

Preface

Temperature is a key environmental signal regulating plant growth and development. Small changes in ambient temperature can affect a wide range of processes throughout the plant lifecycle, from seed germination and plant architecture through to flowering and reproductive development. Prolonged low-temperature treatment can act as a seasonal cue, signaling the onset of winter to prime flowering and seedling development the following spring. In addition to providing important environmental information, exposure to temperature extremes can adversely affect plant survival. The evolution of developmental adaptations to withstand prolonged cold or heat has enabled some species to exploit ecological niches in adverse habitats. In more temperate regions, many plants have evolved acclimation responses to minimize cellular damage associated with freezing and heat stress.

Plants can detect temperature changes as small as 1°C . Despite the importance of temperature in controlling plant growth and survival, our current understanding of how temperature signals are perceived is rudimentary. Suggested thermosensory mechanisms include changes in membrane fluidity, activation of membrane transport channels, altered protein activity, and the direct regulation of gene expression through altered DNA accessibility. Molecular dissection of plant temperature responses has revealed significant crosstalk with light and circadian signaling pathways. The integration of temperature and photoperiod signals provides plants with accurate seasonal information, priming adaptive responses to adverse conditions while preventing the wasteful allocation of resources in milder climates. In natural environments, plants are subject to multiple environmental signals simultaneously, resulting in trade-offs between different stress responses. It is perhaps, therefore, not surprising that temperature has significant effects on plant immunity and defense signaling.

Climate change presents major challenges for global agriculture and the preservation of ecosystems and biodiversity. Current climate models predict future increases in global temperature, with potentially devastating effects on crop production. Relatively moderate increases in ambient temperature ($<6^{\circ}\text{C}$) can invoke dramatic changes in plant development, reducing harvest yield. Increased temperature additionally accelerates flowering, promoting floral development out of synchronization with pollinator lifecycles. Indirect

impacts of elevated temperature on plant development include increased pathogen susceptibility and enhanced water use. The latter may promote leaf cooling in well-watered environments but would have severe consequences in drought conditions. Conversely, exposure to sudden frost can lead to catastrophic crop losses in nonacclimated species. Understanding how plants perceive, integrate, and respond to temperature signals may provide novel molecular targets for the production of crops resilient to climate change and inform predictions as to the impact of global warming on plant ecology and biodiversity. Enhanced knowledge of plant temperature responses could additionally lead to more energy-efficient horticultural production. The stature and flowering time of glasshouse crops are commonly controlled through manipulations of light and temperature. Understanding how plants perceive and respond to small temperature changes at different times of day in diverse light environments will greatly facilitate the design of optimal growth management regimes.

This volume is designed to provide a comprehensive and up-to-date account of the role of temperature in plant development. It is aimed at all students and teachers of modern plant biology, academics with an interest in the environmental regulation of development, and policy makers working in the area of climate change, ecology, and global food security.

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