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FERTILITY EVALUATION OF RUBBER GROWING SOILS OF MEGHALAYA

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Soil samples collected at two depths (0-30 and 30-60 cm) from the rubber growing areas of Meghalaya were analysed for available nutrient status. The organic carbon (OC) content ranged from 5.7 to 21.6 g kg^{-1} and the mean value was 11.7 g kg^{-1}. Highest OC content was recorded in West Garo Hills and lowest in South Garo Hills. In the entire Meghalaya state, 79.40 per cent of soil samples were recorded OC content in the medium range. The nutrient index value for organic carbon for the state as a whole was 1.99 indicating medium range of organic carbon status. Available phosphorus (P) was very low for all the districts and the lowest in South Garo Hills (1.79 kg ha^{-1}). Majority of the samples from all the districts where rubber is cultivated have shown low available and nutrient index values ranged from 1.00 to 1.02 and the fertility rating for available was low for the entire rubber growing areas of Meghalaya state. Wide variation in available potassium (K) content of the rubber growing soils of Meghalaya was observed. The available K ranged from 91.8 to 318.1 kg ha^{-1} and the mean available K was 167.8 kg ha^{-1}. Nutrient index values for available K ranged from 1.92 to 2.10. Fertility rating for available K content was found to be medium for the entire rubber growing soils of Meghalaya. The soil pH ranged from extremely acidic (3.97) to moderately acid (pH 5.41) and 64 per cent soil samples recorded pH between 4.5 to 5.0.

Keywords: Available nutrients, Organic carbon, Rubber, Soil fertility

INTRODUCTION

Rubber cultivation in the north eastern region of India was mostly confined to few public sector plantations till late 1970s. The crop, however, attracted public attention and the incentives offered by the Rubber Board contributed to the expansion of area in the small holding sector. The scheme for accelerated development of rubber plantations for the north eastern region since 1984-85 resulted in real expansion particularly in small holding sector. At present 1,01,685 hectares area is under rubber cultivation in the north eastern region of India and out of these 9,196 hectares is in the Meghalaya state (Rubber Board, 2012). About 80 per cent of total rubber growing areas in Meghalaya are in all the three districts of Garo Hills and Ribhoi district.

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The climate of the state is humid tropical with well defined wet and dry cycles (Satapathy *et al.*, 2000). Mean annual rain fall is 2400 mm. Seventy per cent of the total rainfall is received in the months of May to October. The soil moisture regime is udic in hill slopes but aquic in valleys and soil temperature regime is thermic. The Meghalaya state has been broadly divided in to two physiographic zones *i.e.* central plateau and the lower plateau region. In the upper reaches of central high lands the major erosion is by water which results in loss of top soil through surface wash and sheet erosion. Degradation is severe especially in the southern part of the high land around Cherrapunji. Most of the soils in Meghalaya is acidic with high P fixing capacity and low in available P (Prasad *et al.*, 1981). Information pertaining to the available nutrient status of the soils under rubber cultivation in the north eastern region is very little. This study has been made to assess the soil fertility ratings of the rubber growing soils of Meghalaya.

MATERIALS AND METHODS

Soil samples (n=302) from two depths (0-30 and 30-60 cm) were collected from rubber growing areas of Meghalaya. The samples were air dried, pulverized, passed through 2 mm sieve and analysed for various parameters as per the standard procedure followed after Jackson (1973). Organic carbon was determined by wet digestion method. Bray II extractant was used for pextracting the available P. Neutral normal ammonium acetate was used for K extraction. Soil pH was measured in 1:2.5 soil water suspensions. After analysing the samples, the soil test values were classified as low, medium and high for OC, available P and K based on the fertility rating followed for rubber cultivation (Table 2). The soil test data for 302 samples were grouped district wise and presented in Table 1. Nutrient indices for organic carbon, available P and K were calculated (Parker *et al.*, 1951).

Nutrient indices were interpreted as per the limits suggested by Ramamurthy and Bajaj (1969). An area with a nutrient index value of 1.67 or less is considered as low, between 1.67 and 2.33 as medium and above 2.33 as high.

RESULTS AND DISCUSSION

Available nutrient status and pH of the rubber growing soils of Meghalaya are presented in Table 1.

