Submitted Abstract

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First Author First Name Last Name	 Florian (1) Oberleitner
Submitting Author First Name Last Name	 Florian Oberleitner
Correspondence	Florian.Oberleitner@uibk.ac.at
Co-Authors **>> E-Mails will be not listed**	Hasibeder, Roland (1); Huang, Jianbei (2); Losso, Adriano (3,4); Bär, Andreas (3); Giunta, Andrew (1); Yoshikawa, Akira (1); Hartmann, Henrik (2); Oberhuber, Walter (3); Wieser, Gerhard (3); Mayr, Stefan (3); Bahn, Michael (1)
Organisations	1: Department of Ecology, University of Innsbruck, Austria 2: Department of Biogeochemical Processes, Max Planck Institute for Biogeochemistry, Jena, Germany 3: Department of Botany, University of Innsbruck, Austria 4: Hawkesbury Institute for the Environment, Western Sydney University, Richmond, Australia
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Title	Increasing Impacts Of Recurrent Summer Drought On Tree Growth, Xylem Sap Flow And Dehydration Dynamics Of Larix Decidua And Picea Abies In A Subalpine Forest.
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Abstract

The severity and frequency of drought events is expected to increase in a future climate, but consequences for ecosystems that were previously not affected by drought are highly uncertain. At a subalpine forest site in the Austrian Central Alps, we experimentally exposed mature trees of Larix decidua and Picea abies to multiple years of recurrent summer drought. We continuously monitored tree growth, xylem sap flow and tree water deficit and analyzed xylem anatomy and non-structural carbohydrate (NSC) concentrations and their carbon isotope signature (d13C).

We found that tree growth was limited from the first year of drought in both species, and that the drought effects on growth increased with recurrent drought in P. abies, and to a lesser extend in L. decidua. Both species showed pronounced tree water deficits already shortly after the onset of drought, L. decidua exhibiting larger relative tree water deficits. Xylem anatomy was affected by drought only in P. abies, reflecting a comparatively higher sensitivity to reduced stem water content. Furthermore, while total NSC and soluble sugar concentrations were increased in needles and branches of drought-exposed P. abies trees and starch concentrations reduced in branches of P. abies under drought, NSC concentrations of L. decidua remained largely unaffected. In both species, d13C of soluble sugars of drought exposed trees was increased already at the onset of the third drought, indicating a sustained imprint of previous droughts on water-use efficiency. In contrast to our expectations, the drought response of xylem sap flow did not differ between the two species, which were previously suggested to differ in their water-use strategy. Drought effects on xylem sap flow tended to increase with recurrent drought in both species.

Our study suggests that recurrent drought progressively impairs the functioning of the two treeline species, with species-specific responses likely owing to differences in rehydration capacity and / or cambial tissue sensitivity to water deficit. We conclude that even under comparatively low evaporative demand, typical for most treelines, tree functioning may be strongly impacted by summer drought, especially if such drought events recur during two or more consecutive years.