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Nitrogen Uptake in an Alpine Kobresia Pasture on the Tibetan Plateau: Localization by ^{15}N Labeling and Implications for a Vulnerable Ecosystem

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Abstract

© 2015, Springer Science+Business Media New York. Grasslands are very important regionally and globally because they store large amounts of carbon (C) and nitrogen (N) and provide food for grazing animals. Intensive degradation of alpine grasslands in recent decades has mainly impacted the upper root-mat/soil horizon, with severe consequences for nutrient uptake in these nutrient-limited ecosystems. We used ^{15}N labeling to identify the role of individual soil layers for N-uptake by *Kobresia pygmaea*—the dominating plant in the degraded Tibetan pasture ecosystems. We hypothesized a very efficient N-uptake corresponding mainly to the vertical distribution of living roots (topsoil > subsoil). We assume that *K. pygmaea* develops a very dense root-mat, which has to be maintained by small aboveground biomass, to enable this efficient N-uptake. Consequently, a higher N-investment into roots compared to shoots was hypothesized. The ^{15}N recovery in whole plants (~70%) indicated very efficient N-uptake from the upper injection depths (0–5 cm). The highest ^{15}N amounts were recovered in root biomass, whereby ^{15}N recovery in roots strongly decreased with depth. In contrast, ^{15}N recovery in shoots was generally low (~18%) and independent of the ^{15}N injection depth. This clearly shows that the low N demand of *Kobresia* shoots can be easily covered by N-uptake from any depth. Less living root biomass in lower versus upper soil was compensated by a higher specific activity of roots for N-uptake. The ^{15}N allocation into roots was on average 1.7 times higher than that into shoots, which agreed well with the very high R/S ratio. Increasing root biomass is an efficient strategy of *K. pygmaea* to compete for belowground resources at depths and periods with available resources. This implies high C-costs to maintain root biomass (~6.0 kg DM m⁻²), which must be covered by a very low amount of photosynthetically active shoots (0.3 kg DM m⁻²). It also suggests that *Kobresia* grasslands react extremely sensitively toward changes in climate and management that disrupt this above-/belowground trade-off mechanism.

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Keywords

^{15}N partitioning, above-belowground trade-offs, *Kobresia pygmaea*, pasture degradation, plant strategy, root activity, root biomass