DYNAMICS OF PHOSPHORUS SORPTION IN SOME ACID SOILS OF WEST BENGAL, INDIA

S. DUTTA AND D. MUKHOPADHYAY

See end of article for
authors' affiliations

Correspondence to :
D. MUKHOPADHYAY
Department of Soil Science and
Agricultural Chemistry, Uttar
Banga Krishi Viswavidyalaya,
Pundibari, COOCH BEHAR
(W.B.) INDIA

Accepted : *November, 2007*

ABSTRACT

The kinetics of phosphorus(P) sorption/desorption was conducted with four acid soils of West Bengal (India),to correlate the specific sorption/desorption and kinetic parameters with the important physico-chemical properties of the soils. The soils varied in pH from 4.21 - 5.67, organic carbon from 1.2-10.7g/kg,free Fe_2O_3 from 0.39-3.92 % and available P from 8.7-23.9 mg/kg .It was observed that the amount of sorbed P at a given equilibrium P concentration was higher than that during desorption indicating low desorbability of once sorbed P. The sorption/desorption kinetic data in the given soils were fitted to modified Freundlich type of kinetic equation and the Elovich equation to yield, respectively, the P sorption rate coefficient and the Elovich parmeters, namely, Co, α, and β. The release of the sorbed P was found to be slower than the rate of its sorption, in agreement with the observations, obtained by the P sorption/desorption equilibrium parameters.

Key words : Sorption/desorption, Kinetics, Equilibrium.

Phosphorus is the tenth most abundant element in the earths crust. Its average contribution to earths crust, according to Van Wazer (1958), is nearly 0.12%. In lithosphere, it always occurs in the pentavalent oxidation state and this is true about phosphorus in plant and animal. The total P content in Indian soil ranges from 100 – 2000 p.p.m. (Tandon, 1987).

Phosphorus plays a major role in agricultural production and phosphatic fertilizer is a significant cost worldwide. Plant–available P is inadequate in most acid soils even though the total amount of P may greatly exceed crop or pasture requirements (Graham, 1955). This is reflected in the gap between available and total P. Concentration of inorganic P in the soil solution of many acid soils are low, typically 1-5 mmolm^{-3} or less and even in fertile agricultural soils seldom exceed 10 mmolm^{-3} (Bieleski, 1973). Consequently, most acid soils require fertilizer P to provide soluble P close to the roots to meet plant requirements, but the recovery of this P by plants in the season of application is often only 10-20% (Sharpley, 1985; McLaughlin *et al*., 1987). The rest is incorporated into organic forms, adsorbed to charged surfaces or reacts with cations and precipitates as sparingly soluble inorganic forms. Although, some of the fertilizer P has a residual effect and is recovered in subsequent seasons as a result of microbial turnover and mineralization, and desorption-solubilization reactions.

Soils that are naturally acidic or have become acidic through agricultural activities comprise about 30% of arable land on a global scale (Foy *et al.*, 1978; Von Uexkull and Mutert, 1995). Most of the acid soils are naturally low in phosphorus; require applications of P fertilizers to achieve economic yields. In addition, they are usually high P-fixing (Marschner, 1995), so that much of the applied fertilizer P is locked up in the soil and unavailable to plants.

A further problem of acid soils is the solubilization of aluminium (Al) and manganese (Mn) into the Al^{3+} and Mn^{2+} forms that can result in poor plant growth. A combination of high P fixation capacity and metal toxicity in acid soil can lower down the agricultural production. Aluminium is much more detrimental than manganese because it kills root tips and impairs root hair development; resulting in a stunned root system and greatly reduced uptake of water and nutrients from the soil (Delhaize *et al.*, 1993; Kochian, 1995).

The main motivations for describing adsorption curves were to i) identify the soil constituents involved in adsorption (Adams *et al.,* 1987; Longanathan *et al.,* 1987) ii) predict the amount of fertilizer needs of soils to meet the demand of plant uptake for an optimum yield (Fox and Kamprath, 1970; Roy and De Datta, 1985; Klages *et al.*, 1988) and iii) study the nature of adsorption process to learn more about the mechanisms of the processes (Barrow, 1984, 1987). Reaction between phosphate and soils is quick initially and then becomes slower and continues for long time without reaching any true equilibrium. (Rajan and Fox, 1972; Barrow, 1983a). Ryden *et al.* (1977), reported that the increase in