

## **Retention, Release and Transformation of Phosphate and Potash in Relation to Soil Fertility Potential of Three Major Soils**

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Present work reports behaviour of phosphate and potash fertilizer in three distinct soils. The quantity adsorbed, desorbed and transformed is calculated to interpret fertility potentials of these soils. Bounding energy of the soils to the nutrients is computed from Langmuir's adsorption isotherms, desorption and distribution patterns are developed from the quantities extracted in different forms.

### **INTRODUCTION**

Various soils show different behaviour in presence of specific nutrients which is dependent of their physico-chemical properties<sup>1-3</sup>. The fertilizer added undergoes changes in the soil which effects on nutrient availability of the soil. Amount of nutrient strongly adsorbed on the soils determines the fertility potential. Therefore, nutrient sorption characteristics can be used to evaluate fertilizer requirements of the soil. Ability of soils to release nutrient easily can be evaluated from the desorption patterns where as dominant fraction of nutrient transformed is computed from the transformation patterns.

### **EXPERIMENTAL**

Profile soil samples of distinct type such as, laterite, red sandy loam and forest soils were collected and used for study after usual laboratory processing.

The quantity of phosphate and potash adsorbed as a function of amount added was determined by equilibrating the soils with nutrients for 72 hrs<sup>3</sup>. Phosphate adsorbed was extracted from soils with Bray (No. 1) solution, then amount was estimated by chloro-stannous reduced molybdophosphoric acid method. On the other hand potash adsorbed was determined by flame photometer after extracting it from soils with 1 N neutral ammonium acetate<sup>4-8</sup>.

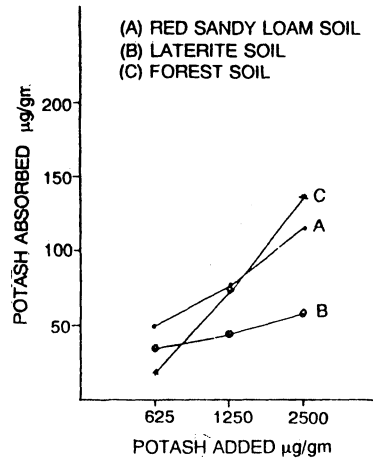
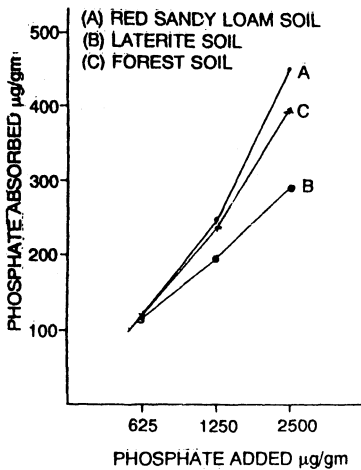
Desorption and selective distribution of phosphate and potash was aimed to study the ability of soils to supply and to transform the nutrients into various forms. Soils after saturating with nutrients were extracted for eight times and amount desorbed was estimated from the extract. Quantity of nutrients transformed into various forms was estimated after saturating the soils with nutrients for 72 hrs. Phosphate was fractionated as saloid bound, aluminium bound, iron bound and calcium bound phosphate where as potash was fractionated as water soluble, 0.1 M calcium chloride extractable, exchangeable and fixed potash.

Results of adsorption were fitted into Langmuir's adsorption isotherm, adsorption

maximum and bounding energy of soils for the nutrients were computed<sup>10</sup>. Desorption and distribution patterns were developed by plotting the quantity of nutrient desorbed and distributed as a function of extraction and form in which distributed<sup>9</sup>.

### RESULTS AND DISCUSSION

The results indicate that the adsorption of phosphate and potash progressively increased with increasing concentration in all the three soils. The increased adsorption of phosphate is probably accompanied by higher energy of adsorption. However more adsorption was recorded by red sandy loam soil compared to other two. This may be probably due to the presence of  $R_2O_3$  as well as fairly high content of clay minerals. Different organic components present in the red sandy soil influence the adsorption of phosphate<sup>1</sup>. Though clay content and organic matter in the forest soil is more, adsorption of phosphate and potash is moderate. Laterite soils supposed to fix high amount of phosphate but it is not reflected in the present study.



**Fig. 1** Phosphate adsorption: (a) Red sandy loam soil, (b) Laterite soil, (c) Forest soil

**Fig. 2** Potash adsorption: (a) Red sandy loam soil, (b) Laterite soil, (c) Forest soil

The isotherm constants 'b' and 'k' showed almost similar trend as that of adsorption properties of the soils. The adsorption maximum is high for red sandy loam soil followed by forest and laterite soil for both, phosphate and potash (Table 1). This suggests that high amount of adsorbate is present in the soil. Bounding energy showed reverse trend as that of 'b' value. As adsorption maxima increases, bounding energy decreases which further implies that adsorbed phosphate and potash could be desorbed easily in the red sandy loam soil compared to laterite and forest soils. The releasing and displacement of adsorbed phosphate

and potash would be rather difficult and require stronger force to release in the laterite soil which has greater binding on the nutrients<sup>6</sup>.

