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USE OF MICAXIST REMINERALIZER AS REPLACEMENT OF SOLUBLE FERTILIZER IN SOYBEAN CULTURE

doctor Joaquim Júlio Almeida Júnior [1], Lucas Silvestre dos Santos [1], Katya Bonfim Ataides Smiljanic [1], Francisco Solano Araújo Matos [1], Aristotle Mesquita de Lima Netto [1], Gabriel Pinto da Silva Neto [1], Victor Júlio Almeida Silva [1], Luis Filipe Almeida Silva [1]

[1] UniFIMES University Center of Mineiros; Agronomic Consultancy Research; Miners. Goiás. Brazil

ABSTRACT

The objective of this work is the use of soil remineralizers in the Agroeste 3730 soybean crop as an organic fertilizer in the central and western regions of Brazil. The experiment was conducted in the 2019/2020 harvest at Fazenda Panamá, municipality of San Antonio da Barra, State of Goiás, in a traditional cultivation system, carried out by the company Pesquisa e Consultoria Agronómica. The location is displayed as geographic coordinates, 18° 38? S stands for latitude and 35°12? Longitude W, altitude 645 m. Agronomic parameters? Plant bioassays? The evaluation was as follows: the populations were analyzed 30 days after germination and the biometry of the plant (buds) was collected at harvest (number of branches, number of pods of one seed, number of pods of two seeds, number of pods of three seeds, number of pods per plant, weight of a thousand almonds and productivity in kg/ha). To assess productivity, the plants are collected in the useful area of each plot and threshed manually by weighing the grains of each plot, for weighing a thousand grains, trays for counting a thousand grains and precision scales for weighing the material. The experiment was designed in randomized blocks and single factor, and the mica dosage was of 7 levels (T1: 0.0 Mg ha-1; T2: 4 Mg ha-1; T3: 8 Mg ha-1; T4: 12 Mg ha-1; T5: 16 Mg ha-1; T6: 20 Mg ha-1; T7: 24 Mg ha-1) and four repetitions. Data were analyzed using the SISVAR program and submitted to ANOVA, and means were compared using Tukey's test, which was used to compare means when significance was detected with ANOVA p = 0.05 probability. The use of micaschist as a soil remineralizer in the first production cycle, obtained a positive result by maintaining productivity at high levels compared to the average in the region and surpassing the national average. The results showed a difference of 16.97 bags of 60 kilos per hectare, between the best treatment compared to the absolute control "zero dose", not being possible to be detected by the average test, but highly noticeable in the rural producer's pocket.

Keyword: Organic fertilizer. Sustainable Agriculture. Soil conditioner. Productivity. Metamorphic rock.

INTRODUCTION

Soybeans (*Glycine max* (L.) Merrill) is an annual herbaceous plant belonging to the Fabaceae family (Leguminosae). Of Asian origin, it has a pivoting root system, rich in bacterial nodules. It is one of the most economically important crops in the world today due to its high protein content (around 40%) and oil (20%) (SEDIYAMA, 2009). According to CONAB (2020), it is estimated that for the 2020/2021 crop there will be an increase in the oleaginous area planted by 3.3% compared to the previous crop, reaching 38.2 million hectares sown, which is expected to increase record production of 134,451.1 thousand tons, and an increase of 7.7% in relation to the previous harvest.

To remain among the largest food producers in the world, Brazil imports large amounts of chemical fertilizers and inputs, which increases the cost of agricultural production. In order to reduce this external dependency, stoneware presents itself as a very promising alternative. It is a technique that consists of adding ground rocks to the soil (rock dust or remineralizer) with the purpose of adding nutrients and making the necessary correction of the soil for agriculture, especially for agroecological crops (THEODORO; ALMEIDA, 2013).

It is a consolidated practice for the use of agricultural limestone and natural phosphate and it has been increasingly common, research conducted with remineralizers that release nutrients from rocks more slowly than chemical fertilizers. The natural action of the factors that cause weathering decomposes the fragments of silicate rocks, releasing in a balanced way part of the nutrients that serve the productive cycle of the crops. Among the most common are the macronutrients K, P, Ca, Mg and sulfur, in addition to micronutrients or trace elements (SOUZA et al., 2017).

