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TECHNOLOGICAL INNOVATION FOR A SUSTAINABLE TROPICAL AGRICULTURE

PROCEEDINGS

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PROCEEDINGS

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AGRONOMIC EFFICIENCY OF GRANULATED ORGANOMINERAL FERTILIZERS BASED ON POULTRY LITTER AND PHOSPHATES

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Introduction

The low availibility of phosphorus (P) in the tropical soil is one of the biggest constraints to the growth and productivity of crops. In tropical regions, most soils are very weathered and rich in iron and aluminium oxi-hydroxides, which, in turn, present accentuated capacity of P absortion. Furthermore, the mineral reserved of phosphorus in the world are finite. Therefore, it is necessary to search for technologies capable of increasing the efficiency of phosphated fertilization, in order to increase the of crop yield and extend the useful life of P mineral reserves.

Tropical soils, in general, possess low content of organic matter, which plays an important role in the soil, not only to improve it structural quality, but also to improve the efficiency of phosphate fertilizers, through the occupation of phosphate adsorption sites in the soil.

One of the sources of organic matter available in Brazil is poultry litter (PL). In 2013, 8,42 million tons of PL were produced (Hahn, 2004; Conab, 2014), which can be used as organic fertilizer. However, if it isn't used appropriately, it can become a source of environmental contamination. Therefore, the use of PL as granulated organomineral fertilizer becomes an interesting alternative, not only from an environmental perspective, but also agronomical. In this context, this paper has as aim to evaluate the agronomic efficiency of granulated organomineral fertilizers produced from poultry litter and mineral sources of phosphorus.

Methods

The organomineral fertilizers (OMF) were produced in the Fertilizer Lab at Embrapa Soils. Initially, all the sources were dried in a dried in a forced-air circulation oven at 65°C, ground and sieved (0,25 mm). Based on the chemical analysis of the organic and mineral sources, the proportion between these sources in the final product was determined. 2% of sodium silicate was added to the compound as binding agent. Later, the compound was processed in a disc granulator and the granules were dried in a forced-air circulation oven at 65°C for 48 hours and sieved, so that the granules had a diameter between 1 and 4mm.

The experiment was performed in a greenhouse, located at the Agronomy College of the Goias Federal University, Goiania, Goias. A completely randomized design was used, in a 4x4+1 factorial scheme (four sources, four doses and the control (without P)) subdivided in time (three cycles of successive cultures), with four repetitions. The sources used were: 1-TSF (triple superphosphate); 2- OMF-B (OMF based on poultry litter (PL) and phosphate rock (PR) Bayovar); 3-OMF-A (PL and PR of Arraias) and 4-OMF-TSP (PL and TSP). The doses of phosphorus (P_2O_5 total) used were 0, 250, 500, 1000 e 2000 mg per pot. The OMF-A, OMF-B and OMF-TSP sources had 11,72, 11,79 and 13,21% of P_2O_5 (total), respectively, and the TSP source had 47,47% of P_2O_5 (total).

The experiment was performed in plastic pots, filled with eight liters of air-dried fine soil, provenient from the subsuperficial horizon of a typical Rhodic Hapludox (Soil Survey Staff, 1999). The acidity was corrected to increase pH (in water) to 6,8, using a compound of pure calcium and magnesium carbonate. After acidity correction, the soil in the pots was grooved to a depth of seven centimeters, where the treatments were applied, filling the grooves with earth. Then, six millet seeds (*Pennisetum glaucum*), cultivar ADR 500, were sown at a depth of two centimeters, keeping three plants per pot. With the aim of identifying more precisely the isolated effect of the phosphate fertilizers studied, a nutritive solution was used, which provided all the nutrients to the plants, except phosphorus. At 45 DAS, the harvest of the first cycle was performed. At this point, the plants were cut next to the soil, washed and dried in a forced-air circulation oven at 65°C for 72 hours, and weighed in order to determine the shoot dry weight (SDW). Subsequently, the plants were ground to determine the P content (Embrapa, 2009). Three consecutive cycles of millets were cultivated in each pot, in order to evaluate the residual effect of the treatments. In all the cycles, the procedures were the same as described for the first cycle. The relative agronomic efficiency (RAE) was calculated according to Chien et al. (1996).

