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No risk - no fun: The tradeoff between avoiding frost and maximizing growth

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Abstract

Leaf-out timing is crucial for the fitness of deciduous trees inhabiting temperate and higher latitudes. Optimal leaf-out allows minimizing freezing damages and herbivory pressure while maximizing growing season length and resource uptake in order to increase their competitiveness. However only a few attempts have been made to classify species according to their strategy along this trade-off.

Using climate chambers, we artificially provoked 5 different flushing dates that span the maximum possible range of natural occurring flushing dates of 4 tree species (Prunus avium, Carpinus betulus, Fagus sylvatica and Quercus robur). Shortly after each of the five leaf-out timings, 12 saplings per species were exposed to a frost treatment that is expected to either kill all leaves (LT_{100}, i.e. lethal temperature killing 100% of the leaves) or to partially damage them. These temperature thresholds have been adapted to each species according to their freezing resistance found in the literature. A subset of 12 indviduals per species served as a control and were not subjected to a frost treatment. Shortly after the frost treatment, all saplings were planted outside in the ground under a shading net (~-60% of light transmission) simulating below canopy conditions at the WSL research facility near Zürich.

Growth parameters (diameter, height) and recovery state (percentage of greenness compared to the control) were regularly measured during the consecutive growing season as well as the leaf coloring in autumn 2019. Preliminary results suggest that cherry and oak have recovered more than 80% by the end of the growing season, whereas beech and hornbeam only recovered about 50%. Oak was the fastest species to recover, already reaching 80% three weeks after the frost treatment. Our results allow to better quantify to what extend damaging spring frost reduces competitiveness for resources (light, nutrients) among species.