



USE OF ORGANIC FERTILIZER WORKING WITH SOIL REMINERALIZERS FOR SUGARCANE CULTIVATION

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ABSTRACT

Objective: The aim of this study was to evaluate the technical variables of the "phytobioassay" of the chemical properties of the aerial part of sugarcane (*Saccharum officinarum* L.) using organic fertilizer in consortium with mica schist remineralizer at different dosages.

Theoretical Framework: The application of organic fertilizers in conjunction with soil remineralizers is a promising and sustainable strategy for sugarcane cultivation. This practice contributes to the maintenance of soil fertility, improves the nutritional efficiency of plants and reduces the environmental impacts associated with intensive agriculture.

Method: The methodology adopted for this research comprises a field study of a scientific nature, with a quantitative approach.

Results and Discussion: The consortium between organic fertilizer and mica schist proved to be highly efficient, providing a gain in productivity in all treatments compared to the absolute control.

Research Implications: The contribution of this research in relation to novelty lies in the approaches that are taken and new methodologies and practical applications. This is justified by the demand for further research on such sustainable practices.

Originality/Value: The contribution of this research in terms of novelty is the approaches that are adopted and new techniques and applications. Its suitability and value are demonstrated by the need for further research in the same line of sustainable practices.

Keywords: Regenerative Cultivation, Sustainable Agriculture, Ecological Fertilizer.

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UTILIZAÇÃO DO FERTILIZANTE ORGÂNICO TRABALHANDO COM REMINERALIZADORES DE SOLO PARA CULTIVO DE CANA-DE-AÇÚCAR

RESUMO

Objetivo: Objetivou avaliar as variáveis técnicas do "fitobioensaio" propriedades químicas da parte aérea da cultura da cana-de-açúcar (*Saccharum officinarum* L.) utilizando fertilizante orgânico em consorcio com remineralizador micaxisto com diferentes dosagens.

Referencial Teórico: A aplicação de fertilizantes orgânicos em conjunto com remineralizadores de solo é uma estratégia promissora e sustentável para o cultivo de cana-de-açúcar. Essa prática contribui para a manutenção da fertilidade do solo, melhora a eficiência nutricional das plantas e reduz os impactos ambientais associados à agricultura intensiva.

Método: A metodologia adotada para esta pesquisa compreende em uma pesquisa à campo é de cunho científica, com abordagem quantitativa.

Resultados e Discussão: O consorcio entre fertilizante orgânico e micaxisto mostrou altamente eficiente proporcionando um ganho em produtividade em todos os tratamentos em comparação com o controle absoluto.

Implicações da Pesquisa: A contribuição desta pesquisa com relação à novidade está nas abordagens que são tomadas e novas metodologias e aplicações práticas. Justificadamente, isso é comprovado pela demanda por mais pesquisas sobre tais práticas sustentáveis.

Originalidade/Valor: A contribuição desta pesquisa em relação à novidade são as abordagens que são adotadas e novas técnicas e aplicações. Sua adequação e valor são comprovados pela necessidade de mais pesquisas na mesma linha de práticas sustentáveis.

Palavras-chave: Cultivo Regenerativo, Agricultura Sustentável, Fertilizante Ecológico.

USO DE FERTILIZANTES ORGÁNICOS QUE TRABAJAN CON REMINERALIZADORES DEL SUELO PARA EL CULTIVO DE LA CAÑA DE AZÚCAR

RESUMEN

Objetivo: El objetivo de este estudio fue evaluar las variables técnicas del "fitobioensayo" de las propiedades químicas de la parte aérea de la caña de azúcar (*Saccharum officinarum* L.) utilizando fertilizante orgánico en consorcio con remineralizador de esquisto de mica a diferentes dosis.

Marco teórico: La aplicación de fertilizantes orgánicos junto con los remineralizadores del suelo es una estrategia prometedora y sostenible para el cultivo de caña de azúcar. Esta práctica contribuye al mantenimiento de la fertilidad del suelo, mejora la eficiencia nutricional de las plantas y reduce los impactos ambientales asociados con la agricultura intensiva.

