Carbon allocation in early successional tree species at elevated air humidity and different soil nitrogen sources

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Global climate change scenarios predict increasing air temperature, enhanced precipitation and air humidity for Northern latitudes. We investigated the effects of elevated air relative humidity (RH) and different inorganic nitrogen sources (NO₃⁻, NH₄⁺) on above- and belowground traits in different tree species, with particular emphasis on rhizodeposition rates. Silver birch, hybrid aspen and Scots pine saplings were grown in PERCIVAL growth chambers with stable temperature, light intensity and two different air humidity conditions: moderate (mRH, 65% at day and 80% at night) and elevated (eRH, 80% at day and night). The collection of fine root exudates was conducted by a culture-based cuvette method and total organic carbon content was determined by Vario TOC analyser. Fine root respiration was measured with an infra-red gas analyser CIRAS 2.

We analysed species-specific biomass allocation, water and rhizodeposition fluxes, foliar and fine root traits in response to changing environmental conditions. The eRH significantly decreased the transpiration flux in all species. In birch the transpiration flux was also affected by the nitrogen source. The average carbon exudation rate for aspen, birch and pine varied from 2 to 3 μg C g⁻¹ day⁻¹. The exudation rates for deciduous tree species tended to increase at eRH, while conversely decreased for coniferous trees (p=0.045), coinciding with the changes in biomass allocation. C flux released by fine root respiration varied more than the fine root exudation, whereas the highest root respiration was found in silver birch and lowest in aspen. At eRH the above and belowground biomass ratio in aspen increased, at the expense of decreased root biomass and root respiration.

Moreover, eRH significantly affected fine root morphology, whereas the response of specific root area was reverse for deciduous and coniferous tree species. However, fine roots with lower root tissue density had higher C exudation rate. Our findings underline the importance of considering species-specific differences by elucidating tree's acclimation to environmental factors and their interactions.