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Enhanced root growth but reduced belowground carbon allocation are the initial responses to water limitation in model Scots pine-soil systems

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Worldwide tree species have been observed to be suffering from extended periods of water limitation, for example due to warmer climate that increases soil evaporation and plant transpiration. These conditions likely do not only affect the growth and vitality of trees but may also feed back on the cycling of carbon and nitrogen at the interface between roots and soils.

In September 2019, we established a mesocosm experiment to mechanistically study on a seasonal basis how the interactions between plants and soil biotic and abiotic resources are altered during events of drought. The mesocosms feature young Scots pine (*Pinus sylvestris* L.) trees and soil collected from a drought-affected natural forest in the Rhone valley, Switzerland; and are treated with three different levels of water availability (control, sufficient water; intermediate drought, 40% reduction; severe drought, 75% reduction). One year after the start of the experiment an isotopic labelling campaign with $^{13}\text{CO}_2$ was conducted to trace the natural pathway of photosynthetic assimilates into above- and belowground carbon pools and fluxes.

During the first growing season of the experiment, severe drought more than doubled the growth of fine roots when compared to the control treatment. In turn, the mean diameter of the fine roots significantly decreased by 22%, and fewer ectomycorrhizal root tips were observed. These findings suggest that trees exposed to drought invest more in within-plant carbon maintenance and in the growth of root systems, rather than in the allocation of carbon to sustain the biology in the rhizosphere for nutrient acquisition. Moreover, post-label soil pore $^{13}\text{CO}_2$ concentrations and total soil CO_2 concentrations were lower under severe drought compared to intermediate and control treatments, indicating a generally reduced carbon metabolism. By tracking the fate of ^{13}C assimilates into fine roots, soils and microbial communities over time we now investigate whether there is a threshold at which Scots pine trees stop investing in providing carbon to the rhizosphere and rather succumb to drought.