Indian Journal of Natural Rubber Research, **14**(1) : 71 - 74, 2001

INFLUENCE OF RUBBER CULTIVATION ON PHYSICO-CHEMICAL PROPERTIES OF SOIL : A CASE STUDY

The commercial cultivation of rubber (*Hevea brasiliensis*) in north eastern (NE) region of India began in the early part of eighties and in Assam, about 11,000 ha of land has already been planted with rubber. The NE India represents a fragile eco-system mainly due to indiscriminate felling of trees, shifting cultivation being practiced for years and high degree of soil erosion, which may cause reduction in water balance, depletion in soil microbial activity and break in nutrient recycling. In this context, rubber plantation may be in effect considered as agro-forestry, which will not only give an excellent cover to the already denuded soil but also restore soil productivity besides generating new employment avenues. Improvement in soil physical properties and build up of soil microflora has been reported from rubber plantations adopting proper agromanagement practices in NE India (Krishnakumar *et al.*, 1990; 1991). This note reports the observations on the influence of rubber cultivation on physico-chemical properties of soil in comparison to an adjacent fallow land.

The present study was undertaken at Nayekgaon in the Kokrajhar District, Assam in a rubber plantation raised since 1989. The area, which was traditionally cultivated with teak, saal and other high value timber, is situated about 75 m above msl and receives an annual rainfall of around 2000 mm. The rubber plants selected for this study were opened for tapping in 1995. No fertilizers were applied to the plants except for an occasional application of farmyard manure.

Six representative soil samples were collected from both the plantations and the nearby fallow land at depths of 0-30 cms and 30-60 cms for estimating physico-chemical properties of soil. Core samplers were used to estimate bulk density and particle density. Mean weight, diameter and aggregate stability were determined by wet sieving method (Baruah and Barthakur, 1997). Organic carbon, total as well as available NPK and exchangeable cations were determined following standard procedures (Jackson, 1973). Available micronutrients were determined by methods described by Singh *et al.* (1999). Soil samples at depths of 0-15 and 15-30 cms were also collected from both the sites in order to estimate the population density of different groups of micro-organisms.

Physical analyses of soils from the two sites are presented in Table 1. Both the soils were clay loam in texture (sand : 22.4 – 24.8%; silt : 33.2 – 35.7% and clay : 38.3 – 40.8% under rubber and sand : 25.2 – 27.5%; silt : 34.2 – 35.2% and clay : 36.8 – 40.3% under fallow land). Bulk density and particle density of the soils under rubber were found to be more or less similar to that of fallow land. This

Table 1. **Physical properties of the soils**

Description	Depth (cm)	Texture	BD (gm/cm^3)	PD (gm/cm^3)	Porosity (%)	MWD (mm)	AS (%)
Rubber	0-30	CL	1.31	2.38	44.95	1.44	66.6
	30-60	CL	1.39	2.46	43.49	1.36	57.9
Fallow	0-30	CL	1.40	2.45	42.85	1.19	58.8
	30-60	CL	1.44	2.48	41.93	1.12	56.7

BD : Bulk density; PD : Particle density; MWD : Mean weight diameter; AS : Aggregate stability; CL : Clay loam.

may be due to higher amount of undecomposed organic matter present in the soils under rubber. The values of porosity, mean weight diameter (MWD) and percentage aggregate stability were marginally higher for the soil under rubber particularly at the surface level which suggested an improved soil structure under rubber plantation. This was in conformity with the results of Krishnakumar *et al.* (1991) and Hosur and Dasog (1995).

The chemical properties of the soils are given in Table 2. No appreciable changes in soil pH were noticed in the two soil sites. Organic carbon and total nitrogen were significantly higher under rubber plantation. The C : N ratio of soils under rubber was narrower than that of fallow land. This may be due to high accumulation of litter under rubber and its subsequent mineralisation.

Total N was found higher under rubber but total P did not show such a trend (Table 3). The plantation started yielding in 1995. Since the requirement of nutrients increases during this phase, the rubber trees might have utilized the native P-source of soil in the absence of external application of P. Reduction in soil available P during yielding phase of rubber was reported by Philip *et al.* (1993). Total K was comparable in both the sites. Available N, P and K in soil were found to be significantly higher under rubber plantation. This could be due to high accumulation of litter and increased microbial activity under rubber.

The litter fall under rubber plantation was quantified as 5950 kg per ha which subsequently returned 94.0 kg N, 8.6 kg P, 23.8 kg K, 51.8 kg Ca and 11.3 kg Mg per ha annually (Singh and Mandal, unpublished). CEC, which is an indication of nutrient supplying capacity of soil, was found to improve under rubber (Table 2). Exchangeable cat-

Table 2. **Chemical properties of the soils**

Description	Depth (cm)	pH	CEC (cmol (P+)/kg)	OC (%)	N (%)	C:N	Micronutrient (ppm) Cu	Zn	Fe	Mn
Rubber	0-30	4.95	12.81	1.75	0.148	11.82	1.40	0.62	44.24	14.44
	30-60	4.78	10.78	1.21	0.101	11.98	0.52	0.24	30.54	10.43
Fallow	0-30	4.83	10.35	1.27	0.096	13.22	1.49	0.70	47.72	23.20
	30-60	4.94	10.27	0.98	0.071	13.80	0.54	0.38	35.18	9.40

Table 3. **Total, available and exchangeable nutrients**

Description	Depth (cm)	Total nutrients (kg/ha) N	P	K	Exchangeable cations (cmol(P+)/kg) K	Na	Ca	Mg
Rubber	0-30	2960 (236)	870 (20.6)	26500 (100.8)	1.96	0.96	4.50	1.12
	30-60	2018 (214)	720 (10.1)	27000 (56.0)	1.36	0.83	3.70	0.98
Fallow	0-30	2240 (192)	901 (4.92)	27000 (62.72)	1.46	1.15	3.51	1.02
	30-60	1780 (175)	690 (4.90)	26400 (49.28)	1.28	0.95	2.91	0.87
CD (P=0.05)		31.17 (7.81)	30.96 (2.40)	NS (4.77)	0.11	NS	0.21	NS

Available N, P and K are given in parentheses

Table 4. **Population of micro-organisms (No./g of soil)**

Description	Depth (cm)	Fungi (x 10^3)	Bacteria (x 10^4)	Actinomycetes (x 10^3)
Rubber	0-15	28.8	108.6	77.3
	15-30	24.7	65.1	59.8
Fallow	0-15	22.6	77.1	72.3
	15-30	14.8	51.2	46.4

ions (EC) were also higher under rubber and Na and Ca were found to be dominant among all the cations as reported also by Mongia and Bandyopadhyay (1993). Marginal decrease in DTPA extractable micronutrients was recorded in the case of soils under rubber compared to that of fallow land.

The population density of various groups of soil micro-organisms (Table 4) were found to be higher under rubber plantation which indicated an increased microbial activity. This may have a beneficial effect on availability of nutrients.

It was quite evident from this study that rubber plantations improve the physical properties of the soil in comparison to fallow lands. However, its beneficial effect on soil chemical properties was much more conspicuous in the surface soil. High accumulation of litter and recycling of considerable amount of nutrients together with increased microbial activity also suggest the sustainability of rubber plantations under sub-tropical humid climatic condition.

The help rendered by Dr. D. Mandal, Research Associate, Division of Soil Science and Agricultural Chemistry, IARI, New Delhi is thankfully acknowledged.

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