The low solubility of rocks is an advantage over chemical fertilization, as it prevents nutrients from being rapidly leached. Plants use the elements necessary for their development and nutrients not absorbed by the roots remain in the soil, interacting with various biological processes and can be used in a new crop cycle. Many factors can interfere with the remineralizing effect of rock dust and the release of nutrients, such as mineralogical origin and chemical composition, grinding characteristics and interactions with soil elements, plants, mycorrhizal fungi and bacteria. (THEODORO et al., 2010).

In this sense, the objective of this work was to use the soil remineralizer in the soybean crop as an organic fertilizer in the Brazilian Midwest region.

MATERIAL AND METHODS

The experiment was carried out in the 2019/2020 growing season, at Fazenda Panamá, in the municipality of Santo Antônio da Barra, in the state of Goiás, in the Straw Direct Planting System, implemented by the company "Pesquisa e Consultoria Agronomica " . The locality presents as approximate geographical coordinates, 18° 38' S of latitude and 35°12' W and 645 m of altitude.

The predominant climate of the region, according to the classification of Alvares et al. (2013) is of the Aw type , defined as humid tropical with a rainy season in summer and a dry season in winter. The average annual rainfall is 1,830 mm, with an average annual temperature of approximately 25°C and an average annual relative humidity of 66% (Figure 1). The rainy season extends from October to March, with the months of December, January and February constituting the rainiest quarter, and the driest quarter corresponding to the months of June, July and August (average of 27 mm).

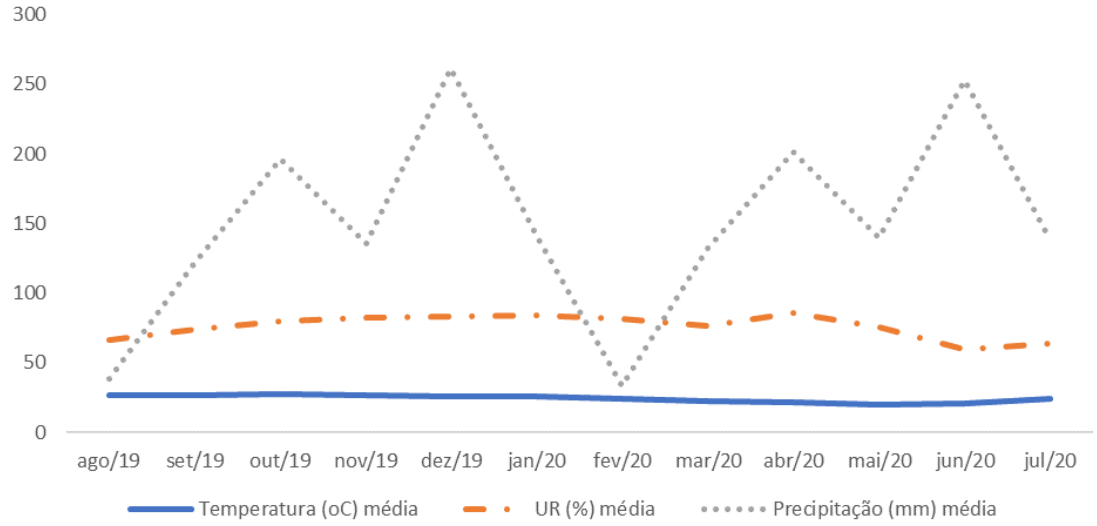

Figure 1 . Maximum temperature (º C) monthly averages, rainfall (mm) monthly averages and relative humidity (%) monthly averages, accumulated in the 2019/2020 harvest in the municipality of Santo Antônio da Barra, state of Goiás. 2020.
Source: Agritempo – Agrometeorological Monitoring System, meteorological station of Santo Antônio da Barra, state of Goiás, 2020.

