Aboveground biomass and soil moisture as affected by short-term grazing exclusion in eastern alpine meadows of the Qinghai-Tibet plateau, China

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Introduction

Heavy grazing substantially influences grassland vegetation and animal nutrition on the Qinghai-Tibet plateau (Guo *et al.* 2003). Degradation is characterized by a reduction in vegetation height, reduced ground cover decrease in species diversity (Wang *et al.* 2007)

The objective of this study was to determine the effects of short-term exclusion from grazing on aboveground herbage, forage nutritive value, and soil moisture in an alpine meadow in the eastern zone of the plateau. Three farms, applying different intensity of grazing over the summer months, were compared.

Methods

Experimental site

The experiment was carried out in Maqu county, Gannan Tibetan Autonomous Prefecture, Gansu province, China (E 100°45′- 102°29′, N 33°06′- 34°30′) in the eastern region of the Qinghai-Tibet plateau. The altitude ranges from 3300 m to 4206 m. Mean precipitation is 615 mm per year and mean temperature is 1.1°C. There is no frost free period.

Experimental design

In May, 2011, three grazing exclusion cages (1.5 m ×1.5 m) were placed randomly on typical summer pasture on each of three farms in the region. General details of the three farms are shown in Table 1.

Sample collection

In the middle of July, August, September and October, all herbage under each cage was harvested and oven-dried to determine total dry weight (DW). The DW of available herbage outside of the cage was harvested at the same time. Crude protein (CP), acid detergent fibre (ADF) and neutral detergent fibre (NDF) was also assessed on all samples. Soil moisture content inside and outside the cage was also measured on each occasion.

Statistical analysis

T tests (SPSS statistics 19.0) were performed for paired samples (inside versus outside cage) for each variable at each sampling.

Results

Herbage mass

Herbage mass inside the cages was significantly greater than that outside the cages in August, September and October on the farm which applied the heaviest grazing intensity (Farm 1, Table 2). Grazing exclusion also significantly affected herbage mass at one of the farms which applied low grazing intensity (Farm 3) in August and September, but not at the other low intensity farm (Table 2).

CP content

There were significant differences in the CP content of available herbage inside versus outside grazing exclusion cages in most months at all farms. On the farm applying high grazing intensity (Farm 1), CP in herbage inside the cage exceeded CP in herbage outside the cage in late summer, whereas the reverse was true for the farm applying the lowest grazing intensity (Farm 3; Fig. 1).

ADF and NDF content

Under heavy grazing at Farm 1, the ADF of herbage inside the cages was significantly higher than outside cages in August and September but significantly lower in July and October. At Farms 2 and 3 the ADF of herbage outside cages was significantly higher than inside cages for most months.

Soil moisture content

Across the different farms, soil moisture under herbage inside cages was significantly higher than under herbage outside cages, except for Farm 2 in the layer of 30-40 cm in July.

Table 1. Grazing area, sheep numbers, and grazing intensity of three case study farms in the eastern region of the Qinghai-Tibet plateau.

Farm	Time of transfer to summer pasture	Pasture type	Area (ha)	Sheep unit (head)	Grazing intensity (head/ ha)
1	End of May	Alpine meadow	157	2294	14.61
2	End of May	Alpine meadow	213	823	3.86
3	End of May	Alpine meadow	667	1312	1.97

Table 2. Herbage mass outside (OC) and inside (IC) grazing exclusion cages during summer

Farm	Month	Herbage mass g/m^2		T value	P value
		Outside cage	Inside cage	(OC-IC)	
1	Jul	11.4±2.09a	15.2±1.44a	-1.074	0.395
	Aug	64.4±14.92b	220.0±15.65a	-11.038	0.008
	Sep	93.8±8.77b	337.5±26.15a	-13.99	0.005
	Oct	93.9±9.49b	205.8±8.23a	-6.398	0.024
2	Jul	112.7±10.61a	100.1±11.51a	1.999	0.184
	Aug	214.0±11.26a	279.7±14.34a	-2.973	0.097
	Sep	252.6±11.76a	319.8±13.60a	-3.824	0.062
	Oct	215.9±11.84a	286.5±9.50a	-3.484	0.073
3	Jul	55.0±1.39a	54.9±2.93a	0.031	0.978
	Aug	142.3±6.89b	240.9±14.39a	-4.907	0.039
	Sep	219.9±16.40b	281.4±14.90a	-30.251	0.001
	Oct	293.5±6.20a	322.5±26.00a	-1.322	0.317

Means with the same letter within months are not significantly different (P<0.05)

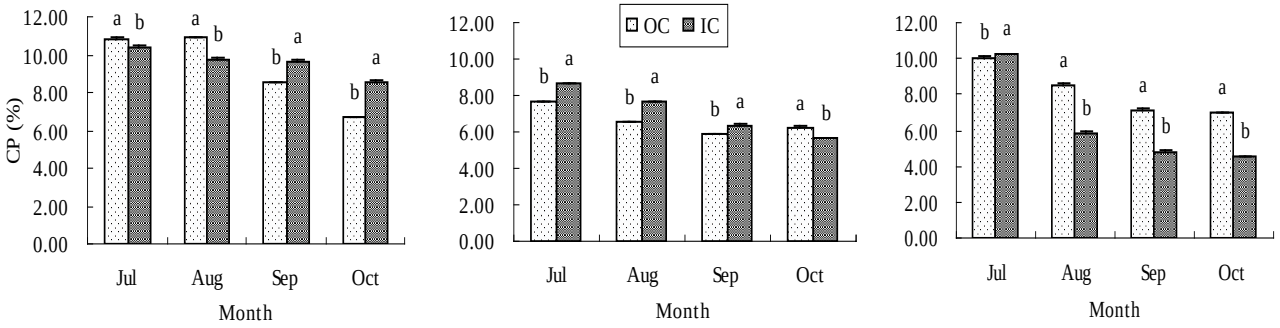

Figure 1. Crude protein (CP) percentage in the dry matter of herbage harvested from inside (IC) or outside (OC) grazing exclusion cages on three farms during summer

Conclusion

This study demonstrated that short-term exclusion from grazing could increase herbage mass, CP content in the herbage, and soil moisture when meadows of the Qinghai-Tibet plateau are grazed intensively. However, under lower grazing intensity, grazing exclusion had minimal effect on biomass, but did reduce the CP and ADF content in the forage. Thus, resting meadows from grazing in summer could improve the feed value of herbage, but it will reduce the diversity of vegetation (data not shown).

References

Guo ZG, Liang TG and Zhang ZH (2003) Classification management for grassland in Gansu Province, China. *New Zealand Journal of Agricultural Research* **46**, 123-131.

Wang, Hui , Guo, Zheng Gang , Xu, Xiang Hong , Liang, Tian Gang and Ren, Ji Zhou(2007) 'Response of vegetation and soils to desertification of alpine meadow in the upper basin of the Yellow River, China', *New Zealand Journal of Agricultural Research* **50**, 491-501