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EVALUATION OF ORGANO-MINERAL GRANULAR FERTILIZERS ENRICHED WITH POTASSIUM SOLUBILIZING MICROORGANISMS

FLÁVIA CRISTINA DOS SANTOS[1], IVANILDO EVÓDIO MARRIEL[1], ELIANE APARECIDA GOMES[1], CHRISTIANE ABREU DE OLIVEIRA PAIVA[1], JOSÉ CARLOS POLIDORO[2], ANTÔNIO CARLOS DE OLIVEIRA[1], ÉDER DE SOUZA MARTINS[3]

[1]Embrapa Maize and Sorghum, Rodovia MG 424, Km 45, C.P. 285, Sete Lagoas, MG, CEP 35701-970, Brasil (flavia.santos@embrapa.br, ivanildo.marriel@embrapa.br, eliane.a.gomes@embrapa.br, christiane.paiva@embrapa.br, antoniocarlos.oliveira@embrapa.br); [2]Embrapa Soils, Rua Jardim Botânico, 1024, Rio de Janeiro, RJ, CEP 22460-000, Brasil (jose.polidoro@embrapa.br); [3]Embrapa Cerrados, BR 020, Km 18, C.P. 08223, Planaltina, DF, CEP 73310-970, Brasil (eder.martins@embrapa.br)

Introduction

Potassium (K) is an essential macronutrient for plants, performing important functions such as activation of several enzyme systems, osmotic regulation, plant resistance to diseases and pests, among others. In fertility management programs, K is a nutrient that can not be overlooked because it is closely related to obtaining high crop yields, and it is the second element absorbed by plants in larger quantities, only behind nitrogen (Marschner, 1997).

Thus, the demand for potash fertilizers in the Brazilian agriculture is high and the availability in the market is almost entirely from soluble sources such as chloride and potassium sulfate. However, almost all of this demand is met by external market (about 90%), which places Brazil in a situation of high dependence on imports of this fertilizer (Birth & Lapido-Loureiro, 2009). Therefore, the search for alternative sources of K, as potassic rocks, is an option to reverse this situation.

The use of rocks in soil fertilization is known since the beginning of agriculture, and researches on the use of alternative sources of K were performed between 1970 and 1980 (Coelho, 2005), with tests under greenhouse and field conditions ir order to evaluate the agronomic potential of various rocks and minerals sources of K. The rocks were applied pure or in mixtures, in natura or after they experience chemical treatment (acidification) or heat. The results indicated that, in most cases, the agronomic efficiency of rock depends on its origin and composition of soil factors, the incubation time, the chemical or heat treatment applied and crop used. In general, the possibility of direct application of the rock was discarded due to low availability of K for plants (Martin et al., 2008). In general, unsatisfactory results using rocks as a source of nutrients are related to the lack of mineralogical characteristics of the material used, and thus, it is important to choose both the material and the proper form for soil application.

Therefore, the aim of this study was to evaluate the potential of granulated organic-mineral fertilizers enriched with K solubilizing microorganisms in the cultivation of millet in a greenhouse test.

Methods

The experiment was conducted in a greenhouse at Embrapa Maize and Sorghum, Sete Lagoas, Minas Gerais, in 2011, in three successive crops. Virgin savannah (Cerrado) soil, classified as Hapludox, clayey, was used, with low K (30.3 mg dm^{-3}).

Millet CMS 01 was used as test plant with a final population of 10 plants per pot containing 4 kg of soil, cultivated for 45 days in each cycle. Soil fertility was corrected to meet the demand of the plant, with application of lime and nutrients, in the first crop, just to check the residual effect of inputs. Only nitrogen was divided into four applications for each cultivation due to its low residual effect.

The experimental design was completely randomized, with four replications. Treatments consisted of a factorial 2x2x3 + 2, and the factors studied were two potassic rocks (verdigris and phonolite), with and without organic source (poultry litter), three treatments related to the use of K solubilizing microorganisms, belonging to Collection of Multifunction Microorganisms of Embrapa Maize and Sorghum (1- M1, 2- M2, 3- without microorganisms) and two additional treatments: control without K and fertilization with potassium chloride. The K dose applied was 200 mg dm^{-3}, in granulated form, involving potassic rocks mixing of inoculated, or not, with solubilizing microorganisms, with or without addition of poultry litter.

At harvest, the dry matter yield of the shoots of millet in each cultivation, extraction of K by plants and available potassium in soil by extrator Mehlich 1 were evaluated. Based on the data of dry matter yield of treatment of each cultivation the relative efficiency of them in relation to KCl (ER (%) = [(productivity of the treatment of interest - productivity of control)/(KCl productivity-productivity of control)]*100) was calculated.

Data were subjected to analysis of variance. Means were compared using LSD at 5% probability test, using the statistical program Sisvar (Ferreira, 2011).

