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INFLUENCE OF SOIL INORGANIC PHOSPHORUS FRACTIONS ON LEAF PHOSPHORUS STATUS IN *HEVEA BRASILIENSIS*

Phosphorus (P) is an essential plant nutrient, the limited availability of which affects crop production in tropical soils. Usually P fertilizers added to these soils react with the iron, aluminium and calcium present and get converted to Fe-P, Al-P and Ca-P (Mengel and Kirkby, 1987; Karthikakuttyamma *et al.*, 1991). Since P-fractions have different solubilities, the availability of P in soil and its uptake by plants depend on the content and rate of release from different P fractions. The noticeable feature of tropical rubber growing soils is that they do not show any relationship between applied P and available P in soil and leaf. Since the major area under rubber cultivation in India is confined to tropical regions, a knowledge on the relation between different soil P fractions, available P and leaf P content may offer an explanation for lower growth response of rubber to P application. The present study was undertaken to understand the relationship between soil P fractions and leaf P content.

One hundred and forty surface soil (0-30 cm) samples were collected from 14 large estates of traditional rubber growing tracts of South India. Leaf samples were also collected from the trees growing in the same fields during August-September. The soil samples were analysed for pH, organic carbon content, total P and available P (Jackson, 1958). The total P in the leaf samples was analysed using an autoanalyser (Karthikakuttyamma, 1989). Thirty samples varying in available P (Bray - II) from trace to 4 mg per 100 g soil were selected and subjected to P fractionation studies (Jackson, 1958). A correlation was worked out (Snedecor and Cochran, 1968) between soil P fractions and the corresponding leaf P content.

In order to elucidate the contribution of each fraction towards available P status in the soil, path coefficient analysis was carried out on the selected 30 samples. The available P was considered as the dependent variable and total P (TP), iron P (Fe-P), aluminium P (Al-P), saloid P (Sal-P) and calcium P (Ca-P) as independent variables.

The mean values for organic carbon, total, available and leaf P contents representing 14 estates in the rubber growing region of South India are given in Table 1. The percentage of leaf P varied from 0.17 to 0.38. A significant positive correlation was observed between total P in soil and leaf P content (r=0.6982) indicating that in addition to P extracted by Bray-II (Bray and Kurtz, 1945), P availability to plants depended upon other pools also (Olsen and Watanabe, 1970).

Thirty soil samples selected for the fractionation study had available P values from trace to 4 mg per 100 g soil. The available P, organic carbon and pH in these soil samples are given in Table 2. The soil pH varied from 4.3 to 5.8. The data in Table

Table 1. **Mean values of soil organic carbon, P fractions and leaf P values of ten samples each from 14 estates in South India**

Name of estate	Location (District)	Organic carbon (%)	Total P (ppm)	Available P (ppm)	Leaf P (%)
Arasu Corporation					
Kodayar	Kanyakumari	1.19	130	2.3	0.21
Paraliyar	Kanyakumari	1.19	213	5.8	0.24
Mylar	Kanyakumari	1.17	392	1.0	0.17
Ambanad	Kollam	1.35	280	15.7	0.23
Ayiranalloor	Kollam	1.91	223	4.2	0.21
Kulathupuzha	Kollam	1.07	157	2.0	0.21
Kumbazha	Pathanamthitta	1.92	260	15.8	0.23
Lahai	Pathanamthitta	1.65	522	17.0	0.23
Mundakayam	Kottayam	1.55	282	3.9	0.26
Boyce	Kottayam	1.44	178	4.6	0.21
Cheruvally	Kottayam	2.78	305	10.8	0.21
Kaliyar	Idukki	1.46	212	25.2	0.24
Vaniampara	Trichur	1.60	354	9.1	0.38
Kulappadam	Palghat	1.24	465	15.0	0.23

Table 2. **Organic carbon, pH and available P of selected soil samples**

Sample No.	Name of estate	Organic carbon (%)	pH	Available P (mg/100 g)
1.	ArasuCorporation	1.03	5.0	trace
2.	Arasu Corporation	1.03	5.2	trace
3.	ArasuCorporation	1.32	4.9	trace
4.	Kumbazha	1.31	4.6	trace
5.	Kumbazha	1.35	5.0	trace
6.	Lahai	1.40	4.8	0.40
7.	Boyce	1.35	4.9	0.38
8.	Kulappadam	0.83	5.3	0.20
9.	Kulappadam	1.11	5.3	0.30
10.	Kulappadam	1.17	5.1	0.20
11.	Lahai	2.23	4.6	0.60
12.	Kaliyar	0.78	4.3	0.80
13.	Kaliyar	1.49	4.8	0.90
14.	Lahai	1.51	4.8	0.70
15.	Boyce	1.66	5.1	0.88
16.	Kaliyar	1.21	4.8	1.30
17.	Kaliyar	1.41	4.6	1.90
18.	Kulappadam	1.76	5.8	1.10
19.	Kulappadam	1.63	5.7	1.30
20.	Boyce	1.07	5.2	1.88
21.	Boyce	1.38	4.8	2.01
22.	Kumbazha	1.95	4.8	2.75
23.	Kumbazha	1.50	4.8	2.10
24.	Lahai	2.13	4.6	2.50
25.	Lahai	1.34	4.6	2.70
26.	Lahai	1.31	4.7	3.30
27.	ArasuCorporation	1.29	5.3	4.00
28.	Kulappadam	0.98	5.0	3.80
29.	Kulappadam	1.22	5.2	3.60
30.	Kumbazha	2.16	5.0	3.50

