Submitted Abstract

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First Author First Name Last Name	 Anna Sofia Görlich
Submitting Author First Name Last Name	 Anna Sofia Görlich
Correspondence	annasofiagoerlich@gmail.com
Co-Authors **>> E-Mails will be not listed**	Delgado Manzanedo, Rubén; Schiendorfer, Katja; Visakorpi, Kristiina; Bieger Altermatt, Annette; Hille Ris Lambers, Janneke
Organisations	Institute of Integrative Biology, ETH Zürich, Switzerland
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Abstract

Temperate forests in the Alps are increasingly pressured by ongoing climate change and severe drought events. A trees' ability to withstand drought and its interactions with other climate change-driven stressors are therefore crucial to understand how forests will respond to environmental change. This is especially important at the seedling stage, where strong environmental filtering on establishment influences species regeneration and thus, the structure of future mountain forest communities. However, the tolerance of seedlings to environmental extremes remains understudied for most tree species. To address this knowledge gap, we explored drought and frost tolerance across 22 widespread Central European tree species present in Swiss forests by growing them in the greenhouse and assessing their tolerance at the seedling stage. We expected that species would vary in their tolerance to these stressors, since summer drought and spring frost are two relevant extreme events affecting seedling survival, but risk varies widely across species ranges. We also expected that adaptation to these stressors might be synergistic (adaptation to one will favour adaptation to the other) or show trade-offs between them, or with other functional traits, which would ultimately affect the process of species regeneration. As expected, drought tolerance differed between species, being generally higher for needle leaved species. However, high inter- and intra-specific variability resulted in non-significant results with respect to leaf type (broadleaves vs. needles). Regardless, high inter-specific variability in tolerance suggests there will be 'winners' and 'losers' under changing climate, whereas high intra-specific variability may favour rapid adaptation of some species. We also found a positive relationship between drought and frost tolerance, which was stronger for seedlings exposed to heavier frost and for needle leaved species. Our results therefore suggest that synergies between drought and spring frost adaptation may be common across Swiss tree species in early developmental stages. This may allow cold-adapted species to have a head start to adapt to increasing drought events. However, the likelihood of this synergy benefitting specific species will depend on the difference between the current vs. future magnitude of drought and frost stress each population experiences, as well as on potential trade-offs with other traits or stress adaptations. Our results suggest that these seedling traits may play an important role in determining adaptation potential and responses to future climate change. However, further research is needed to explore adaptation trade-offs and synergies in seedlings and their role in mountain forest regeneration under climate change.