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Redistributed water by saprotrophic fungi triggers carbon mineralization in dry soils

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Summer droughts are common in temperate forests and especially the upper soil horizons experience soil drought. Drought events can be accompanied by negative effects for forest ecosystems but many plants can reduce drought stress by hydraulic redistribution (HR). Similar processes were recently described for ectomycorrhizal networks but no information is available for mycelia networks of saprotrophic fungi. They strongly contribute to belowground nutrient cycling, C and N mineralization.

We hypothesize that redistributed water by saprotrophic fungi triggers mineralization of organic matter in soils under drought conditions.

The impact of HR by saprotrophic fungi on mineralization was determined using mesocosms comprising two chambers, separated by a 2 mm air gap to prevent bulk flow of water. After inoculation with fungal cultures and a growth phase, both chambers were desiccated. Subsequently, only chamber I was rewetted while chamber II was treated with 13C labelled plant material. CO_2 samples were collected over 7 days after rewetting and analyzed for stable isotope ratio. In addition, enzymatic activity of chitinases and cellobiohydrolases in chamber II was determined after 7 days using the soil zymographie method with fluorogenic 4-Methylumbelliferyl-substrates. A negative control was provided by mesocosms in which hyphal connections between the chambers were severed before rewetting.

Intact fungal connections between the chambers led to a strong increase in volumetric water content in chamber II after rewetting of chamber I and the CO_2 had a higher enrichment in 13C than in the control mescosms with severed connections. Enrichment started 48 h after rewetting and continued for the rest of the experiment. This resulted in a more than two fold higher total carbon mineralization after 7 days in chamber II of mesocosms with intact hyphal connections. In addition, enzyme activities were also strongly increased compared to controls. In conclusion, mycelia networks of saprotrophic fungi contribute to redistribution of water from wet to dry soil and the redistributed water triggers carbon mineralization in dry soils.