



Scots pine water relations in response to drought-induced defoliation and competition by Holm oak trees

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Scots pine is a widely distributed tree throughout boreal regions, but it also occupies more southerly locations thanks to its highly plastic hydraulic architecture. However, many Scots pine populations at dry sites within the Mediterranean basin show clear symptoms of drought-induced decline. Chronic water stress and recurrent drought spells are leading to reduced growth, crown defoliation and increased mortality rates of Scots pine in these areas. In the Prades Mountains (NE Spain), Scots pine decline since the 1990's has been favouring the more drought-tolerant Holm oak trees growing in the understory. This study focuses on the differences in water use and water relations of both species in pure and mixed stands and the influence of crown condition on the response of Scots pine to drought. We established three plots within the same valley: a pure Holm oak coppice, a mixed Scots pine-Holm oak stand, with evident signs of Scots pine drought-induced decline, and a pure Scots pine stand in a moister microsite. In each plot, we monitored sap flow with Granier probes and water potentials, together with meteorological variables and soil moisture during the year 2010. We also investigated the defoliation patterns in Scots pine by measuring shoot growth and needle size in defoliated and healthy trees. Reduced shoot growth and needle mass per area was observed in defoliated pines, a characteristic response of water-stressed trees. Precipitation during July-August of 2010 was only 30% of the long-term climatic average for the area. In response to these drought conditions, defoliated Scots pines showed stronger sap flow reductions than healthy Scots pines, while co-occurring Holm oak trees decreased sap flow only slightly. Scots pine regulated midday water potential at similar values across sites and crown conditions, but defoliated pines showed lower predawn water potentials than healthy pines. Holm-oak water potentials were generally below those observed for Scots pine. These results imply that Scots pine survival is likely to be hampered by reduced carbon gain and enhanced competition for water by Holm oak.