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DTPA EXTRACTABLE SOIL MICRONUTRIENTS IN THE TRADITIONAL RUBBER GROWING REGIONS IN INDIA

Essentiality of micronutrients in rubber (*Hevea brasiliensis*) and the specific deficiency symptoms were established by Bolle-Jones (1954) and Shorrocks (1964). Rubber cultivation is mainly confined to red and lateritic types of soil which are highly weathered acid soils and are reported to be low in available nutrients (Pushpadas and Karthikakuttyamma, 1980). Though micronutrients are present in different forms in soil as minerals, complexes, chelates, ions etc. only a small fraction of these nutrients are absorbed by plants (Hodgson, 1963). The absorption of micro-nutrients by plants depends on various factors such as soil pH, organic matter content, weathering conditions, texture, climate, etc. Continuous cultivation of rubber with modern high yielding clones and constant use of high analysis fertilizers, create deficiency of micro-nutrients in soil. In the traditional regions, rubber cultivation is in the second or third replanting cycle and chances of micronutrient deficiency in the soil cannot be ruled out. The present study was undertaken to evaluate the available micronutrient status in rubber growing soils in the traditional regions of India.

Soil samples were collected from 0-30 and 30-60 cm depths from different rubber estates representing the major traditional rubber growing regions of South India. Available Fe, Mn, Zn and Cu contents in the soils were determined through extraction with 5 mM DTPA extractant (0.005 M DTPA, 0.01 M $CaCl_2$, 0.1 M TEA and pH adjusted to 7.3, Lindsay and Norvell, 1978). The extract was prepared by shaking 10 of soil sample and 20 ml of DTPA extractant for two hours (soil to extractant ratio of 1: 2). The extract was filtered through a Whatman No. 1 filter paper and the micro-nutrients were estimated with an atomic absorption spectrophotometer (GBC). Organic carbon and pH (soil to water ratio 1:2.5) were also estimated (Jackson, 1958).

The data on available Fe status is presented in Table 1. The mean values for surface soil ranged from 9.5 to 51.6 mg per kg. The lowest value was recorded at Bethany (Kanyakumari district) and the highest at Pudukad (Trichur district). Similarly, in the subsurface soil, the values ranged from 7.0 mg per kg soil (Chittar, Kanyakumari district) to 48.2 mg per kg soil (Pudukad, Trichur district). In the subsurface soil, the values ranged from 7.0 mg per kg^{-1} soil (Chittar) to 48.2 mg per kg^{-1} soil (Pudukad). The surface soil had higher available Fe content as compared to the subsurface soil. According to Mohapatra *et al.* (1975), the available Fe content in the soils of Kerala, Tamil Nadu and Karnataka ranged from traces to 21.9 mg per kg soil. Acid soils are relatively higher in soluble Fe content (Lindsay and Schwab, 1982). The content of soluble Fe in soils is extremely low in comparison with the total Fe content. Soluble inorganic forms include Fe^{3+}, $Fe(OH)^{+}$, $Fe(OH)^{2+}$ and Fe^{2+} (Lindsay and Schwab, 1982).

Table 1. **Available Fe status (mg/kg soil)**

Location	Region/District	Surface (0-30 cm)		Subsurface (30-60 cm)	
		Range of values	Mean	Range of values	Mean
Keeriparai	Kanyakumari	7.7 - 18.2 (5)	11.9	3.8 - 16.4 (5)	10.5
Mylar	"	11.6 - 24.1 (5)	16.3	5.6 - 23.9 (5)	13.5
Chittar	"	15.2 - 35.0 (5)	23.2	5.8 - 9.0 (5)	7.0
Bethany	"	9.2 - 10.3 (5)	9.5	3.7 - 9.1 (5)	7.1
Kathiar	"	8.1 - 49.1 (5)	32.4	4.9 - 49.1 (5)	19.9
Kallar	"	7.0 - 34.5 (5)	19.5	3.7 - 17.1 (5)	10.1
Manalodai	"	15.2 - 23.5 (5)	18.4	9.2 - 26.8 (5)	14.1
Trivandrum	Trivandrum	9.3 - 58.0 (7)	43.5	4.8 - 49.4 (7)	19.9
Kulathupuzha	Quilon	21.0 - 60.0 (10)	36.4	19.4 - 51.9 (10)	32.6
Ayiranallur	"	13.2 - 97.5 (10)	51.6	10.4 - 50.6 (10)	24.3
Shaliacary	"	8.1 - 40.9 (10)	19.1	6.8 - 35.3 (10)	15.4
Sittar	"	11.5 - 38.8 (10)	24.9	11.0 - 32.1 (10)	20.9
Konney	Pathanamthitta	15.1 - 46.4 (5)	30.5	9.4 - 34.8 (5)	21.3
Perinad	"	4.4 - 18.9 (10)	14.9	5.9 - 16.1 (10)	12.1
Chethackal	"	11.1 - 24.7 (10)	15.6	7.3 - 14.2 (10)	9.3
Pudukad	Trichur	32.2 - 83.1 (10)	52.7	15.6 - 86.8 (10)	48.2
Calicut	Calicut	3.8 - 78.7 (25)	15.6	2.5 - 87.7 (25)	12.5
Coorg	Mangalore	12.4 - 58.1 (10)	30.0	7.0 - 13.6 (10)	9.3

