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Forms and Distribution of Inorganic P Fractions in the Alkaline Soils of Tamil Nadu*

by

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P is known to exist in organic and inorganic forms in soils. Among the various fractions of inorganic P, phosphates of aluminium, iron and calcium are considered to be important from the point of view of fixation and availability of P in soils. The rate and quantity of P that becomes soluble from these sources under various soil and environmental conditions determine the P status of a soil. Evidence is ample in literature to indicate that distribution and availability of P depend largely on the forms of soil P. Since the different forms of soil P have different solubilities, the forms and distribution pattern might give an indication about the availability of P in the soil. Though much work has been done on the chemistry and behaviour of P in acid soil, due attention has not been paid to soils of alkaline reaction. Therefore systematic investigations are considered necessary to gain an insight into the various phenomena of P behaviour in alkaline soils and the present work refers to a study with Tamil Nadu soils.

Materials and Methods: Forty representative soil samples of alkaline pH were collected from different regions of Tamil Nadu. They were examined for their physical and chemical properties. Fractionation of soil inorganic P was done following the procedure of Chang and Jackson (1957) to estimate the amount and distribution pattern of these P fractions in the soil. The inter-relationships among the different P fractions and their relation to other soil properties were also studied.

Results and Discussion: The data on fractionation of P, pH and percentage of clay are given in Table 1, and the results of statistical analysis are given in Table 2.

Among different inorganic P fractions, aluminium phosphate content of all soils was higher than the amounts of calcium phosphate or iron phosphate. The result is in contrast to the findings of Sengupta and Cornfield (1962) who have indicated that in soils of alkaline reaction the predominant form of P would be calcium phosphate. This might be due to the fact that calcium phosphate, being more soluble at alkaline pH, might have been lost through

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TABLE 1. *Results of fractionation of phosphorus*

ppm of P fractions on moisture free basis				Percentage of P fractions to total phosphorus			
Phosphorus Total	Aluminium Phosphate	Iron Phosphate	Calcium Phosphate	Aluminium Phosphate	Iron Phosphate	Calcium Phosphate	Clay %
Black soils							
157	38	5	26	24.2	3.2	16.6	32.0
443	100	19	83	22.6	4.3	18.7	13.5
1436	82	4	152	5.7	0.3	10.6	16.2
465	79	14	93	17.0	3.0	20.0	23.0
1696	14	21	56	2.0	3.0	8.0	19.6
841	120	11	40	14.3	1.3	4.8	31.2
361	128	18	41	35.5	5.0	11.4	36.0
365	70	5	56	19.2	1.4	15.3	23.8
356	65	6	56	18.3	1.7	15.7	24.3
1688	265	53	75	15.7	3.1	4.4	13.4
310	80	15	49	25.8	4.8	15.8	16.9
628	60	8	79	9.5	1.3	12.6	9.8
262	108	7	21	41.2	2.7	8.6	20.6
166	73	3	60	44.0	1.9	36.1	13.0
945	79	12	40	8.4	1.3	4.2	32.0
450	153	17	29	34.0	3.8	6.4	34.5
460	215	6	53	46.0	1.3	11.5	49.2
Red soils							
100	57	13	21	57.0	13.0	21.0	16.2
110	60	4	36	54.5	3.6	32.7	37.9
144	48	6	65	33.0	4.2	45.1	4.2
899	92	4	152	10.2	4.4	16.9	14.3
232	149	12	130	12.1	1.0	10.6	19.0
179	67	11	34	37.4	6.1	19.6	24.0
524	113	16	65	21.6	3.1	12.4	27.8
209	120	4	26	57.4	1.9	12.4	6.9
377	135	9	75	35.8	2.4	19.9	24.8
Alluvial soils							
338	57	16	22	16.9	4.7	6.6	8.9
406	50	4	49	12.3	1.0	12.1	10.5
144	78	10	57	54.2	6.9	39.6	15.4
646	79	13	80	12.2	2.0	12.4	19.1
635	140	20	94	22.0	3.1	14.8	8.8
550	44	12	11	8.0	2.2	20.0	4.5
241	52	4	14	21.6	1.7	5.9	10.1
164	38	3	13	23.2	1.8	7.9	0.9
244	118	16	38	48.4	6.6	15.6	37.4
446	55	9	58	12.3	2.0	13.0	23.2
416	177	5	58	42.5	1.2	13.9	9.7
480	69	68	27	14.3	3.8	5.4	1.7
330	74	14	93	28.2	4.2	27.9	16.4
432	125	3	63	28.9	0.7	14.6	17.0

TABLE 2. *Results of Statistical Analysis*

Relationship between		Correlation coefficient	Regression equation	No. of pairs
X	Y			
Aluminium phosphate	Calcium phosphate	0.4801***	Y=0.5514X+16.70	33
Aluminium phosphate %	Iron phosphate %	0.8788***	Y=0.1636X− 0.25	28
Total phosphorus	Aluminium phosphate	0.6625***	Y=0.1271X+46.45	25
Clay %	Aluminium phosphate	0.8462***	Y=2.994 X+30.7866	29

***=Significant at 0.1% level

crop uptake or by leaching. As indicated by Carbonell and Valencia (1957), the formation and transportation of various phosphate forms follow the order: Calcium phosphate <aluminium phosphate<occluded phosphate.

Next to the aluminium phosphate in the order of abundance, calcium phosphate stands in the soils taken up for the present study. In acid soils, sesquioxide phosphate are dominant and calcium phosphate is very low. On the other hand, in soils of alkaline reaction, appreciable amount of calcium phosphate occurs, and is more than that of iron phosphate. Presence of considerable amounts of calcium phosphate in these soils has been emphasised by Chai Moo Cho and Caldwell (1959), and Kanwar and Grewal (1960). Very low quantities of iron phosphate in comparison to high low quantities of iron phosphate in comparison to high ones of aluminium and calcium phosphates have been recorded also by Balasubramaniam (1966), and Sengupta and Cornfield (1962).

Aluminium and Calcium phosphate exhibit direct relationship with total P content, indicating that the total P content of soils studied determines the amount of individual form of P. As the total P content increases, the amounts of aluminium and calcium phosphates also increase.

Though the values of individual P forms differ considerably, increase or decrease in the amounts of one form of P is accompanied by a similar trend in other forms of P. This indicates a close regularity of simultaneous variation in the phosphate forms. Aluminium phosphate and calcium phosphate registered a correlation coefficient of 0.480**. The percentage of aluminium phosphate and iron phosphate exhibited a correlation of very high order, r=0.878***. Similar observation has been reported by Vijayachandran (1960) in the laterite soils of South India.

Aluminium phosphate content has been found to increase with clay percentage (r=0.846***). This might be due to the fact that clay contains more aluminium than iron or calcium (Chang and Chu, 1961).

Summary: Fractionation of inorganic P was carried out in forty representative soils of alkaline pH, to determine the contens and distribution pattern of various inorganic P fractions. All the inorganic P fractions expressed as the percentages of total P exhibited a uniform distribution pattern in the soil studied. Among the different forms of P, aluminium phosphate and calcium phosphate are dominant in all soils. Though the values of individual P fractions exhibit considerable variation among themselves, an increase or decrease in the amount of one form of P is accompanied by a similar increase or decrease in other forms also, thus exhibiting a close similarity of variations in the different forms of P.

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