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USE OF MICROORGANISMS AND AMINO ACIDS IN THE CULTIVATION OF CORN IN THE SECOND HARVEST

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ABSTRACT

The study was carried out during the 2021/2022 agricultural year by the company PCAThe research site is located at 18°68' south latitude, 38°31' west longitude, and is approximately 865 meters above sea level. The objective of this study was to evaluate the technical variables of the "phytobioassay" and the properties, using biologicals, amino acids and micronutrients in corn cultivation in southwest Goiás. The crop studied was corn, variety AG 8700 PRO3, and the treatment composition is T1: 0.0 ha-1 (absolute control); T2: 100 g ha-1 (SP) planting furrow + 100 g ha-1 (RV4B) reinforcement at stage V4 via application bar with the bacteria Azospirillum baldaniorum, Bacillus amyloliquefaciens; Bacillus proteolyticus and Pseudomonas aeruginosa; T3: Farm standard (TS): Seed treatment with Poncho and Acorde (Cropfield). The technological variables “Plant Biometrics” evaluated include Plant Population (PP) (DAP) carried out 30 days after germination, Plant Biometric Studies (aerial parts) at harvest, plant population, plant height, stem diameter, seed insertion height first ear, number of ears per plant, number of rows per ear, number of grains per row, number of grains per ear, ear diameter, cob diameter, grain length, ear length without chaff, thousand grain weight and productivity kilogram per hectare. The data were analyzed using the Sisvar procedure. The data obtained were subjected to analysis of variance, using the Tukey test to compare means, when significance of the analysis of variance was detected at p=0.05% probability for comparing means. Analyzing the results, we can conclude that there are no significant differences in all the technical variables studied, with the exception of productivity in kilograms per hectare, which obtained the best result, therefore we can state that the use of bacteria is highly viable in corn cultivation.

Keywords: Agroecology. Sustainable Agriculture. Bacteria.

INTRODUÇTION

Corn (Zea mays L.) cultivation plays a fundamental role in global agriculture, being one of the main sources of food, animal feed and raw materials for various industries. The growing demand for corn poses a significant challenge to agricultural production, which faces pressure to increase productivity in a sustainable manner. In this context, biological control approaches emerge as a promising strategy to combat pests, diseases and improve the health of corn plants. Corn is a crop of great global relevance, both for human food security and for the production of animal feed. and biofuels (FAO, 2020). Maize production faces significant challenges, including pressure from pests and diseases, as well as the need to reduce dependence on chemical pesticides (Oerke, 2006). Biological control involves the use of living organisms , such as predators, parasitoids and beneficial microorganisms, to control pests and diseases in a sustainable manner (Barbosa et al., 1998). The use of biological control agents can reduce environmental impact, minimize the development of resistance in pests and maintain health of ecosystems (Van Lenteren, 2012). Predators such as ladybugs, parasitoids such as wasps and microorganisms such as entomopathogenic nematodes are examples of agents used in biological control (Pedigo et al., 2006), which aligns with principles of sustainable agriculture, reducing the need of chemical pesticides and promoting biodiversity (Gurr et al., 2017). The effectiveness of biological control may vary according to region and conditions

local areas, requiring specific strategies to optimize their use (Pedigo et al., 2006). Effective incorporation of biological control can lead to increases in corn productivity while reducing risks associated with pesticides (Gurr et al., 2017) and represents a promising approach to addressing corn production challenges as agriculture seeks more sustainable and effective solutions. Amino acids are essential building blocks for proteins, but they also play critical roles in plant physiology, from synthesis of hormones to the response to stress (Raven et al., 2005). The application of amino acids can improve the nutrition of corn plants, contributing to their growth, disease resistance and productivity (Sharma; Dietz, 2009). Amino acids play a key role in the ability of maize plants to cope with environmental stresses such as drought, salinity and extreme temperatures (Hayat et al., 2012). Its strategic application can improve the quality of corn grain, increasing protein levels and other essential nutrients (Abd El-Monem et al., 2010). The use of amino acids in agriculture aligns with the principles of sustainable agriculture, reducing dependence on chemical fertilizers and minimizing environmental impact (Dietz et al., 2010).

