http://www.pjbs.org

PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences, 2 (3): 897-899, 1999 Research Article

Phosphate Adsorption/desorption in Seven Soil Series of Pakistan

Nisar Ahmad, Abdul Razzaq and Muhammad Yaseen
Department of Soil Science , University of Agriculture, Faisalabad-38040, Pakistan

Abstract

A laboratory experiment was conducted to study the phosphorus adsorption and desorption characteristics of Pindorian, Satghrah, Shahdara, Wazirabad, Balkassar, Hafizabad and Missa soil series of Pakistan. Surface soil samples of these soil series were collected and analysed for EC, pH, OM, $CaCO_3$, and texture. Five levels of P (50, 100, 200, 400 and 800 ug P/g of soil) were added to these samples and were shaken for 24 hours and got filtrate after centrifugation. The amount of desorbed P was determined by using $NaHCO_3$ solution as an extractant. The soils with high amount of $CaCO_3$ or clay or both adsorbed larger amounts of added P than the soils having the lower amounts of $CaCO_3$ or clay or both. Similarly, the soils with more $CaCO_3$ released the adsorbed P in lower amounts as compared to the soils having less $CaCO_3$ contents. The order of P adsorption by these soils were: Missa > Hafizabad > Balkasser > Pindorian > Satghrah > Shahdara > Wazirabad and the order of desorption were just reverse to it. Although the total amount of adsorbed P increased with increasing P application but the recovery of adsorbed P remained almost same at each level of P application.

Introduction

The supply of P is much important in arid/semi arid regions where its availability is a problem due to its adsorption/ precipitin on $CaCO_3$ and clay contents. These reactions convert the added P into insoluble or less soluble phosphate compounds and the availability of added P to plants hampered. Transformation of P into insoluble and slowly soluble compounds is considered as primary cause of the in efficient utilization of phosphate fertilizers (Sharpley, 1983). Afif *et al.* (1993) found that the loss of availability of P relates to the nature of the processes of adsorption and precipitation but net outcome of these processes is a complex function of the soil composition (amount of clays, $CaCO_3$ and Fe oxides) and P addition rate. Rashid *et al.* (1994) concluded that P-recovery decreased as the $CaCO_3$ contents increased in calcareous soils. Phosphate sorption in soils decreased with the decrease in clay and $CaCO_3$ (Chand *et al.*, 1995). Ahmad *et al.* (1992) concluded that the availability of P affected by clay contents and type of clay mineralogy in addition to other factors. Phosphorus adsorption increased with increasing clay contents in soil (Nakos, 1987 and Dimirkoru, 1993).

Calcium carbonate content also reduced the extract ability of Olsen P (Sarir *et al.*, 1992). The present study is planed to get a better understanding of the adsorption/ desorption of P in different soils. The objectives of the present study were:

- To investigate the extent of adsorption and desorption of P by some soils of Pakistan.
- To study the effect of soil properties like $CaCO_3$ clay contents, OM and pH on the P adsorption/desorption.

Materials and Methods

The laboratory study was conducted in department of soil science, University of Agriculture, Faisalabad. Surface (0-15 cm) soil samples of Pindorian, Satghrah, Shahdara, Wazirabad, Balkassar, Hafizabad and Missa were collected, dried, ground and sieved through a 2 mm sieve. The soil samples were analysed for EC, pH, texture (Moodie *et al.*, 1959), OM (Nelson and Sommers, 1982) and $CaCO_3$ (Richard, 1954). Phosphorus was extracted by $NaHCO_3$ and analysed by using the method described by Watanabe and Olsen, (1965).

Adsorption experiment: Duplicate samples of 2.5 g from each soil were mixed with 25 ml solution of KH_2PO_4 prepared in 0.01 M $CaCl_2$ containing 5, 10, 20, 40 and 80 ug P ml^{-1} in a centrifuge tube. The samples were shaken for 24 hours and filtrate was got after centrifugation. Filtrate was used to determined P. The difference between the amount of P added to the soil samples and estimated from the filtrate gave the amount of adsorbed P.

Phosphorus extraction: The P from the enriched soil samples (Previously treated with P solution of different concentrations) was extracted by using 0.5 M $NaHCO_3$ as extractant.

Results and discussion

The chemical analysis of the soils showed that the Pindorian and Wazirabad were the non-calcareous, Satghrah and Shahdara Slightly calcareous ($CaCO_3$ < 3%), While the Balkassar, Hafizabad and Missa were the moderately calcareous (Table 1). The Pindorian and Shahdara soils were medium in texture. The satghrah, Hafizabad and Missa were comparatively fine textured soils while the Hafizabad and Balkassar soils were coarser in texture. The ECe, pH, OM, and Olsen P were almost same in all the soils with minor variations.

