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CHANGES IN FOLIAR NUTRIENT STATUS OF RUBBER (*HEVEA BRASILIENSIS*) AND SOIL AVAILABLE NUTRIENTS DUE TO APPLICATION OF FERTILIZERS UNDER TRIPURA CONDITIONS

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ABSTRACT

Soil analytical data of ten years from a long term field experiment conducted at RRII, Regional Research Station, Agartala were analysed to monitor the changes in available nutrient status due to application of fertilizers. Higher levels of P application as rock phosphate resulted in significant increase of available soil P (Bray II) at P1 and P2 (30 kg and 60 kg P_2O_5/ha respectively). The concentration of available P also increased over the years indicating a buildup in the soil. The magnitude of change in available K with varying levels of fertilizer K was less compared to P though the trend was similar. Mobility of K was noticed down the soil profile. The status of Ca was concomittant with the level of rock phosphate applied. Study indicated that higher levels of nutrient application and the cnsequent high soil available nutrient status resulted in higher leaf nutrient levels.

INTRODUCTION

The cultivation of rubber was introduced in Tripura in the early 60's. To meet the need for expansion of area under rubber in the country, large areas are to be brought into cultivation in this non traditional rubber growing state, with immense potential. Most of the areas available are degraded forests, a good portion once subjected to shifting cultivation thus not adequate in nutrient contents to support successful crop production (Krishna Kumar and Potty 1989). Though studies have been carried out on the physical and chemical properties of soils under *Hevea* vis vis other ecosystems, a specific study of the soil with reference to the dynamics of nutrients is not available. It was therefore felt worthwhile evaluating the results of a long term fertilizer experiment on rubber in Tripura with a view to monitoring the changes of nutrients in the soil with respect to fertilizer application.

MATERIALS AND METHODS

Soil and leaf analytical data from a nutritional trial planted in 1980 with clone RRIM 600 was taken for assessing the changes in nutrient levels in soil and leaf due to fertilizer application. The experiment was laid out in 1980 at the RRII, Regional Research Station, Agartala at 23° 53' N and 91° 15' E longitude at an altitude of 16.6 M above MSL.

Soil Samples were collected from the patches where fertilization was given periodically. The shade leaves from the lower whorls were collected for leaf analysis. Organic carbon was determined by Walkley and Black's methods as described by Jackson (1973). Available P using Bray II and available potassium using Morgans (1941) reagent were estimated. Calcium and magnesium was estimated using titrimetric method as described by Jackson (1973). The data was analysed for statistical interpretation.

RESULTS AND DISCUSSION

Date on soil organic carbon and available nutrient status are summarized in Table I.

The changes in organic carbon content

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does not show a definite trend over the years. Organic carbon content is lower in the subsurface layer. The enrichment of organic carbon in the surface layer of rubber growing soil has been attributed to an appreciable amount of litter fall, residual effect of cover crop (Krishna Kumar *et al.*, 1991). Compared to other plantation forestry species the sub- surface enrichment of organic carbon (Table I) in the soils under rubber is appreciable and this is due to translocation of humic substances due to comparatively high precipitations.

The mean available phosphorus status in the soil showed a buildup over the years. The data presented are from the 5th year of planting and the trend shows a gradual increase up to the 8th year of planting and then a decline (Table I). The plantation entered the yielding phase in 1989 and subsequently a maginal reduction in the available phosphorus status is manifested.

TableI. Annual change in available nutrient status of soil (mg/100 gm soil)

		1985	1986	1988	1989	1990	1991
Organic	A	0.88	0.86	0.86	0.75	0.74	0.95
carbon (%)	B	0.68	0.67	0.70	0.68	0.60	0.62
Phosphorus	A	0.54	0.60	0.68	0.49	0.26	0.33
	B	0.29	0.32	0.38	0.35	0.13	0.31
Potassium	A	4.76	4.54	3.50	4.01	3.33	4.57
	B	4.52	3.34	2.98	3.21	3.04	4.10
Calcium	A	6.13	10.53	11.80	11.51	11.22	21.76
(In P Plot)	B	5.07	6.53	9.27	9.59	9.04	16.78
Magnesium	A	3.28	3.24	4.07	3.90	6.10	7.51
(In P Plot)	B	2.82	2.97	3.79	3.10	4.25	6.52

A - 0 - 30 cm B - 30 - 60 cm

TableII. Changes in mean soil nutrient values from 1985 to 1991 with varying nutrient dosages (mg/100 gm soil)

		Levels			CD	Percentage increment		
		0	1	2	(P=0.05)	0 to 1	0 to 2	1 to 2
Phosphorus	A	0.21	0.49	0.79	0.21	133.33	276.19	61.22
	B	0.20	0.26	0.41	0.12	30.00	105.00	57.00
Potassium	A	2.77	3.88	4.92	1.87	40.07	77.62	26.80
	B	2.51	3.37	4.22	0.46	34.26	68.13	25.22
Calcium	A	9.98	13.23	15.22	NS	32.57	52.41	15.04
(In P plot)	B	8.03	9.05	10.37	1.15	12.70	29.14	14.58
Magnesium	A	4.93	4.70	4.89	NS	6.09	10.38	4.04
	B	4.14	4.02	4.13	NS	2.89	0.24	2.73

