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Distribution of Inorganic Phosphorus Fractions in Tamil Nadu Soils

G. V. KOTHANDARAMAN[1] and K. K. KRISHNAMOORTHY[2]

Thirty eight soils collected from nine profiles representing the four major soil groups viz., red, black, laterite (high level and low level) and alluvial soils were examined for different forms of inorganic P and their distribution with depth. There was a marked variation in the vertical distribution of P fractions viz., Al-P, Fe-P, Ca-P, Red. sol. P and Occluded P. Total P and inorganic P decreased with depth in most of the profiles except in red and black calcareous and Aduthurai alluvial soils. No definite pattern of distribution of Al-P and Fe-P was observed but the surface layers were rich in Al-P and Fe-P. Ca-P increased with depth in calcareous soils and Aduthurai alluvial soil. Red. sol. P and Occluded P increased with depth in most of the soil profiles. Among the inorganic P fractions, Al-P and Ca-P dominated in black and alluvial soils, whereas Fe-P, Red. sol. P and Occluded P were high in laterite soils.

A knowledge of the amount and distribution of P in soils would provide a logical basis for consideration of the P requirements of different crops. Many workers have tried to study the distribution of various inorganic forms of P in the soil, but the profile studies on the distribution of P with depth have been made only in a few cases. Marked variation in the different forms of inorganic P is a function of genetic differences among soils (Chang and Jackson, 1958; Bapat *et. al.*, 1965). Organic matter, calcium carbonate and sesquioxides appear to be guiding factors in determining the distribution of forms of P (Misra and Ojha, 1969).

Information on the pattern of distribution of P forms not only in the plow layer but also in the soil profiles would enable refining the genetic characteristics of soils of Tamil Nadu. The present investigation was, therefore, undertaken to study the distribution pattern of different forms of inorganic P in major soil groups of Tamil Nadu.

MATERIALS AND METHODS

Thirty eight soils were collected from nine profiles representing the four major soil groups viz., the red, black, laterite (both high level and low level) and alluvial soils. Mechanical analysis of the soils was done by the International Pipette method, free $CaCO_3$ by rapid titration method, organic carbon by the Walkley and Black method as described by Piper (1950). Sesqui-

: Department of Soil Science and Agrl. Chemistry, Tamil Nadu Agricultural University, Coimbatore-641 003

oxides were estimated as per standard procedure. The pH of the soil was determined in a Beckman pH meter, using a soil-water ratio of 1:2.5. Total P was estimated by perchloric acid digestion method as described by Jackson (1958). Fractionation of soil P was done by the modified procedure of Chang and Jackson (1957) after Petersen and Corey (1966).

RESULTS AND DISCUSSION

The data on a soil chemical properties and the fractionation of soil P are given in Table. Saloid-P varied from 0 to 26 ppm and it was virtually absent in the lower horizons of most of the profiles. The Saloid-P was high at the surface layers and this may be due to the result of fertilizer or manure additions or easily mineralised organic P in top layers of the soil profiles. This fraction of P decreased with depth in most of the profiles except those of the two high level laterite soils.

Al-P:

Al-P content of the soils ranged from 3 to 114 ppm with a mean value of 32 ppm. Al-P in red soil profiles No. 1 and 2, laterite soil profiles and alluvial soil profiles No. 8 was high in surface layers, whereas in the case of black soil profile No.4 and alluvial soil profile No.9 the highest Al-P content was observed in the lower layers. No definite pattern of Al-P distribution was observed in most of the profiles but the content was low in the lower horizons of red and laterite soils as reported by Ram Deo and Ruhal (1970) in Mewar soils. Al-P was found to be correlated with total P ($r = 0.471^{**}$) and Ca-P ($r = 0.569^{***}$).

Fe-P

This fraction of P varied widely in the soils, ranging from 8 to 216 ppm with a mean of 45 ppm. Fe-P was high in alluvial soils followed by laterite soils and it was lowest in black soils. Presence of high amounts of Fe-P and Al-P even in the neutral to slightly alkaline alluvial soils may be due to occurrence of considerable amounts of Fe and Al oxides which might have combined with P during various stages of weat-hering (Goel and Agarwal, 1959; Mehta and Patel, 1963).

Fe-P was low in the surface layers of red soil profiles, alluvial soil profile No.9, whereas in the subsoil layers of black soil profile No.4 and high level laterite soil profiles No.6 and 7 there was higher Fe-P. No regular trend of Fe-P distribution was observed in most of the profiles as in the case of Al-P. Fe-P was found to be correlated with total P($r = 0.550^{***}$) and Ca-P ($r = 0.429^{***}$).

