https://doi.org/10.46344/JBINO.2023.v12i01.03

# USE OF ORGANIC FERTILIZER CONSORTIUM WITH MICAXIST REMINERALIZER IN SOYBEAN CULTURE

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## ABSTRACT

This work aimed to use organic fertilizer together with a micaschist remineralizer in the soybean cultivar Agroeste AS 3730 , implanted in the Brazilian Midwest. The experiment was conducted in the 2019/2020 growing season, at Fazenda Panamá, municipality of Itumbiara, state of Goiás, in a conventional cultivation system, implemented by the Nucleus of Study and Research in Fitotechnics , ° 58' S latitude and 45°22' W longitude and 554 m altitude. The agronomic parameters "plant biometry" were evaluated as follows: The population was carried out 30 days after germination, studies of plant biometry (aerial part) were carried out at the time of harvest, that is, number of branches, number of pods of one grain, number of two-grain pods, number of three-grain pods, number of pods per plant, thousand-grain weight and productivity in kilograms per hectare. To evaluate the productivity, the plants were collected in the useful area of each plot and threshing was performed manually by weighing the grains of each plot, and for the weight of a thousand grains, a tray was used to count the thousand grains and weighed on a scale of precision. The experimental design was in randomized blocks and a single factor, and the doses of micaschist remineralizer and organic fertilizer were in 7 T1 levels: 0.0 Mg ha $^{-1}$ absolute control; T2: 4 Mg ha $^{-1}$ micaschist + 1 Mg ha $^{-1}$ organic fertilizer; T3: 8 Mg ha $^{-1}$ micaschist + 1 Mg ha $^{-1}$ organic fertilizer; T4: 12 Mg ha $^{-1}$ micaschist + 1 Mg ha $^{-1}$ organic fertilizer; T5: 16 Mg ha $^{-1}$ micaschist + 1 Mg ha $^{-1}$ organic fertilizer; T6: 20 Mg ha $^{-1}$ micaschist + 1 Mg ha $^{-1}$ organic fertilizer; T7: 24 Mg ha $^{-1}$ micaschist + 1Mg ha $^{-1}$ organic fertilizer, with four replications. Data were analyzed using the SISVAR program. 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. The use of "remineralizing" micaschist in the soybean crop was considered efficient for the proposed objective, as it obtained a difference of 864 kilograms, that is 14.4 bags of 60 kilograms, between the best treatment compared to the absolute control "zero dose" not being detected by the test of averages, but highly perceptible to the rural producer's pocket.

**Keyword:** Agroecological fertilizers. Soil conditioner. Productivity . Sustainable agriculture . Metamorphic rock .

## INTRODUÇÃO

The current way of life associated with population growth, the growing demand for food production and technological development stimulate the generation of waste from different sources in large quantities that, when not handled properly, become contaminants, contributing to environmental degradation, the that compromises the quality of life of the population. The growth of the agro-industrial sector, especially in the Midwest region of Brazil, has generated large amounts of organic waste that can be used sustainably. When associated with mineral sources, they are transformed into organomineral fertilizers and play an important role in the physical, chemical, physicochemical and biological properties of the soil, in plant physiology, in addition to contributing to the reduction of the environmental liability of poultry and pig farming activities ( Kiehl , 1999 ).

The organomineral fertilizer is the result of mixing organic fertilizers that generally have a low concentration of N, P and K, but works as a conditioner for mineral fertilizers because it has properties such as high cation exchange capacity, high water retention, high specific surface and presence of chelates, increased activity of soil biota, reduced plasticity and cohesion, increased soil aeration helping in the penetration and distribution of plant roots, and even provides an increase in the stability and sustainability of the agricultural ecosystem ( Kiehl , 1999) .

Brazil is a major producer of soy, with expectations of an increase in the planted area for the 2020/2021 agricultural year of around 3.3% compared to the previous harvest, reaching 38.2 million hectares planted and a record production of 134,451.1 thousand tons, with an increase of 7.7% compared to the previous harvest (CONAB, 2020).