The application of amino acids must be adapted to local conditions and the specific needs of corn plants (Rouphael et al., 2017). Amino acids represent a promising tool in the search for solutions

sustainable and effective solutions for the challenges of corn production, contributing to grain quality and food security.

Micronutrients are mineral nutrients necessary in very small quantities, but they play a fundamental role in plant health and grain quality, with iron (Fe), zinc (Zn), manganese (Mn), copper (Cu) being essential for corn.), molybdenum (Mo) and boron (B) (Lindsay, 1975), deficiency of which can lead to a series of growth disorders, decreased productivity and lower quality of corn grains (Marschner, 2012).

Balanced micronutrient nutrition is essential for the growth, development and resistance of corn plants. Therefore, effective micronutrient fertilization strategies are essential to ensure that maize plants have adequate access to these nutrients (Cakmak, 2008).

The adequate presence of micronutrients also affects the quality of corn grains, which is essential for their use in food and feed (Welch; Graham, 2004).

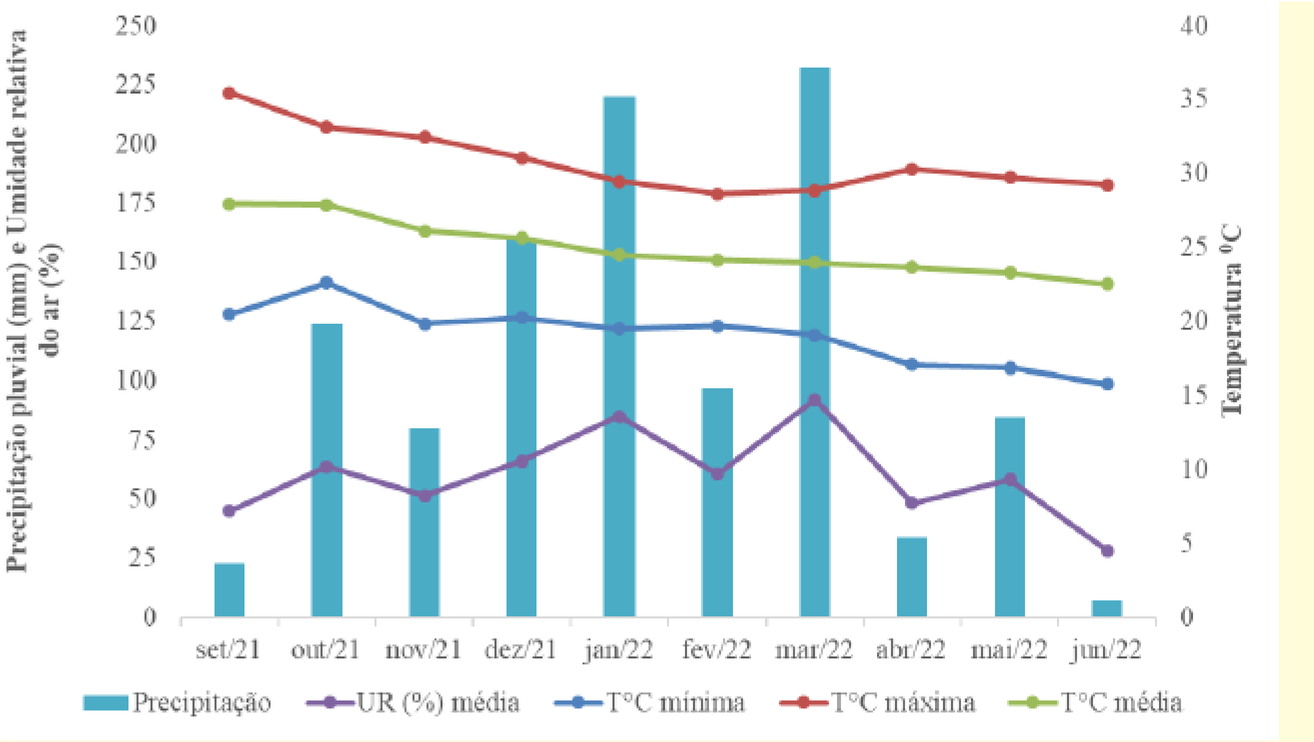
An in-depth understanding of micronutrients in maize crops and the development of appropriate management strategies are essential to meeting growing demand in a sustainable manner and ensuring global food security.

