Title
Soil phosphorus forms after brachiaria

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Introduction

Organic phosphorus can be considered as a potential source of phosphorus for plants. Plant roots and microorganisms transform organic phosphorus into available inorganic phosphorus in soil by the action of phosphatases. Under no-till the activity of acid phosphatases was higher than in the conventional system, but lower than in indigenous soil levels. No-till increases the microbial activity, due to the addition of root exudates, the remains of roots and plant residues, and reduces the temperature range and soil moisture. Phosphorus in the microbial biomass is considered biologically available in the rhizosphere, because the death of microorganisms releases organic P, thus increasing their availability to plants. Due to accumulation of crop residues and increased microbial activity in no-till, it is believed that the P in microbial biomass is a representative fraction potentially available to plants. There is evidence that *Brachiaria* could solubilize non-labile P, which would be an important tool in phosphorus management in systems under no-till and crop rotation. This study aimed to evaluate the activity of phosphatases and the changes in P for the cultivation of Brachiaria, and a possible increase of organic forms of P in soil.

Material and methods

The experiment was carried out in Botucatu, São Paulo, Brazil, in a greenhouse in pots of 8 L. Two soils were used: a Haplorthox (Ox) with $CaCl_2$ pH of 4.1 and 12 mg dm^{-3} of available P and a Hapludult (Ult) with $CaCl_2$ pH of 5.2 and 8 mg dm^{-3} of P available. The treatments consisted of applying 0, 20, 40, 80, 160 mg dm^{-3} of P with and without *Brachiaria ruziziensis*. At harvest, 84 days after emergence, dry matter production, tissue P content, the activity of acid phosphatase, content of total organic phosphorus, water-soluble P, Al-P, Fe-P, Ca-P, P-occluded and microbial P were determined. Data were submitted to analysis of variance and averages compared by t test (LSD, $P < 0.05$). Where appropriate, equations were fitted.

Results and Discussion

Dry matter production and P content in *Brachiaria* increased with P rates in both soils. In general, P contents were above the sufficiency range, between 0.8 to 1.2 g kg^{-1}. Dry matter production was higher in Ox than that in Ult.

Phosphorus content in microbial biomass increased from 5.6 to 43.3 μg g^{-1} with fertilizer application. Microbial P was higher in the presence of *Brachiaria* (Figure 1), which is evidence of the potential of *Brachiaria* to improve conditions for microbial development.

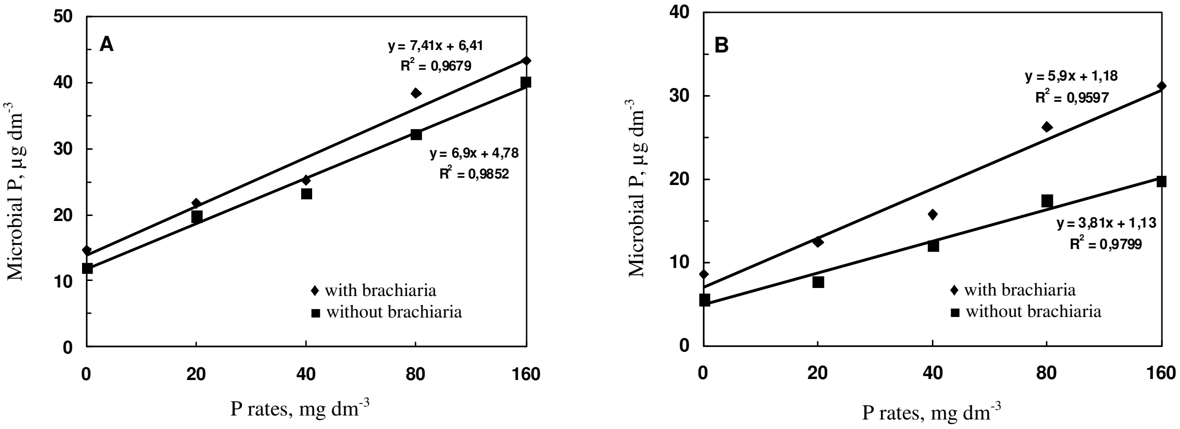

Figure 1: Soil phosphorus in the microbial mass as affected by P rates with and without *Brachiaria* in two soils. A. .. Ox; B. .. Ult

Brachiaria increased microbial P without fertilizer application. The results demonstrate the immobilization of phosphorus by microorganisms in the soil according to rates of P applied. This phenomenon can occur in soils where management systems such as no tillage allow an accumulation of organic matter on the surface, thus creating favorable conditions for microbial development.

