Nutrient Dynamics and Inventory in Tropical Grassland Ecosystem in Southern India

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NUTRIENT DYNAMICS AND INVENTORY IN TROPICAL GRASSLAND ECOSYSTEM IN SOUTHERN INDIA

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Abstract

The present study was to ascertain the distribution of calcium (Ca), magnesium (Mg) and sodium (Na) in the different plant components and in the soil top 30 cm at Kalikesam in Western Ghats region of southern India. Magnesium concentration increased in the order: dead shoots > belowground > litter > aboveground live. Sodium concentration in live shoots was maximum in February (0.51%) and minimum in August (0.05%). Annually 8.94 g/m^2 Ca, 2.41g/ m^2 Mg and 2.30g/ m^2 Na was taken up by plants. The distribution of the three nutrients in plant/soil system indicated that the major portion of the nutrients in the system was retained in the soil, while small fraction of it stayed in plant components. Less than 0.4% of Mg entered the vegetation. Ca and Na entered 16% and 6% respectively.

Keywords: Nutrient dynamics, southern India, grazing land, calcium, soil

Introduction

The mineral component of an ecosystem operates in a dynamic state through a series of inputs and outputs of the essential elements. The biological cycle includes more or less cyclic circulation of nutrients between soil and biotic communities by the processes of uptake, retention and losses (Duvigneaud and Denacyer, 1970). Most studies of nutrient budgets and flux rates have been reported in forest communities and to a lesser degree in grasslands. The present study was undertaken with the following objectives: 1) to ascertain the percentage variation of calcium, magnesium and sodium in the vegetation compartments 2) to prepare the annual uptake of nutrients from soil, their transfer to various vegetation compartments and return to soil.

Material and methods

The study was conducted at Kalikesam ($8^0$17'N; $77^0$20'E) at an altitude of 276 m above mean sea level in Kanniyakumari district, southern India. The annual rainfall was 1496 mm, with the maximum rainfall in June (467 mm) and the minimum in March (12 mm). The mean maximum and minimum temperature recorded were 32.2^0C and 22.5^0C during the study period. The soils of the area are sandy clay loams, with 42.7% water holding capacity and slightly alkaline (pH 7.9). The most important species in the pasture was *Pennisetum polystachyuum* Schult and *Eupatorium odoratum* Linn. and *Desmodium gangeticum* DC.

Aboveground vegetation was harvested at monthly intervals laying quadrats of 50 cm X 50 cm in size each and litter was collected separately. In order to sample the belowground parts, three soil monoliths (25 X 25 X 30 cm) were excavated from the centre of each harvested quadrat. All plant samples collected were oven dried at 75^0C till constant weight was obtained. A portion of these dried samples was ground for the determination of Ca, Mg and Na. Soil samples were collected each month by digging to 30 cm depth. Ca, Mg and Na were determined by an atomic absorption spectrophotometer (Perkin-Elmer, 5000) following recommended guidelines for wavelength selections and linear working ranges. The dry matter production and its transfer between system compartments was calculated following balance sheet approach (Singh and Yadava, 1974). The nutrient content of dry soil was multiplied by the bulk density, and the results are expressed as g/m^2/30 cm.

Results and discussion

The percentage of average nutrient concentrations on a dry matter basis for all plant components are shown in Table 1. The four plant components contain different concentrations of Ca, Mg and Na. The aboveground live components showed maximum concentration of Mg followed by the belowground > Standing dead > litter. Ca concentration in live shoot ranged between 0.28% and 1.65%. In the belowground parts the minimum Na concentration was recorded during April and the maximum in July. The plant components often contain Ca in appreciable amounts than Mg and Na. The decline in concentrations of Mg and Na nutrients from live shoot to dead shoot stage is a common phenomenon in temperate (Bokhari and Singh, 1975) and tropical grasslands (Billore and Mall, 1985; Chaturvedi et al., 1988; Paliwal and Karunaichamy, 1999). An overall decrease in Ca concentration was noted in live shoot with increasing senescence. The decline was due to the withdrawal of nutrients from the shoot during senescence (Clark, 1977), weathering and leaching processes (Tukey, 1970). It is well known that nutrients can leach from leaves under the influence of rainfall. The potentially mobile of nutrients are in the translocation fluids in the leaf and move to the leaching solution by diffusion and mass flow (Tukey, 1970). A comparison between live shoot and belowground showed higher concentration of Na in the latter. Large number of studies reveal that nutrient concentration in belowground parts is generally less than the live shoots both in temperate (Callahan and Kucera, 1981; Ohlson and Malmer, 1990) and tropical grasslands (Chaturvedi et al., 1988; Karunaichamy and Paliwal, 1995). Except for Na, this trend is true for the present study at Kalikesam , but the magnitude of difference varies for various elements.

Annual flow rates of nutrients between soil and plant components are shown in Table 2. The total annual uptake was 8.94, 2.41 and 2.30 g/m^2 for Ca, Mg and Na respectively. Live shoot uptake accounted for Ca, Mg and Na was 87%, 85% and 78% respectively. The live shoot accumulated the major portion of Ca, Mg and Na. The greater accumulation of these nutrients in the live shoots, a result of high nutrient concentration and higher biomass, is the characteristic features of grassland (Billore and Mall, 1976; Chaturvedi et al., 1988). Annually 98% Ca, 70% Mg and 30% Na were returned through litter and belowground components in this grassland. The release of nutrients through the litter decay was much more than through belowground decomposition. On an annual basis, Ca is taken up in higher quantity followed by Mg and Na. Consequently, Na has the highest percentage retained in plant parts (69.5%) followed by Mg (30.3%) and Ca (1.6%). The values of annual uptake and transfer of nutrients in various compartments and their release through litter and belowground decomposition to soil in this grassland ecosystem are higher than temperate grassland ecosystem (Bokhari and Singh, 1975).

In conclusion, less than 0.4% of Mg was entered the vegetation. Ca and Na entered 16% and 6%, respectively. Cycling of mineral elements in tropical grasslands of Western Ghats in Kalikesam was regulated by their greater accumulation in aboveground parts and faster recycling through litter decomposition.

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Table 1 - Average percentage of nutrients (± SE) in the plant components during January 1985 to December 1985 expressed as oven dry weight basis for the tropical grassland at Kalikeasam, Western Ghats.

Components	Nutrient Concentration (%)		
	Ca	Mg	Na
Aboveground live	0.64 ± 0.12	0.17 ± 0.01	0.15 ± 0.04
Standing dead	0.79 ± 0.09	0.14 ± 0.01	0.08 ± 0.02
Litter	0.81 ± 0.11	0.14 ± 0.01	0.14 ± 0.01
Belowground	0.49 ± 0.11	0.15 ± 0.01	0.21 ± 0.04

Table 2 - Annual flow rates of nutrients (g/m^2) between soil and the plants and between plants and soil , with mean nutrient contents (g/m^2) of soil and plant components in tropical grassland ecosystem at Kalikesam in Western Ghats region of Southern India

Nutrients	In soil	Soil to shoots	Litter to soil	Soil to roots	Soil to Plants	Plants to soil
Ca	64.90	7.75	7.68	1.19	8.94	8.80
Mg	1426.20	2.04	1.34	0.37	2.41	1.68
Na	46.00	1.80	0.23	0.50	2.30	0.70