Special Issue Paper

Assessing seasonal drought stress response in Norway spruce (*Picea abies* (L.) Karst.) by monitoring stem circumference and sap flow

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https://doi.org/10.1002/eco.1536

Abstract

Summer drought frequency is expected to increase with climate change in forested regions of Europe. To examine the physiological impacts of low soil moisture on Norway spruce [Picea abies (L.) Karst.], we conducted an irrigation experiment in a Norway spruce-dominated forest of Slovakia. We monitored sap flow (Qs), stem circumference and soil water potential (Ψw), measured needle water potential (ΨI), and estimated potential evapotranspiration (PET) in control and irrigated plots. Soil water availability influenced the response of Qs to PET and the impact of Qs on maximum daily stem shrinkage (MDS). The positive relationship between Qs and PET was constrained below a threshold Ψw near -0.3 MPa. MDS was higher beyond this threshold, for a given value of Qs. Higher MDS and lower tree water status (ΔW) were observed at low Ψw in control plants, suggesting the lower water potential of stems' conducting tissues. Stem circumference increase (SCI) was 62% lower in control trees following the irrigation treatment. Slight SCI recovery was observed in these trees in response to early autumn rainfall, which caused ΔW to return to its pre-drought state. The results demonstrate that low water availability not only reduced Qs, ΔW, SCI, ΨI and increased MDS, but also altered their mutual relations.