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EFFICIENCY OF THE FUSED MAGNESIUM POTASSIUM PHOSPHATE FOR SOYBEAN

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Introduction

Potassium (K) is the second macronutrient most extracted by the soybeans and, in general, the natural levels of this element in Brazilian soils are considered low. Therefore, the supply via fertilizers applied to the soil is essential to ensure productivity. The main source of potassium in Brazilian agriculture is KCl, which is completely imported. One of the strategies to reduce the foreign dependence on potassium is the use of alternative sources.

The use of ground natural rocks (“in natura”) containing K was evaluated for the cultivation of rice (NEPTUNE et al., 1980), corn (Siqueira et al., 1985) and more recently in corn, soybeans and millet (Resende et al., 2006), whose agronomic results were not satisfactory. However, when the potassic rock is fused at high temperatures and calcareous is added, you get the product known as fused magnesium potassium phosphate (TK) with K availability increased (SANZONOWICZ & MIELNICZUK, 1985). In a study to evaluate the fused magnesium potassium phosphate in corn, there was an increase in the production of dry matter and higher K accumulation in plants (FAQUIN et al., 1987) mass. High agronomic efficiency of this source was also observed for Marandu-grass with equivalent or superior results when compared to KCl (ORIOLI JR & Coutinho, 2009). No study, however, was conducted to assess the efficacy of fused magnesium potassium phosphate in providing K for soybean, which is recognized for its strategic importance in the Brazilian agribusiness.

In light of the above, this study aimed to assess the efficacy of the fused magnesium potassium phosphate as a source of potassium for soybean.

Methods

The experiment was conducted in a greenhouse using samples of an Alic Distrophic Red-Yellow medium texture Latosol, with K content extracted by resin equals to 1.7 mmol dm^{-3}. The soil samples were dried, sieved and the liming was performed by applying calcium carbonate + magnesium carbonate (Ca:Mg 3:1). The pots with 3.2 kg of soil were incubated for 20 days and the humidity maintained at 60% of the total pore volume (TPV).

The experimental design was completely randomized, in a factorial scheme consisting of 4 treatments (fused magnesium phosphate without the application of K - control, fused magnesium potassium phosphate (TK) 100%, 50% fused magnesium potassium phosphate (TK) + 50% KCl, 100% KCl) and 2 doses of K (60 and 120 mg kg^{-1} of K_2O), with 4 replicates, totaling 32 experimental units. The chemical characterization of the fertilizers is in Table 1.

The fertilizers evaluated and the others applied on the basic fertilization (in mg kg^{-1}: 300 of P, 50 of N, 30 of S, 0.5 of B, 5.0 of Mn and to 5.0 of Zn) were mixed with the soil in the planting process. Each pot received eight soybean seeds of the cultivar IAC Foscarin-31, the thinning was performed at the 7th day after emergence (DAE), remaining 3 vigorous and uniform plants in each pot. Soil moisture was maintained around 70% of the TPV by adding distilled water, defined by a periodic pot weighing. During the experiment, N was applied 6 times by coverage via aqueous solution at a dose of 50 mg kg^{-1} each. The soybean shoots were cut 41 DAE, washed in distilled water, dried at 65^{o}C, the dry matter quantified and ground. The determination of macro and micronutrients levels was performed by digestion with concentrated HNO_3 and H_2O_2 in a microwave oven, the K reading was held in a flame photometer and the other elements in ICP-OES.

The K concentration in the soybean shoots associated to the dry matter, was used to calculate the K accumulation by the plant. The agronomic efficiency (AE) of the sources was calculated based on the standard treatment, which K was provided 100% as KCl according to AE (%) = (K_{source} – $K_{control}$) / ($K_{standard\ source}$ – $K_{control}$) x 100. The data analysis was made by analysis of variance (ANOVA) and the comparison of means by Tukey test with 95% probability.

Results and Discussion

The dry mass of the soybean shoots was not affected by the K application in the pots at both doses since the amount of dry matter produced in the control treatment did not differ statistically from the other treatments (Table 2). This fact can be assigned to the mean content of K in the soil (1.7 mmol dm^{-3}) in control plants at the planting time, which was enough to meet the demand of the plants.