As a major soybean producer, it is natural that Brazil is also a major consumer of chemical fertilizers, inputs and raw materials for its formulation, which come from abroad, which increases the cost of agricultural production. Chemical fertilizers are highly soluble and are not fully absorbed by plants and leach easily, in many cases constituting surface and groundwater contaminants. Thus, the use of organomineral fertilizers can be a sustainable and promising option to reduce imports and the condition of servitude and dependence on chemical fertilizers.

Soy is an important crop for agribusiness due to the high production of proteins and oils in its seeds, used especially in the production of animal feed and edible oil. *Glycine max* (L.) Merril is a species popularly known as soybean, has Asian origin and belongs to the Fabaceae family ( Leguminosae ). It presents morphological characteristics that are highly influenced by the environment such as height, branching and life cycle. It is herbaceous, annual, erect and autogamous in consistency, has a pivoting root system, rich in bacterial nodules that carry out

biological nitrogen fixation (SEDIYAMA, 2009).

Thus, this work aimed to use the organic fertilizer in conjunction with the micaschist remineralizer in the soybean crop implanted in the Brazilian Midwest.

## MATERIAL AND METHODS

The experiment was carried out in the 2019/2020 crop year, in the soybean crop, cultivar Agroeste AS 3730 , implanted at the Panama Farm, municipality of Itumbiara, state of Goiás, in a conventional cultivation system, implemented by the Nucleus of Study and Research in Phytotechnics. The locality presents as approximate geographical coordinates, 17° 58' S of latitude and 45°22' W of longitude and 554 m of altitude.

The predominant climate of the region, as classified by 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).

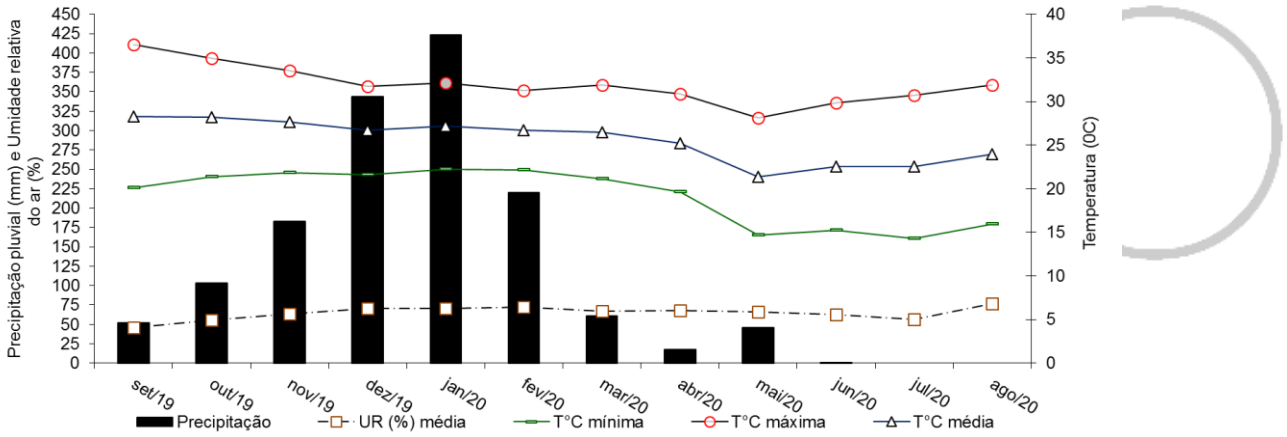


**Figure 1** . Maximum temperature ( ° C ) monthly averages, average temperature ( ° C) monthly averages, minimum temperatures ( ° C) monthly averages and rainfall (mm) and Relative air humidity (%) monthly averages, accumulated in the 2019/2020 harvest in the municipality of Itumbiara, Goiás. 2020.
**Source:** Agritempo – Agrometeorological Monitoring System, Itumbiara meteorological station, state of Goiás, 2020.