Método: La metodología adoptada para esta investigación comprende un estudio de campo de carácter científico, con un enfoque cuantitativo.

Resultados y Discusión: El consorcio entre fertilizante orgánico y esquisto de mica demostró ser altamente eficiente, proporcionando una ganancia en la productividad en todos los tratamientos en comparación con el control absoluto.

Implicaciones de la investigación: La contribución de esta investigación en relación con la novedad radica en los enfoques que se adoptan y en las nuevas metodologías y aplicaciones prácticas. Esto se justifica por la demanda de nuevas investigaciones sobre esas prácticas sostenibles.

Originalidad/Valor: La contribución de esta investigación en términos de novedad son los enfoques que se adoptan y las nuevas técnicas y aplicaciones. Su idoneidad y valor se demuestran por la necesidad de seguir investigando en la misma línea de prácticas sostenibles.



Palabras clave: Cultivo Regenerativo, Agricultura Sostenible, Fertilizante Ecológico.

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1 INTRODUCTION

The cultivation of sugar cane (*Saccharum officinarum*) plays a vital role in the global economy and is a major source of sugar, ethanol and renewable energy. With the increasing demand for biofuels and the need for sustainable agricultural practices, the use of organic fertilizers in combination with remineralizers such as mica schist becomes a promising strategy to promote soil health and increase productivity in sugarcane fields.

The *Saccharum officinarum* is an important plant for both the economic and social spheres in many tropical and subtropical countries, and plays a significant role in the production of sugar, alcohol and renewable energy. (FAO, 2020).

The growing demand for biofuels and the need to increase the productivity of sugarcane fields poses significant challenges for producers, who need to adopt sustainable and efficient agricultural practices (Diniz et al., 2019).

Organic fertilizers, composed of organic waste, animal manure, compost and other organic materials, are a natural source of essential nutrients for sugarcane plants (Cunha et al., 2017).

Aggressive organic fertilizers improve soil structure, increase microbial activity, retain moisture and promote plant health, resulting in healthier and more sustainable crops (Nascimento et al., 2018).

Mica schist is a metamorphic rock rich in essential minerals such as potassium, calcium, magnesium, phosphorus and micronutrients, which can be used as a source of nutrients for sugarcane plants (Hartmann et al., 2015).

The combination of organic fertilizers with remineralizers , such as mica schist, promotes balanced and sustainable fertilization, providing essential nutrients for plants and improving soil structure (Diniz et al., 2020).

The use of organic fertilizers in conjunction with remineralizers contributes to increasing soil fertility, improving nutrient availability and promoting the healthy growth and development of sugarcane plants (Diniz et al., 2020).



The use of organic fertilizers in consortium with remineralizers can help reduce the environmental impact of sugarcane production, generating dependence on chemical fertilizers and minimizing the leaching of nutrients into watercourses (Nascimento et al., 2018).

The integration of organic fertilizers with remineralizers, such as mica schist, appears to be a promising strategy to increase the productivity and sustainability of sugarcane fields, contributing to food and energy security and environmental preservation.

In view of the above, the objective of this study was to evaluate the technical variables of the "phytobioassay" and the chemical properties of the aerial part of the sugarcane crop (*Saccharum officinarum* L.) using organic fertilizers in consortium with mica schist with different dosages.