In view of the above, the objective of this study was to evaluate the technical variables of the "phytobioassay" and the properties, using biologicals, amino acids and micronutrients in corn cultivation in southwest Goiás.

MATERIAL & METHODOLOGY

The study was carried out during the 2021/2022 agricultural year by the company PCA -Agricultural Research and Consulting. The experimental area is located at 18°68' south latitude, 38°31' west longitude, approximately 865 meters above sea level. According to the Köppen classification (2013), the predominant climate in the region is type Aw, with a humid tropical climate, rainy summers and dry winters. The average annual precipitation is 1680-1920 mm, the average annual temperature is 26°C and the average relative humidity is 68% (Figure 1).The rains are mainly concentrated in October, November, December, January, February and March. June to August are the three months with the highest drought rate,with average rainfall of 27 mm, and December to February. The three months with the greatest drought index, making them the three wettest months of the year (Figure 1).

Figura 1. Temperatura máxima, mínima e média (°C), umidade relativa (%) e precipitação (mm) no mês da safra 2021/2022 na Área Experimental da empresa PCA -Pesquisa e Consultoria Agronômica, Mineiros, Goiás. 2022.



Fonte:AGRITEMPO – Sistema de Monitoramento Agrometeorológico Mineiro/INMET. Prefeitura Municipal de Mineiros, Estado de Goiás. 2022.

The soil is of the Quartzareno Neossolo type with a sandy texture, according to the Brazilian Soil Classification System (Embrapa, 2013), cultivated for several years with annual crops.The experimental design used was a 3x1 scheme with randomized blocks and four replications. Each experimental plot consisted of four lines of four meters in length, with an effective area of two lines of two meters in length, spacing between lines of 50 cm and spacing between blocks of 2.0 m in length.The technological variables "Plant Biometrics" evaluated include Plant Population (PP) (DAP) carried out 30 days after germination, Plant Biometric Studies (aerial parts) at harvest, PP - Plant population; AP - Plant height; DC – Collection diameter; AIPE – Height of insertion of the first ear; NEPP – Number of ears per plant; NFE: Number of row per ear; NGF – Number of grains per row; NGPE: Number of grains per ear; DE: Tang diameter; DS: Cob diameter; CG: Grain length; CESP: Ear length without straw; PMG: Weight thousand grains; P Kg ha-1: Productivity kilogram per hectare.To evaluate productivity, ears of 10 plants were collected in the useful areas of each plot and manually threshed, and the seeds from each plot were weighed. The weight of the thousand grains is measured on a pallet and weighed on a precision scale. Weighing is carried out at a standard humidity of 14%.Soil properties were evaluated before implementing the research project to understand the chemical characteristics of the experimental plot. The chemical properties of the soil (pH, P, K, Ca, Mg, H+Al, Al, SB, V (%) and MO) were determined in the layers from 0.0 to 0.20 and 0.20 to 0. 40 m deep following the method proposed by Raij et al (2001). The analyzes were carried out at the UniFIMES Soil Fertility Laboratory and presented results reported in Table 1.

