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PROCEEDINGS

EFFICIENCY OF LIQUID FERTILIZERS MADE FROM SWINE SLURRY

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Introduction

Swine production is a major livestock activities in Brazil. This activity has great importance as a source of income as well as employment for local rural and urban communities. This production is concentrated in some regions, like in the west of the Santa Catarina state, where the volume of swine slurry (SS) produced, which has high potential pollutant, exceeds the availability of areas for agricultural land application of that waste in appropriate rates (Scherer et al., 2010). In this context, the production of liquid organic-mineral fertilizers from SS may be a promising alternative for mitigating the negative impacts of this waste disposal in the environment. Although it occurs in a liquid form, this kind of fertilizers enables the increase in the nutrient concentration and thus it becomes feasible to transport and use as fertilizer in places more distant from the swine producing regions.

The agronomic efficiency of fertilizers in liquid form is equivalent or even superior to traditional solid fertilizers (Chien et al., 2011). Thus, after being transformed into a liquid biofertilizer the SS allows the use of nutrients as well as the wastewater from swine farming with greater efficiency than the direct use of such residues.

This study aimed to determine the efficiency of nitrogen and phosphate biofertilizers prepared from SS in a liquid form, relative to the exclusively mineral liquid fertilizer, through the accumulation of N and P in shoots plants of millet and oat in three consecutive greenhouse crops.

Methods

A greenhouse pot experiment was carried out in Lages, SC, in order to evaluate the agronomic efficiency of nitrogen and phosphate fertilizer in liquid forms prepared from SS in two soil types, one Ultisol (ULT) and an Oxisol (OXI). The soils were limed with a mixture of $CaCO_3$ and $MgCO_3$ in a 2:1 ratio, to raise pH to 6.0. For evaluation the nitrogen fertilizer, a control treatment (No-N) in addition to a liquid mineral fertilizer nitrogen (Min-N) and a liquid organic-mineral nitrogen fertilizer (Org-N) were applied. For the evaluation of the phosphate source, treatments applied were a control (No-P), a liquid phosphatic mineral fertilizer (Min-P) and a liquid organic-mineral phosphate fertilizer (Org-P). Mineral N and P sources used were ammonium nitrate (NH_4NO_3) and phosphoric acid (H_3PO_4), respectively. These fertilizers were dissolved directly in the SS to make the organic-mineral fertilizers, and in distilled water to prepare the mineral fertilizers. The pH of the liquid fertilizers was adjusted to 7.0 with NaOH, and the total content of N and P_2O_5 was adjustedto 14% and 10%, respectively. Nitrogen fertilizers were applied at a rate of 60 mg kg^{-1} of N, while all other nutrients were applied on rates in order to provide high availability in the soil, using the principle “all but one off” (GOEDERT et al., 1986). Thus, P was applied at rates of 125 and 175 mg kg^{-1} to the soils ULT and OXI, respectively. Fhurtermore, rates of 100; 23; 1.3; 0.9; and 1.1 mg kg^{-1} of K, S, Cu, Zn and B were applied in both soils, by using nutrient solutions. In order to evaluate phosphate fertilizers, the same rate (80 mg kg^{-1} of P) was applied in both soils, in addition to 150 mg kg^{-1} of N and the same rates and sources of the other nutrients specified above. The total contents of nutrients in the SS was 31, 3.2, 0.76 and 0.90 kg m^{-3} for C, N, P and K respectively.

The experimental units (EU) were polyethylene pots containing 7.0 kg of dry soil distributed in a randomized block design with four replications. Fertilizers were applied in a liquid form and incorporated into two 4 cm depth holes in each pot, simulating band application distant by about 4 cm from the seed.

Three successive crops were conducted in pots, being two with millet (*Penissetum glaucum*, Leeke), where crop I occurred during the summer-autumn and crop III in the following spring, after a crop II with oat (*Avena sativa*, Linnaeus) during the winter. We cultivated 8 and 10 plants of millet and oat per pot, respectively, who received intermittent irrigation with distilled water to maintain soil moisture near to 80% of the field capacity. In each crop, it was determined the shoot dry mass in growth periods of approximately 50 days after sowing. In Crop I it was done two cuts. It was determined the mass of harvested material after drying at 60 °C and then it was determined total N and P contents. From the accumulated amount of such nutrients in the plants it was estimated the agronomic efficiency index (AEI) of the organic-mineral fertilizer. The ASI was based on the ratio between the amount of N or P increse in relations to the controls (No-N or No-P) promoted by the organic-mineral (Org-N or Org-P) and mineral fertilizers (Min-N or Min-P) according to the methodology described by Goedert et al. (1986).

