

## Effect of Incubation Period on the Phosphate Adsorption in Seven Soil Series of Pakistan

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### Abstract

A laboratory experiment was conducted to study the effect of incubation period on the phosphorus adsorption by the Pindorian, Satghrah, Shandara, Wazirabad, Balkassar, Hafizabad and Missa soil series of Pakistan. Five levels of P (50, 100, 200, 400 and 800  $\mu\text{g P/g}$  of soil) were added to these samples and incubated for 1, 7 and 15 days. Results showed that the amount of adsorbed P increased by increasing the incubation period from 1 to 15 days. The highest adsorption was found after 15 days incubation period and lowest P was adsorbed after incubation period of one day in all the soils and 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/precipitation on  $\text{CaCO}_3$  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 inefficient utilization of phosphate fertilizers (Sharpley, 1983). Chaudhry and Qureshi (1980) reported the average phosphorus fixation of 71, 62, 56 and 29 per cent of the added P in clayey, clay loam, sandy loam and loamy sand soils respectively after one month of incubation. Agbenin and Tiessen (1995) investigated the time dependent phosphate sorption and found that after 50 days, sorption approached a steady state in all soils. Mendoza and Barrow (1987) incubated the five Argentinean soils for period of up to 60 days and found that the amount of P extracted from the soil decreased as the period and temperature of incubation increased. Biswas and Ghoshi (1988) found a decrease in recovery of added P in alkaline alluvial soils with the increase in time and temperature of incubation. Garcia-Rodeja and Gil-sotres (1995) found that the concentration of desorbed P increases with time. The objective of the present study was to investigate the effect of incubation period (time of contact between soil and P) on the phosphate adsorption.

### Materials and Methods

A laboratory study was conducted in the Department of Soil Science, University of Agriculture, Faisalabad. Surface (0-15 cm) soil samples of Pindorian, Satghrah, Shandara, 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) and  $\text{CaCO}_3$ , (Richards, 1954) (Table 1). Phosphorus was extracted by  $\text{NaHCO}_3$  and analysed by using the method described by Watanabe and Olsen (1965).

**Incubation experiment:** Duplicate samples of 2.5 g from each soil were mixed with 25 ml solution of  $\text{KH}_2\text{PO}_4$  prepared in 0.01 M  $\text{CaCl}_2$ , containing 5, 10, 20, 40 and 80

$\mu\text{g P ml}^{-1}$  in a centrifuge tube. Similarly, two more sets of centrifuge tubes were prepared by taking 2.5 g soil and adding 25 ml of each solution. After 24 hour shaking at  $25^\circ\text{C}$ , the first set of tubes were centrifuged immediately while the second and third set were incubated for 7 and 14 days respectively, following shaking daily for an hour. After incubation, these sets were also centrifuged at 2500 rpm for 5 minutes. The supernatant was filtered through whatman filter paper No. 42 and filtrate was used for P analysis. The difference between the amount of P added to the soil samples and estimated from the filtrate gave the amount of adsorbed P.

### Results and Discussion

The amount of P adsorbed by the soils after the incubation period of 1, 7 and 15 days, is presented in Table 2, 3 and 4 respectively. Results showed that by increasing the time of incubation, the P-adsorption was increased in all the soils. The highest amount of adsorbed P was found after an incubation period of 15 days and minimum adsorption was observed after 24 hours incubation period at each level of P-application. In the Pindorian soil, at the highest level of P-application, the maximum amount of P was adsorbed after 24 hours incubation and after that (with increasing contact time), the quantity of adsorbed P decreased. But the difference in amounts of P adsorbed after 24 hours, 7 and 15 days incubation were very small and negligible.

The Satghrah soil adsorbed  $354.0 \mu\text{g g}^{-1}$  in 24 hours incubation,  $374.5 \mu\text{g g}^{-1}$  in 7 days and  $380.1 \mu\text{g P g}^{-1}$  of soil in 15 days incubation period at  $80 \mu\text{g ml}^{-1}$  concentration in the soil solution.

Shandara soil reached to its maximum P adsorption capacity in 7 days at  $5 \mu\text{g P ml}^{-1}$  in soil solution but at higher P concentrations (110, 20 and  $40 \mu\text{g ml}^{-1}$ ), the maximum P adsorption capacity attained in 15 days incubation period. Again at highest level of P application, the maximum P was adsorbed in 7 days.

At lower rate ( $5 \mu\text{g ml}^{-1}$  p in soil solution) of P-application, the Wazirabad soil adsorbed 42.5, 44.7 and  $49.2 \mu\text{g P g}^{-1}$  soil after a incubation period of 24 hours, 7 and 15 days.

