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Nutrient Accumulation in Various Plant Parts of Dominant Tree Species of Three Different Localities

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Abstract: In the present study, accumulation of nutrients (N, P, Ca, Mg, and K) in various plant parts of three different dominant trees i.e., *Acacia senegal* (As), *Acacia tortilis* (At) and *Eucalyptus camaldulensis* (Ec) was estimated. Concentration of nutrients was estimated for bole, first order branch, other branch, foliage, seeds, stump root, lateral root and fine roots. The study was carried out in the sand dunes of Western foot hill gaps of Central Aravalli located at a distance of 10 km n-w to Ajmer, a centrally situated city of Rajasthan. The concentration of nutrients was found to be maximum in foliage except for nitrogen which was estimated higher in seeds of *A. senegal* and *A. tortilis*. A different pattern was recorded for *E. camaldulensis* where N, Ca, and Mg were recorded maximum in other branch, while p and K in foliage parts. Result shows the concentration of nutrients in different tree components in the order: foliage>seeds> their branch>first order branch>bole, and in root components: fine root>lateral root>stump root. Total nutrient concentration was found to be maximum in As followed by At and Ec. It is concluded that the foliage component of various trees has maximum nutrient concentrations. There are marked variations in the concentration of different nutrients in each component.

Key words: Nutrient concentration, tree components, dominant trees, sand dunes

INTRODUCTION

Stabilization of sand dunes is initiated along with enrichment of nutrients and their cycling. The distribution of nutrients in various plant parts and also in the different life forms of the vegetation depends upon the functional balance within the system. In sand dune habitats nutrient storage particularly in the root system is important because they are required for roots or root system as a whole that enhances the sand binding capacity. Nutrient concentration in plants controls the biochemical as well as biogeochemical cycles (Jha, 2000). Many studies have been carried out into nutrient storage and cycling in forests and plantations (Lodhiyal and Lodhiyal, 1997; Pacholi, 1997). The amounts of nutrients taken up depend on the demands of the plant species also on the availability of nutrients in the soil. Nutrient accumulation and the pattern of distribution in different components of plants are affected by climate (Bazilevic and Rodin, 1966) and by the type and age of the species (Ovington, 1968). Lodhiyal *et al.* (1994) pointed out that the major macronutrients limiting the production of a forest crop are N, P and K. According to Chapin and Kedrowski (1983), nutrient availability is a major factor influencing the distribution of plant species.

The major objective of this study was to determine nutrient concentration for bole, first order branch, other branch, foliage, seeds, stump root, lateral root and fine roots of three different dominant trees i.e., *Acacia senegal, Acacia tortilis* and *Eucalyptus camaldulensis*, to compare the concentration of nutrients in the dominant tree species and to know the pattern of accumulation of nutrients in different plant components.

MATERIALS AND METHODS

The area of the study is located at a distance of 10 km n-w to Ajmer, a centrally situated city of Rajasthan lies between 26°25 and 26°29 N latitude and 74°37 and 74°42 E longitude. The area is represented by Aravalli hillocks, sand dunes, sandy plains agricultural fields and fresh water bodies. The region may be regarded as 'ecotone' between NW drier and SE humid climate. The sand dunes selected for present investigation i.e., Pushkar valley Base (dominated by *A. tortilis)*, Leela sewri (dominated by *A. sengal*) and Pachkund (dominated by *E. camaldudensis)* are situated in 48 sq km^2 area in the north-west foot hills of Nagpahar, a prominent mountain belt of central Aravallis. A major part of these sand dunes and sandy plains is stabilized (under the sand dune stabilization programmes by the Forest Department).

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Freshly fallen plant components of the selected tree species (i.e., As, At and Ec) in about 10×10 m area were collected from the sites of study from 10-20 trees of all available girth classes separately and brought to the laboratory. Samples were weighed and equal portions of samples of different sites and of same species were pooled together.