The results were analysed by the Fisher test separately for the sources of N and P and the averages were compared by Student's test, using the SAS software.

Results and discussion

The agronomic efficiency index (AEI) of the Org-N fertilizer (Table 1), calculated based on plant N uptake, differed between soils, being generally highest in the ULT soil. In this soil the Org-N AEI values were 136%, 136% and 211% in the first, second and third crops, respectively, corresponding to 130% in the accumulated effect of all the three crops. Thus, the organic-mineral nitrogen source showed superiority to the mineral source, but only in this soil. In the other soil (OXI) the AEI values of the Org-N were 102%, 119% and 48% respectively, account for 90% in the accumulated effect of all three crops. In this case the organo-mineral source was similar to mineral source in the first two harvests and lower than the Min-N in the third crop.The greater efficiency of Org-N in the ULT soil was attributed to the contribution of organic N compounds existing in the SS and in the soil microbial biomass, which was presumably higher when the organic fertlizer was applied.

The organic matter content in the OXI soil is relatively high, being almost twice of than existing in the ULT, and in this case the contribution of mineralization of this component certainly contributed to the N availability to plants, maintaining also high availability for the treatment Min-N even in the third crop. This could also have occurred in the Org-N, however the death of some plants in pots that received this treatment contributed to decrease its dry mass yield, which limited the amount of N accumulated in the plants causing less value of AEI to this fertilizer. In genereraly, considering the AEI calculated for all three crops, the Org-N fertilizer has highest efficiency in ULT soil and similar eficiency in OXI soil than the Min-N fertilizer, and both accumulated more N than the control that did not receive N.

The AEI of the Org-P fertilizer was 104% in ULT soil at the first crop (Table 2), suggesting it was similar to the Min-P. However, the Org-P AEI for the second and third crops decreased to 88% and 36% respectively, indicating loss of efficiency over time. This suggests that the Org-P fertilizer has not kept available P forms in the soil equivalent to the Min-P, what was not expected, because most of P contained in the SS is in relatively soluble inorganic compounds (Cassol et al. , 2012). Nevertheless, on the OXI soil where the organic matter content was higher, the Org-P IEA ranged between 82% and 104%, without significant variation between crops, showing similar efficiency to the Min-P. Thus, considering all three crops it was observed that the Org-P was less efficient than the Min-P in the ULT, however, in the OXI these two fertilizers had similar efficiency.

Conclusions

The liquid organic-mineral fertilizer prepared from swine slurry has higher efficiency as a nitrogen source than the standard liquid mineral fertilizer in the Ultisol, which is a sandy soil with low organic matter content; in the Oxisol, which is clayey soil with medium to high organic matter content, however, these two fertilizers have similar efficiency.

The liquid organic-mineral fertilizer prepared from swinw slurry has lower efficiency as a phosphate source than the standard liquid mineral fertilizer in the Ultisol, but in the Oxisol the efficiency of these two fertilizers is similar.

Keywords: Manure, organic-mineral fertilizer, fluid fertilizer

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Table 1. Agronomic efficiency index (AEI) of a liquid organic-mineral fertilizer based in swine slurry as a source of nitrogen, estimated in relation to the liquid mineral fertilizer in three successive crops conducted in pots. Means of three replicates.

Soil	Crop I	Crop II	Crop III	AEI total
	AEI (%)			
ULT	136 Ab*	136 Ab	211 Aa	161 A
OXI	102 Bb	119 Ba	48 Bc	90 B
Mean of soils	119a	127a	129a	125

*Means follwed by different letters (lowercase in the line and uppercase in the column) differ (p<0,05) by Student's t test.

Table 2. Agronomic efficiency index (AEI) of a liquid organic-mineral fertilizer based in swine slurry as a source of phosphorus, estimated in relation to the liquid mineral fertilizer in three successive crops conducted in pots. Means of three replicates.

Soil	Crop I	Crop II	Crop III	AEI total
	AEI (%)			
ULT	104 Aa*	88 Bb	36 Bc	76 B
OXI	91 Bb	82 Ab	104 Aa	92 A
Mean of soils	97 a	85 b	70 c	84

*Means follwed by different letters (lowercase in the line and uppercase in the column) differ (p<0,05) by Student's t test.