Ca-P

The Ca-P fraction exhibited an wider variation, with the values ranging from 2 to 404ppm with a mean value of 82 ppm. The amount of Ca-P was considerably high in black soils which are calcareous in nature and the values

TABLE I. Soil Chemical Properties and Fractionation of Soil Inorganic P (ppm)

Soil and profile No.	Depth in cm	Sesquioxides %	Free $CaCO_3$ %	Organic carbon %	pH	Saloid-P	Al-P	Fe-P	Ca-P	Red. Sol.P	Occluded P	Sum of inorganic-P fractions	Total P
Red soil													
1. Kovilpatti	0-22	15.84	1.1	0.39	7.4	8	91	47	60	52	21	289	586
	22-38	12.76	0.6	0.12	7.2	5	39	28	21	64	10	167	368
	38-54	21.39	0.9	0.24	6.7	0	22	29	29	97	22	198	392
	54-68	26.48	1.0	0.15	6.1	6	38	92	29	180	81	376	523
2. Coimbatore	0-10	8.01	0.9	0.15	8.4	12	10	17	28	81	8	156	307
	10-30	12.69	1.1	0.26	8.0	8	22	17	56	60	8	171	313
	30-50	13.74	0.7	0.15	7.6	3	14	20	21	89	8	155	339
	50-70	17.71	0.8	0.15	7.7	8	5	28	28	60	8	137	342
	70-105	21.58	4.5	0.08	8.3	3	5	20	66	145	21	260	448
Black soil													
3. Kovilpatti	0-15	8.49	5.3	0.23	8.3	8	9	8	37	66	29	157	262
	15-45	6.98	4.8	0.12	8.1	8	46	8	66	66	5	199	312
	45-75	9.84	4.9	0.17	8.1	0	23	8	80	53	19	183	286
	75-105	19.95	5.2	0.18	8.2	0	31	8	86	21	5	154	186
4. Coimbatore	0-15	14.62	6.5	0.29	8.3	5	46	56	183	65	5	360	548
	15-30	11.63	5.6	0.27	8.3	3	18	91	223	82	5	422	549
	30-45	17.12	6.2	0.32	8.5	9	112	8	257	66	5	457	551
	45-75	17.11	7.3	0.30	8.4	3	114	17	216	137	5	492	607
Low level laterite soil													
5. Mudukulam	0-17	18.58	–	0.18	5.8	9	14	79	3	30	8	143	257
	17-64	21.07	–	0.08	5.7	0	3	61	72	30	18	114	227
	64-102	22.13	–	0.08	5.7	0	3	61	3	30	20	117	178
High level laterite soil													
6. Kumuli	0-30	22.76	–	0.24	4.7	0	29	25	23	81	15	173	356
	30-75	29.40	–	0.53	4.4	12	22	17	13	61	68	193	358
	75-113	28.25	–	0.60	4.6	26	13	51	29	51	10	180	357
	113-180	28.47	–	0.32	5.0	20	13	17	20	121	10	201	332
	180-225	24.08	–	0.20	5.2	0	5	10	28	120	5	168	228
7. Kodaikanal	0-45	23.50	–	5.76	4.9	5	52	72	47	124	30	330	822
	45-90	36.26	–	0.17	5.3	5	25	153	55	186	38	462	737

	90-135	38.31	—	0.17	5.2	8	18	71	20	125	39	271	480
	135-183	37.42	—	0.17	5.2	5	18	86	61	222	130	522	638
	183-223	37.12	—	0.17	5.0	5	51	35	102	490	280	963	1319
	223-273	34.89	—	0.18	5.0	14	21	70	18	487	291	901	1140
Alluvial soil													
8. Chitrasavadi	0-15	18.40	1.5	0.53	8.3	24	72	43	86	66	39	327	491
	15-75	13.72	0.8	0.29	8.3	3	22	21	47	44	16	153	284
	75-105	11.66	1.1	0.26	8.6	5	28	21	39	5	5	103	236
9. Aduthurai	0-16	16.92	1.0	0.87	7.0	5	22	52	30	60	5	174	394
	16-80	16.16	0.8	0.12	7.4	5	10	52	50	53	38	214	289
	80-108	7.90	0.7	0.05	7.8	0	18	49	205	51	10	333	384
	108-138	11.40	0.8	0.05	7.8	0	61	216	404	241	57	979	1296

ranged from 87 to 257 ppm with a mean value of 143 ppm. Alluvial soils were also rich in Ca-P (mean value 121 ppm) and Ca-P was low in red and laterite soils. It was observed that Ca-P increased with depth in black soil profiles (from 37 to 89 in profile No. 3 and from 183 to 216 ppm in profile No. 4) and in alluvial soil profile No. 9 from 30 to 404 ppm. This can be attributed to the increase of $CaCO_3$ and pH with depth in these soils as reported by Misra and Ojha (1969). The predominance of Ca-P in black and alluvial soil profiles observed in the present investigation was also reported by Indira Raja *et al.* (1967) in Tamil Nadu soils, Ram Deo and Ruhal (1970) in Mewar soils, Mehta *et al.* (1971) in Rajasthan soils and Gupta and Singh (1972) in Vindhyan soils. Significant correlation was obtained between Ca-P and total P ($r = 0.464^{**}$).