To study nutrient concentration of organic material, the plant components were air dried in shade for about one month and a known quantity (4 g) of dried plant parts (freshly fallen) of each selected tree species were taken in 3 replicates and chemical analysis was done. Nitrogen (N) was estimated using micro-kjeldahl distillation unit. A 250 g of plant material was taken and procedure as described by Misra (1968) was followed. Ash content was determined by the method described by Peach and Tracy (1956). The ash was dissolved in 10 mL of HCL and heated on water bath for 15 min. Then it was filtered in a flask through Whatman (No. 42) filter paper. The filter paper was again washed with dilute HCL and water and volume of the filtrate was made up to 250 mL. A 50 mL aliquot was taken from the ash solution and from this aliquot Ca and K contents were estimated according to the method described by Misra (1968). Filtrate from Calcium determination was used for estimation of Mg and further preceded according to the method described by Misra (1968). A 5 g plant material was washed in presence of magnesium nitrate to prevent the loss of the P in ash solution. Percentage of transmission was read at 660 nm on systronic spectrophotometer Model 106. Phosphorus concentration was estimated with the help of standard curve.

RESULTS AND DISCUSSION

The ash content was found to be highest in foliage (As-15.70, At-09.56 and Ec-06.96%) of the tree species as shown in the Table 1-3. However in Ec ash content was maximum in seeds (07.60%). Minimum ash content was found for stump root of the trees (As- 04.40, At-01.12 and Ec-01.78%). The concentration of major nutrients i.e., P, Ca, Mg and K was found to be maximum in foliage except for nitrogen which was estimated higher in seeds of as (10.20%, Table 1) and At (05.10%, Table 2). A different pattern was recorded for Ec (Table 3) where N, Ca and Mg were recorded maximum (N-02.60, Ca-00.80 and Mg-00.36%) in other branch, while p (00.33%) and K (03.80%) in foliage parts.

An analysis of different nutrients (N, P, Ca, Mg, and K) in as tree components, showed that foliage had the higher percentage of nutrients [(Total-26.65%), separately (Ash-15.70, N-6.20, P-0.32, Ca-0.68, Mg-0.35 and K-3.40%) as compared to other components except N, which was maximum in seeds (10.2%). The order of nutrients in different components of as was in the order: Ash>N>K>Ca>Mg>P. Among the tree components, lowest concentration of nutrients was observed in stump root [(Total-08.07%), separately (N-03.3, P-0.003, Ca-0.18, Mg-0.09 and K-0.10%).

Components of at trees showed higher values of ash content (47.10%) as compared to other nutrients (N-16.29, P-0.713, Ca-4.51, Mg-2.22 and K-9.63%). The order of nutrients in different components of at was in the similar order: Ash>N>K>Ca>Mg>P. The foliage of at contained higher amount of total nutrients (Ash-9.56, N-2.40, P-0.240, Ca-1.20, Mg-0.33 and K-3.71%) except N (2.40%) which was maximum in seeds (5.10%) compared to other components.

In the tree components of Ec, nutrient concentration was observed to be lowest as compared to other trees (As-114.397%>At-80.483%>Ec-68.292%). Among the tree components other branch contain higher nutrient (N-2.60, Ca-0.80 and Mg-0.36%) except P (0.174%) and K (1.80%) which was more in foliage component (P-0.330 and K-3.80%). In general the major nutrient was N, however in Ec K was found to be main nutrient (N-10.31 and K-13.36%).

It is clear from the data that overall total nutrient concentration in different components was found to be maximum in as followed by at and Ec.

The concentration of nutrients in as and at trees among different tree components increased as usual, in the order: leaves>twigs>branches>bole (wood+bark) and in the root components: fine roots>lateral roots>stump root. This pattern confirms with the earlier reports of (Rodin and Bazilevich, 1967; Singh, 1969; Lodhiyal, 1990). Tsutsmi (1971) observed that the nutrient concentration of bole and branch varies widely among individual stands even within the same species. Similar observations have been reported for different species of *Eucalyptus* studied elsewhere (Attiwill, 1979, 1980; Hingston *et al.*, 1980; Turner and Lambert, 1983). In the present study, the trend was found bit different for Ec in some of the elements. The nutrient concentration in most of the components of as and at were in the order N>K>Ca>P, similar to the results of Sharma (1993) but in Ec, K was found to be main nutrient.