A - 0 to 30 cm B - 30 to 60 cm NS - Not significant 0 level indicates no nutrient
1st level - 30 kg/ha for N & P and 20 kg/ha for K
2nd level - 60 kg/ha for N & P and 40 kg/ha for K

The distribution of potassium (Table I) also showed an increase during the initial years up to 1989 i.e. the year of opening of the tree and there was a subsequent reduction in the K content over the years from 1989 onwards.

The Ca distribution showed a steady increase over the years (Table I). The enrichment of Ca in the soil can be attributed to recycling of the organic matter in the soil through litter fall and addition through cover crop. The increase in Ca observed has been due to the enrichment consequent on the application of phosphatic rock which contained 45% $CaCO_3$.

Though the changes in Mg content did not show any definite trend there was an increase in general over the years. However, the Mg present is much higher than the critical level fixed for soils under rubber. The soil inherently is rich in Mg in this region from the point of nutrition of *Hevea* and there is substantial input of Mg through rock phosphate which contains about 6% $MgCO_3$.

The nutrient status of the soil has been observed to be influenced significantly by the addition of fertilizers (Table II). In case of P increase observed over the years was significant (Table II). The increase obeserved in the plots receiving first level of P (30 kg/ha.) was as high as 133% and P contents in plots receiving 2nd level was 61% and the trend was consistent. It is to be mentioned that even in the treatments receiving the highest level of the phosphatic fertilizer, the Bray II extractable P could reach only up to 0.75 mg/100 gm soil which is lower than the critical levels fixed. This calls for rescheduling of P recommendation for N.E. region.

The soil available K status also showed an increase in plots receiving first and second levels of K (Table II), the increase being in the order of 40 and 26%. Even in the second level the

Table III. Changes in available leaf nutrient overtime

	Nutrient levels			Percentage increment		
	0	1	2	0 vs 1	0 vs 2	1 vs 2
Nitrogen (%)	3.25	3.31	3.29	1.85	1.23	0.60
Phosphorus (%)	0.18	0.20	0.22	11.11	22.22	10.0
Potasium (%)	0.86	0.97	1.09	12.79	26.74	12.37
Calcium (%) (In P plots)	1.02	1.14	1.20	11.76	17.64	5.26
Magnesium (%) (In P plots)	0.43	0.38	0.42	11.63	2.33	10.52

0 - No nutrient; 1-30 kg/ha for N and P and 20 kg/ha for K; 2-60 kg/ha for N and P and 40 kg/ha for K

Table IV. Percentage increment in nutrient values receiving varying nutrient dosages (surface layer 0-30 cm)

	0 to 1	0 to 2	1 to 2
Phosphorus	133.33	276.19	61.22
Potassium	40.07	77.62	26.80
Calcium (in P plots)	32.57	52.51	15.04
Magnesium (in P plots)	6.09	10.38	4.04

0 - No Nutrient; 1 - 30 kg/ha for N and P and 20 kg/ha for K; 2 - 60 kg/ha for N and P and 40 kg/ha for K

available K status could be raised only to the medium range in the critical level.

A steady buildup of calcium is seen and this is concomitant to the level of applied P suggesting the argument that the enrichment of Ca can be attributed to the application of $CaCO_3$ through rock phosphate applied. The changes in available Ca level has been appreciable and this is a favourable sign for the nutritional and soil physico chemical point since Ca is capable of moderating the deleterious effect of Al, raising pH and favouring higher microbial activity. Changes in nutrients on the surface layers have influenced subsurface layers (Table I).

To monitor the influence of soil nutrient status the data on foliar analysis also were compiled (Table III) and it was clear that with the increase in levels of nutrient through addition of fertilizers, the foliar nutrient level also increased. The N level when increased from 0 to 30 kg/ha there was an increase of 1.85% in the leaf nutrient content and from 30 to 60 kg the increase was in the order of 1.23%. These values have significance as the critical level of N spreads over a narrow range only (3-3.5%) (Pushpadas and Ahammed 1980). The increase in P also recorded 11.11 and 22.22% respectively at the 1st and 2nd levels. However, in the case of P both the soil and leaf nutrient indicated that the level of application is not adequate since it did not reach medium level in the critical levels fixed. Leaf K also showed increase with increasing levels of K addition. In case of K also leaf nutrient status registered within the critical level only after application of K at 40 kg/ha.