Tabela 1. Resultados das análises químicas do solo, com amostras coletadas na área experimental antes do plantio da cultura do milho, variedade AG 8700 PRO3, em pesquisa implantada pela empresa PCA - Pesquisa e Consultoria Agronômica, com uso de diferentes biológicos, aminoácidos e micronutrientes, município de Mineiros, Goiás, 2022.

Prof (cm)	pH	P (Mel)	K^+	Ca	Mg	Al	H+Al	S.B.	CTC	V	M.O.
	$CaCl_2$	mg dm^{-3}	mmolc 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

Corn, variety AG 8700 PRO3, was used with the following treatments: T1: 0.0 ha-1 (absolute control); T2: 100 g ha-1 (SP) planting furrow + 100 g ha-1 (RV4B) reinforcement at stage V4 via application bar with the bacteria Azospirillum baldaniorum, Bacillus amyloliquefaciens; Bacillus proteolyticus and Pseudomonas aeruginosa; T3: Farm standard (TS): Seed treatment with Poncho and Acorde (Cropfield).

The data were analyzed using the Sisvar program proposed by Ferreira (2015) and the data obtained were subjected to analysis of variance, using the Tukey test to compare means, when significance of the analysis of variance was detected at p=0.05% probability for comparison of means.

RESULTS AND DISCUSSION

In the summary of the variance analysis of technical variables for evaluating the

"Plant Biometrics" for the cultivation of corn, variety AG 8700 PRO3, it is noted that none of the block parameters reached significance, and for the treatments, only the productivity in kilograms per hectare showed a significant difference between the treatments tested (Table 2).

It is worth highlighting that the coefficient of variation (CV) was satisfactory, indicating that the data collected for the agronomic parameter "Plant Biometrics" were obtained accurately according to the classification proposed by Carvalho et al. (2003). The results of the present work are similar to those of Nakayama et al. (2013), where the coefficient of variation is within the average range and dispersion is low (Table 2).

Tabela 2. Resumo da análise de variância das variáveis técnicas para cultivo "Biometria Vegetal", em pesquisa implantada pela empresa PCA - Pesquisa e Consultoria Agronômica, com uso de diferentes biológicos, aminoácidos e micronutrientes na cultura do milho, variedade AG 8700 PRO3, município de Mineiros, Goiás, 2022.

FV		PP	AP	DC	AIPE	NEPP	NFE	NGF
Bloco		ns	ns	ns	ns	ns	ns	ns
Tratamentos		ns	ns	ns	ns	ns	ns	ns
Resíduo		-	-	-	-	-	-	-
CV (%)	-	10,15	11,95	37,80	26,65	20,18	3,02	12,73
DMS	-	0,59	0,62	0,95	0,62	0,82	1,08	9,32
FV		**NGRE**	**DE**	**DS**	**CG**	**CESP**	**PMG**	**P kg ha^{-1}**
Bloco		ns	ns	ns	ns	ns	ns	ns
Tratamentos		ns	ns	ns	ns	ns	ns	*
Resíduo		-	-	-	-	-	-	-
CV (%)	-	12,27	8,69	2,22	17,83	4,56	7,69	12,19
DMS	-	149,25	9,77	1,49	8,66	1,65	61,89	2.499

Note in Table 3, the data for the technical variables "Plant Biometrics", with the use of different biologicals, amino acids and micronutrients in corn cultivation, plant population (PP), plant height (AP), collection diameter (DC), was not possible to verify a significant difference between the treatments tested.