According to the new denomination of the Brazilian soil classification system (EMBRAPA, 2013), the dominant soil in the area is the Red Argisol with a clayey texture, originally occupied by Cerrado vegetation and exploited by annual crops for over 15 years. Soil properties were evaluated before the implementation of the research project to understand the chemical characteristics of the experimental area. Soil chemical properties (pH, P, K, Ca, Mg, H+Al, Al, SB, V (%) and MO) the results of the macro and micronutrient contents obtained in the soil analysis were consistent with the Cerrado indications , being low in phosphorus, very low in potassium, and high in calcium and magnesium. The analyzes were carried out at the Soil Fertility Laboratory of the UniRV-University of Rio Verde and are shown in Table 1.

Table 1. Results obtained for the chemical analysis of the soil, sampled before planting soybean cultivar Agroeste 3730 in an experimental area implemented by the company "Pesquisa e Consultoria Agronómica", in the municipality of Santo Antônio da Barra, state of Goiás, 2020.

Depth (cm)	pH	P (Honey)	K^+	Her e	mg	Al	H+Al	SB	CTC	V	MO
	$CaCl_2$	mg dm^{-3}		cmolc dm^{-3}						%	g dm^{-3}
0 – 20	5.4	11.3	52.0	2.5	1.6	0.0	4.2	4.4	8.4	50.2	3.7

Source: Research data, 2020.

Through the diffractometer Bruker D8 Discover and shown in Table 2. X-ray diffraction (XRD) measurements were performed on a diffractometer Bruker D8 Discover . Monochromatic radiation from a copper anode tube was coupled to a Johansson monochromator for operation at 40kV and 40mA, Bragg-Brentano Ø-2Ø configuration, Lynxeye ® 1D detector, 2Ø from 5° to 100° and steps of 0.01°. The sample is kept rotating at 15 rpm. Mica Soil Remineralizer FMX has a final product particle size of 0.3 to 1.0 mm and its classification is determined by IN 5 Chapter 1 Section II of March 10, 2016 and its origin is basalt type "E", Section III, Product Specifications and Warranties, in item I of article 4 (Brasil, 2016), "Remineralizers", remineralizers must present the following minimum specifications and guarantees:

I - Specifications related to physical properties according to Annex I of this normative ordinance;

II - As for the sum of the bases (CaO , MgO , K2O), it must be equal to or greater than 9% (nine percent) p/p;

III - As for the potassium oxide (K2O) content, it must be equal to or greater than 1% (one hundredth) in the weight/weight ratio;

IV - Hydrogen ion potential (pH) in relation to friction, value declared by the registrant. Soil remineralizers in terms of base sum and K2O content (Table 2).

Table 2. Results obtained from the FMX micaschist soil remineralizer from the point of view of the sum of bases and K_2O content, for soybean cultivation, cultivar AGROESTE 3730 , implemented in the Panama farm, by the company "Pesquisa e Consultoria Agronomica", in the municipality of Santo Antônio da Barra, state of Goiás, 2020.

Wet base	Analyzed oxides (%) by mass									
Sample	SiO_2	Mo	With mg/kg	FeHF	MnO	MgO	Dog	BHF	K_2O	P_2O_5
	30.2	25.0	22.4	3.96	<0.05	2.26	3.22	0.1	3.7	<1.0

(<LQ) = Concentration below the quantifiable limit.

Source: Research data, 2020.

The agronomic parameters "plant biometry" were evaluated as follows: the population was analyzed 30 days after germination (DAG), plant biometry studies (aerial part) were carried out at the time of harvest, which are: number of branches (NR), number of one-grain pods (NV1G), number of two-grain pods (NV2G), number of three-grain pods (NV3G), number of pods per plant (NVPP), thousand-grain weight (PMG) and productivity in kilograms per hectare (P Kg ha $^{-1}$). To evaluate the productivity (P Kg ha $^{-1}$), the plants in the useful area of each plot were collected and threshed manually with the weighing of the grains of each plot, and for the weight of a thousand grains (PMG), a tray was used for counting a thousand grains and weighed on a precision scale, both weights were with a standard moisture content of 14%.

