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NUTRIENT FIXATION IN THE *POONTHALPADAM* SOILS OF KERALA*

The *Poonthalpadam* soils covering an area of about 2,000 ha in the Chittoor taluk of the Palghat district of Kerala are a group of unique soils, distinct from the other problem soils, the nature of the problem being more of a physical rather than of a purely chemical nature. The soils are deep and slushy, highly clayey and pose difficulties in the preparation of field, management and cultural practices. Compared to the other problem soils, they have received only very little attention and much less is understood about their salient physico-chemical properties, availability and fixation of applied fertilizers, micro-nutrient status etc.

Thirty eight surface soil samples (0-15 cm depth) and their corresponding subsurface soils samples (15-30 cm depth) were collected from sites well distributed in six villages of the *Poonthalpadam* tract. The physical and chemical properties of the samples were determined by adopting standard analytical procedures outlined by Piper (1942) and Jackson (1958). The fixing capacities of the soils for ammonium, phosphorus and potassium were determined following the methods of Raju and Mukhopadyay (1979), Nad *et al.* (1975) and Jackson (1958) respectively. The data were statistically analysed and correlations between fixing capacities and important physico-chemical properties were worked out.

Ammonium fixation: The ammonium fixing capacity of the surface and subsurface samples ranged from 1.12 to 4.89 and from 1.31 to 7.24 me/100g soil respectively (Table 1). The average values of ammonium fixing capacity of the surface and subsurface samples showed that fixation was more in the subsoils than in the surface ones. According to Grewal and Kanwar (1973), the lower rates of ammonium fixation observed in the surface soils might be due to the presence of fixed ammonium and potassium ions in the clay minerals since both these elements have similar ionic radii and both are fixed under identical conditions. In the samples of soils studied total potassium was generally higher in the surface than in the subsurface layers, while exchangeable potassium was more in the subsurface samples. This suggests that the sites for ammonium fixation in the surface soils are already occupied by potassium in the fixed form which may be considered as a reason for the lesser fixation of applied ammonium in surface soils.

A positive and significant correlation was found to exist between ammonium fixation and free $CaCO_3$ (r = +0.255). Soils which generally contained free $CaCO_3$ invariably had a higher pH. The role of $CaCO_3$ in enhancing ammonium fixation may be by its effect in increasing the soil pH because several clays are known to fix more ammonium both under wet and dry conditions at a higher pH (Grewal and Kanwar, 1973; Bear, 1964).

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Ammonium fixation has also been correlated significantly and positively with other soil chemical properties like clay content ($r=+0.231$) and organic matter ($r=+0.232$). Replacement of cations like Ca and Mg by ammonium ions in the expanding lattices of the clay minerals has been suggested as a reason for ammonium fixation by Barshad (1954). The formation of ammonium organic complexes through linkage in the hydroxyl groups of organic matter in soils rich in organic matter has been observed by Burge and Broadbent (1961) to be responsible for rendering a part of the applied ammonium unavailable to plants.

Phosphorus fixation: The phosphorus fixing capacity of the *Poonthalpadam* soils was determined in one pooled sample each of surface and subsurface soils of a village taken as true representatives of that whole village. This ranged from 35 to 69 per cent and 22 to 70 per cent in the surface and subsurface soils (Table 3) with mean values of 52.67 and 47.00 per cent respectively. The different soil groups of Kerala show P fixing capacity ranging from 36.8 to 84.4 per cent (Nair, 1978). The *Poonthalpadam* soils, which are mostly alkaline containing appreciable quantities of free $CaCO_3$ are definitely prone to more phosphorus fixation than the slightly acidic to neutral soils of the state except the highly acidic soils.

A highly significant and positive correlation exists between the free $CaCO_3$ content and phosphorus fixation in the *Poonthalpadam* soils ($r=+0.947$). The reactions involved in the phosphate cycle show a close relationship between calcium phosphate and pH (Bear, 1964). Hence it is obvious that Ca++ concentration and pH are the controlling factors in the precipitation of calcium phosphates in calcareous soils. Most investigators have found that a minimum solubility of calcium phosphate in soils occurs between pH 7 and 8 and hence fixation as calcium phosphate is more in this range. The pH values of most of the *Poontha/padam* samples are in this range providing an optimum condition for maintaining a higher Ca++ concentration to effect the fixation of phosphorus. Phosphate ions coming into contact with the solid phase $CaCO_3$ are precipitated on the surface of these particles, the amount of precipitation being influenced by the amount of surface area exposed by $CaCO_3$ (Tisdale and Nelson, 1975). The presence of finely divided $CaCO_3$ observed in many of the samples might have contributed to this type of phosphorus fixation.

A positive and highly significant correlation exists between phosphorus fixation and clay content of the soil ($r=+0.614$). According to Prakash and Bhasker (1969), in the alkaline soils of Mysore, phosphorus retention is directly correlated with the surface area of the particles. As clay contributes the maximum to the surface area, such a trend seems to prevail in the case of *Poontha/padam* soils also. With increase in clay content the finer particles for each unit of soil is increasing, thus providing a larger surface area and hence a larger amount of stable isomorphous replacement of silica by phosphorus would normally occur. Nad *et al.* (1975) and Nair (1978) have recorded similar increase in phosphorus fixation with increase in clay content of soils.

