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Stable isotopes reveal ecotypic variation of water uptake patterns in Aleppo pine

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Aleppo pine (*Pinus halepensis* Mill.) has a large natural distribution range that encompasses a multitude of thermal and moisture conditions found in the Mediterranean basin. We hypothesized that due to the recurrent incidences of drought stress and high temperatures that occur at varying degrees along its distribution range, populations of Aleppo pine have undergone ecotypic differentiation in soil water uptake patterns. This study analyzed stable isotopic compositions (δ^{18}O and δ^{2}H) of xylem water to identify adaptive divergence associated to the pattern of soil water consumption by roots of Aleppo pine populations originating from the Mediterranean region. The results from this study show that genetic diversity in the extraction pattern of soil water can be found among populations and ecological regions of Aleppo pine under common garden conditions. However, the ability to detect such differences depended on the period of the year examined. In particular, data collection in full summer (end of July) proved to be the most adequate in revealing genetic divergence among populations, while end of spring and, to a lesser extent, end of summer, were less successful for this purpose. Both water uptake patterns (as estimated by δ^{18}O and δ^{2}H) and above-ground growth, exhibited significant relationships with both climatic and geographical variables. This suggests that the underlying variation among populations can be explained by certain characteristics at origin. In addition, we used a bayesian mixing model (SIAR package for R) that incorporated isotopic signatures from xylem and soil water in order to determine the predominant soil layer of water source consumption at the aforementioned periods of the growing season, where water availably ranged from lowest to highest. This allowed us to gain some understanding of Aleppo pines' differential reaction to drought, at the intraspecific level, across the fluctuating conditions of the growing season by comparing the relative contribution of each water source.

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