Tabela 3 - Avaliação dos valores médios das variáveis técnicas para cultivo "Biometria Vegetal", em pesquisa implantada pela empresa PCA - Pesquisa e Consultoria

TRAT	Doses utilizadas	PP	AP (m)	DC (cm)
T1	Zero (controle absoluto)	3,10	2,25	1,25
T2	100 g ha^{-1} (SP) + 100 g ha^{-1} (RV4B)	2,75	2,50	1,25
T3	Padrão Fazenda (TS)	3,15	2,50	1,00
	CV (%)	10,15	11,95	37,80
	DMS	0,59	0,62	0,95

PP - População de plantas; AP - Altura de planta; DC – Diâmetro de coleto. SP: Sulco de plantio; (RV4B): reforço estádio V4 na barra de pulverização; 100 g ha^{-1} (SP e RV4B): *Azospirillum baldaniorum, Bacillus amyloliquefaciens*; *Bacillus proteolyticus e Pseudomonas aeruginosa*; Padrão fazenda (TS): Tratamento semente com Poncho e Acorde (Cropfield). As médias sem letras nas colunas não são significativamente diferentes a 5% de probabilidade com aplicação do Tukey.
Fonte: Dados da pesquisa, 2022.

Table 4 shows the data for the various "Plant Biometry" techniques:

first spike insertion height (AIPE), spike number per plant (NEPP), number of shoots per spike (NFE), in an experiment conducted using different biologicals, amino acids and micronutrients in the culture of millet, in which it was not possible to verify significant differences between the tested treatments.

Tabela 4 - Avaliação dos valores médios das variáveis técnicas para cultivo "Biometria Vegetal", em pesquisa implantada pela empresa PCA - Pesquisa e Consultoria Agronômica, com uso de diferentes biológicos, aminoácidos e micronutrientes na cultura do milho, variedade AG 8700 PRO3, município de Mineiros, Goiás, 2022.

TRAT	Doses utilizadas	AIPE (m)	NEPP	NFE
T1	Zero (controle absoluto)	1,00	1,10	17,00
T2	100 g ha^{-1} (SP) + 100 g ha^{-1} (RV4B)	1,00	1,05	16,50
T3	Padrão Fazenda (TS)	1,25	1,00	16,25
	CV (%)	26,65	20,18	3,02
	DMS	0,62	0,82	1,08

AIPE – First pin insertion height; NEPP – Number of spikes per plant; NFE: Number of rows per spike; 100 g ha-1 (SP and RV4B): Azospirillum baldaniorum, Bacillus amyloliquefaciens; Bacillus proteolyticus and Pseudomonas aeruginosa; Farm Standard (TS): Seed treatment with Poncho and Chord (Cropfield). The letter-less means in the columns are not significantly different at 5% probability with Tukey's application.
Source: Research data, 2022.

Table 5 records the data for the various "Plant Biometry" techniques,
number of grains per row (NGF), number of grains per spike (NGE) and spike diameter (DE), in the experiment conducted with the use of different biologicals, amino acidsand micronutrients in the culture of millet, in which it was not possible to verify significant differences between the treatments tested.

Tabela 5 - Avaliação dos valores médios das variáveis técnicas para cultivo "Biometria Vegetal", em pesquisa implantada pela empresa PCA - Pesquisa e Consultoria Agronômica, com uso de diferentes biológicos, aminoácidos e micronutrientes na cultura do milho, variedade AG 8700 PRO3, município de Mineiros, Goiás, 2022.

TRAT	Doses utilizadas	NGF	NGPE	DE (mm)
T1	Zero (controle absoluto)	32,50	548,50	52,00
T2	100 g ha^{-1} (SP) + 100 g ha^{-1} (RV4B)	33,00	554,00	50,75
T3	Padrão Fazenda (TS)	35,75	579,75	52,75
	CV (%)	12,73	12,27	8,69
	DMS	9,32	149,25	9,77

NGF – Number of grains per row; NGPE: Number of grains per spike; DE: Shank diameter; 100 g ha-1 (SP and RV4B): Azospirillum baldaniorum, Bacillus amyloliquefaciens; Bacillus proteolyticus and Pseudomonas aeruginosa; Farm Standard (TS): Seed treatment with Poncho and Chord (Cropfield). The letter-less means in the columns are not significantly different at 5% probability with Tukey's application.
Source: Research data, 2022.

