thermosensing mechanisms exist in the plant kingdom. Most signals involved in thermosensing have been identified through experiments performed under laboratory conditions on the model plant Arabidopsis thaliana. However, not much is known about how these operate under realistic conditions or in crops such as hexaploid wheat (Triticum aestivum). Here, we have combined bioinformatic and mathematical modelling approaches to better understand plant responses to realistic temperature experiences in both A. thaliana and T. aestivum. First, we have characterized the whole-transcriptome profile of A. thaliana plants exposed to realistic cooling scenarios and identified potential candidate components for the thermosensing machinery. These have been used to guide the development of a mathematical model aiming to describe the cold sensing mechanism quantitatively. In a separate field experiment, wheat plants have been exposed to distinct winter experiences and their response has been studied at the transcriptomic level. Based on this and using the model previously designed for A. thaliana as a reference, we now aim to characterize the mechanism that underlies temperature sensing in T. aestivum. Wheat is the primary arable crop in the United Kingdom and, as such, a better understanding of its developmental response to realistic temperature experiences and, particularly, warming, is fundamental to ensure future food security. The framework presented here provides a key starting point to achieve this and will be key to direct further research in the field.