The highest K concentrations and accumulation in the soybean shoots were found in the plants that were fertilized with the highest dose of K (120 mg K_2O kg^{-1}). For the K concentration, there was a tendency to increase when part of the K was supplied as KCl, since the treatments KCl and TK + KCl at the lowest dose (60 mg kg^{-1}) had similar behavior. For the highest dose, the KCl source was superior (Table 2). According to COUTINHO NETO et. al (2010) there were no differences in K concentration in the soybean shoots and even on dry matter production of alfalfa plants when exposed to potassium fertilization with KCl and TK sources applied alone or together in different proportions.

The K accumulation (parameter that reflects what was effectively absorbed) showed that regardless of the dose, there was no difference between the KCl and KCl + TK treatments, which are superior to the treatment with only TK (Table 2). This fact shows that the K contained in a source that is insoluble in water TK is quickly released to the plants and this may be related to hydrothermal treatment that the potassium rock is subjected as commented by other authors (SANZONOWICS & MIELNICZUK, 1985; FAQUIN et al., 1987). Thus, the mixture of the TK with soluble KCl could have the same effect as the isolated application of KCl and this means that part of the fertilization with KCl could be suppressed when the fused magnesium potassium phosphate as a source of phosphorus is used, since the product also contains this element, for example. In plants where K was not supplied, the concentration and accumulation of this element in both doses tested was lower than the other treatments (Table 2). Similar behavior of higher K accumulation by millet was observed when these were fertilized with soluble sources KCl and K_2SO_4 compared to isolated application of kaliofilita ($KAlSiO_4$ - insoluble rock) subjected to hydrothermal treatment at doses of 0, 150 and 350 kg ha^{-1} as reported by SANZONOWICS & MIELNICZUK (1985).

The agronomic efficiency of the sources (AE) for the K accumulated in soybean shoots showed effectiveness in TK + KCl treatment, a little inferior to the standard treatment with KCl in 60 and 120 mg K_2O kg^{-1} doses, while the treatment TK showed about 60% AE compared to KCl in both doses (Table 2). This fact allows us to say that the K from TK can be easily solubilized in the rhizosphere and made available to plants as commented by other authors (SANZONOWICS & MIELNICZUK, 1985; FAQUIN et al, 1987).

Conclusions

The fused magnesium potassium phosphate associated with KCl proved to be an efficient alternative source in providing K for soybeans. The lowest agronomic efficiency of fused magnesium potassium phosphate used alone can be compensated by increasing the K dose applied.

Keywords: Availability, potassium accumulation, alternative sources of potassium, *Glycine max*.

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Table 1. Chemical characterization of the fertilizers used in the experiment. *Methods according to Brasil (2007).

Products/Guarantees	Fused magnesium potassium phosphate TK	Fused magnesium phosphate (control)	KCl
	------------------- *Guarantees % (mass/mass basis)* -------------------		
P_2O_5 total*	12.7	17.4	----
P_2O_5 $CA_{2\%}$*	11.7	17.5	----
K_2O $CA_{2\%}$*	4.5	0.7	58.6
K_2O in water*	----	----	58.7
Ca total*	14.9	16.7	----
Mg total*	4.0	6.6	----

CA: citric acid.

Table 2. K concentration and accumulation in the soybean shoots and agronomic efficiency of the sources. TK: fused magnesium potassium phosphate. Means followed by the same lowercase and uppercase letter on the line do not differ from each other by Tukey test at 95% probability for the treatment and K dose, respectively

Treatments	Control	100% TK	50% TK + 50% KCl	100% KCl	Mean
			Dry mass production (g)		
60 mg kg^{-1}	17.9	16.6	18.1	17.8	17.6 ns
120 mg kg^{-1}	16.6	15.8	17.6	17.6	16.9 ns
Mean	***17.2 AB***	***16.2 B***	***17.8 A***	***17.7 AB***	
			K concentration in soybean shoot (g kg^{-1})		
60 mg kg^{-1}	9.2 c	13.5 b	14.2 ab	14.7 a	12.9 B
120 mg kg^{-1}	9.6 c	14.9 b	15.2 b	16.4 a	14.0 A
Mean	***9.4 C***	***14.2 B***	***14.7 AB***	***15.5 A***	
			K accumulation in the aerial part (g pot^{-1})		
60 mg kg^{-1}	165 c	223 b	256 a	261 a	226 B
120 mg kg^{-1}	160 c	235 b	267 a	288 a	238 A
Mean	***162 C***	***229 B***	***262 A***	***274 A***	
			Agronomic Efficiency		
60 mg kg^{-1}	-	61	95	100	-
120 mg kg^{-1}	-	59	84	100	-