Table 3. **Total P and P fractions in soil and corresponding leaf P content**

No.	Total P (ppm)	Inorganic P fractions (ppm)					Leaf P (%)
		Sal-P	Al-P	Fe-P	Ca-P	Total	
1.	288	5.0	6.8	54.0	3.1	68.9 (23.9)	0.17
2.	575	6.7	7.9	57.5	4.2	76.3 (13.3)	0.17
3.	393	2.5	7.5	46.5	2.1	58.6 (14.9)	0.16
4.	763	5.0	8.8	100.0	2.1	115.8 (15.2)	0.21
5.	260	3.3	7.5	51.5	3.1	65.4 (25.2)	0.19
6.	355	5.0	7.8	29.0	2.1	43.8 (12.3)	0.22
7.	575	3.3	8.3	92.5	2.1	106.2 (18.5)	0.2
8.	280	5.0	9.5	37.5	4.2	56.2 (20.1)	0.22
9.	395	trace	28.7	64.0	4.2	96.9 (24.5)	0.24
10.	355	4.2	13.0	51.5	2.1	70.8 (19.9)	0.23
11.	513	4.2	19.8	37.5	2.1	63.5 (12.4)	0.24
12.	355	trace	45.0	29.0	6.2	80.2 (22.6)	0.26
13.	688	3.3	33.3	66.5	2.1	105.2 (15.3)	0.27
14.	543	3.3	20.8	66.5	2.1	92.7 (17.1)	0.24
15.	543	5.0	28.8	29.0	3.1	65.1 (13.0)	0.20
16.	688	trace	70.0	75.0	2.1	147.1 (21.4)	0.26
17.	880	1.7	114.5	75.0	2.1	193.2 (22.0)	0.26
18.	725	6.7	45.0	85.0	8.3	145.0 (20.0)	0.22
19.	418	5.8	41.3	55.0	8.3	110.4 (26.4)	0.25
20.	418	1.7	45.0	55.0	4.2	105.8 (25.3)	0.23
21.	530	4.2	48.8	37.5	2.1	122.5 (23.1)	0.20
22.	463	3.0	43.8	45.0	2.1	93.8 (20.3)	0.26
23.	700	3.3	63.8	60.0	2.1	129.2 (18.5)	0.21
24.	430	3.3	44.5	70.0	4.2	122.0 (28.4)	0.20
25.	563	3.3	63.8	60.0	2.1	129.2 (23.0)	0.21
26.	725	1.7	81.3	55.0	3.1	141.0 (19.5)	0.27
27.	310	6.7	70.0	30.0	6.3	112.9 (36.4)	0.17
28.	583	5.0	75.0	30.0	4.2	114.2 (19.6)	0.24
29.	500	6.7	57.5	47.5	2.1	113.8 (22.8)	0.18
30.	750	8.3	72.5	100.0	2.1	182.9 (24.4)	0.25

Figures in parentheses are percentage of total P.

3 shows that the total P, Sal-P, Al-P, Fe-P and Ca-P contents of the soil samples ranged from 260 to 880 ppm, trace to 8.3 ppm, 6.8 to 114.5 ppm, 29 to 100 ppm and 2.1 to 8.3 ppm respectively. The leaf P values ranged from 0.16 to 0.27 per cent. In all the soils, Fe-P was found to be the predominant fraction as reported earlier, for the rubber growing soils of India (Karthikakuttyamma *et al.*, 1991).

The correlations between different soil P fractions and leaf P content are presented in Table 4. Out of the six fractions studied, only Al-P showed significant positive relationship with available P (r=0.8011) for rubber growing soils as found earlier by Gupta and Misra (1965) and Karthikakuttyamma *et al.* (1991). Leaf P content showed significant positive correlation with total P (r=0.3985) and Al-P (r=0.5771) in the soil suggesting thereby the influence of these fractions on leaf P status. A significant negative relationship was observed between leaf P content and saloid P.

Table 4. **Intercorrelation matrix**

		x1	x2	x3	x4	x5	x6	x7
x1	Available P		0.2685	0.8011 **	-0.814	0.0550	0.1967	0.1678
x2	Total P			0.5445 **	0.6135 **	-0.2354	0.0129	0.3985 **
x3	Aluminium P				0.1839	0.0678	-0.1267	0.5771 **
x4	Iron P					-0.1327	0.0410	0.1520
x5	Calcium P						0.1859	0.0083
x6	Saloid P							-0.4132 **
x7	Leaf P							

The direct and indirect effects of the independent variables (P fractions) on the available P showed that Al-P was the main deciding factor for available P status of the soil. There was direct effect of aluminium-P and indirect effect of total P through Al-P on available P of the soil. Both total P and Al-P can therefore be considered as useful indices of P availability in these rubber growing soils.

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