

## Short Communication

# Phosphate Sorption in Benchmark Vertisol and Alfisol Profiles

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The response of crops to added P is generally less predictable on Vertisols than on other soils such as Alfisols under similar agroclimatic conditions. The cause of low P responses to applied P in Vertisols is not known but is often attributed to sorption of phosphate (Murthy 1988). However, recent work on the behaviour of P in Indian Vertisols indicate that the Vertisols have relatively lower phosphate sorption capacity than other soils such as Ultisols and Oxisols, and that the adsorbed P remained easily desorbable (Sahrawat & Warren 1989; Shailaja & Sahrawat 1990). Comparative studies of phosphate sorption by benchmark Vertisols and Alfisols show that the Vertisols have a higher P sorption capacity and buffer power for phosphate sorption, implying a lower response to fertilizer P. However, all the adsorbed P remained labile to  $P^{32}$  (Sahrawat & Warren 1989).

The results described above were obtained on surface soils and additional information on P sorption in the profile of these soils is needed because partial erosion of the profile may modify P sorption behaviour of the soils. Additionally, Vertisols have the phenomenon of pedoturbation, leading to the mixing of soil materials during shrinking and swelling, thus affecting the P sorption behaviour of these soils.

The aim of this communication is to provide information on the comparative P sorption and the P requirements of horizons in benchmark Vertisol and Alfisol profiles at the ICRISAT Center,

Patancheru (Andhra Pradesh).

Soil profiles from Kasireddipalli series (Vertisol) and Patancheru series (Alfisol) were examined for their P sorption capacities. Some important properties of the profiles of benchmark Vertisol and Alfisol are given in table 1. The Kasireddipalli series is a Typic Pellustert developed on basaltic alluvium on the lower pediments and in depressions. The Patancheru series is in the clayey-skeletal, mixed isohyperthermic family of Udic Rhodustalf developed on weathered granite. The dominant layer silicate minerals are smectite type in the Vertisol and kaolinite type with small proportions of 2:1 layer-lattice clays and sesquioxides in the Alfisol (Murthy *et al.* 1982).

Soil samples were collected from all the horizons of the two profiles, air-dried and processed (< 2 mm). For organic C and total P analysis the samples were ground to pass through a 0.25 mm sieve. For the analyses reported in table 1, pH was measured by a glass electrode using a soil to water ratio of 1:2,

titration method. Carbonate (expressed as  $CaCO_3$ ) was determined by acid neutralization as described by Allison and Moodie (1965). The total P content of the soil was determined by digestion with perchloric acid (Olsen & Sommers 1982). Cation exchange capacity (CEC) of the soils was determined as described by Chapman (1965). Extractable iron in the soil samples was determined as described by Lindsay and Norvell (1978).

The phosphate sorption by the soils from different horizons in the two profiles was studied using the P sorption index (PSI) described by Bache and Williams (1971) with minor modification. In

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**Table 1.** Selected properties of the profiles of the benchmark Vertisol and Alfisol

Horizon	Depth (m)	pH	Org. C (g kg <sup>-1</sup> )	Clay (%)	CaCO <sub>3</sub> (g kg <sup>-1</sup> )	Total P (mg kg <sup>-1</sup> )	CEC [cmol (p <sup>+</sup> ) kg <sup>-1</sup> ]	Extr. Fe (mg kg <sup>-1</sup> )
<i>Vertisol (Kasireddipalli clay)</i>								
Ap	0-0.15	8.3	6.6	51	100.0	220	48	8.1
A11	0.15-0.40	8.5	3.3	54	93.0	150	46	8.1
A12	0.40-0.90	8.9	3.7	56	126.0	160	50	7.4
A13	0.90-1.50	8.9	2.9	59	152.0	190	49	6.1
AC	1.50-1.80	8.7	1.8	65	102.0	200	48	5.2
<i>Alfisol (Patancheru sandy loam)</i>								
Ap	0.10	6.3	6.2	19	—	140	11	11.0
B1	0.10-0.20	6.4	6.6	30	—	120	17	10.0
B21t	0.20-0.50	6.7	6.3	41	—	110	22	7.0
B22t	0.50-1.05	6.6	4.9	41	—	90	18	5.0
BC	1.05-1.45	7.4	2.0	24	15.0	90	26	4.2
C	1.45-1.60	8.0	1.0	26	21.0	140	25	3.1

