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Natural abundance of ^{15}N of a spruce forest ecosystem under acid rain and manipulated clean rain field conditions

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We analysed stable isotopes of N in a spruce forest under ambient rainfall (no further manipulation of the atmospheric input) and clean rain application (10 years of reduced inorganic N- and acid-constituent input). The objectives of the study were to assess whether or not the natural ^{15}N abundance would function as an indicator for the N-status of our forest ecosystems. For this purpose, natural ^{15}N abundance values were measured in needles, litter fall, roots, soil, bulk precipitation, throughfall and soil water of both plots. In the bulk precipitation and throughfall the $\delta^{15}N$ values of NO_3-N were in the range reported by other studies (–16 to + 23‰). In both plots, the throughfall was greatly depleted of ^{15}N compared to the bulk precipitation and this was attributed to nitrification in the canopy leaves, leading to $\delta^{15}N$-depleted nitrate production in the leaves that leaches down the soil surface. Nitrate in seepage water showed a general increase in $\delta^{15}N$ values when it passes through the upper mineral soil (10 cm soil depth) and infiltrates into deeper mineral soil horizons (100 cm soil depth), similar to the $\delta^{15}N$ enrichment of total nitrogen in the mineral soil. We observed ^{15}N depletion in both green needles and litter fall at the clean rain plot, compared to the N-saturated control plot. We assumed it to be due to increased mycorrhizal N-uptake under N limited, i.e. clean rain conditions which are indicated by relatively lower N concentrations of green needles. With respect to the vertical gradient of the ^{15}N abundance in the forest floor, both plots differ from each other, showing an untypical peak of $\delta^{15}N$ depletion in the humus layer, which is more pronounced at the control plot. In contrast to the mineral soil where mineralisation is a dominant process for fractionation we attribute the $\delta^{15}N$ pattern in the forest floor to additional processes like litter input and immobilisation. We conclude that the $\delta^{15}N$ natural abundance analysis is helpful for interpreting the N-status of forest ecosystems but further research is needed especially with respect to the soil-root interface.

Keywords:

acid rain; clean rain; $\delta^{15}N$; stable isotopes; nitrogen; precipitation; throughfall; seepage water; needles; litter; spruce forest

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