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RESEARCH ARTICLE

Nutrient dynamics of *Miliusa tomentosa* in a dry tropical teak forest of Rajasthan

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SUMMARY: A study was conducted in a dry tropical forest at Udaipur, Rajasthan, India during 2008 to study the nutrient concentration in *Miliusa tomentosa* (the second dominant tree species in the teak forest), litter and soil. Observations were recorded to determine the nutrient content *i.e.,* nitrogen, phosphorus, potassium, calcium, magnesium, sulphur, chloride and sodium in the different parts such as lateral roots, tap root, bark, cork, bole, branches, leaves, flowers/fruits/seeds and litter, and to explore nutrient content *i.e.,* nitrogen, phosphorus, potassium, calcium, magnesium, sulphur, chloride, sodium and organic carbon in soils at different depths like 0.00-10.00 cm,10.00-20.00 cm and 20.00-30.00 cm in the same LSE. It was found that the highest amount of the nutrients was present in the foliage and poorer concentration of the nutrients was recorded in the lateral roots. The concentration of the nutrients in the tree components was in the order: reproductive parts > leaf > branch > bole wood > cork > bark in the above ground parts and main root > lateral root in the below ground parts. Greatest amounts of the nutrients were recorded in the 0-10.00 cm depth layer while as the lesser or poorer amounts were recorded in the lower layer. The upper layer of soil was found to contain more number of nutrients because of the high organic content present in the upper layer. The leaf component of the plant was found to be the most metabolically active part and it accumulated the high amount of the nutrient. It was observed that the concentration of the nutrients in the soil decreased while as the concentration of the nutrients in the trees increased indicating the accumulation of the nutrients by the plant. There was the reduction in the nutrient concentration of the litter leaves as well as branch litter indicating the transfer of the nutrients from the litter to the soil.

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The functioning of the ecosystems, particularly with regard to primary production, is generally influenced by the availability of nutrients, and this in turn depends on their distribution and rates of cycling at the ecosystem level. Trees take up large quantity of nutrients from the soil system and, although much of the nutrient uptake is returned to the soil through litter fall, large amount of nutrient are also removed when trees are harvested. If the nutrients are not available to the tree species to an optimum in a forest, the forest is liable to get disturbed. The present investigation was an initial attempt to study the nutrient dynamics of *Miliusa tomentosa* in dry tropical forest of Rajasthan as the nutrient dynamics in dry tropical forests of India have not been extensively studied compared to the other forest types.

EXPERIMENTAL METHODOLOGY

The site was located between 24.580^{0}N Latitude and 73.680^{0}E Longitude in Udaipur of Rajasthan. It has an average elevation of 598 meters (1961 feet). The climate of Udaipur is tropical with the mercury staying between a maximum of 42.3^{0}C and a minimum of 28.8^0 C during summers. Winters are a little cold with the maximum temperature rising to 28.8^0 C and the minimum dipping to 2.5^{0}C. The annual total rainfall received at Udaipur is 61 cm. The forest type is dry tropical forest and the area is totally hilly with

undulating terrain.

The composite plant sample was collected from different parts of plants like leaves, twigs, flowers, fruits, seeds, bole (cork and bark) for 10-15 trees. The samples for the components of roots (main root and lateral root) were collected by digging out roots to 0.5m depth. The samples were taken for two months (January 2008 and March 2008).Composite samples of each component of the selected tree species were oven dried at 30^0C to constant weight and were ground to a fine powder and then taken for the nutrient analysis. The total storage of nutrients in the selected tree species was computed by multiplying the dry weight of the components by their mean nutrient concentration. The values of storage of nutrients in different components were summed up to obtain total storage of nutrients in the selected tree species. After grinding of the plant samples, they were transferred to the polythene bags, were labeled and packed and were stored in the moisture free environment. The samples were stored away from the chemicals, chemical solutions and fertilizers. Composite soil samples were collected at different depths *viz.,* (0 to 10.00cm, 10.00 to 20.00 cm and 20.00-30.00cm). Soil samples were collected from the three different positions and were mixed together to form the final sample. The amount of the nutrients estimated for different strata were summed to obtain total nutrient content down to 30.00 cm depth.

Litter samples were collected from the randomly selected plots of 1m x 1m area and leaf litter and twig litter were collected separately and were weighed separately on site. After that the samples were dried at 30^0C to constant weight, and were ground and passed through the 2mm mesh screen and were taken for nutrient analysis.

For the calculations of the biomass the selected tree species, the average GBH was selected and was harvested. After the harvesting the leaves, branches, twigs, etc. were collected and were weighed separately. The bark, cork and wood were separated from each other using various tools and these were also weighed separately. The main root and the lateral roots were collected by digging to the 1.5m depth or more so that the full root was exposed and was taken out and then weighed. The main root and the lateral roots were weighed separately.