view of the low P sorption capacity of the soils under preliminary experiments, the rate of P application was considerably lower than suggested in the method. The PSI is expressed as  $X \log c$ , where 'X' is the amount of P sorbed (mg P per 100 g soil) from one addition of P at the rate of 50 mg P kg<sup>-1</sup> soil and 'c' is the equilibrium concentration of P (μmol P L<sup>-1</sup>). The details of the method were as follows:

Duplicate soil samples (2 g) were placed in 50 mL centrifuge tubes, 25 mL of 0.01 M CaCl<sub>2</sub> solution containing 100 mg P as potassium dihydrogen phosphate was added. The tubes were kept at 25 ± 1°C for 6 days and were manually shaken for 5 minutes every day. The samples were then centrifuged for 10 min. and filtered through Whatman No. 1 filter paper. The P content in the clear solution was determined by the molybdenum blue method (Olsen & Sommers 1982). The average value was used to calculate the amount of P in solution. The difference between the amount of P added and that recovered in solution was considered to indicate the sorbed P for the soil sample. The PSI was determined using the formula,  $X \log c$  for each horizon in the two profiles.

The PSI index of a soil is a number and its value is relatively lower for a soil with higher P sorption capacity than for a soil with lower P sorption capacity (Bache & Williams 1971). In the Ver-

tisol profile, all horizons sorbed similar amounts of phosphate and the PSI varied from 5.2 to 11.1 (Table 2). The AC horizon sorbed the lowest amount of P, and the Ap and A 11 horizons the highest

**Table 2.** Phosphorus sorption index ( $X \log c$ )\* for different horizons in the profiles of a benchmark Vertisol and Alfisol, ICRISAT Centre

Soil horizon	X(mg P/100 g soil)	c (μmol P L <sup>-1</sup> )	X log c
<i>Vertisol (Kasireddipalli clay)</i>			
Ap	4.85	12	5.2
A11	4.86	12	5.2
A12	4.82	13	5.4
A13	4.80	13	5.3
AC	4.72	230	11.1
<i>Alfisol (Patancheru sandy loam)</i>			
Ap	4.80	13	5.3
B1	4.86	12	5.2
B21t	4.78	10	4.8
B22t	4.97	1.1	0.2
BC	4.79	11	5.0
C	4.75	40	7.6

Note: 'X' is the amount of P sorbed from one addition of P at the rate of 50 mg kg<sup>-1</sup> soil and 'c' equilibrium solution concentration of P

within a narrow range. For the Alfisol, P sorption and the PSI differed markedly between horizons,

B22t horizon had the lowest P sorption and highest PSI of 7.6 (Table 2). The PSI for different horizons in the Vertisol and Alfisol profiles varied from 0.2 to 11.1 and it was the lowest (indicating highest P sorption) for the B22t horizon in the Alfisol profile.

It is important to note that the B22t, an argillic horizon in the Alfisol profile, had a considerably higher P sorption capacity (the lowest PSI) than other horizons. It is reported that clays, particularly (1:1) lattice clays may contribute to P sorption and clay content has been reported to be correlated with P sorption in tropical soils because of higher iron and aluminium activity (Sanyal & DeDatta 1991). The results from this study show that PSI was not significantly correlated with the soil characteristics (see Table 2) for the Vertisol and Alfisol profiles. A combined statistical analysis of the data for the two profiles is not acceptable as the data of the two profiles represent two discrete population.

To sum up, these results imply that a uniformity of P sorption among Vertisol horizons down the profile indicates erosion does not affect amounts of P required. This might be attributed to the mixing of soil materials from different horizons during shrinking and swelling of the Vertisols. Phosphate sorption by the original surface soil and the adjacent underlying B1 and B21t horizons of the Alfisol profile is low. However, under extreme conditions, if this Alfisol horizon is eroded, thus

exposing the B22t horizon, phosphate sorption of new surface soil would be high and rates of p would have to be increased to meet the P requirement of crops grown.

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