Figures in parentheses are the number of samples from individual locations

The available Mn status for the surface soil ranged from 1.0 to 82.7 mg per kg soil (Table 2). The lowest Mn status was recorded from Chethackal (Pathanamthitta district) with the values ranging from 0.38 to 1.88 mg per kg soil. The highest value was recorded at Manalodai and Bethany. The values recorded in Manalodai was from 82.0 to 83.5 mg kg^{-1} soil and in Bethany it was from 82.3 to 82.9 mg per kg soil. The values for the subsurface soil ranged from 0.7 mg per kg soil (Chethackal) to 74.3 mg per kg (Keeripparai, Kanyakumari district). The surface soil registered higher values compared to the subsurface soil. In general, Kanyakumari region had high values of available Mn.

Karthikakuttyamma *et al.* (1989) reported that the exchangeable Mn content in the profile soil samples from the rubber growing soils from different agroclimatic regions ranged from 1.4 to 14.8 mg per kg soil. Divalent Mn absorbed to clay minerals and organic matter is the most important Mn form in the soil solution. In soil solution Mn is largely present as organic complexes and soil pH, organic matter content, microbial activity and soil moisture influence the Mn availability in soil (Dion and Mann, 1946).

The mean values of available Zn in the surface soil ranged from 0.15 to 6.90 mg per kg soil (Table 3). The highest value was

Table 2. **Available Mn status (mg/ kg soil)**

Location	Region/District	Surface (0-30 cm)		Subsurface (30-60 cm)	
		Range of values	Mean	Range of values	Mean
Keeriparai	Kanyakumari	80.5 - 82.5	81.5	45.5 - 82.7 (5)	74.3
Mylar	"	12.5 - 81.9	52.7	11.7 - 80.5 (5)	28.5
Chittar	"	28.6 - 81.2	54.4	5.81 - 37.7 (5)	20.9
Bethany	"	82.3 - 82.9	82.7	40.8 - 82.3 (5)	69.0
Kathiar	"	49.1 - 82.1	66.3	18.8 - 82.2 (5)	39.4
Kallar	"	33.8 - 80.1	60.7	16.0 - 83.3 (5)	36.2
Manalodai	"	82.0 - 83.5	82.7	21.3 - 82.4 (5)	62.1
Trivandrum	Trivandrum	1.5 - 16.2	6.3	0.66 - 13.2 (7)	3.2
Kulathupuzha	Quilon	1.6 - 9.3	3.7	1.5 - 6.7 (10)	4.2
Ayiranallur	"	1.96 - 20.2	9.1	1.2 - 15.8 (10)	5.0
Shaliacary	"	1.98 - 18.9	9.3	2.6 - 18.6 (10)	8.4
Sittar	"	3.5 - 29.4	11.2	3.2 - 33.4 (10)	11.0
Konney	Pathanamthitta	3.8 - 24.0	15.1	5.0 - 18.4 (5)	11.6
Perinad	"	1.8 - 15.5	5.8	1.2 - 11.4 (10)	5.0
Chethackal	"	0.38 - 1.8	1.0	0.1 - 1.2 (10)	0.7
Pudukad	Trichur	6.2 - 11.8	7.7	4.8 - 14.9 (10)	7.7
Calicut	Calicut	0.44 - 38.0	15.9	0.3 - 38.0 (25)	16.9
Coorg	Mangalore	1.8 - 38.0	13.5	1.6 - 38.0 (10)	21.4

Table 3. **Available Zn status (mg/kg soil)**

Location	Region/District	Surface (0-30 cm)		Subsurface (30-60 cm)	
		Range of values	Mean	Range of values	Mean
Keeriparai	Kanyakumari	0.30 - 0.10	0.73	0.08 - 1.40 (5)	0.65
Mylar	"	0.26 - 2.38	0.93	0.24 - 2.90 (5)	0.81
Chittar	"	0.72 - 1.34	1.00	0.26 - 0.80 (5)	0.44
Bethany	"	0.32 - 0.40	0.36	0.10 - 0.16 (5)	0.15
Kathiar	"	0.34 - 1.30	0.96	0.38 - 0.76 (5)	0.26
Kallar	"	0.44 - 2.20	1.20	0.18 - 1.30 (5)	0.74
Manalodai	"	0.64 - 1.10	0.80	0.16 - 1.20 (5)	0.59
Trivandrum	Trivandrum	0.16 - 5.04	1.10	Trace - 1.40 (7)	0.37
Kulathupuzha	Quilon	0.20 - 3.10	0.84	0.35 - 1.20 (10)	0.61
Ayiranallur	"	0.05 - 0.48	0.26	0.06 - 0.84 (10)	0.22
Shaliacary	"	Trace - 0.26	0.15	Trace - 0.52 (10)	0.16
Sittar	"	0.22 - 17.90	3.30	0.70 - 3.90 (10)	2.60
Konney	Pathanamthitta	0.32 - 16.80	6.90	0.24 - 20.00 (5)	8.30
Perinad	"	0.06 - 1.40	0.35	0.02 - 0.16 (10)	0.12
Chethackal	"	0.04 - 0.80	0.20	Trace - 0.16 (10)	0.06
Pudukad	Trichur	0.30 - 0.72	0.52	0.36 - 0.64 (10)	0.54
Calicut	Calicut	Trace - 1.50	0.48	Trace - 1.00 (25)	0.26
Coorg	Mangalore	0.44 - 1.40	0.98	0.40 - 0.94 (10)	0.61

