

**Variations in growth, survival and carbon isotope composition ( $\delta^{13}\text{C}$ ) among *Pinus pinaster* populations of different geographic origins**

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**Abstract**

To evaluate differences in growth and adaptability of maritime pine (*Pinus pinaster* Ait.), we studied growth, polycyclism, needle tissue carbon isotope composition ( $\delta^{13}\text{C}$ ) as an estimate of water-use efficiency (WUE) and survival of seven populations at 10 years of age growing in a performance trial at a provenance test site in Escaroupim, Portugal. Six populations were from relatively high rainfall sites in Portugal and southwestern France (Atlantic group), and one population was from a more arid Mediterranean site in Spain. There were significant differences between some populations in total height, diameter at breast height,  $\delta^{13}\text{C}$  of bulk needle tissue, polycyclism and survival. A population from central Portugal (Leiria, on the Atlantic coast) was the tallest and had the lowest  $\delta^{13}\text{C}$ . Overall, the variation in  $\delta^{13}\text{C}$  was better explained by the mean minimum temperatures of the coldest month than by annual precipitation at the place of origin. Analyses of the relationships between  $\delta^{13}\text{C}$  and growth or survival revealed a distinct pattern for the Mediterranean population, with low  $\delta^{13}\text{C}$  (and WUE) associated with the lowest growth potential and reduced survival. There were significant negative correlations between  $\delta^{13}\text{C}$  and height or survival in the Atlantic group. Variation in polycyclism was correlated with annual precipitation at the place of origin. Some Atlantic populations maintained a high growth potential while experiencing moderate water stress. A detailed knowledge of the relationships between growth, survival and  $\delta^{13}\text{C}$  in contrasting environments will enhance our ability to select populations for forestry or conservation.

**Keywords:** climate change, drought tolerance, maritime pine, polycyclism, provenance trial, tree breeding

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