It is concluded that there are marked variations in the concentrations of different nutrients in each component of the tree species. But the overall total nutrient concentration was found to be maximum in as followed by at and was minimum in Ec. However these differences are due to various reasons i.e., genetic makeup of plant parts of various tree species, affected by climate and also by the type and age of species. The leaf component of the plant is metabolically the most active and accumulates

Table1: Concentration of nutrients (%±SE) in different components of tree *Acacia senegal* (As)

Components	Ash	N	P	Ca	Mg	K	Total
Bole	5.12±0.701	04.2±0.984	0.070±0.005	0.47±0.086	0.10±0.038	0.15±0.017	10.110
First order branch	6.20±1.000	04.7±0.735	0.090±0.006`	0.58±0.600	0.19±0.035	0.37±0.029	12.130
Other branch	7.05±1.110	04.9±0.401	0.100±0.009	1.00±0.132	0.30±0.042	0.49±0.018	13.840
Foliage	15.70±1.570	06.2±1.990	0.320±0.105	0.68±0.069	0.35±0.027	3.40±1.000	26.650
Seeds	5.70±0.927	10.2±3.003	0.200±0.013	0.30±0.025	0.20±0.030	1.50±0.024	18.100
Stump root	4.40±0.502	03.3±0.582	0.003±0.001	0.18±0.006	0.09±0.007	0.10±0.006	08.070
Lateral root	5.20±0.931	03.9±0.501	0.034±0.005	0.20±0.046	0.17±0.035	0.17±0.019	09.670
Fine root	5.80±1.200	09.2±1.000	0.060±0.007	0.23±0.048	0.30±0.025	0.23±0.056	15.820
Total	55.17	46.6	0.877	3.64	1.70	6.41	114.397

Table 2: Concentration of nutrients (%±SE) in different components of tree *Acacia tortilis* (At)

Components	Ash	N	P	Ca	Mg	K	Total
Bole	4.10±0.802	1.00±0.032	0.030±0.006	0.13±0.008	0.16±0.032	0.73±0.071	06.150
First order branch	7.32±1.010	2.00±0.120	0.071±0.008	0.30±0.105	0.32±0.045	1.04±0.032	11.050
Other branch	8.50±1.200	2.30±0.382	0.073±0.005	0.90±0.100	0.34±0.041	1.82±0.042	13.930
Foliage	9.56±1.950	2.40±0.470	0.240±0.015	1.20±0.052	0.33±0.050	3.71±0.720	17.440
Seeds	8.40±0.785	5.10±1.200	0.191±0.013	0.50±0.065	0.37±0.062	2.05±0.252	16.610
Stump root	1.12±0.082	0.84±0.085	0.023±0.005	0.28±0.035	0.11±0.030	0.04±0.012	02.410
Lateral root	3.90±0.750	1.30±0.042	0.031±0.008	1.00±0.132	0.29±0.025	0.10±0.012	06.620
Fine root	4.20±0.834	1.35±0.051	0.054±0.007	1.20±0.130	0.30±0.028	0.16±0.013	07.260
Total	47.10	16.29	0.713	4.51	2.22	9.63	80.483

Table 3: Concentration of nutrients (%±SE) in different components of tree *Eucalyptus camaldulensis* (Ec)

Components	Ash	N	P	Ca	Mg	K	Total
Bole	4.00±0.871	0.98±0.030	0.007±0.001	0.10±0.005	0.07±0.005	0.78±0.060	05.930
First order branch	5.80±0.825	1.70±0.150	0.030±0.005	0.32±0.024	0.18±0.035	1.03±0.031	09.060
Other branch	6.20±0.710	2.60±0.204	0.174±0.013	0.80±0.120	0.36±0.042	1.80±0.027	11.930
Foliage	6.96±1.000	1.50±0.120	0.330±0.100	0.50±0.035	0.28±0.061	3.80±0.100	13.370
Seeds	7.60±1.100	1.21±0.245	0.201±0.012	0.40±0.074	0.31±0.025	2.81±0.270	12.530
Stump root	1.78±0.120	0.02±0.007	0.010±0.002	0.08±0.002	0.03±0.007	1.30±0.012	03.320
Lateral root	3.00±0.950	0.80±0.052	0.022±0.003	0.30±0.071	0.10±0.020	1.04±0.075	05.240
Fine root	3.99±0.250	1.50±0.015	0.021±0.005	0.39±0.035	0.21±0.022	0.80±0.024	06.910
Total	39.33	10.31	0.795	2.89	1.53	13.36	68.292

maximum amount of nutrients therefore it seems that input back to the soil nutrient pool will be maximum by the leaf litter of as in these sand dunes.

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