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Molecular signatures for low temperature memory in *Arabidopsis*

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Plants from temperate regions increase their freezing tolerance during exposure to low, non-freezing temperatures, a process called cold acclimation or cold priming as plants become better prepared for subsequent stresses. Adaptation to alternating temperatures enables plants to survive winter and to cope with recurring cold periods. In spring loss of freezing tolerance occurs during a tightly regulated deacclimation balancing between transition to reproductive growth and the need for maintained freezing tolerance. Cold priming has been intensively investigated whereas processes underlying cold memory are unknown. We showed that the freezing tolerance of two Arabidopsis accessions Col-0 and N14 was higher after priming at 4°C, a lag phase at 20°C and a second cold trigger compared to only primed plants implicating cold stress memory. The triggering response differed from the priming response at the levels of gene expression (RNA-Seq), lipid (UPLC-MS), and metabolite composition (GC-MS). Unique differentially expressed genes after triggering were overrepresented in categories such as lipid and secondary metabolism, stress, redox and cell wall related functions in Col-0 and growth-related functions in N14. Furthermore arabidopsides were accumulated with proposed functions in signalling or as precursors of jasmonic acid. The more freezing tolerant N14 maintained levels of cold-induced metabolites during the lag phase whereas strong accumulation occurred in the less freezing tolerant Col-0 after triggering pointing to genetic differences of transcriptomic and metabolic patterns during cold memory. This is to our knowledge the first report on molecular and metabolic changes accompanying cold stress memory and triggering by a second cold stress.

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