TABLE 1  
LANGMUIR'S ADSORPTION CONSTANTS FOR PHOSPHATE AND  
POTASH BY SOILS

Soil type	b ( $\mu\text{g/g}$ )		K $\times 10^{-3}$	
	Adsorption maximum		Adsorption energy	
	Phosphate	Potash	Phosphate	Potash
Red sandy loam soil	1151	550	24.3	0.4723
Laterite Soil	310	144	251	2.077
Forest Soil	450	180	88	2.905

The results of desorption of phosphate and potash showed that first three extractions desorbed major portion of the nutrients in all the three soils, thereafter desorption tended to almost a constant. The release of phosphate was more in the red sandy loam and forest soils compared to the laterite soil. This is related with the percentage of clay content and free iron oxides present in the soil. Greater releasing capacity is also probably due to high adsorption of phosphate by these soils. On the other hand, desorption of potassium is resolved more in the laterite followed by red sandy loam soil. Initially, high desorption of phosphate in the laterite and potash in the forest soil was achieved. After fifth extraction release rate of potash is constant for all the three soils which suggests that the potassium supplying capacity of these soils is at a constant rate of 4 to 5 ppm.

Data on selective distribution of phosphate and potash revealed that the dominant fraction of the phosphate is aluminium bound followed by iron bound in all the three soils. When phosphate fractionation is made water soluble phosphate gets converted into aluminium phosphorous (Al-P)<sup>5</sup>. The solid bound phosphorous is also high

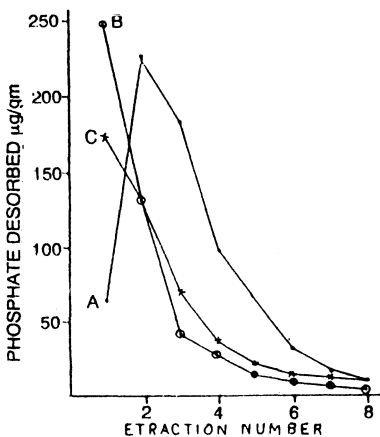


Fig. 3 Phosphate desorption: (a) Red sandy loam, (b) Laterite soil, (c) Forest soil

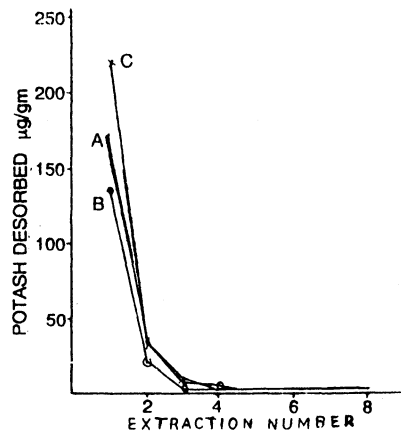
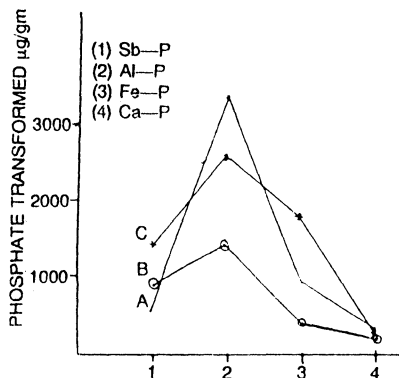
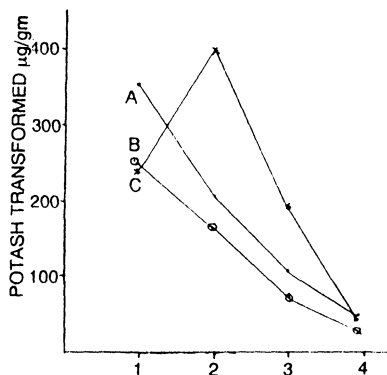


Fig. 4 Potash desorption: (a) Red sandy loam soil, (b) Laterite soil, (c) Forest soil



**Fig. 5** Phosphate transformation: (a) Red sandy loam soil, (b) Laterite soil, (c) Forest soil



**Fig. 6** Potash transformation: (a) Red sandy loam soil, (b) Laterite soil, (c) Forest soil

indicating that the fairly high amount of phosphate are still held loosely in the soil which is readily available to the crop. On the other hand major portion of the added potash was held in the water soluble form followed by loosely bound potassium. Strongly bound potassium is low indicating that these soils do not fix the potassium to large extent. This may be due to the absence of 2 : 1 illite type clay minerals in the soil. The dominant clay mineral in these soil is 1 : 1 kaolinite type which loosely hold potassium on their exchange site<sup>9</sup>.

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### REFERENCES

1. Jr. Andrew Evans, *J. Soil Science*, 140, (1985).
2. D.O. Ataga and U. Omati, *J. Niger. Inst. for Oil palm res.*, 5, 37, (1978).
3. C.C. Biddappa, Ph. D. Thesis, U.A.S. Bangalore, 51 (1972).
4. C.A. Black (Edt), *Methods of Soil analysis*, Agronomy no. 9, part II, 7H-1572, Amm-soc of agronomy, Inc, publisher, Medicon, Wiscosin, U.S.A. (1965).
5. V. Balsubramanian and D.D. Raj, *Madras Agric., J.* 56, 790 (1969).
6. B. Chatterjee and N.P. Datta, *J. Soil Sci.*, 2, 224 (1951).
7. A.J. Dandy, R.J. Morrison and L.D.C. Chase, *Tropical Agric.*, 51, 49 (1982).
8. M.L. Jackson, *Soil Chemical analysis*, Printice Hall, New Delhi, (1967).
9. H.H. Khan, O.P. Joshi and C.C. Bidappa, *PLACROSYM*, V, 411 (1982).
10. S.R. Olsen and F.S. Watiambe, *Soil. Sci. Soc. Amer. Proc.*, 21, 144 (1957).