2 MATERIAL AND METHODS

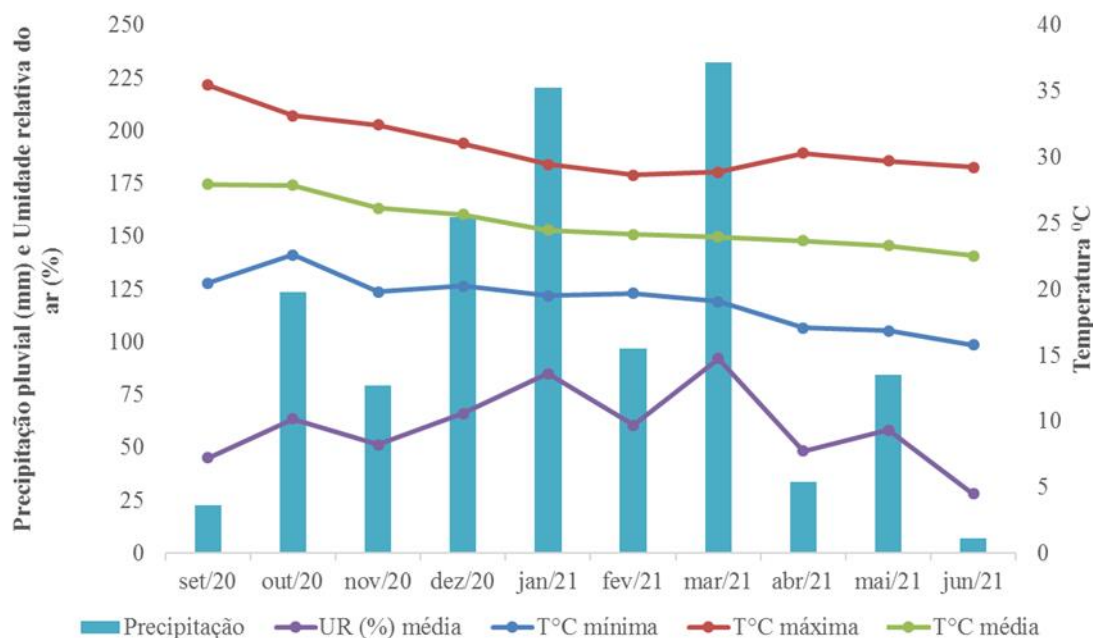
The research was conducted during the 2020/2021 agricultural harvest at Fazenda Trindade, located in the municipality of Itumbiara, in the State of Goiás. The approximate geographic location of the area is 49° 15' 24" W and 18° 18' 43" S, with a longitude of 161 meters and altitude.

The region has a Humid Tropical climate (Aw) according to Köppen (Alvares et al., 2013), characterized as dry in winter and rainy in summer (Alvares et al., 2013). The data on climatic conditions during the research were obtained from the Automatic Meteorological Station of Itumbiara - GO, which is part of the climate monitoring by INMET - National Institute of Meteorology. The average values observed during the research, for average temperature and relative humidity, were 23.10 °C and 64.84%, respectively (Figure 1). The rainfall is 1,830 mm (Figure 1).



Figure 1

THE maximum temperature in (° C) is typically monthly, relative humidity is typically (%) and rainfall is typically (mm) in the experimental area of the company PCA-Pesquisa Consultoria Agrônômica in the municipality of Itumbiara, State of Goiás. 2021



Source: Agrometeorological Trail (AGRITEMPO), Itumbiara / INMET. Municipality of Itumbiara, state of Goiás. 2021.

The new name of the Brazilian Soil Classification System (EMBRAPA, 2013) is Neossolo Quartzarenic , which is a type of soil typically found in the region and of sandy composition, initially covered by Cerrado vegetation and has been cultivated with annual plants for more than a decade.

Soil properties were assessed prior to implementation of the research project to understand the chemical, physical and biological characteristics of the experimental area . Determine the chemical characteristics of the soil , pH, CA+MG, CA, MG, AL, H+AL, K, P, S, B, CU, FE, MN, ZN, in CTC, from zero to layers at 0.20 is 0.20 to 0.40 meters, depth , including alkaline saturation, organic matter, clay , silt and sand . The soil of the area that was conducted for research. Follow the proposed method put Raij et al . (2001). The analysis was carried out at the Exata laboratory (Jatai) of soil fertility and (Table 1).

**Table 1**

The results of chemical analysis of the soil, sample collected in the experimental area, before planting sugarcane cultivar CTC 9001, due to the increasing amount of organic fertilizer in the soil with the addition of mica schist remineralizer . Itumbiara. The state of Goiás, 2021.

Depth (cm)	pH	P (Honey)	K ⁺	Her e	Mg	Al	H+Al	SB	CTC	V	MO
	CaCl ₂	mg dm ⁻³								%	g dm ⁻³
0 – 20	4.6	7.0	0.4	17	6	1	21	23.4	44.4	52.74	16
20 – 40	4.6	2.0	0.2	15	8	1	25	23.2	48.2	48.17	11

Source: Survey data, 2021.

