Subalpine grass species are directly fertilized by atmospheric nitrate.

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Abstract

Mountainous grasslands are vulnerable to nitrogen (N) atmospheric deposition because of little acidification buffering capacity in soils and optimized N uptake strategies of native plants in response to historical nutrients limitation. Here, we investigated the sources of N to two typical grass species in the French Alps meadows (*F. paniculata, D. glomerata*), using the triple isotopes (Δ17O, δ18O and δ15N) of plant-tissue nitrate (NO3-). We demonstrate that this technique help to quantify, in the field, the direct contribution of atmospherically deposited NO3- to plant NO3- pool (up to 33% in our study). Distinct temporal patterns in NO3- isotopic composition in leaves and roots reflected the seasonal evolution of plant N uptake. Direct foliar uptake of atmospheric nitrate accounted for 3-16% of plant NO3- demand, a non-negligible pathway for N uptake in plants under natural conditions especially when growing on subalpine nutrient poor soils. We observed 15N gradual enrichment of NO3- from soils to leaves which suggested the importance of NO3- assimilation in contributing to plant total N. This multi-isotopic approach has a unique potential to decouple atmospheric N input pathways into plant species and to better constrain its fate in the environment.

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