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IMPORTANT INORGANIC PHOSPHORUS FRACTIONS IN RUBBER GROWING SOILS

Phosphorus (P) management is the most intricate problem in tropical soils as majority of them immobilise P. Phosphorus fertilizers added to these soils react with soil components and get transferred to Fe-P, Al-P and Ca-P which constitute the active inorganic P fractions. Phosphorus from these fractions is released slowly to soil solution. The availability and uptake of P thus largely depend on the amount of P fractions present in soil. It also indicates the degree of weathering undergone by soil (Mathen and Raj, 1980; Stella and Venugopal 1987). Investigations on inorganic P fractions are helpful in the fields of soil genesis, soil chemistry and fertility. As most of the rubber growing soils are confined to tropical regions and our knowledge on the P fractions of such soils is meagre, the present investigation was taken up to quantify the active inorganic P fractions.

Forty-six soil samples collected from rubber estates of Alappuzha, Idukki, Kanyakumari, Kottayam, Kollam, Kozhikode, Palakkad, Pathanamthitta, Dakshina Kannada, Thane and Ratnagiri districts were utilised for the study. From all the locations surface (0-30 cm) soils were taken and from certain locations sub soil samples were also included. When more than one sample was taken at the same depth in a location, average values were considered. The soil samples were analysed for pH (1:2.5 soil water ratio), organic carbon and total P by standard analytical procedures (Jackson, 1958). Available P was estimated by Bray II extractant (Bray and Kurtz, 1945). Fractionation of soil inorganic P was undertaken by the modified Chang and Jackson procedure (Peterson and Corey, 1966). Correlations of inorganic P with pH and available P were also calculated (Snedecor and Cochran, 1968).

Results on organic carbon, pH and available P are given in Table 1. Organic carbon was found to vary from 0.5 per cent in the soils of Sawanthawadi (Thane) to 3.15 per cent in the soils of Central Experiment Station (Pathanamthitta). The soil pH ranged from 4.6 at Lahai Estate to 6.2 at Regional Research Station, Dapchari. The highest quantity (5.25 ppm) of available P was extracted from soils of Sawanthawadi and the rubber nursery at Karikkattoor, while the lowest quantity of available P was obtained from soils of Malankara Estate. Data presented in Table 1 indicate that all the soils are low in available P.

The total P, saolid P, aluminium-P, iron-P and calcium-P recorded from the samples are presented in Table 2. Total P was found to vary from 200 ppm, in the soils of Sawanthawadi to 880 ppm in that of Kottayam. Kothandaraman and Krishnamoorthy (1979) have reported 557 ppm and 357 ppm of total P for laterite and red soils respectively of Tamil Nadu. For soils of Kerala, Stella and Venugopal (1987) have reported a total P values as high as 3627 ppm for soils at Kootala (Trissur) and 107.3 ppm for that at Thonnackal (Thiruvananthapuram). The wide variation noticeable in the quantity of total P from different regions can be attributed to the differences in parent rocks from which these soils are formed. The total P content is often used as one of the

indices of weathering (Sanchez, 1976). With increase in weathering intensity, total P was found to decrease (Mathen and Raj, 1980).

Saloid bound P was in traces in most of the soils. Maximum amount of 2.08 ppm was observed in the top soils of Lahai Estate. Trace amounts of saloid bound-P indicates that phosphorus in these soils exists in forms other than loosely bound.

Al-P values were found to vary from 4.2 ppm in the soils of Malankara to 22.8 ppm in the soils of Dapchari. The percentage of Al-P to total P was the maximum (6.78), in the surface soils of Karikkattoor and the minimum (0.84) in the surface soils of Malankara. Stella and Venugopal (1987) have reported Al-P values range from 2.1 ppm to 230.2 ppm for soils of Thiruvananthapuram and Trissur. In the present investigation, Al-P was found to be significantly correlated with available P ($r = 0.49$). This observation is in conformity with the findings of Gupta and Misra (1968) for soils

Table 1. **Organic carbon, pH and Bray II-P**

District	Location	Depth (cm)	Organic carbon (%)	pH	Bray II-P (ppm)
Kanyakumari	Maruthumpara	0–30	1.63	5.4	5.00
		30–60	0.76	5.2	2.70
	Chittar	0–30	1.79	5.9	4.36
Quilon	Kadakamon	0–30	0.60	5.5	1.28
Aleppey	Chunakara	0–30	0.78	4.9	2.95
Pathanamthitta	Lahai Estate	0–30	1.60	4.8	3.60
		30–60	1.45	4.6	2.30
	Karikkattoor	0–30	1.37	4.8	5.24
		30–60	0.67	4.9	1.85
	Chethackal	0–30	3.15	4.7	5.20
Kottayam	Panampunna Estate	0–30	1.82	4.7	2.40
Idukki	Malankara Estate	0–30	0.81	5.0	0.90
	TR & T Estate	0–30	1.56	4.9	2.50
		30–60	1.20	4.9	1.40
Kozhikode	Poonoor Estate	0–30	1.56	4.9	3.60
		30–60	1.02	5.0	1.80
Palakkad	Mannarghat Estate	0–30	1.53	5.5	5.00
		30–60	0.93	5.4	1.80
Dakshina Kannada	Sampaji Estate	0–30	2.26	4.6	3.15
		30–60	1.16	5.7	3.40
Thane	Dapchari	0–30	1.42	6.0	2.60
		30–60	0.80	6.2	3.30
Ratnagiri	Sawanthawadi	0–30	0.78	5.4	5.25
		30–60	0.50	5.0	1.95

