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Growth and physiological response of young plants of Mediterranean species under a simulated heat wave

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Drought-induced mortality of seedlings and young plants is critical for the assessment of forest vulnerability in Mediterranean environments. Forecasted projections of climate changes indicate trends of increasing temperature and alteration in precipitation pattern in the Mediterranean region with a high probability of extreme events, such as heat waves. Many Mediterranean shrubs and trees show very plastic responses to fluctuating climate parameters in adult plants due to physiological adjustments, as well as to the occurrence of structural hydraulic traits (throughout the whole root-stem-leaf system), which allow adaptation and survival under limiting conditions. However, compared to adult plant systems, seedlings and young plants are more vulnerable to environmental stressors. Species-specific sensitivity to stressors during the early stages of seedling/young plant establishment is expected to affect vegetation dynamics and forest productivity. Within this framework, there is increasing interest in understanding if, how and to what extent, young plants are able to tolerate prolonged water stress combined with high temperature regimes.

The aim of this study was to evaluate the effect of a simulated heat wave on growth and physiological behaviour of one-year-old plants of Quercus ilex L. and Arbutus unedo L. subjected to two regimes of water availability. The experiment was conducted under a plastic tunnel situated at the University of Naples Federico II, Southern Italy. Rooted cuttings of potted Q. ilex and A. unedo, were transplanted at the end of April into pots containing peat moss and placed on troughs, with a plant density of 10 plants·m-2. Two irrigation treatments were applied based on the plant daily water use (100% reintegration of water - Control, C; 50% reintegration of water -Water Stressed, WS) and arranged in a randomized complete block design with six replicates of five plants/treatment per each species. At about 115 days from transplantation, irrigation was suspended for three weeks corresponding to the maximum peak of registered temperatures, and later restored for one month more. Plant growth, leaf gas exchange, leaf water potentials and photochemistry, were measured during the growing cycle. PAR and air temperature and humidity were recorded during the whole experiment. During the cultivation cycle plant primary and secondary growth was measured by recording plant height, stem basal diameter, leaf and shoot number every third week. Leaf gas exchange and leaf water potential were also measured monthly. At the end of the experiment, the plant total dry biomass (leaf, stem and root) and mortality were determined.

The two species showed different responses, with A. unedo plants being more resistant under deficit irrigation, but showing higher mortality than Q. ilex after the heat wave. Q. ilex showed reduced relative growth rate and total biomass accumulation after drought due to promptly lowering of leaf water potential and reducing stomata opening. In both species, pre-acclimation to water shortage allowed a better surviving capability to the simulated heat wave.

Understanding the behaviour of young tree and shrub species under severe fluctuations of climate parameters furnishes useful information for the management of not only natural ecosystems but also urban green areas.