Fertilizer application decreased the activity of acid phosphatases, whereas Brachiaria increased it (Figure 2). The activity was, in general, higher in Ox. In this soil an average of 669 mg g of p-nitrophenol g^{-1} h^{-1} was observed in the lower P rate, and in the higher P rate an average of 541 mg of p-nitrophenol g^{-1} h^{-1} was determined. Differences in activity of acid phosphatase were lower in Ult, with values of 568 and 481 g of p-nitrophenol g^{-1} h^{-1} for the lower and higher P doses, respectively. It can be inferred that changes in the values observed in treatments without grass may be a consequence of the activity of the enzyme produced by microorganisms in the soil, but not of Brachiaria itself.

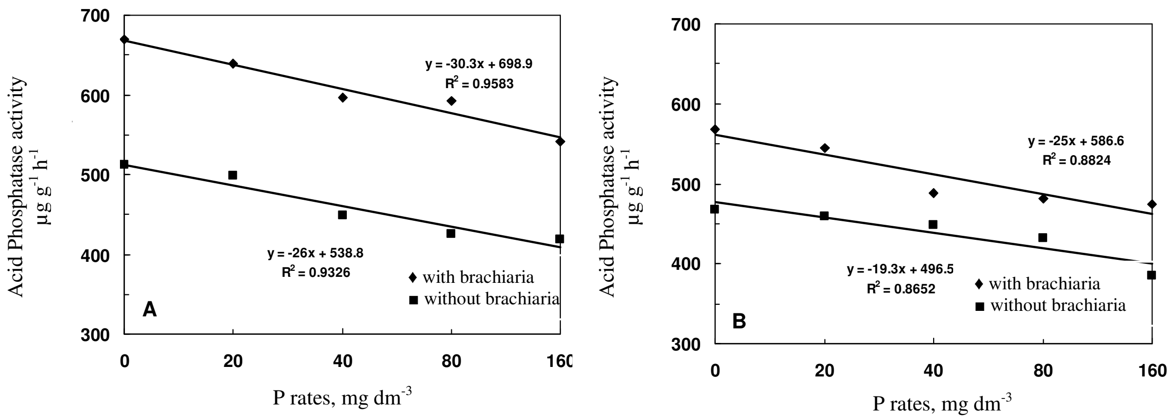

Figure 2: Soil acid phosphatase activity (µg p-nitrophenol g^{-1}. h^{-1}) as affected by P fertilizer with and without Brachiaria in two soils. A. .. Ox, B. .. Ult.

Phosphorus application increased the levels of labile soil P, irrespective of grass cultivation. However, no effects were observed in the labile inorganic P fraction. The inorganic fraction of non-labile P responded to P fertilizer, but not to *Brachiaria*. Similar results were found for the Ca bound P. A decrease in levels of Ca-P was also observed after the grass was grown.

There was an increase in the non-labile fraction of organic P when P rates were applied, irrespective of *Brachiaria*. The values of this fraction in Ox were higher than those in Ult. In the residual P fraction, no effect was observed for either fertilizer or *Brachiaria*.

Growing *Brachiaria* in both soils, as well as applying P fertilizer, increased soil labile organic P.

As expected, there was no effect of fertilizer rates on non-labile organic P. However, total content of inorganic P was increased with P rates. The values observed in this fraction were related to the doses of fertilizer applied. There was no effect of treatments in total organic phosphorus fraction.

In sum, phosphorus fertilizer rates increased the dry matter accumulation in *Brachiaria*. The accumulation of microbial P was positively affected by the phosphate fertilizer. Conversely, the phosphorus doses reduced the activity of soil acid phosphatases.

Growing *Brachiaria* in the pots led to changes in some phosphorus fractions, but these changes might not be enough to improve the nutrition of a subsequent crop in a rotation system.