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Phosphate and Sulphate Adsorptions in Bungor Series Soil

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Abstract
Phosphate and sulphate adsorption in Bungor series soil were studied using soil sample and equilibrated with 0.1 M $CaCl_2$ containing concentrations of phosphate and sulphate of 0, 50, 100, 200, 400, 800 and 1200µg^{-1} phosphate and sulphate was determined using double beam spectrophotometer. The result of the study shows that Bungor series soil has high capacity to adsorb phosphate and sulphate ions..
Keywords: Phosphate, sulphate, adsorption, Bungor series soil

1. Introduction

Tropical soils are mostly acidic in nature and have high anion adsorption capacity though the adsorption capacity differs from soil to soil. Nutrient elements taken up by plants are in the form of cations and anions. The anions taken up by plants include phosphate ($H_2PO_4^-$, HPO_4^{2}-), sulphate (SO_4^{2-}), nitrate (NO_3^-) and chloride (Cl^-) whereby these anions are adsorbed on the surface of minerals soil. Studies on phosphate adsorptions on Malaysia soils have been reported by Owen (1947) and Zaharah (1979). However sulphate adsorption studies have not been extensively carried out compared to phosphate adsorption.

Studies on phosphate adsorption have shown that on acid soils hydrated ions and aluminium oxides play primary role in phosphate adsorptions (Hsu and Rennie, 1962, Bromfield, 1965 and Bromfield, 1967). Partfit (1977) reported that adsorption process on synthetic iron oxides is a ligand exchange reaction where pairs of FeOH react with phosphate to give a binuclear bridging Fe-O-P(O_2)-O-Fe complex in which two of the O atoms of the phosphate ions are coordinated each to different Fe^{3+}. Studies also showed that phosphate is strongly adsorbed to the edges of Al(OH)H_2O groups (Kyle et. al. (1966). The resulting complex is probably a binocular bridging form of Al-O-P(O_2)-O-Al. At higher concentraction phosphate adsorption takes place on gibbsite and kaolinite even though the edges sites are fully occupies by phosphate.

The Longmuir equation have been use to characterize the adsorption of phosphate in soils and soil minerals. The Longmuir isotherm gives a relative measure of the energy by which phosphate is bounded to the solids and a relative adsorption maximum.

The adsorption of sulphate is known to take place on clay minerals (Black et. al, 1979). Other soil components such as iron and aluminium oxides and hydroxides also play important role in phosphate adsorption (Ensminger, 1954). Zaharah (1980) reported that the Longmuir equation can be used to characterize sulphate adsorption. The objective of this study was to determine the phosphate and sulphate adsorption on Bungor series soil.

2. Materials and Methods

Peninsular Malaysia is located within the equatorial zone between latitudes 10 5' and 60 45'N and longitudes 990 and 1040 20'E with South China Sea lies to the east while Straits of Malacca to the west of the peninsula. Soil samples of Bungor series soil (Typic Kandiudult, fine clay, kaolinitic, isohyperthermic) were collected from 0-15 cm depth at Km 59.2 Kuantan - Temerloh, Road Pahang, Peninsular Malaysia. Some physical properties of Bungor series soil are shown in Table 1 and some chemical properties of Bungor series soil are as in Table 2.

Table 1: Some physical properties of Bungor series soil

Depth cm	Horizon	Coarse sand %	Fine sand %	Silt %	Clay %	Silt % Clay
0 - 20	Ap	19.1	52.2	10.3	18.1	0.57
20 - 35	B_1	15.4	44.2	9.7	30.7	0.30
35 - 52	B_{t1}	14.4	41.2	9.0	35.3	0.25
52 - 70	B_{t2}	13.7	41.1	9.1	36.1	0.25
70 - 90	B_{t3}	11.9	38.5	8.4	41.2	0.20
90 - 135	B_{t4}	10.2	36.4	8.1	44.3	0.18
135 - 190	B_5	10.0	35.2	7.7	47.1	0.16
190 - 226	C	11.4	40.8	8.8	39.0	0.22