Table 1. **Available nutrients and soil pH of the rubber growing soils of Meghalaya**

Location	Organic carbon ($g\ kg^{-1}$)	Available nutrients ($kg\ ha^{-1}$)		pH
		Phosphorus	Potassium	
West Garo Hills	12.4 (6.8 - 21.6)*	4.03 (0.67-26.88)	191.1 (100.8-309.1)	4.83 (3.97-5.41)
East Garo Hills	11.9 (6.9 - 18.7)	6.27 (0.89-14.56)	206.3 (91.8-318.1)	5.01 (4.37-5.27)
South Garo Hills	11.5 (5.9 - 15.9)	1.79 (0.45-3.58)	122.7 (94.0-143.4)	4.94 (4.54-5.24)
Ribhoi district	11.4 (6.3-15.6)	3.58 (0.45-12.54)	172.0 (96.0-302.4)	4.97 (4.83-5.13)
Other district	11.2 (5.7-15.5)	2.69 (0.67-11.42)	146.9 (107.5-282.2)	4.96 (4.45-5.20)
Mean	11.7 (5.7-21.6)	3.58 (0.45-26.88)	167.8 (91.8-318.1)	4.94 (3.97-5.41)

*In parenthesis are the range values of the nutrients

Organic carbon status

Organic carbon content in soil ranged from 5.7 to 21.6 g kg^{-1} and the mean value (11.7g kg^{-1}) is in the medium range as per the fertility rating for rubber. Considering the entire area, OC content was highest in the soils of West Garo Hills (17.5%) followed by East Garo Hills (14.7%). In Ribhoi, about 17.4 per cent of the soil samples (79.40%) recorded low OC content (Table 4). In all other districts of the Meghalaya state, majority of the samples have shown OC content in the medium range. When the entire rubber growing areas of Meghalaya is considered, 9.47, 79.40 and 11.1 per cent samples recorded low, medium and high level of OC, respectively. Nutrient index value for organic carbon is highest (2.09) for West Garo hills and corresponding fertility rating for OC is medium for the state (Table 3). Nutrient index for soil OC content for Meghalaya state is 1.99 and it ranged from 1.88 to 2.09. In the north eastern region soil OC content was low due to jhuming preceded by burning of litter debris (Krishnakumar and Potty, 1989). Low organic carbons were also reported where jhumming cultivation was practiced prior to rubber cultivation in Tripura (Choudhury *et al.*, 2001; Datta *et al.*, 2001).

Table 2. **Soil Fertility standards followed for rubber**

Parameter	Standard		
	Low	Medium	High
Organic carbon (g kg^{-1})	< 7.5	7.5-15.0	> 15.0
Available P (kg ha^{-1})	< 20.0	20.0-50.0	> 50.0
Available K (kg ha^{-1})	< 100.0	100.0- 250.0	> 250.0
Available Mg (kg ha^{-1})	< 20.0	20.0-50.0	> 50.0

Available phosphorus status

Available P content (Table 1) was found to be very low in the rubber growing soils of the entire Meghalaya state. The values ranged from 1.79 kg ha^{-1} in South Garo Hills to 6.27 kg ha^{-1} in East Garo Hills. Considering the Meghalaya state as a whole, the mean value was found to be 3.58 kg ha^{-1} and it ranged from 0.45 to 26.88 kg ha^{-1}. Available P content was low in 99.6 per cent of the samples collected from all the districts of Meghalaya (Table 4). Nutrient index value for available P for entire state was 1.004 and it ranged from 1.00 to 1.02 for East Garo, South Garo, West Garo Hills, Ribhoi and other districts of Meghalaya. Fertility rating was low for available P for all the district of Meghalaya (Table 3). The low content of available P in the soils of the region may be due to the highly acidic nature of soils

Table 3. **Nutrient Index and Fertility rating of the rubber growing soils of Meghalaya**

