Harnessing cold adaptation for post-glacial colonisation: galactinol synthase expression and raffinose accumulation in a polyploid and its progenitors

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Abstract

Allotetraploid white clover formed during the last glaciation through hybridisation of two European diploid progenitors from restricted niches: one coastal, the other alpine. Here, we examine which hybridisation-derived molecular events may have underpinned white clover's post-glacial niche expansion. We compared the transcriptomic frost responses of white clovers (inbred line and an alpine-adapted ecotype), extant descendants of its progenitor species and a resynthesised white clover neopolyploid to identify genes that were exclusively frost-induced in the alpine progenitor and its derived subgenomes. From these analyses we identified galactinol synthase, the rate-limiting enzyme in biosynthesis of the cryoprotectant raffinose, and found that the extant descendants of the alpine progenitor as well as the neopolyploid white clover rapidly accumulated significantly more galactinol and raffinose than the coastal progenitor under cold stress. The frost-induced galactinol synthase expression and rapid raffinose accumulation derived from the alpine progenitor likely provided an advantage during early post-glacial colonisation for white clover compared to its coastal progenitor.

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