Nutrient composition and flux in a semi-arid grazing land of Southern India

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Introduction

The distribution and cycling of minerals in various compartments of the ecosystem form one of the important aspects of ecosystem study. The uptake of nutrients through the root system and their release via litter and root decomposition depends upon a number of factors including the species, growth and stage of maturity. The semi-arid grazing land ecosystem at Madurai has developed under short evolutionary grazing histories and low moisture regimes, in which grazing pressure has had dramatic effects on the plant community and biomass (Karunaichamy 1992). The biological cycle includes circulation of nutrients between soil and biotic communities by the phenomena of uptake, retention and loss (Duvigneaud and Denacyer 1970). No systematic studies are available on the nutrient cycling of semiarid grazing land of southern India. Therefore, the present study aims to study the distribution of Ca, Mg and Na in vegetation and to estimate the annual nutrient budget in grazed and ungrazed lands dominated by *Chrysopogon fulvus* (Spreng) Chiov.

Methods

The study area is located in the southern part of Tamil Nadu ($9^0$58’N; $78^0$10’E) at an altitude of 100 m above mean sea level. The ungrazed area of the study period was similar to the grazed area prior to study. Average monthly temperature ranges between 35.3^{0}C and 25.3^{0}C. The mean annual rainfall was 571 mm during the two years study. Twenty quadrants of 50 x 50 cm were sampled randomly in grazed and ungrazed area at monthly intervals. Litter was collected carefully from each plot. The root phytomass was evaluated by excavating soil samples of 25x25x30 cm. Soil samples (30 cm depth) were also taken at the same harvested plot for determination of soil nutrients. Total Ca, Mg and Na in plant components and soil were estimated using an atomic absorption spectrophotometer. The transfer of nutrients between various compartments and the release of nutrients through root and litter disappearance were calculated following balance sheet approach (Singh and Yadava 1974).

Results

Live shoot component showed higher content of Ca, Mg and Na in both grazed and ungrazed area (Table 1). Live shoot contains maximum nutrient content than other components. The trends of soil nutrient concentrations were in the following order Mg>Na> Ca in both grazed and ungrazed areas. The maximum storage of nutrients was in lives shoots and root components. The relative proportions of three elements differed considerably in different plant components.

Sodium concentration in roots showed strong correlation with air temperature in grazed area, Y=28.25+2.77X. This explains about 27% variability in the Na concentration due to mean air temperature (r=0.52, P<0.001) and no correlation was observed with rainfall. Table 2 shows the average standing states of different nutrients. The maximum storage of Ca and Na occurred in the below ground parts while the minimum nutrient storage was found in litter.

Table 1. Nutrient (%) in the vegetation components in both grazed and ungrazed area (± S.E).

Components	Calcium		Magnesium		Sodium	
	Grazed	Ungrazed	Grazed	Ungrazed	Grazed	Ungrazed
Live shoots	1.23 ± 0.65	(1.30 ± 0.71)	0.23 ± 0.13	(0.22 ± 0.01)	0.40 ± 0.06	(0.14 ± 0.01)
Dead shoot	0.50 ± 0.05	(0.73 ± 0.05)	0.16 ± 0.02	(0.16 ± 0.07)	0.30 ± 0.06	(0.14 ± 0.09)
Litter	0.38 ± 0.05	(0.49 ± 0.05)	0.10 ± 0.01	(0.12 ± 0.01)	0.11 ± 0.02	(0.10 ± 0.01)
Root	1.09 ± 0.05	(0.66 ± 0.46)	0.19 ± 0.01	(0.16 ± 0.01)	0.32 ± 0.05	(0.11 ± 0.02)

Table 2. Storage (g/m^2) of nutrients on average standing states of the nutrients in both grazed and ungrazed area (± S.E).

Components	Calcium		Magnesium		Sodium	
	Grazed	Ungrazed	Grazed	Ungrazed	Grazed	Ungrazed
Live shoot	1.82 ± 0.70	(2.19 ± 0.71)	0.42 ± 0.16	(0.40 ± 0.10)	0.46 ± 0.25	(0.27 ± 0.12)
Dead shoot	0.32 ± 0.14	(0.59 ± 0.25)	0.11 ± 0.05	(0.13 ± 0.04)	0.29 ± 0.13	(0.13 ± 0.06)
Litter	0.11 ± 0.05	(0.34 ± 0.16)	0.03 ± 0.01	(0.07 ± 0.02)	0.03 ± 0.01	(0.07 ± 0.03)
Root	1.91 ± 0.69	(2.30 ± 1.14)	0.35 ± 0.18	(0.54 ± 0.24)	0.63 ± 0.56	(0.52 ± 0.25)
Total	4.16 ± 0.43	(5.42 ± 0.46)	0.91 ± 0.08	(1.14 ± 0.11)	1.41 ± 0.12	(0.95 ± 0.09)

Table 3. Uptake, transfer and release of nutrients in a grazed and ungrazed area of semi-arid region.

Nutrients	Soil		Uptake		Release		Retention	
	Grazed	Ungrazed	Grazed	Ungrazed	Grazed	Ungrazed	Grazed	Ungrazed
Calcium	133.5	120.3	8.9	11.7	6.5	10.7	2.4	1.0
Magnesium	577.5	830.0	1.6	2.5	1.2	2.4	0.4	0.1
Sodium	75.5	82.6	2.7	2.1	2.0	1.7	0.7	0.4

Annually 8.88 g/m^2 of Ca, 1.59 g/m^2 of Mg and 2.74 g/m^2 of Na was taken by plants (Table 3). The distribution of Ca, Mg and Na in plants and soil system indicated that major portion of nutrients retained in the soil.

Less than 0.4% of Mg entered in the vegetation. More than 5% of Ca and Na were entered in the semi-arid grazing land ecosystem.

Conclusion

Cycling of mineral element in a semi-arid grazing land was regulated by both live shoot and root compartments and faster recycling through root decomposition. Grazing not only demotes the nutrient economy of the system but also slow down its circulation within the plant biomass.

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