

Assessing phosphorus extractability by Olsen P and AL-P tests in acid soils after P fertilization with compost versus mineral fertilizer

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Soil P tests, like the Olsen (Olsen-P, Olsen et al., 1954) and Ammonium Lactate (AL-P, Egnér et al., 1960) methods, are useful tools to assess P phytoavailability. Such methods should provide accurate agronomic meaning in order to achieve a sustainable P fertilization. The properties of composts, namely the organic matter content together with the P-chemical forms in the fertilizers, could influence soil P sorption after fertilization and consequently change the amount of P extracted by such soil P tests. Using the same rate of P fertilization applied by different fertilizers, e.g. compost (CP) or single superphosphate (SSP) we hypothesized that Olsen and AL-P methods are able to discriminate differences in the soil P availability induced by fertilizer properties. So, the main objective of this work was to evaluate the accuracy of two soil tests commonly used in Europe, the Olsen and AL-P methods, in assessing P availability after application of compost or single superphosphate to a low-P acid soil. To do so, an incubation experiment was performed over 140 days. The soil used was a low-P dystric Regosol and the fertilizer used was a compost obtained through aerobic composting of sewage sludge mixed with sawdust (CP) and the single superphosphate (SSP). The experimental design was completely randomized with two fertilizers, four P application rates and four replicates of each treatment generating a total of 32 incubation boxes. The P application rates (kg P ha^{-1}) were: 6.5, 13, 26 and 52. The amount of compost used was constrained by the levels of N sustainable fertilization with a maximum application rate of 170 kg N ha^{-1} from organic amendments. Therefore, P application rates of 26 and 52 kg ha^{-1} were achieved through the addition to the compost of SSP: the rate of 26 kg P ha^{-1} was set by adding $19.5 \text{ kg P ha}^{-1}$ in the form of SSP to the compost, and the 52 kg P ha^{-1} rate by adding 39 kg P ha^{-1} in the form of SSP. The compost and the SSP were finely ground to 0.5 mm and sieved before applying to the soil, and maintained in the dark at $25 \text{ }^\circ\text{C}$ and at 70% field capacity. After incubation, a composite soil sample was taken of each treatment and replicates, and analyzed for AL-P and Olsen-P. P forms in the compost and in the SSP were also analyzed by a sequential fraction method (Traoré et al. 1999): the first extraction was performed with H_2O ($\text{H}_2\text{O-P}$), the second with 0.5 M NaHCO_3 (pH 8.5; $\text{NaHCO}_3\text{-P}$), the third with 0.1 M NaOH (NaOH-P) and the fourth with 1 M HCl (HCl-P). P in the inorganic forms $\text{H}_2\text{O-Pi}$ or $\text{NaHCO}_3\text{-Pi}$ is considered to be easily available to crops; the NaOH-Pi is considered to be mainly bound to Fe and Al oxides or metal-organic complexes, and thus evaluated as being moderately labile and the HCl-Pi is regarded as being bound mainly to Ca in low-solubility precipitates, such as apatite or octacalcium phosphate, and thus represent stable P forms (Traoré et al., 1999; Gagnon et

al., 2012). The total dissolved P in the extracts of the first three fractions was also analyzed by acid-potassium persulfate digestion (American Public Health Association, 2012) and the dissolved organic P (Po) was calculated as the difference between the total dissolved P and inorganic P quantified in each fraction. In all the cases, orthophosphate P in solution was determined by the molybdate blue method of Murphy and Riley (1962). The compost used in this work has an organic matter content of 640 g kg⁻¹ (dry matter) with a C/N = 27. CP has 0.42 g P kg⁻¹ with 80% of this total amount of P in inorganic forms (Pi). SSP has 94 g kg⁻¹ of Pi. CP had almost 50% of the total amount of Pi in forms easily available to crops and 37% in forms considered moderate labile, mainly bound to Fe and Al oxides or metal-organic complexes. Contrary to this, in SSP the forms of Pi considered easily available to crops represent almost 86% of the total amount of P, with a trace amount of NaOH-Pi fraction. In addition, The HCl-Pi fraction was similar between CP (15%) and SSP (13%). After 140 days of soil incubation with the fertilizers the amount of P extracted by AL-P and Olsen methods showed to be significantly higher after CP treatments in relation to SSP at the same P rate. Even applying simultaneously compost and SSP, there was a significant increase in soil P availability relatively to the SSP treatments. From these observations, we conclude that the organic matter content of CP might have prevented soil P sorption, which further explains the higher P availability in all CP treatments. Thus, both methods were able to discriminate differences of soil P availability caused by fertilizer properties.

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