The amount of nutrients(N,P,K and Na) in the soil was determined by the micro-Kjeldhal technique for N(Peach and Tracy, 1956),flame photometry for K and Na, Pwas determined by Phospho-molybdic blue colorimetric method (Jackson, 1958). Organic carbon, Ca, Mg, Cl and S were determined following Narwal *et al.* (2007).The amount of nutrients in the each stratum of soil was estimated from bulk density, soil volume and nutrient concentration values. The volume of soil per hectare for a soil stratum multiplied by the bulk density gave the weight of soil, which in turn multiplied by corresponding nutrient concentration yielded the nutrient content in that particular stratum. The amount of nutrients estimated for different layers were summed up to obtain total nutrient content down to 30.00 cm depth. The standing state of the nutrients in trees was computed by multiplying the dry weight of each component by respective nutrient concentrations.

EXPERIMENTAL FINDINGS AND DISCUSSION

The concentration (%) and content (kg/ha) of various nutrients are recorded in Table 1and 2. The highest concentration of the nitrogen contents was recorded in the leaves (1.416%) while as the less amounts were recorded in the lateral root. The percentage nitrogen content varied between 0.257 per cent – 1.416 per cent. Leaves contained the high amount of nitrogen in terms of kg/ha. The phosphorous content varied between 0.035 per cent - 0.109 per cent. The poorer concentration of the phosphorus was recorded in the main root (0.035%) followed by the bole wood (0.037%). The overall range of phosphorus was between 16.3 kg/ha – 258.7 kg / ha. The percentage of the total phosphorus content was not much more different from January, 2008 to the March 2008. The highest amounts of the potassium was recorded in the leaves (1.8%), because leaves are regarded as the most metabolically active part of the plant, while as the lesser amounts of potassium was recorded in the lateral root 0.72 per cent. The potassium ranged between 266.5 kg / ha in lateral root to 4271.4 kg /ha in leaves. Greater amounts of the calcium was recorded in the bark (3.84%) followed by the leaves (2.48%).Content wise, the most calcium amount resided in the branches (6763.4 kg / ha) because of the higher biomass contributed by them. The percentage magnesium content ranged between 0.2940 per cent in leaves to 0.588 per cent in bark, indicating that the higher amount of the magnesium was recorded in the bark, while as the lesser amounts was recorded in cork (0.147%). In terms of kg/ha, the magnesium content varied between 93.6 kg/ha in cork to 955.9 skg/ha in the bole wood. The sulphur content was more or less same in both the months and it ranged from 0.08 per cent in lateral root to 5.48 per cent in the branches. In terms of the kg/ha, it ranged from 29.6 kg / ha (lateral root) to 14758.4kg/ha in branches. The percentage chloride content varied between 0.227 per cent in bark to 0.588 per cent in leaves and in terms of kg/ha, it ranged between 97.6 kg/ha in bark to 2111 kg / ha in leaves. Overall it was found that the concentration of the nutrients increased in the various components of the *Miliusa tomentosa* while as in leaves the nutrient content decreased. Same observations were reported by Bargali *et al.* (1992) for Eucalyptus plantation, Perala and Rolfe (1982) for populus, pine and picea stands. In each part of the plant, the concentration of the various nutrients varied from one part of plant to another.

By analysing the soil samples from the three different

Table 1 : Concentration(%) of various nutrients in different parts of *Miliusa tomentosa* in dry tropical forest of Rajasthan

Component	N		P		K		Na		Ca		Mg		S		Cl	
	January 2008	March 2008	January 2008	March 2008	January 2008	March 2008	January 2008	March 2008	January 2008	March 2008	January 2008	March 2008	January 2008	March 2008	January 2008	March 2008
Leaves	1.416	1.394	0.109	0.102	1.8	1.7	0.24	0.21	2.48	2.32	0.294	0.196	5.19	5.103	0.568	0.511
Branches	1.226	1.187	0.063	0.062	1.15	1.17	0.22	0.23	2.16	2.48	0.343	0.343	5.5	5.46	0.752	0.781
Bark	0.604	0.621	0.053	0.054	0.81	0.83	0.16	0.18	3.84	3.92	0.588	0.637	4.91	4.98	0.227	0.227
Cork	0.817	0.834	0.067	0.069	0.92	0.94	0.18	0.19	3.6	3.76	0.147	0.160	4.65	4.69	0.653	0.681
Bole wood	0.996	1.013	0.037	0.038	0.94	0.97	0.2	0.22	2.8	3.12	0.245	0.343	3.06	3.09	0.284	0.312
Main root	0.296	0.308	0.035	0.036	0.81	0.83	0.19	0.2	1.44	1.68	0.441	0.49	3.35	3.406	0.568	0.596
Lateral root	0.257	0.274	0.044	0.045	0.72	0.75	0.12	0.13	2.08	2.24	0.392	0.441	0.08	0.102	0.582	0.61
Total	5.612	5.633	0.408	0.406	7.15	7.19	1.31	1.36	18.4	19.52	2.45	2.61	26.74	26.83	3.634	3.718

Table 2 : Content (kg/ha) of various nutrient in different parts of *Miliusa tomentosa* in dry tropical forest of Rajasthan

