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Hydraulic lift in cork oak trees in a savannah-type Mediterranean ecosystem and its contribution to the local water balance

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Abstract

The aim of this study was to identify the sources and depth of water uptake by 15-years old *Quercus suber* L. trees in southern Portugal under a Mediterranean climate, measuring $\delta^{18}O$ and δD in the soil–plant-atmosphere continuum. Evidence for hydraulic lift was substantiated by the daily fluctuations observed in Ψ_s at 0.4 and 1 m depth and supported by similar $\delta^{18}O$ values found in tree xylem sap, soil water in the rhizosphere and groundwater. From 0.25 m down to a depth of 1 m, δD trends differed according to vegetation type, showing a more depleted value in soil water collected under the evergreen trees (−47‰) than under dead grasses (−35‰). The hypothesis of a fractionation process occurring in the soil due to diffusion of water vapour in the dry soil is proposed to explain the more depleted soil δD signature observed under trees. Hydraulically lifted water was estimated to account for 17–81% of the water used during the following day by tree transpiration at the peak of the drought season, i.e., 0.1–14 L tree^{-1} day^{-1}. Significant relationships found between xylem sap isotopic composition and leaf water potential in early September emphasized the positive impact of the redistribution of groundwater in the rhizosphere on tree water status.

Abbreviations: hydraulic lift – (HL); leaf water potential – (Ψ_L); soil temperature – (T_S); soil water content – (SWC); soil water potential – (Ψ_S); vapour pressure deficit – (VPD); tree transpiration – (E)

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