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Seasonal variations in soil and plant water status in a *Quercus suber* L. stand: roots as determinants of tree productivity and survival in the Mediterranean-type ecosystem

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Abstract

Studies were conducted to examine changes in soil (Ψs) and plant water status during summer in a 16-year old *Quercus suber* plantation in southern Portugal. Continuous measurements were conducted between May 2003 and August 2004, while discontinuous measurements were conducted on a monthly basis between May and September 2003 and repeated between March and September 2004. Intensive measurements were conducted on five trees with mean height and DBH of 5.3 m and 11.6 cm, respectively, growing at close proximity to each other. Weather conditions and soil water potential (Ψs) at the rhizosphere of each of the trees measured at 0.3 and 1 m soil depth were continuously monitored. Predawn (Ψpd) and midday (Ψmd) leaf water potentials were determined every month. Soil and plant samples were also collected in June and September from different locations within the study site for $\delta^{18}O$ isotope composition analysis. Pressure–volume (p–v) curves were constructed from plant shoots at different times during the vegetative period to determine osmotic potential at full saturation (Π^{100}), water potential at turgor loss point (Ψ_{tlp}), relative water content at turgor loss point (R^*_{tlp}) and bulk modulus of elasticity (ε). Significant $P < 0.05$ decline in Ψs occurred between May and September, the lowest value recorded being –2.0 MPa. Decline in soil moisture affected tree water status, but decline in leaf water potential varied significantly ($P < 0.05$) among the trees. At the end of summer drought, lowest Ψpd measured was –1.7 MPa while the highest measured during this time was –0.8 MPa. Differences among trees were attributed to differences in rooting depth, as shown by regression analysis of ^{18}O isotopes. Radial stem growth ceased when Ψs within the upper 0.3 m depth approached –1.5 MPa. The upper soil layers contributed approximately 33% of the total tree water requirement, between spring and mid summer when drought was experienced by trees. Deep soil layers however, supplied most of the water required during drought and no growth was recorded during this time. Stressed trees increased solute concentration of their tissues by a Magnitude of 0.7 MPa while bulk tissue elastic modulus increased by about 17 MPa. The study emphasizes the significance of roots as determinants of tree productivity and survival in the Mediterranean ecosystems.

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