Component	N		P		K		Na		Ca		Mg		S		Cl	
	Jan 2008	March 2008	Jan 2008	March 2008	Jan 2008	March 2008	Jan 2008	March 2008	Jan 2008	March 2008	Jan 2008	March 2008	Jan 2008	March 2008	Jan 2008	March 2008
Leaves	3360.2	3342.4	258.7	244.5	4271.4	4074.9	569.5	503.4	5885	5561	697.7	469.8	12315.9	12231.9	1347.8	1224.9
Branches	3280.8	3213.9	168.6	167.6	3077.4	3162.5	588.7	621.7	5780.2	6763.4	917.9	927.1	14711.8	14758.4	2012.4	2111
Bark	259.7	281.6	22.8	24.5	348.2	376	68.8	81.5	1650.8	1775.8	252.8	288.6	2110.8	2255.9	97.6	102.8
Cork	520.1	550.5	42.7	45.5	585.7	620	114.6	125.3	2291.8	2480.5	93.6	161.6	2960.2	3094	415.7	449.3
Bole wood	2760.9	2824.9	102.6	105.9	2605.7	2703.4	554.4	613.1	7761	8695.4	679.1	955.9	8482.3	8611.8	787.2	869.5
Main root	222.9	236.5	26.4	27.6	609.9	637.4	143	153.6	1084.2	1290.2	332.1	376.3	2522.6	2615.8	427.7	457.7
Lateral root	95.1	105.5	16.0	17.3	266.5	288.9	44.4	50.2	770	862.8	145.1	169.9	29.6	39.3	215.5	235
Total	10499.7	10555.3	638.1	632.9	11764.8	11863.1	2083.5	2148.8	25223	27429.1	3118.3	3349.2	43139.4	43607.1	5304	5450.2

depths *viz.,* 0-10.00 cm, 10.00-20.00 cm and 20.00-30.00 cm from the study area, teak forest, it was observed that the soil nutrient concentration decreased with an increase in the depth of the soil. The decreasing order of the amount of the nutrients present at the three different depths is shown below :

0-10.00 cm depth > 10.00-20.00 cm depth > 20.00-30.00 cm depth

The percentage nitrogen content varied from 0.084 per cent – 0.1232 per cent. Higher amounts of nitrogen recorded in the 0-10.00 cm depth layer. Poorer amounts of the phosphorus were recorded from the 20.00-30.00 cm. The phosphorus content ranged from 0.001per cent - 0.0024 per cent. The phosphorus content increased from one month to another month. The calcium content in term of the kg/ha ranged between 6570.1 kg/ha – 11946.7 kg /ha. Poorer amounts of the calcium were recorded for the March 2008 as compared to January 2008. The highest amount of the potassium was recorded by 0-10.00 cm depth layer and was equal to 0.12 per cent. The potassium content also became poorer from one month to another month. The percentage of total sodium content varied greatly from one month to another month and it ranged between 0.17 per cent – 0.23 per cent. Greater amounts of the magnesium were recorded for the 0-10.00 cm depth and the percentage magnesium depth and the percentage magnesium ranged between 0.98 per cent – 1.176 per cent. Sulphur content varied from 276.3 kg/ha – 657.1 kg/ha and the reduced amounts of the sulphur were recorded for the month of March 2008. The chloride content varied between 0.142 per cent - 0.17 per cent. The lower concentration of the chloride was recorded in the month of March 2008 indicating the uptake of the chloride by the plants. The organic carbon of the soil also decreased from one month to another month. Greater amounts of the organic carbon was recorded for 0-10.00 cm depth layer while the poorer amount was recorded for 20.00-30.00 cm layer.

In the present study, greater proportion of nutrients occurred in surface soil (Table 3) reflecting the massive inputs of nutrients to the soil through litter fall. Soil nutrient concentration decreased with lower down the depth. This pattern of nutrient distribution is in agreement with the reports of Lodhiyal and Lodhiyal (1997).

Table 4 summaries the total quantity of the various nutrients present in the leaf litter as well as the branch litter. It was observed that the higher amount of the nutrients was present in leaf litter as compared to the branch litter. The high amount of magnesium was present in the branch litter as well as leaf litter followed by the chloride and nitrogen. As expected, the leaf litter and also the branch litter was poorer in nutrient concentration than the healthy green plant, but at the same time it was also observed that the nutrient concentration in the litter decreased from Jan., 2008 to March 2008 due to the transfer of the various nutrients to the soil by the process of decomposition and leaching. Table 4 also summarizes the conc. of N, P, K, Na, Ca, Mg, S and Cl in the leaf litter and twig litter. The percentage of the nitrogen varied from 0.14 per cent – 0.1456 per cent. Greater amount of the potassium was recorded in the litter leaves (0.52%-0.54%), while as the poorer amount was recorded for the litter twigs. The highest amount of phosphorus content was recorded for branches (0.039%), while as the poorer or the lesser amount of phosphorus was recorded for leaves (0.035%). In terms of percentage the sodium varied between 0.12 per cent (branch) – 0.19 per cent (leaves) and in terms of kg/ha it ranged between 414 kg/ha-858.8 kg/ha. The calcium, magnesium and sulphur contents showed the same trend with higher concentration of nutrients in the branches than the twig. In contrast to it the higher value of the chloride in the leaf litter was recorded. The overall range of chloride in litter was recorded to be equal to 0.172 per cent -0.553 per cent.

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