The experimental design was in randomized blocks and a single factor, and doses of FMX micaschist, with 7 levels (T1: 0.0 Mg ha $^{-1}$; T2: 4 Mg ha $^{-1}$; T3: 8 mg ha $^{-1}$; T4: 12 Mg ha $^{-1}$; T5: 16 mg ha $^{-1}$; T6: 20 mg ha $^{-1}$; T7: 24 mg ha $^{-1}$) and four replications. Each experimental plot consisted of four rows of four meters in length with a useful area of two rows of two meters in length and spacing of 50 cm between rows and spacing between blocks of 2.0 meters in length. The remineralizer used was distributed on the surface of the planting line, without incorporation.

Data were analyzed using the SISVAR program, proposed by Ferreira (2019). The data obtained were submitted to analysis of variance, with the means compared by the Tukey test, when significance was detected for the ANOVA ap=0.05 of probability for the comparison of means.

RESULTS AND DISCUSSION

When observing the summary of the analysis of variance estimated for the biometric parameters for the soybean crop, cultivar AGROESTE 3730 , it was not possible to detect a significant difference between the blocks.

For the treatment variance factor, the variables measured were: plant population, plant height, number of branches, number of one-grain pods, number of two-grain pods, number of three-grain pods, number of pods per plant, weight of a thousand grains and productivity in kilograms per hectare, and none of them obtained a significant difference between the tested treatments (Table 3).

It is observed that the coefficients of variation (CV) were satisfactory, indicating that the data collected from the agronomic parameters, "plant biometry", were accurately obtained according to the classification proposed

by Carvalho et al. (2003). The results of the present study are similar to those obtained by Nakayama et al. (2013), in which the coefficients of variation are within the range considered as medium and with low dispersion.

Table 3 . Summary of the analysis of variance (F), of the agronomic parameters "plant biometry" for the soybean crop, cultivar AGROESTE 3730 , and according to the increasing doses of micaschist remineralizer FMX used in an experiment implemented by the company "Pesquisa e Consultoria Agronomica", in the municipality of Santo Antônio da Barra, state of Goiás, 2020.

FV	GL	PP	AP (cm)	AIPV (cm)	NR	NV1G
Block	3	us	us	us	us	us
treat	6	us	ns	ns	ns	ns
Erro	30	-	-	-	-	-
CV%	-	9,67	9,93	23,72	35,53	81,78
DMS	-	7,33	17,77	6,97	1,81	8,87
FV	**GL**	**NV2G**	**NV3G**	**NVPP**	**PMG (g)**	**P Kg ha^{-1}**
Bloco	3	ns	ns	ns	ns	ns
Trat	10	ns	ns	ns	ns	ns
Erro	30	-	-	-	-	-
CV%	-	26,10	44,61	30,51	11,35	13,69
DMS	-	14,03	17,46	31,62	33,6	1.214,24

The symbols "** and *" refer to the significance level being: **significant at the 1% probability level (p<0.01); * significant at the 5% probability level (0.01=<0.05); ns : not significant (p<0.05). Plant population (PP), plant height (AP), number of branches (NR), number of one-grain pods (NV1G), number of two-grain pods (NV2G), number of three-grain pods (NV3G), number of pods per plant (NVPP), thousand-grain weight (PMG) and productivity in kilograms per hectare (P Kg ha $^{-1}$).
Source: Research data, 2020.

It is observed in Table 4 that the agronomic parameters "plant biometry" , plant population, plant height, number of branches, number of pods of a grain did not show significant difference between the tested treatments. In work carried out by Welter et al. (2011) with rock dust of basaltic origin, analyzing the variables plant height, number of branches, the results did not show significance. Almeida Junior et al. (2020) carried out work in the soybean crop with the technological variables of plant population, plant height, first pod insertion height, number of branches and number of pods in a grain.

Despite not obtaining a significant difference, the data remained at high levels for all the agronomic characteristics tested and the productivity was above the national average with the use of rock dust, data that corroborate this work. In work carried out by Costa et al. (2018) with organomineral fertilizer, no significant difference was found in the production components, plant population per meter, plant height, insertion of the first pod and number of branches, data that are similar to those of this work.

Table 4 . Averages of the agronomic parameters "plant biometry" for soybean cultivation, cultivar AGROESTE 3730 , and as a function of increasing doses of FMX micaschist remineralizer used in an experiment implemented by the company "Pesquisa e Consultoria Agronomica", in the municipality of Santo Antônio da Barra, state from Goiás, 2020.

