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SOIL NUTRIENT STATUS DURING THE IMMATURE PHASE OF GROWTH IN A *HEVEA* PLANTATION

Growth and development of plants is supported to a great extent by soil nutrients although the quantity of nutrients absorbed differs from one species to another. Though rubber (*Hevea brasiliensis*) is grown under good management practices, the impact its cultivation may have on the physical and chemical properties of soil has not been comprehensively examined. Rubber is a plantation crop, which is cultivated in about 18 per cent of the total agricultural land in Kerala (Chattopadhyay, 1996).

Rubber tree has 30 to 35 years of economic life span and the crop is in the second or third planting cycle in most of the traditionally cultivated areas in India. Monocropping of a species for decades results in depletion of organic matter (Doran *et al.*, 1996). The rubber plantations are mostly located in degraded forests and deforested areas. Studies by Karthikakuttyamma (1997) revealed that in rubber growing soils the organic carbon (OC) content is lower than that in soils of adjacent forests. Potassium (K) and Magnesium (Mg) contents also tended to decrease with continuous rubber cultivation. However, recent investigations showed that most of the rubber growing soils have a medium to high status of OC content (NBSS and LUP, 1999).

The major sources of nutrient addition to rubber growing soils are inorganic fertilizers and leaf litter of rubber and cover crops. Leaf litter is the major organic input. Rubber tree takes about seven years to attain tappable girth in traditional rubber growing areas. During this period the trees do not attain a dense canopy. Hence establishment of cover crops during the immature phase is recommended and practiced by most farmers in Kerala. The change in intensity of soil nutrients due to rubber cultivation is expected to be different during the immature and mature phases because, the quantity of litter differ in the two phases. About three to five tonnes of litter are reportedly added through cover crops during the initial four to five years while the annual litter addition through mature trees is of the order of about six tonnes per hectare per annum (Krishnakumar and Potty, 1992). The soil nutrient status during the immature phase of rubber cultivation has not been carefully examined. Hence this study was taken up in two fields of the Rubber Research Institute of India farm at Kottayam, where the standard of plantation management was good.

The two fields where this investigation was carried out were on gentle slopes. Establishment of cover crops (*Pueraria phaseoloides* in most parts and *Mucuna bracteata* in the periphery of the fields) were satisfactory in both the fields during the initial four to five years. These fields were under continuous cultivation of rubber since 1950s. The first cycle of rubber was completed in 1989 and the trees were felled. Two multiclonal experiments were laid out in these fields, one with 13 clones and seven replications and the other with 13 clones having five replications.

The soil samples (0 to 30 cm) from all the 91 plots of Experiment No.1 and from the 65 plots of Experiment No.2 were collected and analysed separately. Two samples from each plot were collected, pooled and subjected to chemical analysis. The first sampling was done in 1989 just before the new planting. The second sampling was done in 1997 just before the trees were subjected to regular tapping.

Nitrogen fertilizer was added at a dose of 20 kg/ha in the first year, 50 kg/ha during the next two years, 40 kg/ha during the years third and fourth and 30 kg/ha during each of the remaining four years. P was added in the same quantity as that of nitrogen while potassium fertilizer was added at the rate of 10 kg/ha in the first year and 30 kg/ha during the next seven years thereafter. Mg was added of three kg/ha in the first year, 12 kg/ha during the next two years and 7.5 kg/ha during the two years thereafter. N was added in the form of urea and ammonium phosphate sulphate, P in the form of rock phosphate, K in the form of muriate of potash and Mg in the form of magnesium sulphate.

The samples were analysed for OC, available phosphorus (Av. P), potassium (Av. K), magnesium (Av. Mg) and pH. Available Calcium (Av. Ca) content was also determined in the case of Experiment No.1. The OC estimation was done by Walkley-Black method. Av. P was estimated by colorimetry using Bray II extractant and Av. K by flame photometry using ammonium acetate as the extractant. Av. Ca and Av. Mg were estimated by Atomic Absorption Spectrophotometer (model – GBC 902) (Jackson, 1973). The results were subjected to appropriate statistical analysis.

The data on nutrient status and soil reaction are summarized for the years 1989 and 1997 in Table 1. The initial OC content of the two fields was very high. The OC content decreased by about 20 per cent bringing down the category from very high to high when the 1989 and 1997 values were compared. The continuous high OC content in rubber plantations is partly due to the good management practices like establishment of leguminous cover crops and soil conservation measures.

Exposure of the soil to sunlight causes increased organic matter decomposition which may account for the relative depletion in OC status during the initial years of rubber cultivation. Less rubber litter was incorporated in the soil during these years. Moreover, the soil disturbances in a rubber planting cycle like. pitting, terracing *etc.* is high during the initial years which may have reduced the soil organic matter content. However, as the plantation enters the mature phase, tree canopy closes lowering sunlight penetration and there by reducing the decomposition rate greatly. Also the litter addition increases substantially as the density of the canopy increases. Soil disturbance is also reduced. Hence the depletion in OC status during the initial years of rubber cultivation is substantially compensated in the comparatively long spell of the mature phase. However, the observed changes in soil OC content did not significantly affect the plant growth as the girth or girth increment of rubber plants did not show any correlation with the initial or final soil OC content.

Table 1. **Changes in soil nutrient status**

Nutrient	Experiment 1			Experiment 2		
	1989	1997	Change (%)	1989	1997	Change (%)
Organic carbon (t/ha)	36.06	28.33	-21.43*	46.14	37.20	-19.38*
Av. Phosphorus (kg/ha)	23.60	23.14	-1.90	19.75	22.83	+15.57
Av. Potassium (kg/ha)	73.47	77.68	+5.70	105.30	94.80	-9.93*
Av. Calcium (kg/ha)	141.97	260.96	+83.81*	-	257.60	-
Av. Magnesium (kg/ha)	60.12	26.43	-56.03*	31.36	38.10	+21.42*
pH	4.57	4.52	-1.10	4.35	4.48	+2.90*

*Significant at 5% level

The changes in P status were not significant over the years. In Experiment 1, the Av. P status was almost maintained, but there was some increase in Experiment 2, which was not significant. Presence of large fixed P reserves in the form of Fe or Al phosphates might have contributed to this. The substantial increase in Av. Ca content may have transformed more P to the available pool. At the same time, this observation is an indication of sufficient inorganic P addition.

In the case of K status the results were different in the two experiments. In Experiment 1, the K content increased by 5.7 per cent while in Experiment 2, it decreased by 9.9 per cent. The change in the first case was not significant while in the second case it was significant, but not substantial. In Experiment 1 the initial K status was slightly less than that in Experiment 2. In both experiments K status was low throughout the experiment period. The change in Av. Ca status was determined only in Experiment 1, where 84 per cent increase was noted. One reason for this may be the incidental input of Ca through rock phosphates as no direct Ca addition was made.

It is generally acknowledged that agricultural operations have a disturbing effect on the soil environment. Though this is inevitable, it is possible to minimize the adverse effects to a great extent by adopting suitable management practices. Plants derive most of the nutrients required for their growth and development from the soil. Hence soil nutrients get depleted unless they are regularly replenished. Rubber being a perennial crop remains in the field for long periods and hence the soil exhaustion is a continuous process. Fertilizer addition must, therefore, be supplemented with cover crop establishment and adoption of soil conservation measures.

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