The *Saccharum officinarum* implementation of the CTC 9001 cultivar involved randomization of blocks of four replicates, with a single treatment factor that was described as having ten different levels. T1: 0.0 (absolute control, zero dose), T2: 3.0 Mg ha⁻¹ organomineral fertilizer + 3.0 Mg ha⁻¹ mica schist, T3: 6.0 Mg ha⁻¹ organomineral fertilizer + 6.0 Mg ha⁻¹ mica schist, T4: 9.0 Mg ha⁻¹ organomineral fertilizer + 9.0 Mg ha⁻¹ mica schist, T5: 12.0 Mg ha⁻¹ organomineral fertilizer + 12.0 Mg ha⁻¹ mica schist, T6: 15.0 Mg ha⁻¹ organomineral fertilizer + 15.0 Mg ha⁻¹ mica schist, T7: 18.0 Mg ha⁻¹ organomineral fertilizer + 18.0 Mg ha⁻¹ mica schist, T8: 21.0 Mg ha⁻¹ fertilizer organomineral + 21.0 Mg ha⁻¹ mica schist, T9: 24.0 Mg ha⁻¹ organomineral fertilizer + 24.0 Mg ha⁻¹ mica schist, T10: 27.0 Mg ha⁻¹ organomineral fertilizer + 27.0 Mg ha⁻¹ mica schist.

The “Plant Biometry” technological variables evaluated include: plant population (90 DAP “days after planting”); tons of sugarcane per hectare (12 months after planting); total sugar recovered (analyzed within 24 hours after sample collection). Other technical variables were collected one (one) day before harvest: plant population; plant height; number of internodes; stem diameter, sugarcane, Sugar content in; Corrected Brix reading ; Wet weight of the cake, Percentage of oligosaccharides (sucrose); Reducing sugar; Total reducing sugar; Moisture: Moisture content of the cake.

The experimental plot consisted of four eight-meter-long rows, with the effective area of the plot being two six-meter rows, with a spacing between rows of 1.50 meters and a spacing between blocks of 2.0 meters. After 30 (DAG) days of crop germination, the product used is dispensed through the wand.

Statistical analysis of the data was performed using the SISVAR procedure proposed by Ferreira (2019). The information obtained in the experimental data collection was subjected to ANOVA and the means were compared by the Tukey test when ANOVA significance was detected at p=0.05% probability for comparison of means.



3 RESULTS AND DISCUSSION

We can observe in (Table 2) that the agronomic characteristics, plant population, plant height, number of internodes, and stem diameter did not differ significantly between the treatments tested. However, although the treatments did not differ significantly, it is possible to observe that nutritional management with humic acid, fulvic acid, fungi, bacteria, and micronutrients increased in relation to the absolute control treatment with zero dose. In a study carried out by Almeida Júnior et al (2020), with different doses of soil remineralizer in soybean crops, it was not possible to verify a significant difference in the technological variable plant population per meter. This result demonstrates that plantability, germination, and seed survival achieved their objective, as there was no variation in the expected population, as specified for the variety implemented. In a study carried out by Almeida Júnior et al (2020), with different doses of soil remineralizer in soybean crops, it was not possible to verify a significant difference in the technological variable plant height and first pod insertion height. In a study carried out by Almeida Júnior et al (2024) in sugarcane crops, cultivar RB86-7515, due to the increasing doses of basalt rock powder remineralizer for the technological variable number of internodes, there was a significant difference between the treatments used. It also reports that biotic and abiotic factors do not interfere with a healthy and well-nourished plant, therefore it must express its maximum genetic condition and states that basalt rock powder is highly viable in sugarcane production, as it maintains high productivity and chemical characteristics at high levels. In work carried out by Almeida Júnior, et al., (2024), evaluating the average values of the technical variables for cultivation “Plant Biometry” diameter of the corn collar throughout the research, it was not possible to find a significant difference between the treatments.