Table 2: Some chemical properties of Bungor series soil

Depth cm	pH H_2O	Organic C %	Total N %	C/N	Exchangeable Bases Ca	Mg	K	BS %	CEC cmol(+) kg^{-1} soil
					cmol(+)	kg^{-1}	soil		
0 - 20	4.8	0.94	0.09	10.0	0.22	0.15	0.12	17.0	3.06
20 - 35	4.6	0.42	0.05	8.5	0.10	0.06	0.06	8.0	3.12
35 - 52	4.9	0.32	0.04	7.4	0.14	0.07	0.07	10.0	3.53
52 - 70	5.0	0.26	0.04	7.1	0.08	0.05	0.04	6.0	3.05
70 - 90	5.0	0.20	0.03	6.0	0.10	0.04	0.02	6.0	3.39
90 - 135	5.1	0.20	0.04	5.2	0.08	0.04	0.02	5.0	3.39
135 - 190	5.1	0.19	0.03	5.0	0.04	0.03	0.07	5.0	3.37

Ten gram of air dry soil sample was weighed into plastic vial and equilibrated with 0.1 M $CaCl_2$ containing concentrations of phosphate and sulphate of 0, 50, 100, 200, 400, 800 and 1200 µg/g. The suspension was shaken for 24 hours then filtered using Whatman filter paper no. 42. Phosphate was determined by method of Bray and Kurtz (1945) using Perkin-Elmer double beam spectrophotometer at 882nm. Sulphate was determined using turbidimetric method of Juo and Boyd (1967) by using Perkin-Elmer double beam spectrophotometer at 660nm. Adsorbed P or S were calculated by using the equation:

P or S adsorbed = P or S applied to soil – P or S in filtrate .

3. Results and Discussion

Table 3 shows the result of phosphate adsorption on Bungor series soil. Phosphate adsorbed increases with increasing concentration in the equilibrated suspension but the percentage adsorption decreases.

Table 3: Phosphate adsorption on Bungor series soil

Treatment (µ/g)	Absorption	P in filtrate (µg/g)	P not adsorbed (µg/g)	P Adsorbed (µg/g)	Adsorption %
0	0.027	2.14			
50	0.048	3.81	1.67	48	96
100	0.041	3.25	1.11	99	99
200	0.056	4.44	2.30	198	99
400	0.108	8.57	6.43	394	99
800	0.515	81.71	79.57	720	90
1200	1.450	230.1	227.92	972	81

The results obtained are similar with the results as reported by Zaharah (1979) that phosphate adsorption tended to level off up to an equilibrium concentration at 1.24mg g^{-1} soil. The Bungor series soil showed an increase in the amount of P adsorbed after this point. The same result was reported by Gunary (1970) to be due to adsorption of P after the monolayer adsorption has achieved on the adsorption sites. This is due to the organic matter present which provide a major site for P adsorption (Table 2).

The results showed that the quantity of sulphate adsorbed increases with increasing applies sulphate however the percentage adsorption decreases (Table 4).

Table 4: Sulphate adsorption on Bungor series soil

Treatment (µg/g)	Absorption	S in filtrate (µg/g)	S not adsorbed (µg/g)	S Adsorbed (µg/g)	Adsorption (%)
0	0.11	12.1			
50	0.14	15.4	3.3	47	94
100	0.16	17.6	5.5	95	95
200	0.30	33.0	21.0	179	90
400	0.31	42.6	30.5	370	92
800	0.26	71.5	59.4	741	93
1200	0.28	154.0	141.9	1059	88

The results showed that percentage of adsorption is high showing that Bungor series soil has high sulphate adsorption capacity. This is due to high clay content (Table 1) which is known to play important role in sulphate adsorption process (Black et. al, 1979). Other soil components such as aluminium oxides and hydroxides play a vital role in the adsorption process. Zaharah (1980) reported that although Bungor series soil is low in amorphous oxides its capacity to adsorb sulphate is high. It is due to high organic matter which might have positive effect on sulphate adsorption (Table 1).
At higher concentractions the percentage of adsorption decreases showing that chemical reaction is taking place. At low concentractions there are many adsorption sites on the surface of soil particles. As these sites are filled up the soil particles are not able to adsorb sulphate ions at increasing sulphate concentractions.
These findings show that Bungor series soil has high capacity to adsorb phosphate and sulphate ions making them not readily available for plant growth.

4. Conclusion

Bungor series soil has high capacity to adsorb phosphate and sulphate ions therefore making the added phosphate and sulphate not readily available for plant uptake. However the percentage adsorption decreases with increasing concentraction.

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