TR	D kg ha $^{-1}$	PP	AP (cm)	AIPV (cm)	NR	NV1G
1	Zero	20.00	74.00	13.75	2.00	3.75
two	4,000	23.50	77,50	11,50	2,50	7,50
3	8.000	22,00	76,75	12,00	1,75	6,00
4	12.000	23,50	72,00	12,75	2,00	5,50
5	16.000	20,80	76,75	11,25	2,50	3,00
6	20.000	23,50	82,75	13,75	2,00	3,25
7	24,000	20.00	76.00	13.00	2.50	3.50
CV%	-	19.67	9.93	23.72	35.53	81.78
DMS	-	17.33	17.77	6.97	1.81	8.87

Treatments (TR), Dose in kilograms per hectare (D kg ha $^{-1}$), Plant population (PP), plant height (AP), number of branches (NR), number of pods in a grain (NV1G) , by the Tukey test at 5% probability.
Source: Research data, 2020.

Table 5 shows the averages of the agronomic parameters, number of two-grain pods, number of three-grain pods, number of pods per plant, thousand-grain weight and productivity in kilograms per hectare for soybean cultivar AGROESTE 3730 in due to the increasing doses of remineralizer tested, where it was not possible to verify a significant difference between the treatments, but it can be noted that the productivity remained at high levels. The best result found was for treatment T2, which presented an average of 4,130 kilograms per hectare and the absolute control "zero dose" T1 with an average of 3,112 kilograms per hectare, obtaining a difference of 1,018 kilograms, that is, 16.97 bags of 60 kilograms per hectare, not being detected by the "Tukey" average test at 5% probability, but highly noticeable for the rural producer's pocket.

Alovisi et al. (2017) worked with corn and soybean crops that were not influenced by the addition of basalt powder and bioactive in the technological variables of productivity in kilograms per hectare and weight of a thousand grains. In work carried out with a soil remineralizer conducted by Almeida Júnior et al. (2020) testing technological variables in soybean cultivation, such as number of two-grain pods, number of three-grain pods, number of pods per plant, thousand-grain weight and productivity in kilograms per hectare, also found no significant difference between the treatments, but the data were kept at high levels for all

agronomic characteristics and productivity above the average of the region where the work was implemented.

Table 5 . Averages of the agronomic parameters "plant biometry" for soybean cultivar AGROESTE 3730 , as a function of increasing doses of FMX micaschist remineralizer used in an experiment implemented by the company "Pesquisa e Consultoria Agronomica" in the municipality of Santo Antônio da Barra, state of Goiás , 2020.

TR	D kg ha $^{-1}$	NV2G	NV3G	NVPP	GMP (g)	P kg ha $^{-1}$
1	Zero	29.75	21.00	54.60	127.50	3,112
two	4,000	21,75	16,75	46,00	127,50	4.130
3	8.000	18,00	15,25	39,25	126,00	4.080
4	12.000	21,75	14,75	41,88	131,75	3.662
5	16.000	25,00	19,25	47,40	108,00	4.075
6	20.000	24,75	18,00	45,90	132,50	3.665
7	24.000	20,00	12,25	35,32	133,25	3.612
CV%	-	26,10	44,61	30,51	11,35	13,69
DMS	-	14,03	17,46	31,62	33,6	1.214,24

Treatments (TR), Dose in kilograms per hectare (D kg ha $^{-1}$), number of two-grain pods (NV2G), number of three-grain pods (NV3G), number of pods per plant (NVPP), weight of one thousand grains (PMG) and productivity in kilograms per hectare (P Kg ha $^{-1}$), by the Tukey test at 5% probability.
Source: Research data, 2020.

CONCLUSION

The use of micaschist FMX as a soil remineralizer in soybean cultivar A groeste 3730 , showed positive results by maintaining productivity at high levels compared to the average in the region and surpassing the national average.

The results showed a difference of 16.97 bags of 60 kilos per hectare, between the best treatment compared to the absolute control "zero dose", however, this difference was not detected by the test of averages, but it presented an excellent cost benefit .

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