

# Identifying drivers of foliar toughness during white spruce spring bud burst: implications for the phenological window of opportunity of herbivores

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## **Abstract**

Many herbivorous insect pests of north temperate forest tree species have life histories that require the insect to feed on young, rapidly growing tree tissues. For example, young instars of eastern spruce budworm (*Choristoneura fumiferana*) consume expanding shoot tips of white spruce (*Picea glauca*) during spring bud burst. Once shoot development has progressed beyond the insect's window of opportunity, increased accumulation of chemical and physical defences decrease foliar nutritional quality. As such, developmental asynchrony between insect and host phenology can lead to reduced insect performance and fitness. In this study, we investigated foliar traits affecting the phenological window of opportunity in five families of white spruce with different times to bud burst. In forcing experiments, elevated temperatures compressed the time required for shoot elongation, effectively synchronizing bud burst across families. Lignification and potentially suberization of the hypodermis and epidermis of developing needles showed the highest correlation with foliar toughness, previously shown to be a key predictor of the phenological window of opportunity for spruce budworm. Cuticle development, on the other hand, appears to play a more limited role in defining the phenological window of opportunity. We are currently developing hyperspectral imaging methods to non-destructively measure foliar toughness in the field.