

ROLE OF CALCIUM CARBONATE ON PHOSPHATE SORPTION IN SOIL

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ABSTARCT

The results obtained showed that for all CaCO₃ levels, the phosphate sorption was increased with the increase in the added phosphorus from 5.0 to 1000 µg g⁻¹ soil. It was further observed that at 10% calcium carbonate no precipitation of calcium phosphate was noticed even at higher phosphorus additions. However, when the calcium carbonate level was increased from 20% to 50%, the calcium phosphate precipitation was apparent at the phosphorus additions of 500 and 1000 µg g⁻¹ soil respectively.

Key words: Calcium carbonate, Phosphate, Sorption, soil property, plant.

INTRODUCTION

The phosphate has high affinity for mineral surfaces; therefore, the phosphorus is often the least available of the biologically essential elements. Efficiency of the applied P fertilizer is only about 20% under alkaline calcareous soils conditions. It is thought that calcium carbonate governs the phosphate sorption and replenishment of solution P to meet plant roots uptake rate. Phosphorus fertilizer recommendations as currently practiced in Pakistan are generalized and not site specific. Fertilizer is a costly input hence; its efficient use through soil specific recommendations is increasingly recognized. Javid and Rowell (2002) reported that the phosphate sorption capacity of Pakistani soils was well correlated with clay and organic matter contents ($r^2 = 0.75$ and 0.18 for clay and 0.60 and 0.65 for organic matter respectively). Phosphate compounds formed during incubation periods in different soils behaved in a different way for their phosphate availability at later stage.

Agbenin and Tissen (1995) reported that the adsorption from high initial phosphorus added levels was initially low than that from the low initial phosphate levels but slowly increased with increasing incubation period and might be due to the greater number of phosphate ions could be desorbed. Torrent (1995) concluded that the surface adsorption and precipitation are the major phosphate retention processes depressing the availability of applied phosphorus. Phosphorus fertilization of some calcareous soils produces poorly soluble calcium phosphate compounds at the site of fertilizer particle and precipitated calcium phosphate forms in the vicinity of the particle.

Almost total P fertilizer requirements of our country depend mostly on the imported phosphate fertilizer, which is also an expensive commodity. For complete understanding of P bioavailability it is essential to understand the processes involved in its sorption. It is anticipated that this study will provide useful data for site-specific fertilizer recommendations and formulation of fertilizer management strategies.

The soluble phosphate compounds when added to the soil react rapidly with various soil components like CaCO₃, clay, organic matter, iron and aluminum oxides and are quickly converted to the slowly available forms. In addition to these properties, adsorption also depends on contact time between soil and phosphate and temperature (Indiati *et al.*, 1999).

It was therefore, considered essential to study the relationship of phosphate adsorption in soil with varying calcium carbonate and phosphorus levels which could help in better fertilizer management for economical crop yield.

MATERIALS AND METHODS

The study was carried out to asses the effect of calcium carbonate levels on P sorption in soil. A bulk surface soil sample (0-15cm) was collected from Agriculture Research Farm of Sindh Agriculture University, Tando Jam. Soil samples as air dried, crushed, and passed through 2 mm sieve. The sample was analyzed for soil texture, organic matter, lime content, pH, electrical conductivity and available phosphorus by (Jackson, 1985). Soil samples containing calcium carbonate 20, 30, 40 and 50% were prepared. Phosphate sorption data was obtained by shaking 10 g soil samples (in duplicate) with 100ml of 0.01M CaCl₂ in 300 ml glass bottles. The samples were prepared in triplicate. Varying P amounts of 5, 10, 25, 50, 100, 250, 500 and 1000 µg g⁻¹ soils were added as KH₂PO₄ and samples were shaken for 2 days (48 hours) on an orbital shaker at the speed of 150 rpm. About 5-8 drops of toluene

were also added to the suspension to suppress the microbial activity. At the end of incubation, the samples were filtered through Whatman filter paper No. 42. The concentration of P in filtrate was determined following Murphy and Riley (1962). The amount of P sorbed was calculated Fox and Kamprath (1970).

RESULTS AND DISCUSSION

The results obtained showed an increasing positive relationship between CaCO_3 levels and P sorption, for all P levels.

Table 2. Effects of calcium carbonate and phosphorus levels on phosphate sorption.

