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Temperature-driven plasticity in growth cessation and dormancy development in deciduous woody plants: a working hypothesis suggesting how molecular and cellular function is affected by temperature during dormancy induction

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Abstract The role of temperature during dormancy development is being reconsidered as more research emerges demonstrating that temperature can significantly influence growth cessation and dormancy development in woody plants. However, there are seemingly contradictory responses to warm and low temperature in the literature. This research/review paper aims to address this contradiction. The impact of temperature was examined in four poplar clones and two dogwood ecotypes with contrasting dormancy induction patterns. Under short day (SD) conditions, warm night temperature (WT) strongly accelerated timing of growth cessation leading to greater dormancy development and cold hardiness in poplar hybrids. In contrast, under long day (LD) conditions, low night temperature (LT) can completely bypass the short photoperiod requirement in northern but not southern dogwood ecotypes. These findings are in fact consistent with the literature in which both coniferous and deciduous woody plant species' growth cessation, bud set or dormancy induction are accelerated by temperature. The contradictions are addressed when photoperiod and ecotypes are taken into account in which the combination of either SD/WT (northern and southern ecotypes) or LD/LT (northern ecotypes only) are separated. Photoperiod insensitive types are driven to growth cessation by LT. Also consistent is the importance of night temperature in regulating these warm and cool temperature responses. However, the physiological basis for these temperature effects remain unclear. Changes in water content, binding and mobility are factors known to be associated with dormancy induction in woody plants. These were measured using non-destructive magnetic resonance micro-imaging (MRMI) in specific regions within lateral buds of poplar under SD/WT dormancing inducing conditions. Under SD/WT, dormancy was associated with restrictions in inter- or intracellular water movement between plant cells that reduces water mobility during dormancy development. Northern ecotypes of dogwood may be more tolerant to photoinhibition under the dormancy inducing LD/LT conditions compared to southern ecotypes. In this paper, we propose the existence of two separate, but temporally connected processes that contribute to dormancy development in some deciduous woody plant: one driven by photoperiod and influenced by moderate temperatures; the other driven by abiotic stresses, such as low temperature in combination with long photoperiods. The molecular changes corresponding to these two related but distinct responses to temperature during dormancy development in woody plants remains an investigative challenge.

Keywords *Cornus sericea* · Dormancy · Magnetic resonance imaging · Photoinhibition · *Populus* · Temperature

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Lack of plant environmental synchrony is considered to be the primary cause of abiotic stress injury. Plant synchrony