Table 1
Ammonium and potassium fixing capacity of surface and subsurface soil samples, me/100g soil

Sl. No.	Ammonium fixing capacity		Potassium fixing capacity	
	Surface	Subsurface	Surface	Subsurface
1	2	3	4	5
1	2.72	1.94	2.68	2.50
2	2.31	3.38	5.92	1.33
3	1.38	1.69	4.31	5.05
4	4.12	3.80	6.80	5.75
5	3.13	3.13	7.58	4.89
6	4.10	2.20	5.36	5.01
7	2.31	2.89	2.51	3.38
8	2.57	2.31	5.58	4.20
9	3.69	3.51	1.30	2.30
10	4.63	2.61	7.93	6.20
11	2.42	2.28	6.35	7.05
12	4.33	3.13	4.86	5.18
13	3.51	4.70	3.48	4.20
14	2.46	1.94	6.22	7.34
15	2.69	3.43	1.56	2.81
16	1.79	5.60	6.09	5.18
17	4.38	2.24	4.06	3.17
18	2.50	3.21	5.10	6.25
19	2.57	2.72	7.11	2.55
20	2.42	3.43	6.22	5.78
21	3.38	2.91	7.29	5.25
22	4.89	7.24	4.99	3.88
23	2.01	3.80	3.01	2.17
24	4.36	1.69	4.20	4.18
25	1.60	2.61	1.89	1.58
26	1.12	1.31	4.75	6.38
27	1.23	2.50	2.36	5.91
28	3.69	1.85	1.04	5.23
29	2.69	2.09	3.79	3.79
30	1.38	1.57	1.08	2.63
31	2.24	3.58	3.83	1.54
32	1.64	2.31	3.83	6.17
33	2.38	2.38	2.01	5.35
34	2.24	1.83	2.16	5.08
35	1.64	2.09	2.35	3.79
36	2.65	1.31	1.20	3.18
37	1.57	2.24	1.76	5.09
38	4.48	4.18	5.22	4.17

Potassium fixation: The variation in the potassium fixing capacity of the surface samples is from 1.04 to 7.93 me/1 OOg, while that in the subsurface samples is from 1.33 to 7.34 me/1 OOg (Table 1). Potassium fixing capacities equivalentto 4.00, 1.93, 1.83 and 0.12 me/1 OOg have been recorded for the black, forest, *Pokkali* and laterite soils of Kerala (Anon, 1980). The range of potassium fixing capacity recorded for the *Poonthalpadam* soils in this study is higher than those obtained for the other soil types of Kerala.

Potassium fixation is correlated with the clay content positively and significantly (r= +0.985). Grewal and Kanwar (1973) observed 85.0 to 97.8 per cent potassium fixation occurring in the clay fraction of some Punjab soils. Zabravskaya (1974) reported that particles less than 10 microns are responsible for potassium fixation. Positive and significant correlation between clay percentage and potassium fixation has been obtained by Ramanathan and Krishnamoorthy (1976) for the South Indian soils, Joshi *et al*. (1978) for the arid soils of Jodhpur, and Ranganathan and Satyanarayana (1980) for the Karnataka soils.

Table 2

Phosphorus fixing capacity of surface as subsurface soil samples, percent

Village	Surface	Subsurface
Chittoor proper	69	70
Kuttippallam	56	47
Thamarachira	49	58
Thekkedesam	63	44
Valiavallampathy	42	41
Perumatty	35	22

Table 3

Coefficients of simple correlation between nutrient fixation and soil properties

Sl. No.	Variables X	Variables Y	Coefficient of correlation (O	No. of pairs of values (n)
1	Ammonium fixation	Free calcium carbonate	+ 0.255*	76
2	Ammonium fixation	Organic matter	+ 0.232*	76
3	Ammonium fixation	Clay	+ 0.231*	76
4	Phosphorus fixation	Free calcium carbonate	+ 0.947*	12
5	Phosphorus fixation	Clay	+ 0.614*	12
6	Potassium fixation	Clay	+ 0.985*	38
7	Poiassium fixation	Sand	—0.774*	38

* Significant at 0.05 level

A significant negative relationship exists between potassium fixation and sand percentage (r = —0.774) suggesting clearly the role of clay minerals in potassium fixation which is higher in soil samples rich in clay.

സംഗ്രഹം

കേരളത്തിലെ പൂന്തൽപാടം മണ്ണിന് പ്രധാന സസ്യമൂലകങ്ങളായ നൈട്രജൻ (അമോണിയം), ഫോസ്ഫറസ്, പൊട്ടാസ്യം എന്നിവയെ യൗഗികീകരിക്കാനുള്ള കഴിവ് കൂടുതലാണ്. ഈ പ്രക്രിയയെ നിയന്ത്രിക്കുന്ന പ്രധാന ഘടകം, മണ്ണിലെ കളിമണ്ണിന്റെ അംശം ആണെന്നു കണ്ടു.

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