S.No.	P level $\mu\text{g g}^{-1}$	CaCO ₃ Level									
		10%		20%		30%		40%		50%	
		PE	PS	PE	PS	PE	PS	PE	PS	PE	PS
1	5.0	0.33	1.63	0.20	2.75	0.15	3.41	0.12	3.75	0.06	4.4
2	10	0.34	6.51	0.20	7.96	0.15	8.4	0.15	8.5	0.09	9.13
3	25	0.43	20.63	0.21	22.8	0.18	23.2	0.16	24.0	0.16	24.0
4	50	0.79	42.03	0.25	47.5	0.19	48.1	0.18	48.8	0.18	49.0
5	100	0.99	90.03	0.87	91.2	0.56	94.4	0.30	97.9	0.31	97.9
6	250	2.37	226.3	1.10	239.0	1.06	239.4	0.90	244.6	1.00	247.3
7	500	4.61	453.9	0.65	493.5	0.79	486.8	0.82	491.8	0.80	492.1
8	1000	46.56	534.4	1.01	989.9	0.54	993.0	0.15	994.6	0.70	998.5

PA = Phosphorus added = $\mu\text{g g}^{-1}$, PE = Phosphorus at equilibrium = $\mu\text{g 10 ml}^{-1}$, PS = Phosphate sorbed by soil = $\mu\text{g g}^{-1}$

Effect of calcium carbonate levels:

CaCO₃ =10%

At 10% calcium carbonate in the soil and P levels of 5, 10, 25, 50, 100, 250, 500 and 1000 μgg^{-1} soil, the phosphate sorbed was 1.63, 6.51, 20.63, 42.03, 90.03, 226.3, 453.9 and 534.4 μgg^{-1} soil respectively (Table 2). The results revealed no precipitation in the system. Phosphate sorption increased for increasing of phosphorus added levels. Similar results were reported by Torrent (1995).

CaCO₃ =20%

At 20% calcium carbonate in the soil and P levels of 5, 10, 25, 50, 100, 250, 500 and 1000 μgg^{-1} soil, the phosphate sorbed was 2.75, 7.96, 22.85, 47.5, 91.25, 239.0, 493.5 and 989.9 μgg^{-1} soil respectively (Table 1). The results revealed that calcium phosphate precipitation was formed during process at phosphorus added levels of 500 μgg^{-1} soil. Phosphate sorption increased with the increasing of phosphorus levels. Similar results were reported by Torrent (1995).

CaCO₃ =30%

At 30% calcium carbonate in the soil and P levels of 5, 10, 25, 50, 100, 250, 500 and 1000 μgg^{-1} soil, the phosphate sorbed was 3.41, 8.5, 23.2, 48.1, 94.4, 239.9, 492.1 and 994.6 μgg^{-1} soil respectively (Table 1). The results

revealed no precipitation in the system. Precipitation was also observed for P levels of 500 $\mu\text{g g}^{-1}$ soil. Phosphate sorption increased for increasing of phosphorus levels. Similar results were reported by Torrent (1995).

CaCO₃ =40%

At 40% calcium carbonate in the soil and P levels of 5, 10, 25, 50, 100, 250, 500 and 1000 $\mu\text{g g}^{-1}$ soil, the phosphate sorbed was 3.75, 8.41, 24.0, 48.8, 97.9, 244.6, 491.8 and 998.5 $\mu\text{g g}^{-1}$ soil respectively (Table 1). The results revealed that calcium phosphate precipitation was formed during process at phosphorus added levels of 500 $\mu\text{g g}^{-1}$ soil. Phosphate sorption increased with the increasing of phosphorus levels. Similar results were reported by Torrent (1995).

CaCO₃ =50%

At 50% calcium carbonate in the soil and P levels of 5, 10, 25, 50, 100, 250, 500 and 1000 $\mu\text{g g}^{-1}$ soil, the phosphate sorbed was 4.4, 9.13, 24.0, 49.0, 97.9, 247.9, 468.8 and 99.3 $\mu\text{g g}^{-1}$ soils respectively (Table 2). The results revealed that calcium phosphate precipitation was formed during process at phosphorus added levels of 500 $\mu\text{g g}^{-1}$ soil (Table 1). Phosphate sorption increased for increasing of phosphorus levels. Similar results were reported by Torrent (1995).

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