Results and discussion

The statistical analysis showed no significant difference ($p < 0.05$) for the variables assessed in the first cultivation of millet. This result can be explained because the experiment was made with potassic rock, with slow and gradual release of potassium so that the effect of fertilization may be manifested later.

In the second cultivation, in the analysis of potassium extracted by plants, treatments containing phonolite, in general, were higher than the control without K and did not differ from the treatment with KCl (Figure 1A). Still about this variable, there was a significant difference considering the split of the microorganism within organo-mineral with phonolite ($p < 0.10$), where the combined use of the rock with M1 provided a 22% higher potassium extraction than the treatment without microorganism (Figure 1A). As for the available potassium in the soil, also in the second crop, the biofertilizers treatments with phonolite rock microorganisms associated with M1 and M2 were superior to treatment without microorganism, absolute control and KCl (Figure 1B). As it is of interest in this study, these results show that the microorganisms solubilize more potassium than the other treatments, since there was no difference in dry matter produced in the second cultivation.

In the third crop, the dry matter yield of M1 treatment did not differ from M2, but exceeded 23% in the treatment without microorganism, 137% in treatment without application of K and 95% in treatment with KCl (Figure 1C), showing the potential of this technology. There was no statistical difference for potassium extracted by plants and the available potassium in the soil. It is evident, from the results presented, the greater efficiency of the rock phonolite compared to the rock verdigris, since there was no significant result for the latter; as well as the importance of using an organic source, in this case, poultry litter, as a carbon source for microorganisms because the treatments with poultry litter were statistically higher than those without it.

The phonolite rock is of volcanic origin and has about 8.4% K_2O. The dominant mineral in this rock is feldspar, where the K is “trapped” in the crystal structure. This fact makes it insoluble in weak acids that commonly occur in nature, which reduces its efficiency when used as an agricultural fertilizer (Cortes et al., 2010). Therefore, the results of this study are of great importance because they show the potential response of plants to use this rock associated to solubilizing microorganisms of K. Moreover, it is evident the importance of the residual effect of this input, since in the early crops there was only the effect of K extracted by plants and of available K in soil of treatments with microorganisms compared to treatment without microorganism. While the response in productivity, which is in fact of greatest interest, there was only in the third crop.

The calculation of the relative efficiency of the treatments using phonolite plus poultry litter, associated to solubilizing microorganisms of K (Table 1) reinforces the potential of this input with greater efficiency in numerical values, of the granulated in relation to KCl already in first crop, especially in the third crop, and including statistical difference ($p < 0.10$).

Conclusions

The organo-mineral fertilizers of potassic phonolite rock with poultry litter associated with solubilizing microorganisms of K, M1 and M2, have potential for use in agriculture. However, field experiments are needed to validate this potential.

Keywords: Potassium fertilizer, biofertilizers, millet

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Table 1. Relative efficiency (%) of granulated phonolite rock with poultry litter associated with solubilizing microorganisms of K, of each cultivation of millet

Treatment	Cultivation 1	Cultivation 2	Cultivation 3
M1	117,4	112,9	313,4
M2	100,2	115,7	288,0

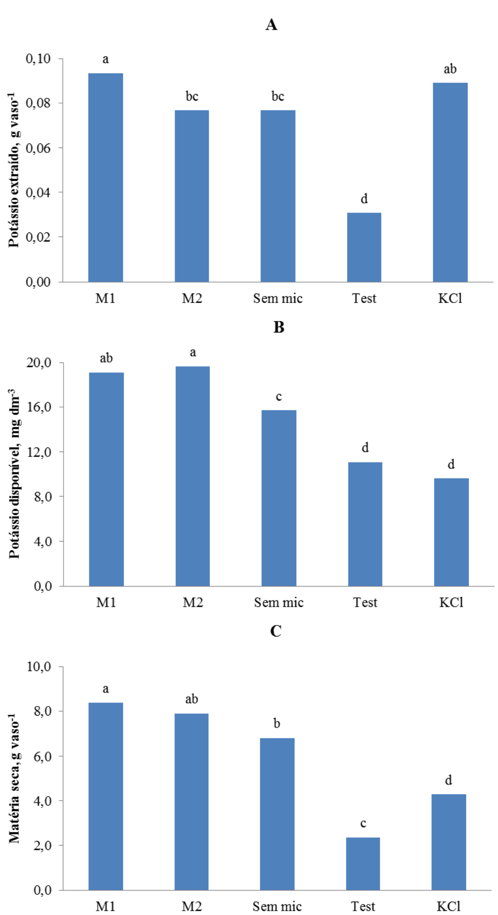

Figure 1. Potassium extracted by plants of millet in the second cultivation (A), available potassium in the soil after harvest of the second crop (B) and dry matter yield of millet in the third cultivation (C) in the treatments with microorganisms M1, M2, without microorganisms (considering the granulated rock phonolite plus poultry litter), absolute control without K and fertilization with KCl. (Treatments followed by the same letter do not differ by Tukey test at 5%)