Fertility evaluation of the soils under rubber plantations in Tripura

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ABSTRACT


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Majority of rubber plantations in Tripura are raised on denuded lands. These soils were once subjected to shifting cultivation. Due to this reason, soils were highly degenerated and low in essential plant nutrient content. As a result crop productivity of these soils is less. However, rubber plants respond well to NPK fertilizer particularly where soils are poor in nutrient status. In order to apply fertilizer judiciously in these soils, fertility status of soils under rubber was studied. As a part of discriminatory fertilizer recommendation (DFR) to growers, about 3800 soil samples were collected from planters' fields during 2003-2010 at two depths viz. 0-30 cm and 30-60 cm. These soils were collected from different rubber growing locations of Tripura and were analyzed for pH, organic carbon, available phosphorus, available potassium and exchangeable calcium and magnesium to ascertain their fertility status. Analysis of data revealed that majority of the soils is acidic in reaction and pH of the soils varied from 3.86 to 5.90 with a mean value of 4.56. Organic carbon content of the soils ranged from 0.31 to 2.13 with a mean value of 0.89 percent. The soils were low (30%) to medium (65%) in organic carbon status. Available phosphorus status of soils under rubber was low. Available potassium content ranged from 1.5-60.1 with a mean value of 5.32 mg/100gms of soil. Most of the rubber growing soils were low (59 %) to medium (39%) in available potassium status. Exchangeable calcium and magnesium were in sufficiency range. Nutrient index for organic carbon, phosphorus and potassium was calculated and were found lower than 1.67 indicating poor fertility status of the soils under rubber cultivation. On the basis of nutrient index, a soil fertility map at the subdivision level for organic carbon, available phosphorus and potassium was prepared based on which fertilizer dose can be optimized for achieving better productivity of the crop and sustainability of soil.

Key words: Rubber soils, Fertility, Nutrient index, Fertility map, Tripura

Introduction

In India, rubber plantations are traditionally raised in the south-western part of India, mostly in the state of Kerala and Kanyakumari District of Tamil Nadu located between 8° and 12°N Latitude. However, due to the increased demand of natural rubber and non-availability of land in the traditional regions, rubber cultivation is extended

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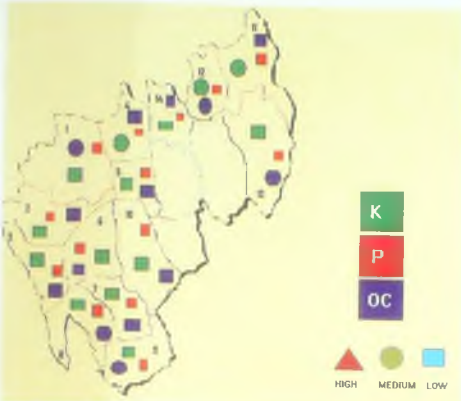

Soil fertility map of the subdivisions in Tripura

to Northeastern states of India, particularly in Tripura (20-28°N Latitude). In Tripura, initial rubber plantation was established during 1963 and large scale plantations, particularly by small holders, were established from the early part of 1980. At present, in Tripura around 59,000 ha land is under rubber plantation and rubber production was about 25,875 mt (Anon, 2013). It is estimated that another 41,000 ha of land could be brought under rubber cultivation in due course.

Most of the plantations are raised in the denuded lands (hillocks/uplands). Majority of the rubber growing soils of Tripura belong to the order Ultisol, Alfisol and Inceptisol. Parent materials are generally sedimentary in nature containing sandstone and shale whereas the traditional rubber growing soils viz. Kerala and Kanyakumari District of Tamilnadu are laterite and red soils in nature. In Tripura, texture of rubber growing soils is sandy clay loam, sandy loam and or clay loam whereas in traditional region, they belong to clay or sandyclayloam. Soils under rubber cultivation in Tripura are acidic in reaction and poor in nutrient status. These soils were once subjected to shifting cultivation which was usually

Table 1. General fertility status of soils* under rubber in Tripura

Parameter	Range	Mean	CV(%)
pH	3.86 - 5.90	4.56	6.2
OC(%)	0.31 - 2.11	0.89	35.8
Av.P (mg/100g soil)	0.01 - 5.19	0.23	116
Av.K (mg/100g soil)	1.5 - 60.1	5.32	67.8
Ex.Ca** (Cmol p+)/kg)	0.28 - 2.7	0.71	76
Ex.Mg** (Cmol(p+)/kg)	0.23 - 2.2	0.69	78.1

* n=3862, ** n = 1524 , depth =0-60 cm

preceded by burning of organic matter. As a result, organic carbon of the soils under rubber in Tripura is low. Physical condition of these soils like aggregate stability, soil aeration is inferior to soils of Kerala. Weeds like *Imperata cylindrica* (lalang / thatch grass) grow profusely in these soils which also remove a considerable amount of nutrients. Again due to high rain fall, essential cations are also leached out, thereby further reducing the soil fertility. As a result, crop yield in this location is low in comparison to traditional rubber growing belt. Therefore, regular application of fertilizer to soil is necessary for maintaining the soil fertility at a desired level to obtain optimum growth and yield of rubber (Krishnakumar and Potty, 1989 a; b).