Location	No. of soil samples	Nutrient index			Fertility rating		
		Organic C	P	K	Organic C	P	K
West Garo Hills	122	2.09	1.02	2.05	M	L	M
East Garo Hills	56	1.94	1.00	2.10	M	L	M
South Garo Hills	46	2.00	1.00	1.92	M	L	M
Ribhoi district	42	1.88	1.00	2.00	M	L	M
Other district	36	2.05	1.00	2.00	M	L	M
Mean		1.99	1.004	2.01			

L= Low, M = Medium

(Borthakur, 1992; Singh *et al.*, 1999; Mandal *et al.*, 2000). Almost all the soils of Meghalaya are reported to be acidic with high P fixing capacity and low in available P (Prasad *et al.*, 1981). The rate of mineralization of organic P in the soils of this region is reported to be very low because of very low soil pH (<5.0), lower base saturation (20-40%) and high exchangeable Al (2.0 to 7.0 cmol (P+) kg ha^{-1}) coupled with high rain fall (200 to 455 cm), low temperature (1 to 26 ^{0}C) and high elevation (> 1000 m above MSL) (Prasad *et al.*, 1981 and Verma and Bhatt, 2001). Soils with acidic reaction developed intense weathering and hence the calcium phosphate is transformed into iron phosphate which results in low availability of P (Lasker *et al.*, 1983). Most of the acidic soils of India have been found to be deficient in phosphorus (Raychaudhuri *et al.*, 1963).

Available potassium status

A wide variation has been observed in available K content of the rubber growing soils of Meghalaya. Its value ranged from 91.8 to 318.1 kg ha^{-1} (Table 1). The mean available K content in the rubber growing soils of Meghalaya was 167.8 kg ha^{-1}. Available K is highest in the soils of East Garo Hills (206.3 kg ha^{-1}) while it was lowest in South Garo Hills (122.7 kg ha^{-1}). Among the soil samples analysed, 7.66, 82.85 and 9.39 per cent of samples fall under low, medium and high available K status, respectively (Table 4). Nutrient index value for available K for the Meghalaya state was 2.01 and its ranged from 1.92 for South Garo Hills to 2.10 for East Garo Hills district of Meghalaya. Fertility rating for available K content was medium for the entire state of Meghalaya (Table 3). As the clay minerals of soils of this region are kaolinite and illite, the potassium fixed was not readily available to the plants, though it becomes slowly available afterwards (Ghosh and Hasan, 1976).

Soil reaction

Soil reaction is acidic for all the districts of Meghalaya (Table 1). The soil pH ranged from extremely acidic (3.97) to moderately acidic (5.41) but in majority of areas, the pH was between 4.5 to 5.0. Average pH value for the Meghalaya state was 4.94. High rainfall coupled with high temperature (at lower altitudes) and undecomposed organic matter associated with low temperature at high altitudes, and hilly topography are the factors conducive for the formation of acid soils in this region. These conditions resulted in the losses of alkali and alkaline earth metals from the exchange complex of surface soils.

Table 4. **Soil characteristics of rubber growing areas of Meghalaya (Percentage of soil samples)**

Location	No. of soil	Organic carbon			Available phosphorus			Available potassium		
	samples	L	M	H	L	M	H	L	M	H
West Garo Hills	122	8.2	74.2	17.5	97.99	2.01	0.00	8.7	77.2	14.1
East Garo Hills	56	9.10	76.3	14.7	100.0	0.00	0.00	6.1	77.9	16.0
South Garo Hills	46	7.7	84.6	7.7	100.0	0.00	0.00	7.7	92.3	0.0
Ribhoi district	42	17.4	76.9	5.6	100.0	0.00	0.00	11.3	76.9	11.8
Other districts	*36*	*5.0*	*85.0*	*10.0*	*100.0*	*0.00*	*0.00*	*5.0*	*90.0*	*5.0*
Mean		9.47	79.40	11.10	99.60	0.40	0.00	7.66	82.85	9.39

L= Low, M = Medium and H = High

CONCLUSION

Soil fertility ratings have shown that OC and available K were in the medium level in Meghalaya soils. Nutrient index for OC content and available K for the state as a whole was 1.99 and 2.01, respectively. Majority of the samples had low available P and nutrient index values ranged from 1.00 to 1.02. Fertility rating for available P was low for the entire Meghalaya state. The soil pH ranged from very strongly acidic to moderately acidic.

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