

Phosphate desorption in Luvisols and Solonetz from a Mediterranean region



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Introduction

Transfer of P from soil to water is controlled by the P retention capacity in the solid phase, namely by the equilibrium between adsorbed and precipitated forms. Desorption of P and/or phosphate dissolution govern the amount of P released into drainage water, runoff or freshwater. Soil P evaluated by Olsen method showed a strong correlation with the capacity of soil to desorb P and, within certain limits, to the transfer of P to water. This transfer of P relates to losses that occur either in surface horizons, or in subsurface horizons (to drainage water, to runoff or by soil erosion to freshwater).

Results

Addition of P brought soil samples into the range 7-60 mg P kg⁻¹ (Olsen method), and between 24 and 124 mg P Kg⁻¹ (Ammonium Lactate method, AL-P). At short term, considering a 60-day plant growing cycle, it was observed that P concentration in solution exceeded 0.1 mg P L⁻¹ (considered as the critical level for groundwater quality) in 2 samples (6% of a total of 32); it was higher than 0.05 mg P L⁻¹ (the critical level for runoff to prevent water eutrophication) in 47% of the samples; and exceeded 0.02 mg P L⁻¹ (the critical level in aquatic systems) in 60% of the samples.

Overall, it was concluded that soil capacity to transfer P to water is related with the sorption capacity of the solid phase surfaces, that is, the surfaces of reactive Fe and Al oxides, and with exchange base cations, especially calcium.

Objectives

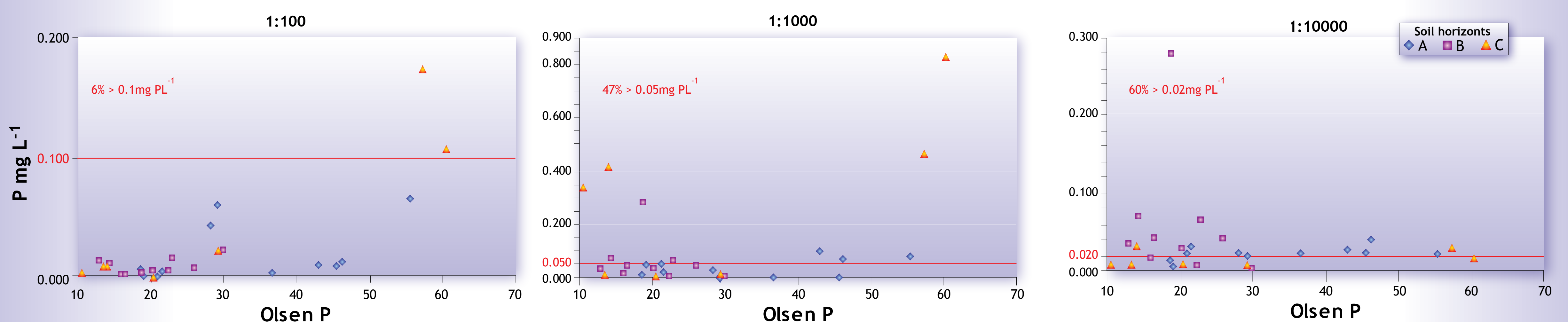
This study aimed to evaluate the capacity of surface (Ap) and subsurface (Bw, Bt, Btn and C) horizons to desorb P to drainage water, runoff and superficial waters.

Materials and Methods

The study was carried out on samples of a set of eleven pedons from Southern Portugal belonging to three Reference Soil Groups: Cambisols (1), Luvisols (7) and Solonetz (3). After evaluation of P sorption, P was added to soil in amounts from 6 to 160 µg P / g soil to reach a soil solution concentration of 0.5 - 0.6 mg P L⁻¹, which is adequate for plant nutrition.

P was added in the form of a commercial fertilizer (superphosphate, 18% P₂O₅), using 50 g of soil. After this addition, soil samples were wetted to 70% of their field capacity and incubated for 4 months at 23°C. After incubation soil samples were finely ground and suspended in a CaCl₂ 2x10⁻³ M solution in the following soil:solution ratios: 1:100; 1:1 000 and 1:10 000. These ratios simulate the amount of P desorbed to drainage water (1:100), to runoff (1:1 000), and to freshwater (1:10 000).

Solution was sampled after 14, 30 and 60 days. Solution samples were centrifuged at $\approx 1.04 \times 10^5 \text{ m s}^{-2}$ for 15 min and dissolved P was measured by the Murphey and Riley method (1962). Soil P was evaluated by Olsen method and by Ammonium Lactate method.



Correlation between P desorbed to water changes when it was considered Olsen P or AL-P values.

$$r(\text{Olsen P} \times \text{P1:100}) = 0.679 \text{ (p} \leq 0.001)$$

$$r(\text{Olsen P} \times \text{P1:1000}) = 0.292 \text{ (ns)}$$

$$r(\text{Olsen P} \times \text{P1:10000}) = 0.312 \text{ (ns)}$$

$$r(\text{AL-P} \times \text{P1:100}) = 0.658 \text{ (p} \leq 0.001)$$

$$r(\text{AL-P} \times \text{P1:1000}) = 0.611 \text{ (p} \leq 0.01)$$

$$r(\text{AL-P} \times \text{P1:10000}) = 0.046 \text{ (ns)}$$

Conclusions

After fertilization, study soils showed a high capacity to transfer P to runoff and to aquatic systems, which allows us to a proper soil and fertilizer management.