Submitted Abstract

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Abstract

Trees in mountain forest systems are exposed to extreme climatic conditions with high spatial and temporal variation. Factors such as low air and soil temperatures, intense frost or long snow coverage and associated short vegetation periods are challenging for trees at high elevation. Additionally, also mountain ecosystems will have to face pronounced change in mean climate conditions and an increasing risk of climate extremes (e.g. heat waves, extended drought periods) with ongoing global warming. However, our current knowledge of how trees at the treeline respond to changing climatic conditions (especially to pronounced summer droughts) is scarce.

To gain new insights into the eco-physiology of drought-stressed trees at the treeline, we studied two coniferous species (Picea abies; Larix decidua) growing at an experimental field site located at ~2000 m asl (Kaserstattalm, Tyrol, Austria), where through-fall was excluded from trees during vegetation periods since 2016. With a main focus on the hydraulic system (i.e. xylem), drought-induced structural and functional changes were assessed: we studied tracheid characteristics and xylogenesis dynamics of stressed and control trees as well as seasonal and annual changes in hydraulic traits (e.g. sap flow, hydraulic conductivity, water potential). In micro-CT observations of branch samples, we quantified the trees' vulnerability to drought-induced embolism and relevant anatomical traits.

Results demonstrate species-specific changes in the dynamics of xylem formation under long-term drought stress. Drought stress also affected structural traits of wood cells which in consequence led to changes in hydraulic efficiency and/or hydraulic vulnerability.

Conifers dominate the treeline ecotone and a better understanding how future climatic conditions affect their xylem formation and functionality will help to better anticipate individual tree responses and ecosystem dynamics at high altitude.