Table 2

The average values of agricultural properties for sugarcane cultivation, including the second cut, were increased depending on the dose of organic and remineralizing mica schist fertilizer, implemented in partnership with the company PCA-Pesquisa Consultoria Agronômica in the Municipality of Itumbiara, state of Goiás, 2021.

TREAT	Dose Mg ha ⁻¹	PP	AP	NEN	A.D
T1	Zero	9.50	2.75	15.75	2.00
T2	3.0 + 3.0	10.00	2.00	16.00	2.00
T3	6,0 + 6,0	9,25	2,25	16,00	2,25
T4	9,0 + 9,0	10,25	2,00	14,00	2,00
T5	12,0 + 12,0	9,25	2,50	15,25	2,00
T6	15,0 + 15,0	10,25	2,50	14,00	2,00
T7	18,0 + 18,0	11,00	2,75	17,50	2,00



T8	21,0 + 21,0	9,75	3,00	17,25	2,00
T9	24,0 + 24,0	9,00	3,00	16,00	2,00
T10	27,0 + 27,0	9,50	2,00	15,00	2,00
CV (%)		16,72	15,11	12,40	7,81
DMS		3,99	0,90	4,72	0,38

TRAT: Treatments; DC: Stem diameter; AP: Plant height; PP: Plant population; NEN: Number of internodes; DMS: Mean significant dose; CV: Coefficient of variation; mean with a “lowercase” letter in the column differs significantly at 5% probability by Tukey's test .

Source: Survey data, 2021.

It can be observed in (Table 3) for agricultural properties, BRIX: The sugar content of sugarcane is measured in pounds per acre; the corrected LS: The saccharimetric reading is corrected for the treatments used; the variable TCH: Quantity of cane per hectare, did not differ according to the treatments used, but the variable PBU: Cake weight, differed significantly according to the treatments used, with treatment T6 having the highest average of 125 pounds per hectare, and treatment T7 having the lowest average of 75 pounds per hectare. In addition, the treatment with the lowest value was located in treatment T6, with an average value of 137.35 grams. In work carried out by Almeida Júnior, et al., (2024) in sugarcane cultivation, cultivar RB86-7515, depending on the increasing doses of basalt rock powder remineralizer for the technological variable tons of sugarcane per hectare (TCH) , there was a significant difference between the treatments used, it also reports that biotic and abiotic factors do not interfere in a healthy and well-nourished plant, therefore it must express its maximum genetic condition and states that basalt rock powder is highly viable in sugarcane production, as it maintains high productivity and chemical characteristics at high levels.

**Table 3**

The average values of agricultural properties for sugarcane cultivation, including the second cut, were increased depending on the dose of organic and remineralizing mica schist fertilizer, implemented in partnership with the company PCA-Pesquisa Consultoria Agrônômica in the Municipality of Itumbiara, state of Goiás, 2021.

TREAT	Dose Mg ha ⁻¹	TCH ha ⁻¹	BRIX	LS Fixed	PBU (g)
T1	Zero	75 f	19.58	69.64	148.93 ab
T2	3.0 + 3.0	87 and	20.15	72,13	141.28 ab
T3	6.0 + 6.0	89 e	19.58	68.23	149.99 ab
T4	9.0 + 9.0	88 e	19.53	68.55	146.55 ab
T5	12.0 + 12.0	105 d	19.11	66.25	149.83 ab
T6	15.0 + 15.0	125 a	20.05	69.97	137.35 b
T7	18.0 + 18.0	120 b	20,75	74,14	151,96 a
T8	21,0 + 21,0	121 b	20,24	71,71	142,71 ab
T9	24,0 + 24,0	109 c	19,44	69,44	143,87 ab
T10	27,0 + 27,0	109 c	20,36	73,80	144,60 ab
CV (%)		0,97	4,35	6,39	3,81
DMS		2,43	2.10	10.94	13.51

TRAT: Treatments; BRIX: Sugar content in sugarcane; TCH: Tons of sugarcane per hectare; Corrected LS: PBU: Wet cake weight; Corrected saccharimetric reading; DMS: Mean significant dose; CV: Coefficient of variation; mean with a "lowercase" letter in the column differs significantly at 5% probability by Tukey's test.