The predominant soil in the area, according to the new name of the Brazilian Soil Classification System (Embrapa, 2013) is Red Argisol with clayey texture , which was originally occupied by Cerrado vegetation and has been exploited by annual crops for more than 15 years.

The soil attributes were evaluated before the implementation of the research project to know the chemical characteristics of the experimental area. Soil chemical attributes (pH, P, K, Ca, Mg,

H+Al, Al, SB, V (%) and MO) were determined in layers from 0.0 to 0.20 m deep, following the methodology proposed by Raij and Quaggio (2001). The results of the macro and micronutrient contents obtained in the soil analysis, as indicated for the cerrado, phosphorus with low levels, potassium with very low levels, calcium with high levels and magnesium, depending on the depth from 0.0 to 0.20 m and levels high. The analyzes were carried out at the Soil Fertility Laboratory of UniRV -University of Rio Verde and are shown in (Table 1).

**Table 1.** Results obtained from the chemical analysis of the soil sampled before planting in the experimental area for the implantation of the soybean cultivar Agroeste AS 3730 by the Nucleus of Study and Research in Phytotechnics , in the municipality of Itumbiara, 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 $dm^{-3}$ | | | | | | | BR | g $dm^{-3}$ |
| 0 – 20 | 5.3 | 5.2 | 0.3 | 3.0 | 1.3 | 0.0 | 4.4 | 4.4 | 8.8 | 50.3 | 29.5 |

**Source:** Research data, 2020.

Organomineral fertilizer uses organic waste as a source of organic matter, mixing it with mineral nutrients such as nitrogen, phosphorus and potassium. Thus, the compost resulting from this mixture has some advantages such as the gradual release of nutrients, resulting in less loss by leaching of mineral nutrients. Phosphorus is less fixed in soil colloids and the use of organominerals reflects in greater agronomic efficiency and use by plants.

The organic matter used as raw material to formulate the organomineral fertilizer is built by several nutrients whose presentation is in the form available for absorption. Among the components are the macronutrients N 2.80%, $P_2O_5$ 3.0%, $K_2O$ 3.0%, Ca 6.6%, Mg 0.67%, S 2.10%, micronutrients Fe 0 .25%, Mn 210 ppm, Cu 247ppm, Zn 512 ppm, B 218 ppm, Na 0.51%, as well as total organic carbon 36.23%, organic matter 62.3%, moisture 17%, pH 9.03 and C/N ratio 17:1.

The characteristic of organomineral fertilizer is to provide nutrients in a balanced and gradual way depending on the development of the crop, that is, in the initial phase the plant uses its seed reserves and later absorbs the nutrients contained in the mineral portion, then those contained in the mineral portion. organic portion according to its nutritional and development needs, since nutrients remain available in organic compounds throughout the crop cycle.

In the micaschist remineralizer the analyzed oxides (%) ($SiO_2$ , $TiO_2$ , Al2$O_3$ , $Fe_2O_3$ , MnO , MgO , CaO , $Na_2O$, $K_2O$, $P_2O_5$, $SO_3$ and LOI) were determined by measuring X-ray diffraction (XRD) in a diffractometer *Bruker D8 Discover* and are shown in Table 2. The measurement of X-ray diffraction (XRD) was performed in a diffractometer *bruker d8 Discover* . Monochromatic radiation from a tube with copper anode coupled to a *Johansson monochromator* for Ka1 operating at 40kV and 40mA, Bragg-Brentano Ø-2Ø configuration, *Lynxeye ® unidimensional detector* , 2Ø from 5º to

100° and step of 0.01° was used. The samples were kept rotating at 15 rpm.

