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Kobresia pygmaea pasture degradation and its response to increasing N deposition

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Kobresia pygmaea is a dominant plant species on the Tibetan Plateau covering ca. one fifth of the total area. Severe degradation by overgrazing is ongoing at K. pygmaea pastures in recent decades. Nitrogen (N) deposition is also increasingly exacerbated across the Tibetan Plateau. Up to now the response of K. pygmaea pastures with increasing degradation to N deposition is unclear. We aimed at: (1) evaluating the effect of pasture degradation on carbon (C) and N contents of soil, root, microbial biomass and leachate, (2) determining N allocation to plant, soil and microbial biomass after N addition and (3) making an estimation of N storage and loss in Kobresia pasture.
We used three Kobresia root mat types varying in their degradation stages: (1) living root mats, (2) dying root mats and (3) dead root mats. We also added two levels of 15NH415NO_3 solution to simulate N deposition (control: 2.5 kg N/ha; deposition 50.9 kg N/ha) and traced the 15N in the soil-plant system. Leaching of NH4+, NO_3- and DON were detected by homogeneously adding distilled water to each sample and collecting the leachate afterwards.
Total N content lost by leaching increased 6.5 times following the degradation from living to dead root mats. This indicated that living Kobresia effectively decreased N loss from leaching due to N uptake by plants. The microbial biomass C to N (MBC/MBN) ratio narrowed from 10.2 to 7.5 and then to 5.0 for living, dying and dead root mats, respectively. This shows the degradation K. pygmaea shift the ecosystem from a N-limited to a C-limited status for microbes. Nitrogen addition increased above-ground plant biomass (AGB) as well as its total N content in living root mat while MBC and MBN were not affected. This shows K. pygmaea is more sensitive to N addition than microorganisms. N allocation (% of total N added) by AGB, below-ground plant biomass and soil in living root mats were 22.1%, 22.7% and 17.6%, respectively. No significant effect between these parameters was identified indicating that N allocation was independent to the giving amount of N. Up to 1.86 Mg N/ha were stored in living root mat (0-5 cm). In contrast, dead and dying root mats maintained about 2.0 Mg N/ha and 2.1 Mg N/ha, respectively. N loss in leachate of living root mat regarding a precipitation of 355 mm during growing season (equal to 85% of annual precipitation) was estimated to be around 3.6 kg N/ha (3.4 kg DON and 0.2 kg NH4-N). This amount was up to 6.5 times higher in dead root mat (23.6 kg N/ha with 19.1 kg NO_3-N, 4 kg DON and 0.5 kg NH4-N). Therefore, degradation of K. pygmaea significantly increased N loss via leaching, especially NO_3-N loss. We conclude N deposition facilitates the growth of K. pygmaea, which may positively affect plant productivity as well as C sequestration. In the absence of K. pygmaea, however, N deposition will lead to high N loss.
Key words: Nitrogen allocation, Kobresia pygmaea, above-ground biomass, microbial biomass carbon and nitrogen