Materials and methods

In Tripura, soil testing services in connection with rubber cultivation and fertilizer recommendation was initiated during mid-eighties and a mobile soil testing van (MST) was introduced during 1987 to cater to the need of rubber growers. The method of collecting representative soil/ leaf samples from field were demonstrated to the growers and the growers then collected soil samples from their field and brought to the laboratory for obtaining recommendations on fertilizer application. In routine soil testing for discriminatory fertilizer recommendation (DFR), representative soil samples collected from two depths viz. 0-30 cm and 30-60 cm and were tested for soil reaction (pH), organic carbon (OC), available phosphorus (P), available potassium (K) and exchangeable calcium (Ca) and magnesium (Mg). Data thus generated were compiled and were classified as low, medium and high as per the existing nutrient ratings (Table 2). During the period 2003-2010, 3862 soil samples, received from grower's field in Tripura were analyzed. They were compiled and fertility status of the rubber growing soils of Tripura was evaluated. The soil samples were further grouped district and sub-division wise to assess the fertility status. The nutrient index (NI) in respect of organic carbon (OC), available phosphorus and available potassium were calculated (Rammoorthy and Bajaj ,1969) :

NI = (L x 1 + M x 2 + H x 3) / Total No of soil samples analyzed where L , M and H are the number of soil samples falling under low , medium and higher category as per critical values fixed for a given nutrient (Table 2) . Nutrient Index value of 1.67-2.33 is rated as medium and less than 1.67 is low and greater than 2.33 are high.

Results and discussion

General fertility status of soils under rubber

Table 2. Soil fertility standards for rubber plantations

Nutrient	Low (L)	Medium (M)	High (H)
OC (%)	< 0.75	0.75 - 1.5	> 1.5
Available P (mg/100 g soil)	< 1.00	1.00 - 2.5	> 2.5
Available K (mg/100 g soil)	< 5.00	5 - 12.5	> 2.5

Table 3. General fertility rating of the soils* under rubber in Tripura

Parameter	Low	Medium	High	Nutrient index	Fertility rating
OC	1838 (47.6 %)	1831 (47.4%)	189 (4.9%)	1.57	L
P	3650 (94.5%)	170 (4.4%)	42 (1.1%)	1.06	L
K	2263 (58.6%)	1510 (39.1 %)	9 (0.3%)	1.43	L

*n=3862

up to a depth of 60 cm is presented in Table 1. Data showed that organic carbon content of the soils under rubber ranged from 0.31 to 2.13 per cent with a mean value of 0.89 per cent (Table 1). On an average, 95 per cent of the soils of this region are either low or medium in organic carbon content. Nutrient index for organic carbon is 1.57 indicating low fertility status. Choudhury *et al.*, (2001, 2004) worked out the nutrient index of soils under rubber plantation in certain locations of north-eastern states and found that NI values for organic carbon ranged from 1.34-2.38 and they were low to medium in status.

In the present study, NI values for organic carbon under rubber soils of Tripura were also low. A wide variation in available phosphorus was observed among the soils tested. The values ranged from 0.01 to 5.19 mg/100 g with a mean value of 0.23 mg/100g soil. Majority of the soils are falling under very low to low category and it was further confirmed by its lower NI value (1.06). In other Northeastern states, NI for available P ranged from 1- 1.14 indicating its poor status in these soils (Choudhury *et al.*, 2001). Available potassium content of soils under rubber in Tripura ranged from 1.5 to 60.1 mg/100 g of soil with a mean value of 5.32 mg/100g soil. About 58 per cent of the soils were low in available potassium and 39 per cent showed medium values. NI value for potassium was found low (1.43). The corresponding values for other Northeastern states varied from 1.72-2.28 (Choudhury *et al.*, 2001) suggesting medium status for available potassium.

In Tripura, majority of the soils under rubber are poor in available potassium. Soil pH ranged from 3.86 to 5.90 with a mean value of 4.56. The rubber soils of Tripura are predominantly acidic in nature. Choudhury *et al.*, (2001, 2004) also reported the similar pH values (3.94-5.97) while working with rubber soils of other Northeastern states. Distribution of rubber plantations in different districts of Tripura is presented in Table 4. The state of Tripura has four districts viz. West, South, North and Dhalai. Highest area under plantation is in West District followed by South.