The micaschist soil remineralizer has a final product granulometry of 0.3 to 1.0 mm and its classification was determined by IN 5 of March 13, 2016 in Chapter 1, Section II as the origin is basaltic rock of class " E", Section III, Product Specifications and Warranties, in subsection I "Remineralizers" of Article 4 (BRASIL, 2016) remineralizers must present the following minimum specifications and guarantees:

I - In relation to the specification of a physical nature, pursuant to Annex I of this Normative Instruction;

II - In relation to the sum of bases ( CaO , MgO , $K_2O$), it must be equal to or greater than 9% (nine percent) in weight/weight;

III - In relation to the potassium oxide ($K_2O$) content, it must be equal to or greater than 1% (one percent) in weight/weight; and

IV - In relation to the Hydrogenionic potential (pH) of abrasion, value as declared by the registrant. soil remineralizer from the point of view of the sum of bases and K2O content (Table 2).

**Table 2.** Results obtained for a micaschist soil remineralizer from the point of view of the sum of bases and $K_2O$ content, for the soybean cultivar Agroeste AS 3730 , and as a function of increasing doses of micaschist remineralizer FMX and organic fertilizer used in an experiment implemented by the Nucleus of Study and Research in Phytotechnics, in the municipality of Itumbiara, 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 plant population was analyzed 30 days after germination (DAG). Studies of the biometry of the plants (aerial part) were carried out at the time of harvesting, which are: number of branches (NR), number of pods of one grain (NV1G), number of pods of two grains (NV2G), number of pods three grains (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 were collected in the useful area of each plot and threshed manually by weighing 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 the doses of micaschist in 7 T1 levels: 0.0 Kg ha $^{-1}$ absolute control; T2: 4 Mg ha $^{-1}$ micaschist + 1 Mg ha $^{-1}$ organic fertilizer; T3: 8 Mg ha $^{-1}$ micaschist + 1 Mg ha $^{-1}$ organic fertilizer; T4: 12 Mg ha $^{-1}$ micaschist + 1 Mg ha $^{-1}$ organic fertilizer; T5: 16 Mg ha $^{-1}$ micaschist + 1 Mg ha $^{-1}$ organic fertilizer; T6: 20 Mg ha $^{-1}$ micaschist + 1 Mg ha $^{-1}$ organic fertilizer; T7: 24 Mg ha $^{-1}$ micaschist + 1 Mg ha $^{-1}$ organic fertilizer, with 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 (2014). 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 viewing the summary of the analysis of variance estimated for the biometric parameters for the soybean crop, cultivar Agroeste AS 3730, it was not possible to detect a significant difference between the blocks.

The analysis of variance for the treatments was also observed, the variables measured were: plant population, plant height, number of branches, number of pods of one grain, number of pods of two grains, number of pods of three grains, number of pods per plant, weight of a thousand grains and productivity in kilograms per hectare, and only plant height, a significant difference was found between the tested treatments (Table 3).

It is noted 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 work are similar to Nakayama et al. (2013), in which the coefficients of variation are within the range considered medium, with low dispersion.

**Table 3** . Summary of the analysis of variance (F), of the agronomic parameters "plant biometry" for the soybean cultivar Agroeste AS 3730 , as a function of increasing doses of micaschist remineralizer and organic fertilizer used in an experiment implemented by the Nucleus for Study and Research in Phytotechnics , in the municipality of Itumbiara, state of Goiás, 2020.

| FV | GL | PP | AP (cm) | AIPV (cm) | No | NV1G |
|---|---|---|---|---|---|---|
| Block | 3 | our | our | our | our | our |
| Trat | 6 | our | * | our | our | our |
| Error | 30 | - | - | - | - | - |
| cv% | - | 6,14 | 6.49 | 13.45 | 22.05 | 26,53 |
| DMS | - | 1,90 | 12,07 | 12,93 | 1,97 | 3,41 |
| **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% | - | 27,42 | 22,93 | 25,68 | 11,44 | 13,05 |
| DMS | - | 14,12 | 18,24 | 29,86 | 27,03 | 979,45 |

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.