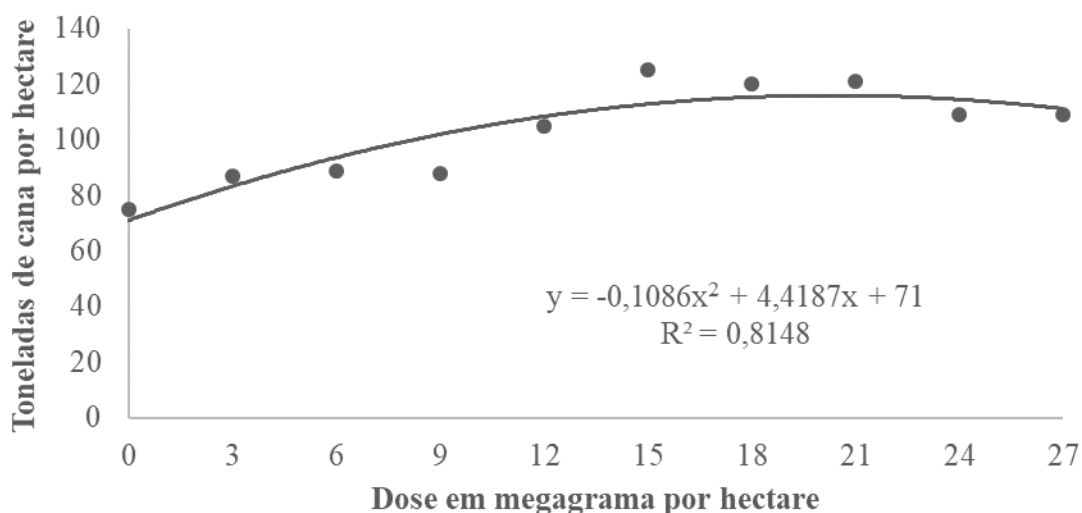
Source: Survey data, 2021.

It can be seen in the second-order polynomial graph (Figure 2) for the technological variable TCH: Tons of sugarcane per hectare, in sugarcane cultivation, CTC 9001, and in sugarcane harvesting, the dose of organic and remineralizing mica schist fertilizer is 7.77 tons per hectare.



Figure 2

Second-order polynomial function for agricultural characteristic, TCH: Tons of sugarcane per hectare, in sugarcane cultivation, CTC 9001, second portion of sugarcane, as a function of increasing doses of organic fertilizer and Mica Shale Remineralizer, implemented in partnership with the company PCA-Pesquisa Consultoria Agronômica in the municipality of Itumbiara, in 2021.

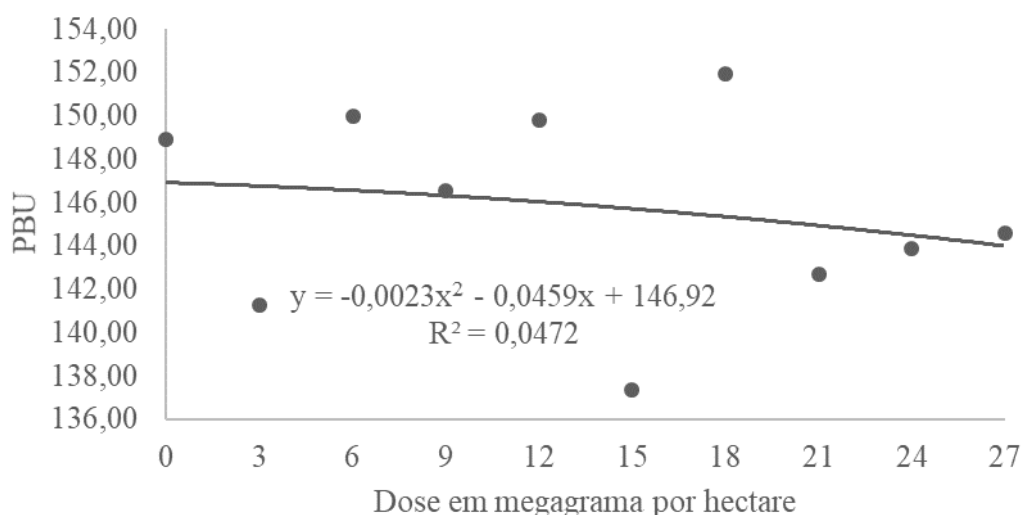


Source: Survey data, 2021.

