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Phosphorus sorption characteristics in some calcareous, non-calcareous and acid piedmont soils of Bangladesh

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Abstract: A laboratory experiment using Calcareous, Non - Calcareous and acid Piedmont soils was conducted to estimate the phosphorus (P) sorption characteristics. Evaluation of the fitness of Langmuir, Freundlich and Tempkin equations was performed to elucidate the relationships of P sorption parameters with soil acidity, organic carbon and iron content. Fifteen different soil samples (0 - 15 cm) were shaken with 20 ml 0.01 M $CaCl_2$ solution containing 0- 1000 mg kg^{-1} P separately for 16 hours. P subject to sorption was inferred from the difference between concentration of soluble P added to the initial solution and the concentration of P in the solution at equilibrium. The tested soils varied in P sorption, energy of adsorption, adsorption maxima and buffering capacity. Application of P increased the adsorbed P linearly and the coefficient of determination (R^2) varied from 0.9988 to 0.9997. Adsorption of P by the soils showed a good relationship with pH, free Fe and amorphous Fe but not with crystalline Fe and organic carbon. The slope of P adsorption decreased significantly ($P< 0.001$) with an increase in pH. The P adsorption isotherm for all three studied soils fit well into Langmuir, Freundlich and Tempkin models (R^2 = 0.8139 to 0.9709). The Tempkin adsorption equation fit better than the Langmuir and Freundlich equations. The maximum P adsorption capacity varied based on background P concentration of soils and varied from 617 to 1481 mg g^{-1} where the highest value was observed in Calcareous Soil (S_1) and the lowest in extremely acidic Piedmont soil (S_{15}). The energy of adsorption was highest (1.80 µg ml) in Piedmont Soil (S_{15}) and lowest (0.75 µg ml^{-1}) in Calcareous Soil (S_1). The buffering capacity was varied from 144 to 183 where the highest value was found in Piedmont Soil (S_{13}) and the lowest in Calcareous Soil

(S_1). Soil pH was positively correlated with maximum adsorption capacity (*b*), negatively correlated with energy of adsorption (*k*), buffering capacity (BP) and intercept of the Freundlich adsorption isotherm (*a*). The adsorption parameters of the soils showed good relationship with each other. The maximum adsorption capacity showed a significant negative correlation with buffering capacity (r = -0.62) and with intercept of Freundlich equation (r = -0.81). Energy of adsorption showed a significant positive liner relationship with buffering capacity (r = 0.79). The relationship between buffering and intercept of Freundlich equation was also positive (r = 0.87).

Keywords: Phosphorus sorption, buffering capacity, energy of adsorption, isotherm equations, rice soils

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