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Rooting depth: a key trait connecting water and carbon metabolism of trees

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Drought episodes accompanied by heat waves are thought to be the main cause of increasing rates of tree decline and mortality in several biomes with consequent ecological/economical consequences. Three possible and not mutually exclusive mechanisms have been proposed to be the drivers of this phenomenon: hydraulic failure caused by massive xylem cavitation and leading to strong reduction of root-to-leaf water transport, carbon starvation caused by prolonged stomatal closure and leading to impairment of primary and secondary metabolism, and finally attacks of biotic agents. The different mechanisms have been reported to have different relevance in the different species. We analyzed the seasonal changes of water relations, xylem sap isotopic composition, and concentration of non-structural carbohydrates in four different woody species co-occurring in the same habitat during a summer drought. Analysis of rain and deep soil water isotopic composition were also performed. Different species showed differential access to deep water sources which influences the gas exchanges and the concentration of non structural carbohydrates (NSC) during the dry season. Species with access to deeper water maintained higher NSC content and were also able to better preserve the integrity of the water transport pathway. On the basis of our results, we propose that rooting depth is a key trait connecting water and carbon plant metabolism, thus mediating the likelihood of hydraulic failure vs carbon starvation in trees subjected to global warming.