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High resilience of water related physiology after five years of repeated summer drought of mature beech and spruce.

Benjamin D. Hesse[1], Timo Gebhardt[1], Benjamin D. Hafner[2], Kyohsuke Hikino[1], Karl-Heinz Häberle[3], and Thorsten E.E. Grams[1]

[1]Land Surface-Atmosphere Interactions - AG Ecophysiology of Plants, Technical University of Munich, Freising, Germany
[2]School of Integrative Plant Science, Cornell University, Ithaca, USA
[3]Restoration Ecology, Technical University of Munich, Freising, Germany

Acclimation processes in a changing climate require the ability to tolerate and survive abiotic stress events (e.g. drought), challenging especially immobile and long-living species and ecosystems, such as forests. The drought years 2018/2019 in Central Europe have laid bare the vulnerability of temperate forest ecosystems to drought and heat. The recovery phase after the stress event represents a crucial phase, especially after intense and repeated drought periods, and might be different for anisohydric and isohydric species.

The second phase of the Kranzberg Forest Roof (KROOF) experiment in southeast Germany focused on the watering of mature more anisohydric European beech (*Fagus sylvatica* L.) and more isohydric Norway spruce (*Picea abies* (L.) H. Karst.) after five years of repeated experimental summer drought. Both treatments, the former throughfall-exclusion (TE, recovering trees) and control (CO) plots were labeled with ^{2}H enriched water by controlled watering, to end the experimental drought. Pre-dawn leaf water potential, stomatal conductance, xylem sap flow density (at breast height and crown base) and leaf osmoregulation were recorded for two growing seasons after drought release and the resilience and recovery times were calculated.

All measured parameters were strongly reduced by on average 30% in both species due to the drought treatment. While the distribution of the labeled water upon irrigation across the soil profile occurred within a few days in both treatments, the water uptake and distribution within the trees was delayed by several days in recovering trees compared to control trees and in recovering spruce compared to recovering beech. Additionally, upon drought release recovering beech reached full resilience (i.e. same level as control trees) earlier than recovering spruce in water potential, stomatal conductance and xylem sap flow density and even showed signs of overcompensation by surpassing the control trees. No differences were found between the two species in the recovery of leaf osmoregulation.

The “opposing” drought mitigation strategies seem to be responsible for the differences detected between more anisohydric beech and spruce during the recovery period. For example, the lack of recovery of xylem sap flow density at crown base in TE spruce indicates a re-filling of the stem water reservoirs upon watering. Additionally, we found fast responding parameters as water

potential (hours to days) and stomatal conductance (days to weeks) compared to slow responding parameters such as osmoregulation (weeks to months) and full hydraulic recovery, i.e. xylem sap flow density, may even take years. Rapid physiological recovery after drought events, which are expected to increase in frequency and intensity with ongoing climate change, will be beneficial for overall recovery and might put faster-reacting trees in favor over slower responding species.