Madras agric. J. 62 (7): 435—438, July, 1975.

Fractions of Inorganic Phosphorus and Their Relation to Availability in Soils

By

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ABSTRACT

Ca-P fraction dominated the alluvial and red soils of Tamil Nadu. The values ranged from 70.70 to 895.25 ppm with a mean value of 140.65 ppm. Barring the alluvial soil of Cholavandan which registered as high as 895.25 ppm of Ca-P, all the other soils contained only less than 210 ppm. Al-P fraction was found to be low in red and alluvial soils but spectacularly high in black soils. Reductant soluble iron phosphate ranged from 28.25 to 45 ppm. Fe-P fraction was found to be high in red, alluvial and laterite soils but low in black soils. There were significant correlations between the Fe-P fraction and available P in soil obtained through Olsen's and Bray's No. 2 methods. The present investigation has revealed that Fe-P fraction is found to be the prime source of phosphorus in soil available to the plants more easily.

INTRODUCTION

Chang and Jackson (1957 a) classified the inorganic phosphate in soils into four main groups: *viz.*, Ca-P, Al-P, Fe-P and reductant soluble iron phosphate. The insoluble P fraction in conventional phosphorus fractionation extractant has been termed as "non-extractable phosphorus" (Bauwin and Tyner 1957) and is equivalent to reductant soluble iron phosphate fraction (Chang and Jackson 1957 b). This fraction is believed not to contribute towards phosphate fertility in well drained soils, but its importance in waterlogged soils has been realised in recent years. Data on the various fractions of inorganic phosphorus found in the representative soils of Tamil Nadu and their influence on the availability of phosphorus as extracted by few chemical extractants are reported.

MATERIALS AND METHODS

Soil samples representing major soil groups of Tamil Nadu *viz.*, red, black, alluvial and laterite were collected from eleven selected places in the southern districts of Tamil Nadu. These soils were air dried, processed and analysed for inorganic phosphorus fractions by the method of Chang and Jackson (1957 a) except for reductant soluble iron phosphorus which was analysed by a modified method of Jackson (1967). These soil samples were also analysed for the available phosphorus status by the following methods *viz.* i. By Olsen's 0.5 M $NaHCO_3$ method with a soil extractant ratio of 1: 10 (Olsen *et al.*, 1954), ii. By Bray's No. 2 method using 0.03 N NH_4Cl in 0.1 N HCl extractant with a soil extractant ratio of 1:12 (Bray and Kurtz, 1945) and iii. By measuring the phosphate

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potentials using 0.01 M $CaCl_2$ extractant with 1:2.5 soil extractant ratio (Asyling, 1954). The phosphate potential values were calculated by using the equation $\frac{1}{2}$ p Ca + p H_2PO_4. The different fractions of phosphorus were correlated against the available phosphorus content obtained through the above mentioned methods.

RESULTS AND DISCUSSION

Fractions of inorganic phosphorus: It was found that the Ca-P fraction dominated the alluvial and red soils. The values ranged from 70.70 to 895.25 ppm with a mean value of 140.65 ppm. Except the alluvial soil of Cholavandan which had registered as high as 895.25 ppm of Ca-P, all the other soils contained less than 210 ppm. Al-P fraction was found to be low in red and alluvial soils but very high in black soils. Red and alluvial soils had registered values only below 25.00 ppm but black soils were found to contain as high as 127 to 273 ppm. Reductant soluble iron phosphate had ranged from 28.25 to 165.74 ppm in all the soils except alluvial soil of Cholavandan which contained 452.66 ppm. Fe-P fraction was found to be high in Red, Alluvial and laterite soils but low in black soils (Table 1).

TABLE 1. Fractions of inorganic phosphorus in air dried soils (ppm of P on moisture free basis)

Soils	Al-P	Fe-P	Ca-P	RS. Fe-P
Red (Theni)	10.57	49.97	70.70	68.74
Red (Kappalur)	18.40	46.80	143.05	51.26
Red (Dindigul)	25.40	89.25	162.65	130.37
Black (Thirumangalam)	210.47	10.70	145.72	49.65
Black (Koilpatty)	273.05	45.20	208.71	83.29
Black (Dindigul)	127.00	2.65	161.65	95.70
Alluvial (Cholavandan)	16.80	66.30	895.25	452.66
Alluvial (Cumbum)	22.17	79.77	179.35	109.37
Alluvial (Ambasamudram)	17.50	26.42	135.75	28.25
Laterite (Pannaikkadu)	69.12	74.65	110.52	165.74
Laterite (Madurai)	43.20	28.60	88.40	79.29

Relationship between fractions of phosphorus and available phosphorus: The correlation coefficient obtained between the fractions of phosphorus and the available phosphorus values (Table 3) by different extracting procedures are presented in Table 2. Olsen's available phosphorus in air dried soil was found to significantly correlate with Fe-P (r=0.707**) and RS.Fe-P (r=0.568**) and there were non-significant correlations with other fractions. Bray's No. 2 available phosphorus also correlated with Fe-P (r=0.630**) and did not show any significant correlation with other fractions of phosphorus. Phosphate potential values determined in the air dried sample was not correlated with any of the fractions. When the Olsen's P was correlated against the total phosphorus uptake by the crop, Fe-P (0.458*) was found to correlate significantly. Neither the Bray No. 2 P nor the phosphate potential values were found to correlate with the total uptake of phosphorus. Al-Abbas and Barber (1964) have reported that the iron phosphate gave the best correlation with the phosphorus values extracted by different agents. In the present study also, as discussed earlier there were significant correlations with the Fe-P fraction and the soil available P obtained through Olsen's and Bray's No. 2 methods. This is also in agreement with the findings of Khanna (1967), and Cholitkul and Tynes (1971) who considered that Fe-P as the major source of labile P or the available P in low land rice farming. Thus the present study reveals that Fe-P fraction was found to be the prime source of phosphorus in soil available to the plants more easily.

TABLE 2. Relationships between fractions of phosphorus in soil and available phosphorus by different methods

Methods	Al-P	Fe-P	Ca-P	RS. Fe-P
Olsen's P	N. S.	0.707**	N. S.	0.568**
Bray No. 2 P	N. S.	0.630**	N. S.	N. S.
Phosphate potential	N. S.	N. S.	N. S.	N. S.
Relationship with total uptake of phosphorus	N. S.	0.458*	N. S.	N. S.

TABLE 3. Available phosphorus in air dried soils by different methods (ppm on moisture free basis)

Soils	Olsen's method	Bray II method	Phosphate potential value
1.	14.13	10.20	3.62
2.	16.84	13.54	4.38
3.	20.20	12.09	4.81
4.	6.95	3.78	4.56
5.	8.56	3.69	4.44
6.	13.25	28.48	4.26
7.	16.32	38.55	4.18
8.	18.70	16.32	4.00
9.	16.70	10.50	4.49
10.	14.28	24.48	4.51
11.	13.00	20.90	6.00

ACKNOWLEDGEMENT

The senior author wishes to thank the Indian Council of Agricultural Research, New Delhi, for the award of a Junior Research Fellowship during the period of study. The authors thank the Tamil Nadu Agricultural University for according permission for this publication which forms a part of the M. Sc. (Ag.) dissertation.

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