Table: 1 Physical and chemical characteristics of the soils

Soil Series	Clay (%)	$CaCO_3$ (%)	OM (%)	EC dS/m	pH	Olsen P (ug g^{-1})	Textural Class
Pindorian	23.8	0.4	0.62	1.0	7.8	17.4	Silty Clay Loam
Satghrah	38.7	2.0	0.54	1.2	8.9	16.5	Loamy Clay
Shahdara	21.0	1.8	0.32	0.8	8.1	9.1	Clay Loam
Wazirabad	15.2	0.3	0.48	0.7	7.4	7.1	Sandy Loam
Bulkasar	16.2	9.8	0.28	0.6	7.8	4.8	Sandy Loam
Hafizabad	36.6	10.1	0.53	2.1	8.0	17.5	Loamy Clay
Missa Silty	32.7	13.4	0.23	0.6	7.8	4.9	Loamy Clay

Table: 2 Phosphorus adsorption (%)* by the soils after incubation period of 24 hours

	Initial P concentration in soil solution (ug ml^{-1})				
Soil series	5	10	20	40	80
Pindorian	80.2	81.6	71.0	59.7	37.0
Satghrah	83.6	83.0	76.2	65.3	44.3
Shahdara	74.2	60.4	56.8	40.6	23.7
Wazirabad	85.0	58.0	30.9	15.5	8.4
Bukasar	86.0	81.5	79.9	77.5	69.5
Hafizabad	89.2	87.8	85.1	82.1	80.0
Missa	91.6	88.88	87.6	89.3	86.4

Table 3: Phosphorus desorption (%)* by the soils after an incubation period of 24 hours Initial P concentration soil solution(ug ml^{-1}).

Soil series	5	10	20	40	80
Pindorian	96.3	84.3	83.2	83.3	86.1
Satghrah	90.4	84.8	69.5	71.1	72.9
Shahdara	92.4	85.9	85.5	85.6	84.2
Wazirabad	84.0	92.2	95.0	98.1	93.9
Bukasar	51.4	54.7	53.2	55.6	58.7
Hafizabad	73.3	67.8	58.3	56.2	57.2
Missa	44.5	47.5	51.6	49.1	51.0

Adsorption of P by soils: The Fig.1 showed that the total amount of adsorbed P increased as the amount of P added in soil was increased in all the soils except Wazirabad. The Wazirabad adsorbed almost the same amount of P at each level of P-application. Similar results were found by Singh *et al.* (1991) in salt affected soils. Although the total quantity of adsorbed P increased with the addition of P but the relative amount of adsorbed P was decreased with increasing the amount of added P. (Table 2). Results revealed that the P adsorption capacity of different soils was: Missa> Hafizabad> Balkassar> Pindorian> Satghrah> Shahdara> Wazirabad.

Relationship between P adsorption and soil properties: Results showed that the total adsorbed P is directly related to the amount of $CaCO_3$ and generally with clay contents. Results revealed that as the $CaCO_3$ contents in soils increased, the amount of P adsorbed increased at each level of P application but the effects of $CaCO_3$ were more prominent at higher level of P addition (Table 2).The Balkassar, Hafizabad and Missa (High $CaCO_3$ conte adsorbed higher amounts of added P than the Pindo Satghrah, Shahdara and Hafizabad (with low Ca contents). Similarly fine textured soils (Hafizabad Missa) adsorbed larger quantities of P as compare coarse textured soils (Wazirabad and Bulkassar). The re of more adsorption due to the presence of high $CaCO_3$ clay contents might be the retention and formatio relatively insoluble compounds of added P with Ca Sharif (1985) found that the applied P under transformation by reacting with clay and Ca compo and converted into less available form of P. T requirements appeared to be controlled by primari calcareousness and clay contents (Das *et al.* (1993), R *et al.* (1994) and Agbenin and Tiessen, (1995).

Phosphorus desorption: Results showed that the quantity of extracted (desorbed) P increased by incr the rates of P application but the recovery of adso from the each soil was almost the same at all the le

