Introduction

Soil contamination by heavy metals originating from phosphate fertilizers has become a concern in several countries. Thus, much research has been conducted to evaluate the presence of such metals in these amendments (McBride and Spiers, 2001, Loganathan et al. 2003, Mendes et al. 2006). The heavy metal concentration in phosphate fertilizers is dependent on the rock phosphate used as raw material. The main Brazilian rock phosphates are low in lead. Accordingly, many researchers have recommended their use without drawbacks regarding environmental contamination. However, little information is available either on the uptake of Pb by plants in soils fertilized with different phosphate fertilizers or on the long term accumulation of such metal in soils. This work aimed to determine the Pb concentration in different phosphate fertilizers as well as the Pb uptake by corn (*Zea mays* L.) grown on a soil amended with these fertilizers.

Materials and Methods

The soil used in the experiment was a loamy Ultisol collected from 0-20 cm depth and passed through a 2 mm sieve. The Pb total concentrations in the phosphate fertilizers were obtained by nitric-perchloric acid digestion (3:1 v/v) (Table 1). Soil samples (3 dm^3) in plastic pots received doses of four different sources of P: single superphosphate, Araxá rock phosphate, and Gafsa rock phosphate. The P doses (equivalent to 0, 100, 300, 500 and 800 kg ha^{-1} of P_2O_5) were incorporated into each soil sample in the pots. The highest doses were used to simulate phosphate successive applications. The treatments were arranged in a 4 x 5 factorial scheme, set in a completely randomized block design, with three replications. Two corn plants were grown in each pot. Two 30-day successive croppings were performed.

The data were subjected to variance analysis and regression equations were adjusted for Pb concentration in shoots as a function of P doses applied to soil.

Results and Discussion

The mean values of Pb in the P fertilizers studied as well as the metal amount added to soil taking in account a 100 kg ha^{-1} application are shown in Table 1. The rock phosphates presented marked differences regarding Pb concentration. The Araxá phosphate presents a relatively low Pb concentration confirming results by Mendes et al. (2006). On the other hand, Gafsa rock phosphate possessed much higher Pb contents per kg of fertilizer (234 mg kg^{-1}).

Table 1. Mean values of Pb in P fertilizers and estimated amount of Pb in soil through an application of 100 kg ha^{-1} of each fertilizer

P source	Lead	
	mg kg^{-1}	g ha^{-1}
Single superphosphate	54	5.4
Triple superphosphate	21	2.1
Araxá rock phosphate	49	4.9
Gafsa rock phosphate	234	23.4

It can be noticed that the triple superphosphate Pb concentration is lower than found in other works (Prochnow et al. 2001, Mendes et al. 2006). The Pb concentrations for both soluble superphosphates complies with the guidelines for Pb contents in P fertilizers in Brazil (Ministry of Agriculture, 2009).

The application of Araxá rock phosphate did not promote significant difference between the two corn croppings but increased the Pb mean concentration in shoots 7, 11, 16, and 18 times, respectively, for the 100, 300, 500 and 800 kg ha^{-1} of P_2O_5 doses (Figure 1). The Araxá phosphate presented the lowest Pb available content in plants among all the fertilizers tested. In contrast with the other P sources tested, Gafsa phosphate promoted higher P uptake in the first cropping as compared to the second one. This is probably due to both the high solubility of such phosphate and its high Pb contents.

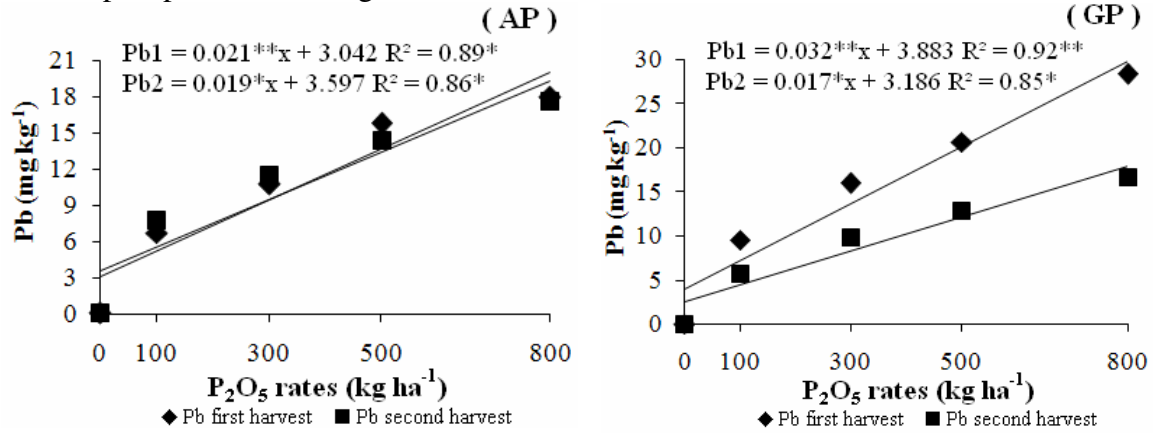

Figure 1. Pb concentrations in corn shoots in two croppings as a function of Araxá and Gafsa rock phosphates applied to soil. AP = Araxá Phosphate and GP = Gafsa Phosphate.

The increasing rates of superphosphates applied to soil raised the Pb concentration in corn shoots (Figure 2). This increment was higher in the second cropping compared to the first one. Applying single and triple superphosphate at the 100 and 300 kg ha^{-1} of P_2O_5 rates increased 10- and 15-fold the Pb shoot concentration, respectively, as compared to the control.

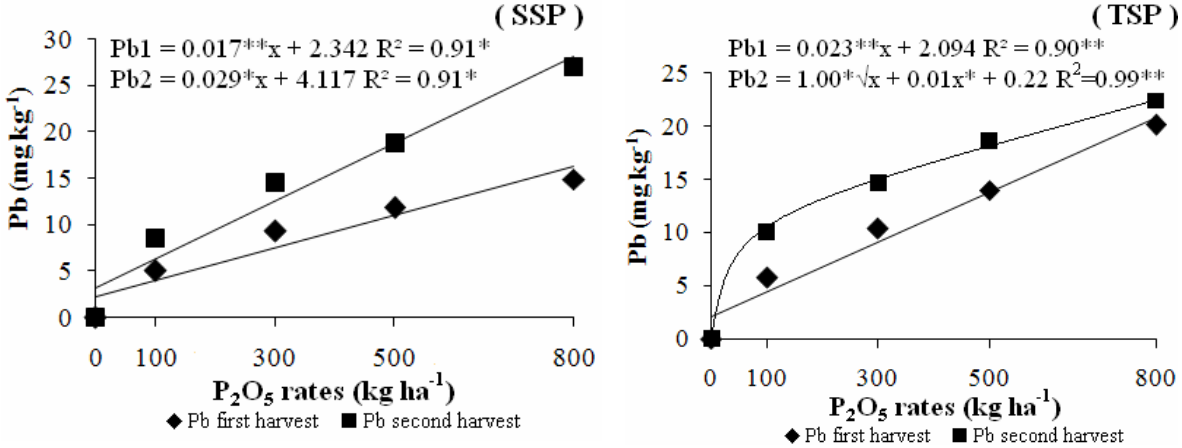

Figure 2. Pb concentrations in corn shoots in two croppings as a function of single and triple superphosphates applied to soil. SSP = single superphosphate and TSP = triple superphosphate.

Conclusions

Gafsa rock phosphate presented the highest Pb concentration. Gafsa application also resulted in the highest Pb concentration in corn shoots.

References

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