

Using the anion exchange membranes to determine the phosphorus desorption of two distinct soils

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Phosphorus (P) desorption isotherms assess the P stability in soil solution in relation to labile adsorbed P, reflecting the reverse reaction between soil solution P and soil constituents. Despite the practical difficulties in establishing these reactions, P desorption isotherms bear valuable information to predict crops needs and environmental risks when managing soils with various P contents.

The current work uses a new P desorption method that establishes the relationship between equilibrium P concentration and P remaining adsorbed after successive anion exchange membrane (AEM) extractions. Two soils were considered: one soil incubated with 250 mg P kg⁻¹ (K₂HPO₄) under controlled conditions (20° C at 70% field capacity) during 30 days, soil A, and one soil agriculturally enriched in P, soil B. Dry soil samples were allowed to equilibrate in a CaCl₂ 0.01M solution during 21 hours being shaken during four periods of 30 minutes. After, the soil suspensions were centrifuged and the equilibrium P concentrations were determined. It followed an extraction with one AEM in a soil:water suspension during 60 minutes. After, the AEM was removed and P was eluted from the AEM with HCl 0.5M during 60 minutes. The resulting soil:water suspension was restored to give a 0.01M CaCl₂ suspension by adding an adequate amount of CaCl₂. This procedure was repeated for 18 days. Phosphorus adsorption isotherms, based on the procedure proposed by Fox and Kamprath (1970), were also determined for both soils under study. Data obtained in the adsorption experiment was fitted to the modified Freundlich model [$p = a \times c^{(b/a)} - d$]. The accumulated desorbed P, by the successive AEM extractions and equilibriums, in soil A was 210 mg P kg⁻¹, value that did not reach the amount of added P during the incubation (250 mg P kg⁻¹). However, when compared to the amount of P initially adsorbed, as predicted by the d parameter of the modified Freundlich adsorption model ($d = 100$ mg P kg⁻¹), soil A desorbed higher quantities of P. The equilibrium P concentrations, varied between 2.026 mg P L⁻¹ in the first equilibrium (removing 29.0 mg P kg⁻¹) and 0.038 mg P L⁻¹ in the last. These observations point at the presence of high amounts of easily extractable P and suggest the low stability of the added P in soil A. Further investigation with respect to soil P enrichment should be carried out in order to bring the laboratory incubation closer to field conditions.

In soil B the accumulated amount of desorbed P, 150 mg P kg⁻¹, was lower than the d parameter of the modified Freundlich adsorption model ($d = 577$ mg P kg⁻¹) but higher than the extractable P by the one-single extraction Olsen method (104 mg P kg⁻¹). In this soil, the equilibrium P concentrations varied between 0.266 and 0.046 mg P L⁻¹. These results evidence a higher P stability of soil B and a higher capacity to maintain the equilibrium P concentration in the last equilibriums. The new P desorption method performed in distinct soils has accomplished its aim and has provided reliable data to establish relationships between equilibrium P concentration and adsorbed P.

Fox, R. L. and E. J. Kamprath. 1970. Phosphate sorption isotherms for evaluating the phosphate requirements of soils. Soil Science Society of America Proceedings, 34: 902-906.