

## Comparison of different adsorption equations in describing sulphate adsorption before and after removal of organic matter in some Alfisols of Orissa

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### ABSTRACT

Efficiencies of Freundlich, Langmuir, Temkin and initial mass adsorption equations were compared to describe  $\text{SO}_4^{2-}$  adsorption in four Alfisols of Orissa before and after removal of organic matter. There was increase in  $\text{SO}_4^{2-}$  adsorption in all the soils after removal of organic matter. It was significant in the Suakati and Badbil soils containing more than 1% organic carbon. The initial mass adsorption equation was the best in describing  $\text{SO}_4^{2-}$  adsorption both before and after removal of organic matter as evidenced by its highest average  $R^2$  and the lowest average SE values of all. The Freundlich equation was superior to the Langmuir and Temkin equations, whereas Temkin equation was superior to the Langmuir one in describing  $\text{SO}_4^{2-}$  adsorption before and after removal of organic matter.

**Key words :** Sulphate adsorption, Freundlich, Langmuir, Temkin and initial mass adsorption equations

Sulphur is a secondary major plant nutrient. A part of the added  $\text{SO}_4^{2-}$  in soil is adsorbed and the rest remain in the soil solution with a dynamic equilibrium existing between these two forms. With removal of  $\text{SO}_4^{2-}$  from soil solution the adsorbed  $\text{SO}_4^{2-}$  is released to the soil solution to maintain the equilibrium and consequently becomes available to the plant. Sulphate adsorption in soil can be described by the Freundlich, Langmuir and Temkin equations. Nodvin *et al.* (1986) suggested the initial mass adsorption equation which describes sulphate adsorption successfully. It is a simple linear partitioning model constructed by plotting the  $\text{SO}_4^{2-}$ -S adsorbed against the amount of  $\text{SO}_4^{2-}$ -S added.

Sulphate adsorption in soil is influenced by several factors of which organic matter is one. It has both positive and negative effects on sulphate adsorption. The positive effect is due to protonation of COOH, OH and  $\text{NH}_2$  groups of the organic compounds at low pH developing positive charges and attracting the negatively charged  $\text{SO}_4^{2-}$  leading to nonspecific adsorption (Martinez *et al.*, 1998). Negative effect of organic matter on  $\text{SO}_4^{2-}$  adsorption is due to coating of the organic matter on the surface of the colloidal particles and blocking the sulphate adsorption sites. Besides this, the organic anions compete with  $\text{SO}_4^{2-}$  to occupy the adsorption sites causing a reduction in  $\text{SO}_4^{2-}$  adsorption (Martinez *et al.*, 1998). The net effect of organic matter on sulphate adsorption depends on the dominance of one factor over the other.

More than 70% of the cultivated area in Orissa is covered by Alfisols. These soils are moderately to strongly acidic with high iron and aluminium oxide contents and

are dominated by low active clay (Das, 1985). Addition of organic matter constitutes an important part of the soil management practices in these soils. Information is lacking in the comparison of different adsorption equations in describing  $\text{SO}_4^{2-}$  adsorption in these soils with and without organic matter. The present communication reports the comparative efficiencies of Freundlich, Langmuir, Temkin and initial mass adsorption equations in describing  $\text{SO}_4^{2-}$  adsorption in some Alfisols of Orissa both before and after removal of organic matter.

### MATERIALS AND METHODS

Surface soil samples (0 –15 cm) having variable organic carbon contents were collected from some representative red and lateritic soils of Orissa belonging to Alfisols. The selected areas were Suakati and Badbil in district Keonjhar, Sukinda in district Jajpur and Jashipur in district Mayurbhanj. Some of the important physical and chemical properties of the soils were determined by standard procedures. Free Fe and Al oxides were determined in the Na-citrate – bicarbonate – dithionite extracts of soil (Jackson, 1956). Amorphous Fe and Al oxides were determined in 0.2 M  $\text{NH}_4$  – oxalate + 0.2 M oxalic acid (adjusted to pH 3.0) extracts of soil (Shuman, 1982) with destruction of oxalate ions. Iron was determined colourimetrically by orthophenanthroline red ferrous complex (Jackson, 1973). Aluminium was determined by aluminon method (Black, 1965). Crystalline Fe and Al oxides were determined from the difference between their free and amorphous forms.