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Table 1: Physical and chemical characteristics of the soils

Soil Series	Clay (%)	CaCO <sub>3</sub> (%)	ECdS/m	pH	Olsen P ( $\mu\text{g g}^{-1}$ )	Textural Class
Pindorian	23.8	0.4	1.0	7.8	17.4	Silty Clay Loam
Satghrah	38.7	2.0	1.2	8.9	16.5	Loamy Clay
Shandara	21.0	1.8	0.8	8.1	9.1	Clay Loam
Wazirabad	15.2	0.3	0.7	7.4	7.1	Sandy Loam
Bulkasar	16.2	9.8	0.6	7.8	4.8	Sandy Loam
Hafizabad	36.6	10.1	2.1	8.0	17.5	Loamy Clay
Missa	32.7	13.4	0.6	7.8	4.9	Loamy Clay

Table 2: Phosphorus adsorption by the soils after an incubation period of 24 hours

Soil series	Initial P concentration in soil solution ( $\mu\text{g ml}^{-1}$ )				
	5	10	20	40	80
	<----- $\mu\text{g g}^{-1}$ soil----->				
Pindorian	40.1	81.6	142.0	238.6	296.4
Satghrah	41.8	83.0	164.2	261.2	354.0
Shandara	37.1	60.4	113.5	162.4	199.8
Wazirabad	42.5	58.0	61.8	62.0	67.3
Balkassar	43.0	82.5	159.4	288.4	546.0
Hafizabad	44.6	87.8	170.2	328.5	640.1
Missa	45.8	88.8	175.2	357.3	690.0

Table 3: Phosphorus adsorption by the soils after an incubation period of 7 days

Soil series	Initial P concentration in soil solution ( $\mu\text{g ml}^{-1}$ )				
	5	10	20	40	80
	<----- $\mu\text{g g}^{-1}$ soil----->				
Pindorian	46.0	82.5	155.3	254.0	289.4
Satghrah	44.1	87.4	168.1	307.9	374.5
Shandara	45.8	73.9	137.4	194.5	215.9
Wazirabad	44.7	68.8	119.5	132.8	131.8
Balkassar	47.5	92.8	185.7	358.2	588.2
Hafizabad	48.0	94.2	188.4	372.0	697.3
Missa	48.5	96.2	190.8	383.5	727.1

Table 4: Phosphorus adsorption by the soils after an incubation of 15 days

Soil series	Initial P concentration in soil solution ( $\mu\text{g ml}^{-1}$ )				
	5	10	20	40	80
	<----- $\mu\text{g g}^{-1}$ soil----->				
Pindorian	48.6	85.1	161.4	260.0	288.8
Satghrah	48.0	90.3	180.5	317.1	380.1
Shandara	47.1	86.9	158.0	214.7	217.8
Wazirabad	49.2	70.8	138.9	134.9	135.8
Balkassar	47.9	94.3	192.9	378.0	591.3
Hafizabad	49.4	97.8	193.9	382.6	681.0
Missa	50.0	98.0	198.2	393.4	730.2

At highest rate of P application ( $80 \mu\text{g P ml}^{-1}$  in soil solution), this soil adsorbed  $67.3$ ,  $131.8$  and  $135.8 \mu\text{g P g}^{-1}$  soil after 24 hours, 7 and 15 days incubation period respectively.

The P adsorption capacities of the Balkassar, Hafizabad and Missa soils also increased with increasing the incubation time. The highest amounts of P adsorbed were related to the maximum incubation time (15 days) and lowest values for P-adsorption were found in minimum incubation time in

all the three calcareous soils.

These results guided towards the point that the steady state condition (equilibrium) attained within 7 day incubation. The further increase in incubation time did not show the further adsorption with same rate. The reason might be that the maximum number of adsorption sites were saturated after 7 days and after that, a steady state condition of equilibrium reached with in a period of 15 days. Tisdale *et al.* (1985) reported the similar results. Then

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reported that the amounts of P sorbed by soils are depend on the saturation of sorption complex or the number of sites available for reaction with added P. Agbenin and Tiessen (1995) investigated the time dependent P sorption of 5 soils and found a rapid initial phase followed by a slower sorption phase. At 50 days, sorption reached a steady state in all soils. Chand *et al.* (1995) found that the steady state equilibrium in low-P fixing alluvial soils is attained within two days. The results of incubation experiments on 19 soils showed that in all soils and at all P rates, availability index decreased with time (Afif *et al.*, 1993).

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