The results obtained were submitted to analysis of variance and, when the test F was significant, the qualitative treatment means were compared using the Tukey's test (α=0,05). The contrast of means was also performed with the control treatment by means of the Dunnett's test (α=0,05)

Results and discussions

The production of shoot dry weight (SDW) and the accumulation of P in the plants were influenced by the factors source and P doses, a significative interaction of these factors being observed (Table 1). The successive millet crops also influenced these variables, and a decrease with the increase of cycles was observed. However, for the source with lower solubility (OMF-A), the production of SDW was not influenced by the crops, possibly due to the gradual liberation.

In the first and second crop cycles, the highest productions of SDW were observed in the portions fertilized with the OMF-TSP source. The organomineral fertilizers enhanced by phosphate rocks (OMF-A e OMF-B) provided the production of SDW similar to the soluble TSP source, except the OMF-A source in the first cycle. Therefore, OMF enhanced by phosphate rocks, even having less solubility, present a satisfactory performance compared to the reference source (TSP).

The SDW production using the OMF-TSP source was approximately 41, 58 and 2% higher than the TSP source in the first, second and third crop cycles, respectively (Table 1). For the accumulation of P in the plant, the difference between these sources was even bigger, especially in the first crop, where the OMF-TSP source was approximately 104% higher than the TSP source. These results indicate that the association of a poultry litter with a soluble P source (TSP) increases considerably the production of SDW, as well as the accumulation of P in the plant.

Table 2 presents the relative agronomic efficiency (RAE) results for the production of dry matter of plants. There was interaction of the sources with the doses of P. The highest RAE was obtained using the OMF-TSP source, in relation to the other organomineral sources. In comparison with the TSP source, it is possible to notice that the presence of organic matter in the fertilizer granule increased the efficiency of the TSP mineral source, with the exception of the smallest dosage. These results are in accordance with what was observed by Santos et al. (2010), who noticed an increase in productivity of sugarcane stems when a mineral source of P (TSP) was applied with sugar cane filter cake in the crop groove. Despite having less solubility than the soluble source (TSP), the OMF-B source, except in the smallest dosage, presented similar results to the TSP source.

Conclusions

The association of poultry litter and triple superphosphate (TSP) in the form of granulated organomineral fertilizer presents agronomic efficiency higher than a TSP source, as well as a bigger accumulation of phosphorus in the plant and higher production of shoot dry weight;

Organomineral fertilizer enhanced by phosphate rock Bayovar presented agronomic efficiency similar to the soluble TSP source.

Keywords: Organic matter, adsorption, phosphate rock, *Pennisetum glaucum*.

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Table 1. Production of shoot dry weight (SDW) and accumulation of phosphorus in shoot of millet (*Pennisetum glaucum*) in three consecutive crops in function of doses of granulated organomineral fertilizers

Fontes	Crop cycles		
	1st	2nd	3rd
	SDW (g per pot)		
OMF-A	9,60 cA*	8,90 bA*	9,30 aA*
OMF-B	12,20 bA*	9,94 bB*	9,75 aB*
OMF-TSP	18,36 aA*	14,49 aB*	9,21 aC*
TSP	13,06 bA*	9,17 bB*	9,02 aB*
Control	0,12	2,84	6,81
Source x cycle=11,91**	CVcycle=20,32%	Source x dose =2,25**	CVsource=22,67%
	Accumulation of P in shoot (mg per pot)		
OMF-A	9,66 cA*	5,78 bB*	8,04 bA*
OMF-B	12,96 bA*	7,27 bB*	8,34 bB*
OMF-TSP	29,31 aA*	13,66 aB*	10,79 aC*
TSP	14,40 bA*	12,31 aB*	9,99 abC*
Control	0,21	2,57	3,84
Source x cycle=49,54**	CVcycle=19,62%	Source x dose=12,92**	CVsource=24,55%

Means followed by same small letter in the column or capital letter in the row do not differ according to Tukey's test ($p \leq 0,01$); **F test significance ($p \leq 0,01$); *Different from control according to Dunnett's test ($p \leq 0,01$).

Table 2. Relative agronomic efficiency (RAE) of granulated organomineral fertilizers enhanced by differents mineral sources of phosphorus

P sources	Phosphorus levels (mg per pot of P_2O_5)			
	250	500	1000	2000
	RAE (%)			
OMF-A	39,70 b	44,78 c	63,97 c	60,02 c
OMF-B	40,91 b	77,40 b	85,55 bc	72,63 bc
OMF-TSP	106,22 a	160,46 a	167,64 a	162,93 a
TSP	100,00 a	100,00 b	100,00 b	100,00 b

Means followed by same small letter in the column or capital letter in the row do not differ according to Tukey's test ($p \leq 0,05$).