Table 4. District-wise distribution of rubber area (ha) in Tripura*

District	Immature	Mature	Total (ha)
West	15,677	13,392	29,069
South	7,185	12,795	19,980
North	3,517	3,925	7,442
Dhalai	3,736	1,004	4,740
Total	30,115	31,116	61,231

* as on 31.3.13 (NRETC, Rubber Board, Agartala)

Though organic carbon status in the four districts in Tripura showed similar trend, but relatively high organic carbon content was observed under soils of West District (Table 5). However, NI values for organic carbon of the

Table 5. District - wise fertility rating of the rubber growing soils in Tripura

District	No of samples	OC(%)				Available P				Available K			
		Distribution of samples			NI	Distribution of samples			NI	Distribution of samples			NI
		L	M	H		L	M	H		L	M	H	
West	2130	984	1054	89	1.58	2055	63	12	1.04	1402	703	23	1.35
South	1248	617	559	71	1.56	1143	84	21	1.10	696	509	53	1.48
North	378	181	176	20	1.57	355	20	3	1.06	136	238	14	1.69
Dhalai	106	54	44	8	1.56	98	8	0	1.07	44	61	2	1.60

Table 6. : Subdivision - wise fertility status of the rubber growing soils in Tripura

Sub division	No of samples	OC(%)				Available P				Available K			
		Distribution of samples			NI	Distribution of samples			NI	Distribution of samples			NI
		L	M	H		L	M	H		L	M	H	
1.Sadar	460	162	281	16	1.68	45	8	4	1.03	372	78	10	1.21
2.Bishalgarh	618	250	216	23	1.42	610	6	2	1.02	451	162	5	1.27
3.Sonamura	658	266	356	36	1.65	643	13	3	1.03	440	214	4	1.34
4.Khowai	370	163	192	15	1.60	325	35	3	1.11	118	248	4	1.69
5.Teliamura	24	16	8	0	1.33	24	0	0	1.16	20	4	0	1.16
6.Udaipur	298	168	116	14	1.48	278	13	7	1.08	148	141	9	1.53
7.Santirzar	92	57	31	4	1.42	80	7	5	1.18	61	28	3	1.37
8.Belonia	360	140	20	21	1.67	311	34	4	1.12	203	147	10	1.46
9.Sabroom	170	68	90	13	1.67	157	11	2	1.08	101	65	4	1.43
10.Amarpur	328	185	123	20	1.50	306	18	4	1.08	174	126	28	1.55
11.Dnagar	242	140	88	14	1.48	230	9	3	1.06	82	154	6	1.69
12.Kailashr	86	20	62	4	1.97	79	7	0	1.08	22	60	4	1.77
13.Kanchanpr	50	22	26	2	1.73	46	4	0	1.08	26	20	4	1.56
14.Kamalpur	106	54	44	8	1.56	98	8	0	1.07	44	60	2	1.60

four districts are almost same and falling under low category (1.57). Available phosphorus values of all the districts are low. Corresponding nutrient index values are also low. The available phosphorus status of the rubber growing soils of Tripura are low because of higher P-fixation capacity due to formation of insoluble Fe and Al-phosphates at low pH. Available potassium content of the soils are low to medium status with majority of the soils under west district (65.8%) showed lower values (< 5mg/100 g soil) whereas most of the soils under north district (62.9 %) were relatively rich in available potassium and classified as medium status. This is also revealed in their higher NI value (1.69) which is falling under medium category. The State of Tripura has

seventeen sub-divisions out of which soil samples were collected from fourteen subdivisions for DFR. Fertility status of these places is presented in Table 6. On a perusal of soil fertility data it is quite evident that soils under Kailasahar subdivision of North District of Tripura are relatively rich in organic carbon values (72.1 %) and their NI values for organic carbon was 1.97 suggesting that these soils are medium in fertility status. The reason might be due to deposition of soils from the nearby hills and lower rate of decomposition of organic matter. Teliamura, Santirbazar and Bishalgarh subdivision of Tripura have lower soil organic carbon values and their NI values for organic carbon were also low. Available phosphorus status of all the subdivisions is poor.

Nutrient index values of these places are also quite low which ranged from 1.02 - 1.16. Available potassium status of three subdivisions namely Kailashar, Khowai and Dharmanagar have shown medium status whereas Teliamura, Sadar and Bishalgarh subdivision showed poor available potassium content of soils. Higher potassium values in Kailasahar and Dharmanagar could be attributed to higher content of potassium-bearing minerals present in these soils. The clay fraction of rubber growing soils of Tripura contain an appreciable amount of hydroxy - interlayer -vermiculite minerals which can fix a substantial amount of potassium in the clay matrices thereby reducing their availability to plants. Nutrient index values of these soils ranged from 1.16 - 1.77 indicating the wide variability in the availability of potassium.

In traditional rubber growing soils of Kerala, nutrient indices (NI) for organic carbon, phosphorus and potassium was reported by Karthikakutty Amma *et al.*, (1991). They found that NI for organic carbon ranged from 1.91-2.71 with a mean value of 2.29. Similarly, NI for available phosphorus and potassium ranged from 1.1 - 1.55 and 1.27 - 1.84 respectively. In general, NI values of organic carbon under rubber soils of Kerala are higher than soils of Tripura whereas NI values for phosphorus and potassium are comparable.

Available nutrient status under rubber growing soils of Tripura was evaluated. A soil fertility map at the subdivision level for organic carbon, available phosphorus and potassium is prepared. On the basis of this a subdivision wise revised general fertilizer recommendation can be formulated which will be a step forward in the direction of optimum use of fertilizers for improving the productivity and sustainability of the soil.

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