Ca content in leaf was monitored comparing the Ca contained in plots receiving phosphorus (Table III). It has been noticed that there was an increase in Ca Content within the

Table V. Changes in mean soil available nutrient values from 1985 to 1990 with varying nutrient dosages (sub-surface layer : 30 -60 cm)

	Nutrient levels (mg/100 gm soil)			CD (P=0.05)
	0	1	2	
Phosphorus	0.20	0.26	0.41	0.12
Potassium	2.51	3.37	4.22	0.46
Calcium (in P plots)	8.03	9.05	10.37	1.15
Magnesium (in P plots)	4.14	4.02	4.13	NS

0 - No Nutrient NS - Not significant
1 - 30 kg/ha for N and P and 20 kg/ha for K
2 - 60 kg/ha for N and P and 40 kg/ha for K

Table IV. Percentage increment in nutrient values receiving varying nutrient dosages (Surface layer 0-30 cm)

	0 to 1	0 to 2	0 to 2
Phosphorus	30.00	105.00	57.69
Potassium	34.26	68.13	25.22
Calcium (in P plots)	12.70	29.14	14.58
Magnesium (in P plots)	-2.89	-0.24	2.73

0 - No Nutrient;
1 - 30 kg/ha for N and P and 20 kg/ha for K
2 - 60 kg/ha for N and P and 40 kg/ha for K

leaf also with increasing levels of P, the increase being 11.76% and 17.64%. The Mg content did not fit into any definite pattern.

The data prensented hitherto suggest that there is some increase in buildup of nutrient in the soil with the application of fertilizers in Tripura, the increase being appreiciable in P, K and Ca. It is also made out that the levels of application of fertilizers adopted in this experiment is not adequate to prop up the soil nutrient levels to the range prescribed as critical level. The increase of nutrients observed in the trial can be attributed not only to the application of fertilizer but also caused by recycling of nutrients through leaf litter, cover crop and understorey vegetation. The data suggests that in rubber plantation depletion of soil nutrients occur due to crop growth and removal through latex. Neverthless soil fetility is restored to a considerable extent due to litter fall and leguminous cover crop which forms part of the ecosystem.

The data pertains to the first 10 years of planting and the study need to be extended further to get an in sight into the impact of rubber plantation on the soil system with reference to the nutrient status in one economic life cycle. Studies have already been conducted comparing rubber with other plantation forestry systems and natural forests and these studies have also pointed out that rubber has no adverse effects and helps in soil physical andmoisture retention characteristics (Krishna Kumar et al 1990). The ecological desirability of the crop thus stands fortified.

TableVII. Changes leaf nutrient over time

	Nutrient levels (mg/100 gm soil)			Percentage increment		
	0	1	2	0 vs 1	0 vs 2	1 vs 2
Nitrogen	3.25	3.31	3.29	1.85	1.23	-0.60
Phosphorus	0.18	0.20	0.22	11.11	22.22	10.0
Potassium	0.86	0.97	1.09	12.79	26.74	12.37
Calcium (in P plots)	1.02	1.14	1.20	11.76	17.64	5.26
Magnesium (in P plots)	0.43	0.38	0.42	-11.63	-2.33	10.52

CD (P = 0.05) - Not significant; 0 - No nutrient
1 - 30 kg/ha for N and P & 20 kg/ha for K
2 - 60 kg/ha for N and P & 40 kg / ha for K

Table VIII. Correlation between available soil and leaf nutrients

	r	?
Soil phosphorus Vs leaf phosphorus	0.99**	0.99
Soil potassium vs leaf potassium	0.99**	0.99

** *Significant at 1% level*

REFERENCES

JACKSON, M.L. 1973. Soil chemical analysis. Prentice Hall of India (P) Ltd, New Delhi

KRISHNA KUMAR, A.K., CHANDRA GUPTA, SINHA, R.R., SETHURAJ, M.R., POTTY S.N., THOMAS EAPEN, and KRISHNA DAS 1992. Ecological impact of rubber (*Hevea brasiliensis*) plantations in North East India II. Soil properties and biomass recycling. Indian J. Nat. Rub. Res. 4(2) : 134-141.

KRISHNA KUMAR, A.K., THOMAS EAPEN, NAGESWARA RAO, POTTY, S.N. and SETHURAJ, M.R. 1990. Ecological impact of rubber (*Hevea brasiliensis*) plantations in North East India I. Influence of soil physical properties with special reference to moisture retention. Indian J. Nat. Rub. Res. 3(1) : 55-63.

KRISHNA KUMAR, A.K. and POTTY, S.N. 1989. A new fetilizer recommendation for rubber for North Eastern region. Rubber Board Bulletin 24(4) : 5-8.

MORGAN, M.F. 1941. Chemical diagnosis by the universal soil testing system. Bulletin of the Connecticut Agricultural Experiment Station 450.

PUSHPADAS, M.V. and AHAMED, M. 1980. Nutritional requirement and manurial recommendations. In Hand Book of Natural Rubber Production in India Ed P.N. Radhakrishna Pillai, Rubber Res Inst. of India, Kottayam, pp 154-184.