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Seasonal dynamics of radial growth and stem water deficit in co-occurring saplings and mature conifers under drought: Canopy density affects water stress experienced by saplings

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Size-mediated climate sensitivity of trees will affect forest structure, composition and productivity under a warmer and drier climate. Therefore, the influence of tree size (saplings vs. mature trees) and site conditions on radial stem growth and stem water deficit of Picea abies (dry-mesic site; canopy cover [CC]: 70 %) and Pinus sylvestris (xeric site; CC: 30 %) were evaluated in a drought-prone inner Alpine environment (c. 750 m a.s.l.). Stem radius variations (SRVs) of saplings (mean stem diameter [SDM]: 2.3 cm) and co-occurring mature trees (SDM: 24 cm) were continuously recorded by dendrometers during two years (n = 6 - 8 individuals per species and size class). Growth-detrended SRVs (SSRV), which represent reversible shrinkage and swelling of tissues outside the cambium and contribute most to stem water storage capacity, were calculated by removing the Gompertz-modeled daily growth from SRVs. Dendrometer records revealed that irrespective of tree size, radial growth in Pinus sylvestris occurred in April-May, whereas the main growing period of Picea abies was April-June and May-June in saplings and mature trees, respectively. Growth-detrended SRVs were approximately twice as large in Pinus sylvestris compared to Picea abies indicating more intense exploitation of stem water reserves at the xeric site. Linear relationships between SSRVs of mature trees vs. saplings and climate-SSRV relationships revealed greater use of stem water reserves by mature Picea abies compared to saplings. This suggests that the strikingly depressed radial growth of Picea abies saplings was primarily caused by reduced carbon availability beneath the dense canopy. In contrast, a tree size effect on the seasonal dynamics of radial growth, stem water deficit and climate-SSRV relationships was mostly lacking in Pinus sylvestris, indicating comparable water status in mature trees and saplings under an open canopy. Results of this study provide evidence that development of a buffered microclimate under dense canopy mitigates water stress experienced by saplings and favors tree recruitment at drought-prone sites.

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