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Pinus sylvestris switches respiration substrates under shading but not during drought

Henrik Hartmann (1), Sarah Fischer (1), Stefan Hanf (2), Torsten Frosch (2), Jürgen Poppp (2), and Susan Trumbore (1)

(1) Max-Planck Institute for Biogeochemistry, Jena, Germany (hhart@bgc-jena.mpg.de), (2) Leibniz Institute of Photonic Technology, Jena, Germany

Reduced carbon assimilation during prolonged drought forces trees to rely on stored carbon to maintain vital processes like respiration. It has been shown, however, that the use of carbohydrates, a major carbon storage pool and main respiratory substrate in plants, strongly declines with deceasing plant hydration. Yet, no empirical evidence has been produced to what degree other carbon storage compounds like lipids and proteins may fuel respiration during drought.

We exposed young scots pine trees to carbon limitation using either drought or shading and assessed respiratory substrate use by monitoring the respiratory quotient, δ^{13}C of respired $CO_2$and concentrations of the major storage compounds, i.e. carbohydrates (COH), lipids and amino acids.

Generally, respiration was dominated by the most abundant substrate. Only shaded trees shifted from carbohydrate-dominated to lipid-dominated respiration and showed progressive carbohydrate depletion. In drought trees respiration was strongly reduced and fueled with carbohydrates from also strongly reduced carbon assimilation. Initial COH content was maintained during drought probably due to reduced COH mobilization and use and the maintained COH content may have prevented lipid catabolism via sugar signaling.

Our results suggest that respiratory substrates other than carbohydrates are used under carbohydrate limitation but not during drought. Thus, respiratory substrate change cannot provide an efficient means to counterbalance carbon limitation under natural drought.