Reductant-soluble P

This fraction of P was found to be high in laterite soils ranging from 30 to 490 ppm, followed by red soils from 60 to 180 ppm. Chang and Jackson (1958) observed that highly weathered soils always contained appreciable amouts of reductant soluble and occluded forms of P. This observation has been confirmed in the present study since the laterite and red soils are considered to be highly weathered. The Red. sol. P was found to increase with depth in most of the profiles. This can be mainly attributed to the highly leached condition of the profiles where the Red. sol. P is accumulated in the lower horizons along withiron oxide. Highly significant correlation of Red. sol. P with total P ($r = 0.902^{***}$) was obtained.

Occluded P

This fraction of P was high in the high level laterite soils of Kodaikanal (Profile No. 7), the values ranging from 30 to 291 ppm and it was low in black soil profile No. 4 (5 ppm). Occluded P was found to increase with depth in most of the profiles and this may be attributed to the highly leached condition of the profiles where it is accumulated in lower horizons along with total sesquioxides. Occluded P was found to be correlated with total P (r = 0.463**).

Total - P

The total P status of the soils studied showed a wide variation, ranging from 178 to 1319 ppm. The highest P content was recorded in the high level laterite soils (Profile No. 7) and the lowest in the low level laterite soil (profile No. 5). It was observed that total P increased with depth in red soil profile No. 2 (from 307 to 448 ppm) and in black soil profile No. 4 from 548 to 607 ppm. The increase of total P with depth in the above soil profiles may be associated with higher pH and $CaCO_3$ as observed in these profiles and this may also be related to less weathering of apatite as reported by Goel and Agarwal (1960), Misra and Ojha (1969) and Mehta *et al*. (1971).

Total P decreased with depth in soil profiles No. 3, 5, 6 and 8 and this may be attributed to the fall of organic P as reported by Williams and Saunders (1956), Gupta and Singh (1972) and Chandrabhan and Tripathi (1973). The decrease in the organic matter and organic P content observed down the profile also lends support to this view. The high content of total P in the surface layers may be attributed to the result of fertilizer and manure additions. The total P content in the soil profiles No. 1, 7 and 9 was high in surface layers and decreased in second and third layers and again increased in the lower horizons. As stated by Smech (1973), the relative magnitude of P redistribution within the soil profile appears to be a function of the degree of profile development. Highly significant correlations were obtained between the total and all the inorganic P fractions and the close relationship indicated that an equilibrium exists between the total P and other forms in soils.

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REFERENCES

BAPAT, M. V., G. C. PADOLE, N. G. TOTEY and V. G. BEDEKAR. 1965. Forms of P in Vidharbha soils. *J. Indian Soc. Soil Sci.* **13**: 31-36.

CHANDRABHAN and B. R. TRIPATHI. 1973. Total and available phosphorus status of certain selected soil profiles of Uttar Pradesh. *J. Indian Soc. Soil Sci.* **21**: 277-82.

CHANG, S. C. and M. L. JACKSON. 1957. Fractionation of soil phosphorus. *Soil. Sci.* **84**: 133-44.

CHANG, S. C. and M. L. JACKSON. 1958. Soil phosphorus fractions in some representative soils. *J. Soil Sci.* **9**: 109-19.

GOEL, K. N. and R. R. AGARWAL. 1959. Forms of soil phosphorus in genetically related soils of Kanpur in Indian Gangetic alluvium. *J. Indian Soc. Sci.* **7**: 155-61.

GOEL, K. N. and J. SINGH. 1972. Soil phosphorus fractions of Vindyan soils of Mirzapur district. *Indian. J. agric. Sci.* **42**: 685-89.

GUPTA, M. L. and J. SINGH. 1972. Soil phosphorus fractions of Vindyan soils of Mirzapur districi. *Indian. J. agric. Sci.* **42**: 685-89.

INDIRA RAJA, M., F. L. DANIEL and S. VARADARAJAN. 1967. *Maximisation of pnospnate potential in soils of Madras State.* Final report of the maximisation of phosphate Potential scheme, ICAR.

JACKSON, M. L. 1958. *Soil chemical analysis* Prentice Hall Inc. New York.

MEHTA, P. C., and S. S. PUNTANKAR and S. P. SETH. 1971. Vertical distribution of phosphorus in the soils of Western Rajasthan *J. Indian Soc. Soil Sci.* **19** : 389-94.

MISRA, S. G. and S. K. OJHA. 1969. P distribution in black and red soils of U. P. *Madras agric. J.* **56** : 455-62.

PETERSEN, G. W. and R. B. COREY. 1966. A modified Chang and Jackson procedure for routine fractionation of inorganic soil phosphates. *Soil Sci. Soc. Amer. Proc.* **30** : 563-64.

PIPER, C. S. 1950. *Soil Plant Analysis.* Hans Publication, Bombay.

RAM DEO and D. V. S. RUHAL. 1970. Studies on the inorganic phosphorus fractions in Mewar soils. *J. Indian Soc. Soil Sci.* **18** : 15-20.

SMECK, N. E. 1973. Phosphorus : An indicator of Pedogenic weathering processes. *Soil Sci.* **115** : 199-206.

WILLIAMS, E. G. and W. M. H. SAUNDERS. 1956. Distribution of phosphorus in profiles and particle size fractions of some Scottish soils. *J. Soil Sci.* **7** : 90-108.