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Photosynthetic traits of Pinus halepensis and Pinus brutia under regional and seasonal variation

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Mediterranean pine forests are increasingly exposed to prolonged and intense heat and drought events; yet, their seasonal photosynthetic responses and the controlling drivers remain underexplored. We studied the seasonal variation in photosynthetic traits of *Pinus halepensis* and *P. brutia*, across three regions in Greece, i.e., Lesvos, Sani, and Xanthi. Measurements were conducted from summer 2024 to spring 2025 using portable gas exchange systems at three plots per site and four dominant, non-neighbouring pines per plot, on both sunlit and shaded needles. We used light-response curve fitting (NRH model) to estimate light-saturated net assimilation (A_{max}), dark respiration (Rd), and Quantum Yield (QY). Our primary objectives were to investigate differences among the regions, species, and seasons, and to assess the impact of concurrent microclimatic drivers. Our preliminary results show significant variation in A_{max} across regions and seasons. Overall, A_{max} of *P. brutia* at Xanthi was the highest among the studied sites, particularly in spring and autumn, followed by *P. halepensis* at Sani, which exhibited peaks in Amax in spring and winter. Such a bimodal growth pattern was not observed in *P. brutia* at Lesvos, which showed a narrow seasonal range with lower overall photosynthetic capacity, compared to the other regions. Sun leaves did not display any statistically significant difference in Amax values compared to shade leaves ($P > 0.05$). Rd substantially varied across regions and was the lowest in *P. brutia* at Lesvos and highest at Xanthi ($P < 0.001$), highlighting interspecific and regional differences in respiratory cost. QY declined with increasing temperature ($P < 0.001$) in Sani, suggesting moderate thermal sensitivity on photosynthetic efficiency. In contrast, no significant relationship was detected at Lesvos and Xanthi, suggesting a potential species-level difference in thermal responses. A PCA analysis revealed distinct trait clustering by region, with A_{max} and QY explaining more than 55% of the variance. The differentiation between *P. halepensis* and *P. brutia* in multivariate space reflects contrasting acclimation strategies to site-specific environmental pressures. Our results suggest that pine photosynthesis exhibits seasonal sensitivity, with implications for carbon gain under future Mediterranean climates.

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