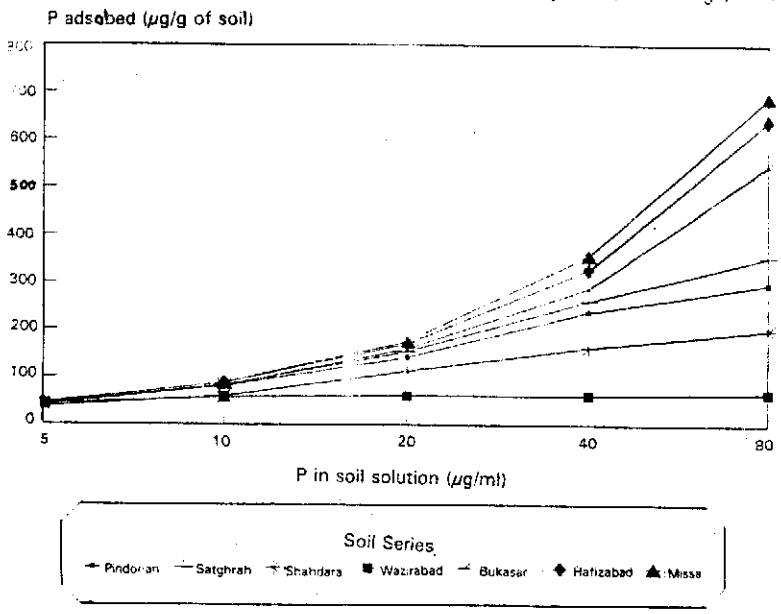

Fig. 1: P adsorption by the soil samples after 24 hours incubation

applied P (Table 3). The extract ability of adsorbed P was directly and negatively related to the amount of $CaCO_3$ and clay contents. The soils having large quantity of $CaCO_3$ or clay or both released lower quantity of adsorbed P and vice versa. The Pindorian, Satghrah, Shahdara and Wazirabad released P in higher amounts as compared to the Balkassar, Hafizabad and Missa (with high $CaCO_3$ contents). The effect of OM, pH and EC on the amount of P adsorbed and desorbed was not apparent. The reason might be almost the same status of all soils with respect to OM, pH and EC.

References

Afif, E., M. Martar and J. Torrent, 1993. Availability of phosphate applied to calcareous soils of West Asia and North Africa. Soil Sci. Soc. Am. J., 57: 756-760.

Agbenin, J.O. and H. Tiessen, 1995. Phosphorus sorption at field capacity and soil ionic strength: Kinetics and transformation. Soil Sci. Soc. Am.J., 59: 998-1005.

Ahmad, N., M.T. Saleem and I. T. Twyford., 1992. Phosphorus research in Pakistan. A Review. Proc. Symp. on Role of Phosphorus in crop production. NFDC Islamabad., December 1992, pp: 69.

Chand, M., S.N. Randhawa and A. C. Vig, 1995. Phosphate adsorption characteristics of some bench mark soils of N.W. India and their relationship with soil properties. J. Indian Soc. Soil Sci., 43: 582-586.

Das, P.K., G.C. Sahu and S.S.K.N. Acharya, 1993. Effect of soil Characteristics on phosphate fixing capacity of some Alfisols. J. Indian Soc. Soil. Sci., 41: 51-55.

Dimirokou, A., I. Mitsios, A. Ioannou, C.P. Pashalidis and M. Doula, 1993. Kinetic study of phosphorus desorption by Alfisols and Entisols. Commun. Soil. Sci. Plant Anal., 24: 989-1001.

Moodie, C.D., H.W. Smith and R.A. McCreery, 1959. Washington State college, Mimeograph.

Nakos, G., 1987. Phosphorus adsorption by forest soils. Commun. Soil Sci. Plant Anal., 18: 279-286.

Nelson, O.W. and L.E. Sommers, 1982. Total carbon, organic matter. In Page *et al.* (eds.) Methods of soil analysis. Part 2.Soil Sci. Soc. Am. Madison, Wisconsin.

Rashid, M.T., M.Yasin and M.S.Zia, 1994. Phosphorus availability to wheat in three calcareous soils of rice tract. Proc. 4th National Cong. Soil Sci., Islamabad, May 24-26 (1992) pp: 265-269.

Richards, L.A., 1954. Diagnosis and improvement of Saline and alkali soils. USDA. Hand book 60, Washington, DC.

Sarir, M.S., I.D. Pulford and T.H. Flowers, 1992. Transformation of phosphorus and its availability to plants. Proc. Sym. on the Role of phosphorus in crop production. December, 1992, NFDC, Islamabad.

Sharif, M., 1985. Improvement of phosphate fertilizer efficiency. In: International Seminar on fertilizer use efficiency, November, 4-6, 1985, Lahore. Fauji Fertilizer Company, Lahore.

Sharpley, A.N., 1983. Effect of soil properties on the Kinetics of phosphorus desorption. Soil Sci. Soc. Am. J., 47: 462-467.

Singh, R.K., T.G. Sastry, M.B. Sengupta, N.N. Goswami and B.P. Singh, 1991. Phosphate adsorption in salt affected soil. J. Indian Soc. Soil. Sci., 39: 446-451.

Watanabe, F.S. and S.R. Olsen, 1965. Test of an ascorbic acid method for determining phosphorus in water and $NaHCO_3$ extracts from soil. Soil Sci. Soc. Am. Proc., 29: 677-678.