Effect of Grazing on Soil Carbon and Nitrogen in Alpine Madow, Eastern of Tibetan Plateau

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Introduction

As the grassland ecosystem in the Tibetan Plateau is very fragile, overgrazing likely leads to more serious damages to it than other ecosystems. In the past 30 years, 37% of the alpine meadows have been heavily damaged by grazing causing degradation of native vegetation, a decline in species richness and feed value, and more seriously soil erosion (Six *et al.* 2004). The impact of grazing on alpine grasslands appears to be hysteresis, as the soil needs more time to recover than the vegetation. So analysing the effect of grazing intensity on soil characteristics is an important way to reveal how grazing influenced grassland ecosystem. Although much research about grazing effects on nutrients, immobilization of carbon (C) and nitrogen (N) in soils and soil microbes have been done in different terrestrial environments, similar effort has rarely focused on the Tibetan Plateau. In this study, soil organic carbon (SOC) and total nitrogen (STN) in 0-30 cm soil depth were measured in the alpine meadow at the northeastern margin of the Tibetan Plateau, to determine suitable grazing intensity from the viewpoints of soil health and fertility, and providing a scientific basis for guiding the reasonable use of the alpine meadow.

Methods

Field site and soil sample collection

The experiment was conducted in Tianzhu County, Gansu Province, China. The elevation ranges from 2900 to 3100 m. There is a wet and cold climate in this region with an average annual temperature of -0.20 to 1.30°C. The grazing treatments ran from July to October every year since 2009. The treatments included: no grazing (CK), light grazing (LG, 0.8 yak/ha), medium grazing (MG, 1.0 yak/ha) and heavy grazing (HG, 1.2 yak/ha). Elevation was divided into 3 ranges and one of 3 replicates for each treatment appeared in the same range. Three quadrats were randomly chosen in each replicate. Soil was sampled at three layers (0-10, 10-20 and 20-30 cm) and the same layer from 5 cores was mixed in each quadrat, in 2011.

Chemical and biological analyses

Soil organic carbon (SOC) was determined using potassium dichromate oxidation method. Soil total nitrogen (STN) was determined using the Kjeldahl method (Vance *et al.* 1987).

Table 1. STN and SOC in 0-30 cm soil depth under different grazing intensities in the alpine meadow.

Treatment	STN content (g/kg)			SOC content (g/kg)		
	0-10 cm	10-20 cm	20-30 cm	0-10 cm	10-20 cm	20-30 cm
CK	6.87a	5.89a	5.26a	74.59a	61.92b	54.61a
LG	7.21a	6.29a	5.57a	84.30a	67.09ab	55.00a
MG	6.96a	6.21a	5.42a	86.77a	68.86a	58.94a
HG	6.01b	5.48b	5.00a	79.86a	62.85ab	71.84a

Results

Soil total nitrogen (STN) content decreased with soil depths under three grazing intensities, showing that 0-10 cm >10-20 cm>20-30 cm (Table 1). STN content in the 0-10 and 10-20 cm soil layers under HG was significantly reduced by 12.5% and 10.7%, respectively compared with those under the CK (P<0.05), while those under LG and MG showed no significant change. There were no significant differences in soil organic carbon (SOC) contents of the 0-10 and 20-30 cm layers among three grazing intensities. But SOC content was increased significantly in the 10-20 cm soil layer under MG, by 11.21% compared to that under the CK (P<0.05).

Different lowercase letters within the same column of the same soil layer indicate significant difference at P<0.05.

Discussion

There is still debate about the impact of grazing and grassland management on soil organic carbon and total nitrogen. Milchunas and Lauenroth (1993) compared the effect of grazing with non-grazing among 236 sites world-wide and found that there was no consistent impact of grazing on soil organic carbon and total nitrogen. There might be a positive correlation in some locations, but a negative correlation in others. This suggests that the relationship between grazing and SOC, STN was influenced by many factors, *e.g.* soil initial conditions, ecological conditions and so on. The results of this study showed that heavy grazing may lead to the

reduction of STN content in the surface soil, and medium grazing may increase SOC content in 10-20 cm layer.

Conclusion

The STN content in the surface (0-20 cm) soil under HG was significantly reduced by 12.5% and 10.7%, respectively compared with those under the CK at the northeast edge of the Tibetan Plateau alpine meadow. The data suggested that heavy grazing is possibly harmful to the soil.

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