We can see in the second-order polynomial curve (Figure 3) for the PBU technological variable: Wet cake weight, in the sugarcane crop, C TC 9001, second-cut cane, and as a function of the increasing doses of organic fertilizer and mica schist remineralizer, where it was possible to calculate the optimal dose, which obtained the value of 9.97 tons of organic fertilizer and mica schist remineralizer per hectare.

**Figure 3**

Second-order polynomial function for agricultural characteristic, TCH: Tons of sugarcane per hectare, in sugarcane cultivation, CTC 9001, second portion of sugarcane, as a function of increasing doses of organic fertilizer and Mica Shale Remineralizer, implemented in partnership with the company PCA-Pesquisa Consultoria Agronômica in the municipality of Itumbiara, in 2021.



Source: Survey data, 2021 .

It can be seen in (Table 4), in the average values of the agronomic characteristics, that the technological variables, Pol % Broth: sucrose content of the sugarcane; Purity %: Purity of the extracted broth; AR Broth (%): Reducing sugars of the broth, did not obtain a significant difference between the treatments tested, but the variable Fiber (%): Wet cake resulting from pressing, obtained a significant difference between the treatments tested, with treatment T7 having the highest value found, with an average of 13.03 percent of fiber and treatment T6 obtained the lowest value with an average of 11.86 percent of fiber.

Table 4

Average values of agronomic characteristics for sugarcane cultivation, cultivar CTC 9001, second-cut cane, and as a function of increasing doses of organic fertilizer and mica schist remineralizer, implemented in partnership with the company PCA-Pesquisa Consultoria Agronômica in the municipality of Itumbiara, state of Goiás, 2021.

TREAT	Dose Mg ha ⁻¹	Pol% Broth	Purity (%)	AR Broth (%)	Fiber (%)
T1	Zero	16.80	85.74	0.70	12.79 ab
T2	3.0 + 3.0	17.35	86.04	0.69	12.18 ab
T3	6.0 + 6.0	16.45	84.00	0.76	12.88 ab
T4	9.0 + 9.0	16.53	84.65	0.74	12.60 ab



T5	12.0 + 12.0	16.00	83.63	0.77	12.86 ab
T6	15.0 + 15.0	16.84	84.00	0.76	11.86 b
T7	18.0 + 18.0	17.79	85.78	0,70	13,03 a
T8	21,0 + 21,0	17,25	85,17	0,72	12,30 ab
T9	24,0 + 24,0	16,74	85,99	0,69	12,39 ab
T10	27,0 + 27,0	17,74	87,12	0,65	12,44 ab
CV (%)		6,07	2,31	9,50	3,54
DMS		2,50	4,79	0,17	1,08