Table 4 shows the agronomic parameters "plant biometry" plant population, plant height, number of branches, number of pods in a grain , by the Tukey test at 5% probability and only the plant height biometry showed difference significant among the treatments tested. In work carried out by Welter et al. (2011) with rock dust of basaltic origin, obtained the opposite result to this work when analyzing plant height, but the number of branches was not significantly affected .

In work carried out by Almeida Júnior et al. (2020) with the soybean crop, the opposite result was also obtained in the technological variable "plant height", but other variables tested such as plant population, height of insertion of the first pod, number of branches and number of pods in a grain did not occur. significant difference, corroborating this work. In work carried out by Costa et al. (2018) with organomineral fertilizer , no significant difference was found for production components such as plant population per meter, first pod insertion and number of branches, data that are similar to those of this work.

**Table 4** . Averages of the agronomic parameters "plant biometry" for soybean cultivar Agroeste AS 3730 , as a function of increasing doses of micaschist remineralizer and organic fertilizer used in an experiment implemented by the Nucleus for Study and Research in Phytotechnics, in the municipality of Itumbiara, state of Goiás, 2020.

| TR | D Mg ha $^{-1}$ | PP | AP (cm) | AIPV (cm) | NR | NV1G |
|---|---|---|---|---|---|---|
| 1 | Zero | 13.25 | 78.75b | 10.00 | 3.25 | 3.50 |
| two | 4+1 | 13.25 | 80 ab | 8.50 | 3.75 | 3.75 |
| 3 | 8+1 | 13.00 | 83.25 ab | 9,25 | 4.00 | 3.75 |
| 4 | 12+1 | 13.00 | 78 ab | 9,25 | 4.00 | 4.00 |
| 5 | 16+1 | 13.25 | 71.75 ab | 9.50 | 3.75 | 2.50 |
| 6 | 20+1 | 13.25 | 78,75 ab | 8,50 | 4,25 | 5,75 |
| 7 | 24 + 1 | 13,50 | 86,25 a | 9,25 | 3,75 | 4,75 |
| **CV%** | - | 6,14 | 6,49 | 13,45 | 22,05 | 26,53 |
| **DMS** | - | 1,90 | 12,07 | 12,93 | 1,97 | 3,41 |

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.

Figure 2 shows the second-order polynomial curve for the agronomic parameter "plant biometry" that plant height in the soybean crop, cultivar Agroeste AS 3730 , obtained its best result in treatment T7, which was similar to treatments T2, T3, T4, T5 and T6, and treatment T1, absolute control, zero dose, was the treatment that obtained the lowest plant height, with an average of 78.75 centimeters. The highest height registered an average of 86.25 centimeters.

