EGU22-3524, updated on 12 Aug 2022
https://doi.org/10.5194/egusphere-egu22-3524
EGU General Assembly 2022

Plant-fungal feedbacks of nitrogen deposition to peatland carbon sink potential

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We examined how changes in plant-fungal relationships induced by atmospheric nitrogen (N) deposition alter nutrient limitation and carbon sequestration in two main types of peatlands, bogs and fens. The study was carried out at three of the longest running nutrient addition experiments on peatlands: Whim Bog, United Kingdom, Mer Bleue Bog, Canada, and Degerö Stormyr Fen, Sweden. The treatments receive an additional load of 1.6-6.4 N g m^{-2} y^{-1} either as ammonium, nitrate, or ammonium nitrate with or without phosphorus (P) and potassium, alongside with unfertilized controls.

We determined the peak season aboveground biomass production and coverage of vascular plants using the point intercept method and measured fine roots production rates using the ingrowth core method. The ingrowth roots were also studied for amount of the root-associated fungi based on ergosterol and chitin concentrations (living and dead fungal mass indicators). In addition, we sampled fine roots from ericoid mycorrhizal shrubs and microscopically quantified them for abundance of fungal colonization as well as measured their potential to produce a set of hydrolytic enzymes degrading organic matter. The leaves of dominant vascular plants were analyzed their isotopic $\delta^{15}N$ patterns and nutrient contents under different nutrient addition treatments.

Long-term nutrient addition increased foliar $\delta^{15}N$ of shrubs, suggesting that ericoid mycorrhizal fungi were less important for plant N supply with increasing N load. Under high inorganic N availability, the plant biomass allocation shifted from belowground to aboveground at the two shrub-dominated bog sites: Mer Bleue and Whim, but not at the wet sedge dominated Degerö Stormyr. Unexpectedly, mycorrhizal colonization rates did not change significantly, but the presence of endophytic fungal mycelia in ericoid roots as well as ergosterol and chitin content in all fine roots generally increased under nutrient load. Interestingly, high doses of ammonium

alleviated N deficiency in ericoid shrubs, whereas low doses of ammonium and nitrate improved plant P nutrition, indicated by the lowered foliar N:P ratios. Shrub root acid phosphatase activities correlated positively with foliar N:P ratios, suggesting enhanced P uptake as a result of improved N nutrition.

Collectively, altered biomass allocation to roots and fungi, altered functionality of root associated fungi and altered plant reliance on nutrient uptake systems as well as altered function of roots and their associated fungi in degrading organic matter suggest changes in the quantity and quality of carbon input to peat soils under nitrogen load. The study revealed that the responses depend on the dose and form of N added and interestingly may interact with uptake of other nutrients. The plant-fungal feedbacks also seem to differ between the two functionally and structurally distinct peatland types.