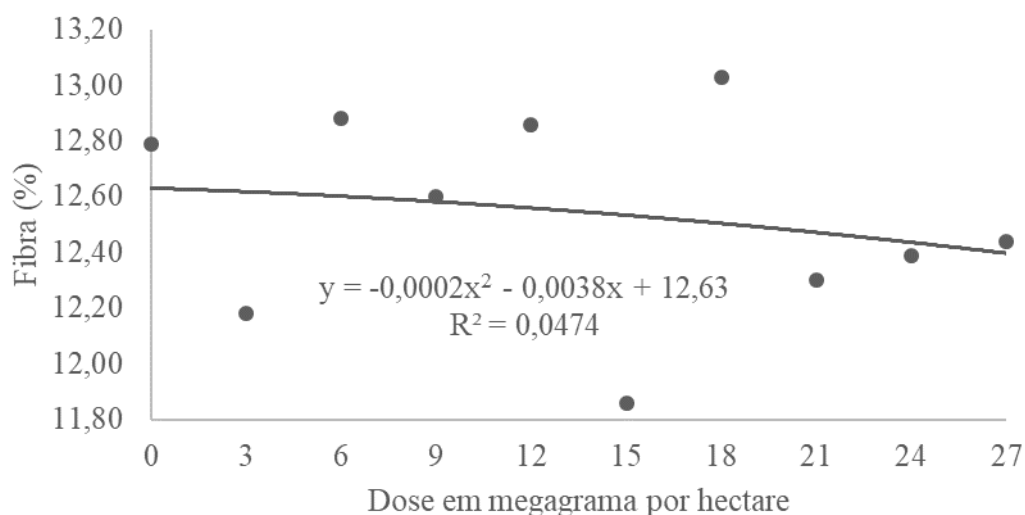
TRAT: Treatments; Pol % Broth: Sucrose content of the cane; Purity%: Purity of the extracted broth; AR Broth (%): Reducing sugars in the broth; Fiber (%): Wet cake resulting from pressing, CV: Coefficient of variation; DMS: Significant average dose; mean with "lowercase" letter in the column differs significantly at 5% probability by Tukey's test.

Source: Survey data, 2021.

This is quite evident in the second-order polynomial graph (Figure 4) for the technological variable Fiber (%): The wet cake resulting from pressing, in sugarcane cultivation, CTC 9001, second cut of the cane, depends on increasing the doses of organic fertilizer and mica schist remineralizer, the ideal dose was calculated at 9.50 tons of organic fertilizer and mica schist remineralizer per hectare.

Figure 4

Second-order polynomial function for agricultural characteristic, TCH: Tons of sugarcane per hectare, in sugarcane cultivation, CTC 9001, second portion of sugarcane, as a function of increasing doses of organic fertilizer and Mica Shale Remineralizer, implemented in partnership with the company PCA-Pesquisa Consultoria Agronômica in the municipality of Itumbiara, in 2021.



Source: Survey data, 2021.



We can observe in (Table 5) for the technological variables Pol % Cane: The percentage of oligosaccharides in (sucrose); AR %: The reducing sugar content of the cake; Moisture: Amount of moisture in the cake, which does not differ between the treatments tested.

Table 5

Average values of agronomic characteristics for sugarcane cultivation, cultivar CTC 9001, second-cut cane, and as a function of increasing doses of organic fertilizer and mica schist remineralizer, implemented in partnership with the company PCA-Pesquisa Consultoria Agronômica in the municipality of Itumbiara, state of Goiás, 2021.

TREAT	Dose Mg ha ⁻¹	Pol % Cane	AR (%)	ATR Kg t ⁻¹	Humidity (%)
T1	Zero	14.03	0.59	140.46	70.13
T2	3.0 + 3.0	14.65	0.58	146.43	70.13
T3	6.0 + 6.0	13.72	0.63	137.98	70.07
T4	9.0 + 9.0	13.86	0.62	139.11	70.33
T5	12.0 + 12.0	13.35	0.65	134.49	70.49
T6	15.0 + 15.0	14.30	0.65	143.58	70.47
T7	18.0 + 18.0	14.80	0.58	147.84	68.93
T8	21.0 + 21.0	14.53	0.61	145.48	69.96
T9	24.0 + 24.0	14.07	0.58	140.85	70.59
T10	27.0 + 27.0	14.91	0.55	148.60	69.73
CV (%)		6.02	9.67	5.49	1.26
DMS		2.08	0.14	19.03	2.14

TRAT: Treatments; Pol % Cane: Percentages of oligosaccharides (sucrose); AR%: Reducing sugars; Moisture: Moisture content of the cake, CV: Coefficient of variation; DMS: Mean significant dose; mean without "lowercase" letter in the column does not differ significantly at 5% probability by Tukey's test.

Source: Survey data, 2021.

4 CONCLUSION

The use of organic fertilizers in consortium with remineralizers, such as mica schist, represents an innovative and sustainable approach to sugarcane production, benefiting both producers and the environment.

The consortium between organic fertilizer and mica schist proved to be highly efficient, providing a gain in productivity in all treatments compared to the absolute control.

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