See Table 6 for the data for the various "Plant Biometry" techniques,

elderberry compression (CS), seed compression (CG) and spike compression without blade (CESP), in experiment conducted using different biologicals, amino acids and micronutrients in millet culture, in which it was not possible to verify significant differences between the treatments tested.

Tabela 6 - Avaliação dos valores médios das variáveis técnicas para cultivo "Biometria Vegetal", em pesquisa implantada pela empresa PCA - Pesquisa e Consultoria Agronômica, com uso de diferentes biológicos, aminoácidos e micronutrientes na cultura do milho, variedade AG 8700 PRO3, município de Mineiros, Goiás, 2022.

TRAT	Doses utilizadas	DS (mm)	CG (mm)	CESP (cm)
T1	Zero (controle absoluto)	29,75	22,25	16,75
T2	100 g ha^{-1} (SP) + 100 g ha^{-1} (RV4B)	29,25	21,50	16,50
T3	Padrão Fazenda (TS)	29,50	23,50	17,00
	CV (%)	2,22	17,83	4,56
	DMS	1,49	8,66	1,65

DS:Elderberry diameter; CG:Grain compression; CESP:Stemless spike compression; 100 g ha-1 (SP and RV4B): Azospirillum baldaniorum, Bacillus amyloliquefaciens; Bacillus proteolyticus and Pseudomonas aeruginosa; Farm Standard (TS): Treatmentsimply with Poncho and Chord (Cropfield). The letter-less means in the columns are not significantly different at 5% probability with Tukey's application.

Source: Research data, 2022.

Table 7 shows the analysis for the variable techniques "Plant Biometry", in

an experiment conducted with the use of different biologicals, amino acids and micronutrients in the culture of millet, in which the variable weight of a thousand grains (PMG) did not present any significant difference between the treatments tested. For the variable technique "Plant Biometry", productivity in kilograms per hectare (P Kg ha-1), it was possible to verify a significant difference between the treatments, being that the best result was obtained for the T2 treatment which presented an average of 10.609 Kg hectare and the treatment with the lowest result obtained, was found for the T1 dose zero treatment (absolute control) with an average of 7.687 Kg hectare, which shows a robust difference of 2.922 Kg hectare, compared to the absolute control. In comparison with the standard for seed treatment, a difference of 541 kg/hectare was found, or 9.0 bags/hectare, which covers the cost of treatment with microorganisms and has excellent profitability.

Tabela 7 - Avaliação dos valores médios das variáveis técnicas para cultivo "Biometria Vegetal", em pesquisa implantada pela empresa PCA - Pesquisa e Consultoria Agronômica, com uso de diferentes biológicos, aminoácidos e micronutrientes na cultura do milho, variedade AG 8700 PRO3, município de Mineiros, Goiás, 2022.

TRAT	Doses utilizadas	PMG (g)	P Kg ha^{-1}
T1	Zero (controle absoluto)	346	7.687 b
T2	100 g ha^{-1} (SP) + 100 g ha^{-1} (RV4B)	388	10.609 a
T3	Padrão Fazenda (TS)	379	10.068 ab
	CV (%)	7,69	12,19
	DMS	61,89	2.499

PMG: Peso mil grãos; P Kg ha^{-1}: Produtividade quilograma por hectare; 100 g ha^{-1} (SP e RV4B): *Azospirillum baldaniorum, Bacillus amyloliquefaciens*; *Bacillus proteolyticus e Pseudomonas aeruginosa*; Padrão fazenda (TS): Tratamento semente com Poncho e Acorde (Cropfield). As médias sem letras nas colunas não são significativamente diferentes a 5% de probabilidade com aplicação do Tukey.
Fonte: Dados da pesquisa, 2022.

CONCLUSION

When analyzing the results produced, it can be concluded that there are no differencessignificant in all technical variables studied, with the exception of productivity in kilograms per hectare, which allows us to affirm that the use of bacteria is highly viable in corn cultivation.

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