Table 2. **Total P and inorganic P fractions (ppm)**

District	Location	Depth	Total P	Inorganic fractions				
				Saloid P	Al–P	Fe–P	Ca–P	Total
Kanyakumari	Maruthumpara	0–30	280	T	10.4 (3.71)	25.0 (8.9)	12.5 (4.5)	47.9 (17.1)
		30–60	280	1.04	8.3 (2.96)	33.4 (11.9)	12.5 (4.5)	55.2 (19.7)
	Chittar	0–30	248	1.01	14.6 (5.89)	28.0 (11.3)	10.7 (4.3)	54.4 (21.9)
Kollam	Kadakamon	0–30	540	T	14.7 (2.72)	101.1 (18.7)	16.2 (3.0)	132.0 (24.4)
Alapuzha	Chunakara	0–30	265	0.57	8.3 (3.13)	27.9 (10.6)	11.5 (4.3)	48.3 (18.2)
Pathanamthitta	Lahai Estate	0–30	580	2.08	16.7 (2.71)	83.4 (14.4)	33.4 (5.8)	135.6 (23.4)
		30–60	680	1.04	12.5 (1.84)	62.6 (9.2)	20.9 (7.7)	97.0 (14.3)
	Karikkattoor	0–30	255	T	17.3 (6.78)	31.9 (12.5)	3.2 (1.2)	52.3 (20.5)
		30–60	300	T	6.4 (2.13)	28.2 (9.4)	4.2 (1.40)	38.8 (12.9)
	Chethackal	0–30	590	T	20.8 (4.01)	62.5 (10.6)	14.4 (2.4)	97.7 (16.6)
Kottayam	Panampunna Estate	0–30	880	T	12.5 (1.42)	75.1 (8.5)	16.7 (2.0)	104.3 (11.9)
Idukki	Malankara Estate	0–30	500	T	4.2 (0.84)	75.1 (15.0)	12.5 (2.5)	91.8 (18.4)
	TR & T Estate	0–30	600	1.04	16.7 (2.78)	57.7 (9.6)	25.0 (4.2)	100.4 (16.7)
		30–60	550	T	12.5 (2.27)	46.2 (8.4)	19.2 (3.5)	77.9 (14.2)
Kozhikode	Poonoor Estate	0–30	430	T	16.7 (3.88)	53.8 (12.5)	15.4 (3.6)	85.9 (20.0)
		30–60	400	1.04	12.5 (3.13)	30.8 (7.7)	11.5 (2.9)	55.8 (14.0)
Palakkad	Mannarghat Estate	0–30	400	T	20.9 (5.23)	23.1 (5.8)	15.4 (3.9)	59.4 (14.9)
		30–60	330	T	8.3 (2.10)	19.2 (5.8)	11.5 (3.5)	39.0 (11.8)
Dakshina Kannada	Sampaji Estate	0–30	400	T	16.7 (4.18)	32.7 (8.2)	23.1 (5.8)	72.5 (18.1)
		30–60	360	1.04	8.3 (2.31)	23.9 (8.3)	31.8 (8.8)	71.0 (19.7)
Thane	Dapchari	0–30	530	T	16.3 (3.07)	74.5 (14.1)	20.0 (3.8)	110.7 (20.9)
		30–60	590	T	22.8 (3.86)	82.3 (14.0)	17.3 (2.9)	122.4 (20.7)
Ratnagiri	Sawanthawadi	0–30	255	T	6.3 (2.45)	25.0 (9.3)	2.9 (1.1)	34.1 (13.4)
		30–60	200	T	5.2 (2.60)	19.8 (9.8)	1.0 (0.5)	26.0 (13.0)

Figures in parentheses are percentage to total P. T Trace

of U.P. Tyagi and Das (1969) for submontaneous soils of U.P. and Sharma *et al.* (1979) for brown hill soils of Simla.

Fe-P values ranged from 19.2 ppm to 101.08 ppm, the minimum being observed for soils of Mannarghat and the maximum for soils of Kadakamon. The percentage of Fe-P to total P was the highest (15.02) for soils of Malankara and the lowest for soils of Mannarghat. No significant correlation was obtained between Fe-P and available P ($r = 0.21$) indicating that Fe-P is not a good index of P availability in rubber growing soils.

Ca-P content was found to be high in Sampaji Estate, and low in Sawanthawadi, the values being 31.75 ppm and 0.95 ppm, respectively. The percentage of Ca-P to total P was the maximum (8.82) for soils of Sampaji and the lowest (0.48) for soils of Sawanthawadi. Ca-P was also not significantly correlated with available P ($r = 0.15$).

A perusal of the data (Table 2) indicates that the total active inorganic fractions studied constituted below 25 per cent of the total P in most cases. The remaining quantities of P might be organic and occluded forms inside iron and aluminium oxide coatings. Organic P in soil may vary from 20 to 85 per cent. Of the three active forms, Fe-P is found to be the predominant fraction in all the soils studied. Gupta and Singh (1972) have observed higher amount of Fe-P for red soils of Mirzapur district, U.P., Kothandaraman and Krishnamoorthy (1979) for red and laterite soils of Tamil Nadu and Stella and Venugopal (1987) for soils of Kerala. As weathering intensifies, Ca-P decreases with concomitant increase in Fe-P fraction. High quantities of Fe-P fraction in all the soils under investigation indicate that these soils are strongly weathered. This observation is in agreement with the findings of Stella and Venugopal (1987) for laterite soil series identified in different regions of Kerala.

From the present investigations, it is observed that P fixation in rubber growing soils is high, as evident from the higher proportion of Fe-P in these soils. This study also indicates that Al-P can be considered as a better index of phosphorus availability than Fe-P or Ca-P.

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