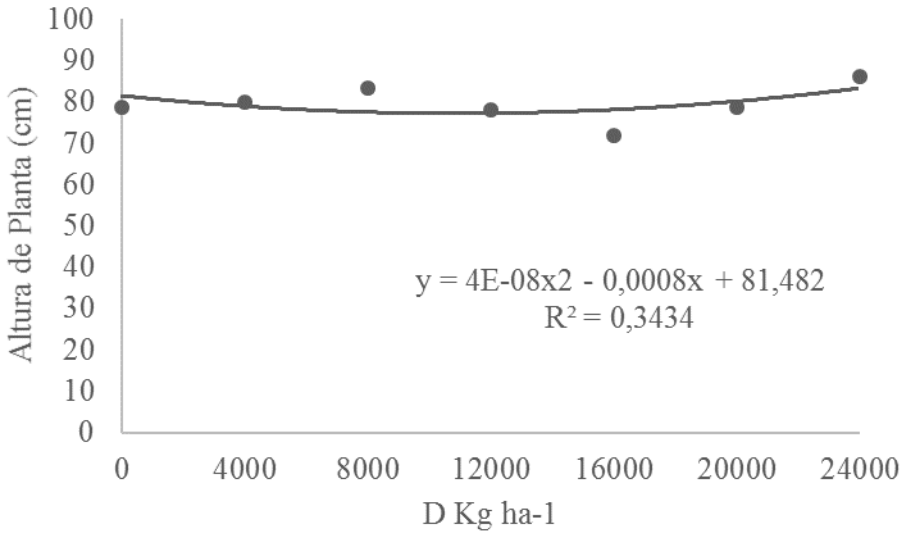


**Figure 2.** Second-order polynomial curve of the technological variable plant height for the soybean crop, cultivar Agroeste AS 3730 , as a function of increasing doses of micaschist remineralizer and organic fertilizer used in an experiment implemented by the Nucleus for Study and Research in Phytotechnics, in the municipality of Itumbiara, state of Goiás, 2020.
**Source:** Survey data, 2019.

It is recorded in Table 5 that the averages for the agronomic parameters "plant biometry", 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 crop and cultivar Agroeste AS 3730 at the different remineralizer doses tested, it was not possible to find a significant difference between the treatments used, but it can be noted that productivity remained at high levels. The best result obtained was for treatment T2 with an average of 3,533 kilograms per hectare and the absolute control "zero dose" treatment T1 obtained an average of 2,669 kilograms per hectare, which registered a difference of 864 kilograms, that is 14.4 bags of 60 kilos. Although the difference was not detected by the "Tukey" mean test at 5% probability, it was highly noticeable for the rural producer's pocket.

Alovisi et al. ( 2017) worked with corn and soybean crops and reported that these crops were not influenced by the addition of basalt powder and bioactive in the technological variables, 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) evaluated the technological variables in the soybean crop of number of two-grain pods, number of three-grain pods, number of pods per plant, thousand-grain weight and productivity in kilograms per hectare. There was no significant difference between treatments , but all agronomic characteristics were maintained at high levels and productivity was above the national average.

**Table 5** . Averages of the agronomic parameters "plant biometry" for soybean cultivar Agroeste AS 3730 and as a function of increasing doses of micaschist remineralizer and organic fertilizer used in an experiment implemented by the Nucleus for Study and Research in Phytotechnics, in the municipality of Itumbiara, state of Goiás, 2020.

| TR | D kg ha $^{-1}$ | NV2G | NV3G | NVPP | GMP (g) | P kg ha $^{-1}$ |
|---|---|---|---|---|---|---|
| 1 | Zero | 22.25 | 20.50 | 46.38 | 90 | 2,669 |
| two | 4 + 1 | 17,75 | 22,50 | 43,95 | 100 | 3.533 |
| 3 | 8 + 1 | 22,00 | 26,25 | 52,33 | 107 | 3.492 |
| 4 | 12 + 1 | 20,50 | 24,25 | 48,47 | 105 | 3.436 |
| 5 | 16 + 1 | 23,25 | 19,75 | 45,25 | 105 | 3.309 |
| 6 | 20 + 1 | 28,75 | 28,50 | 62,98 | 105 | 3.209 |
| 7 | 24 + 1 | 19,75 | 24,50 | 59,00 | 105 | 3.183 |
| **CV%** | - | 27,42 | 22,93 | 25,68 | 11,44 | 13,05 |
| **DMS** | - | 14,12 | 18,24 | 29,86 | 27,03 | 979,45 |

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 the FMX micaschist remineralizer to replace conventional fertilizers for the first time in this area, in the soybean crop, maintained all agronomic parameters at high levels and especially the productivity of the crop, which was expressed within a high mean compared to the average in level national. The results showed a difference of 864 kilograms, that is, 14.4 bags of 60 kilograms per hectare, between the best treatment compared to the absolute control "zero dose". The difference was not detected by the means test, but it presents high economic viability.

We also conclude that this research should be conducted for four more seasons in the same area and with the same treatments so that we can consolidate the results obtained in this work.

## THANKS

Special thanks to Agronomist Natal Moura Martins for providing the necessary area and inputs, Pedreira Araguaia and Tratto Agronegócios for supplying the micschist FTX remineralizer, and to the components of the Nucleus for Studies and Research in Plant Science for contributing directly or indirectly in the implementation and conduction of this project.

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