recorded from Konney (Pathanamthitta district) where the individual samples recorded very high variation with the values ranging from 0.32 to 16.80 mg per kg soil. In the subsurface soil, the mean values varied from 0.06 to 8.30 mg per kg soil. The highest value was again recorded at Konney with individual sample values of 0.24 to 20.0 mg per kg soil. In general, the available Zn status was very low. Some locations recorded only traces of available Zn.

Zinc deficiency is common in alkaline soils and in leached acid sandy soils. Mohapatra *et al.* (1975) reported that the soils in Kerala, Tamil Nadu and Karnataka were low in available Zn with values ranging from traces to 7.7 mg per kg soil.

Available Cu status ranged from 0.34 to 7.80 mg per kg soil in the surface soil (Table 4). The lowest value of 0.34 mg per kg soil was recorded from Trivandrum and the highest value of 7.80 mg per kg soil from Konney (Pathanamthitta district). In the subsurface soil the mean values ranged from 0.19 mg per kg soil (Trivandrum) to 5.50 mg per kg soil (Pudukad, Trichur district). The values from Trivandrum ranged from 0.06 to 0.64 mg per kg soil in the surface soil and 0.06 to 0.38 mg per kg soil in the subsurface soil. In general, it was observed that the southern regions were low in Cu status compared to the other regions.

The soil samples were acidic in reaction and the organic carbon status of the

Table 4. **Available Cu status (mg/kg soil)**

Location	Region/District	Surface (0-30 cm)		Subsurface (30-60 cm)	
		Range of values	Mean	Range of values	Mean
Keeriparai	Kanyakumari	0.64 - 2.54	1.20	0.36 - 1.70 (5)	0.86
Mylar	"	0.18 - 0.58	0.42	0.16 - 0.44 (5)	0.28
Chittar	"	0.60 - 2.80	1.40	0.46 - 1.42 (5)	0.86
Bethany	"	1.08 - 3.50	2.00	0.32 - 0.58 (5)	0.46
Kathiar	"	0.34 - 0.82	0.67	0.26 - 0.76 (5)	0.45
Kallar	"	0.74 - 2.12	1.80	0.24 - 2.40 (5)	1.30
Manalodai	"	0.52 - 1.20	0.71	0.24 - 1.00 (5)	0.62
Trivandrum	Trivandrum	0.06 - 0.64	0.34	0.06 - 0.38 (7)	0.19
Kulathupuzha	Quilon	0.44 - 10.00	3.20	0.36 - 7.40 (10)	1.90
Ayiranallur	"	0.02 - 4.40	1.90	0.14 - 2.80 (10)	0.93
Shaliacary	"	0.98 - 14.00	5.20	0.44 - 3.80 (10)	1.90
Sittar	"	0.62 - 10.00	4.20	1.20 - 10.00 (10)	3.70
Konney	Pathanamthitta	3.80 - 10.00	7.80	1.00 - 6.00 (5)	3.90
Perinad	"	0.10 - 8.90	5.70	1.00 - 14.00 (10)	3.90
Chethackal	"	1.16 - 2.70	1.60	0.72 - 1.02 (10)	0.81
Pudukad	Trichur	2.50 - 8.70	4.70	2.50 - 10.00 (10)	5.50
Calicut	Calicut	0.06 - 15.00	2.90	0.30 - 15.00 (25)	4.40
Coorg	Mangalore	0.46 - 2.28	1.50	0.54 - 4.10 (10)	1.50

soils were in the medium to high range. Correlations were worked out between organic carbon *vs* the available micronutrients, and pH *vs* micronutrients. All the nutrients exhibited positive correlations with organic carbon as reported by many workers and the values were significant for available Mn (r=0.22*). According to Godo and Reisenauer (1980), Mn chelates formed from exuded citrate and melate contribute significantly to the availability of Mn in soil. The correlations between pH and available micronutrients were not significant. This might be due to the narrow range in the pH values exhibited among the samples.

Wide variations in the available micronutrient status estimated through DTPA extractant were recorded between rubber plantations from different regions. The highest variation was observed for Mn status. Similarly Zn status also exhibited wide variation ranging from traces to high. In general, most of the soils were deficient in available Zn status.

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Mercykutty Joseph
M. P. Prasad
Antony P. Antony and
K.I. Punnoose

Rubber Research Institute of India
Kottayam, Kerala - 686 009
Kerala, India.