

Highly absorbent clay mineral soils can drastically reduce the efficiency of phosphate fertilizers⁽¹⁾

Gabriel Araújo Paes Freire⁽²⁾; Paulo Guilherme Salvador Wadt⁽³⁾; Elaine Almeida Delarmelinda⁽⁴⁾; Laércio Vieira de Melo Wanderley Neves⁽⁵⁾; Valdomiro Severino de Souza Júnior⁽⁶⁾; Karina Thais Lima Burity⁽⁷⁾

⁽¹⁾ Work undertaken with the support of National Council for Scientific and Technological Development – CNPq. ⁽²⁾ Phd student, Universidade Federal de Campina Grande, Campina Grande, PB. ⁽³⁾ Researcher, Embrapa Rondônia, Porto Velho, RO. ⁽⁴⁾ Teacher, Universidade Federal de Rondônia, Presidente Médici, RO. ⁽⁵⁾ Pós-Doutorando, Universidade Federal Rural de Pernambuco, Recife, PE; ⁽⁶⁾ Teacher, Universidade Federal Rural de Pernambuco, Recife, PE. ⁽⁷⁾ Phd student, Universidade Federal Rural de Pernambuco, Recife, PE.

Resumo — Phosphate anions interact with the surfaces of clay minerals in soils through precipitation or adsorption reactions, a process referred to as phosphate fixation. The propensity for phosphate fixation is linked to the presence of iron oxides (such as goethite, hematite, and ferrihydrite), aluminum oxides (gibbsite), and 1:1 clay silicates (kaolinite). It is negligible in acidic soils that are rich in highly electronegative clay minerals (HECM) unless these minerals are present in alkaline conditions. Some studies have highlighted phosphate adsorption and precipitation in soils containing smectites and hydroxy-interlayered vermiculites. We hypothesize that the aluminum forms in HECM are particularly reactive with phosphate anions, even when not in equilibrium with the soil solution. In this study, we analyzed surface horizon samples (pedogenetic horizon A) from five soil types in the southwest Amazon, representing four geological sedimentary formations and one metamorphic formation. We evaluated the Maximum Phosphorus Adsorption Capacity (MPAC) of these soils. Adsorption isotherms were constructed by plotting the amount of P adsorbed against the equilibrium solution concentration, following the hyperbolic form of the Langmuir equation. The determination coefficients (r^2) for the linear model aligned with the Langmuir equation were high across all soil samples, accurately depicting the phosphate adsorption patterns. MPAC values ranged between 677 and 1,346 mg kg⁻¹ of P. At lower phosphate concentrations, adsorption was more pronounced, with the rate of adsorption decreasing as the phosphate concentration in the equilibrium solution increased. Our findings reveal that soils rich in HECM exhibited a higher MPAC than those predominated by oxidic minerals. The adsorption of phosphate by highly electronegative minerals, while unexpected in acidic conditions, is observed only in alkaline soils. We attribute this to the presence of positively charged hydroxy-aluminum polymers within the interlayers of vermiculite and smectite, whose specific surface areas and reactive sites may be more potent than those found in minerals like gibbsite. For effective P fertilization management, it is crucial to consider these phosphate fixation mechanisms. The residual P serves as an indicator to assess the extent of these reactions and, in conjunction with the extractable P in weak acid solutions, to determine P availability for crops.

Termos para indexação: amazon, phosphorus, sorption, fertilizer, soil testing.