INFLUENCE OF BIOREGULATORS ON THE DEVELOPMENT AND PRODUCTIVITY OF THE PEANUT CROP

INFLUÊNCIA DE BIORREGULADORES SOB O DESENVOLVIMENTO E PRODUTIVIDADE DA CULTURA DO AMENDOIM

INFLUENCIA DE LOS BIORREGULADORES EN EL DESARROLLO Y LA PRODUCTIVIDAD DEL CULTIVO DEL CACAHUETE

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Mateus Eduardo do Rio[1], Gabriel Felipe Cardoso Dias da Silva[2], Rafael Rombi Schulz[3], Jonathan dos Reis Soares[4], Vagner Amado Belo de Oliveira[5], Delcio Cardim[6]

ABSTRACT

The peanut (*Arachis hypogaea* L.) is a legume of high economic and agronomic value, especially in rainfed agricultural systems, where strategies that optimize physiological and productive performance are essential. The aim of this study was to evaluate the effects of different doses of the biostimulant Stimulate, applied via foliar spraying, on the development and productivity of the BRS 421 OL peanut cultivar, in the Nova Alta Paulista region, in the municipality of Parapuã - SP. The experiment was conducted between August 2024 and July 2025, in a completely randomized design, with five treatments (0, 250, 500, 750 and 1000 mL ha^{-1} of Stimulate) and six replications. Four consecutive weekly applications were made from the V5 stage onwards. The variables analyzed included weight with husk, weight without husk, losses per 25 kg bag and the commercial standard of the grains. The doses of 250 and 500 mL ha^{-1} stood out significantly compared to the control, with the highest average yield values. The percentage of losses per bag and the standard of the grains showed no significant differences between the doses of biostimulant. Regression analysis showed an increase in productivity and a decrease in the percentage of loss per bag up to the 500 mL ha^{-1} dose of Stimulate. The phytoremediator is an efficient alternative for increasing peanut

[1] Undergraduate Student in Agronomic Engineering. Centro Universitário de Adamantina (FAI).
E-mail: 54821@fai.com.br Orcid: https://orcid.org/0009-0002-2787-4237
Lattes: http://lattes.cnpq.br/0547879471969057
[2] Undergraduate Student in Agronomic Engineering. Centro Universitário de Adamantina (FAI).
E-mail: 11221@fai.com.br Orcid: https://orcid.org/0009-0003-8938-4556
Lattes: http://lattes.cnpq.br/8463512683061021
[3] Undergraduate Student in Agronomic Engineering. Centro Universitário de Adamantina (FAI).
E-mail: 56922@fai.com.br Orcid: https://orcid.org/0009-0000-9216-6996
Lattes: http://lattes.cnpq.br/9193037314568317
[4] Undergraduate Student in Agronomic Engineering. Centro Universitário de Adamantina (FAI).
E-mail: 51422@fai.com.br Orcid: https://orcid.org/0009-0002-8244-3691
Lattes: https://lattes.cnpq.br/1209386124082358
[5] Dr. in Agronomic Engineering. Centro Universitário de Adamantina (FAI). E-mail: vagner@fai.com.br
Orcid: https://orcid.org/0000-0002-9924-5512 Lattes: http://lattes.cnpq.br/9153822100920446
[6] Dr. in Agronomic Engineering. Centro Universitário de Adamantina (FAI). E-mail: delcio@fai.com.br
Orcid: https://orcid.org/0009-0002-8244-3691 Lattes: https://orcid.org/0009-0007-1380-412X

productivity under rainfed conditions, contributing to more sustainable and technified practices in the crop.

Keywords: *Arachis hypogaea*. Growth Regulators. Productivity. Rainfed.

RESUMO

O amendoim (*Arachis hypogaea* L.) é uma leguminosa de elevado valor econômico e agronômico, especialmente em sistemas agrícolas de sequeiro, onde estratégias que otimizem o desempenho fisiológico e produtivo são essenciais. Este estudo teve como objetivo avaliar os efeitos de diferentes doses do bioestimulante Stimulate, aplicado via pulverização foliar, sobre o desenvolvimento e a produtividade da cultivar BRS 421 OL de amendoim, na região da Nova Alta Paulista, no município de Parapuã - SP. O experimento foi conduzido entre agosto de 2024 e julho de 2025, em delineamento inteiramente casualizado, com cinco tratamentos (0, 250, 500, 750 e 1000 mL ha^{-1} de Stimulate) e seis repetições. Realizaram-se quatro aplicações semanais consecutivas a partir do estádio V5. As variáveis analisadas incluíram peso com casca, peso sem casca, perdas por saca de 25 kg e padrão comercial dos grãos. As doses de 250 e 500 mL ha^{-1} destacaram-se significativamente em relação à testemunha, apresentando os maiores valores médios de produtividade. O percentual de perda por saca e o padrão dos grãos não apresentaram diferenças significativas entre as doses de bioestimulante. Por meio da análise de regressão, observou-se um acréscimo na produtividade e uma diminuição no percentual de perda por saco até a dose de 500 mL ha^{-1} do Stimulate. O fitorregulador configurando-se como uma alternativa eficiente para o incremento da produtividade do amendoim em condições de sequeiro, contribuindo para práticas mais sustentáveis e tecnificadas na cultura.

Palavras-chave: *Arachis hypogaea*. Reguladores de Crescimento. Produtividade. Sequeiro.

RESUMEN

El cacahuete (*Arachis hypogaea* L.) es una leguminosa de alto valor económico y agronómico, especialmente en sistemas agrícolas de secano, donde son esenciales estrategias que optimicen el rendimiento fisiológico y productivo. El objetivo de este estudio fue evaluar los efectos de diferentes dosis del bioestimulante Stimulate, aplicadas vía pulverización foliar, sobre el desarrollo y la productividad del cultivar de maní BRS 421 OL en la región de Nova Alta Paulista, en el municipio de Parapuã - SP. El experimento se realizó entre agosto de 2024 y julio de 2025, en un diseño completamente aleatorizado, con cinco tratamientos (0, 250, 500, 750 y 1000 mL ha^{-1} de Stimulate) y seis repeticiones. Se realizaron cuatro aplicaciones semanales consecutivas a partir del estadio V5. Las variables analizadas fueron el peso con cáscara, el peso sin cáscara, las pérdidas por saco de 25 kg y el estándar comercial de los granos. Las dosis de 250 y 500 mL ha^{-1} destacaron significativamente respecto al testigo, con los valores medios de rendimiento más elevados. El porcentaje de pérdidas por saco y el estándar de los granos no mostraron diferencias significativas entre las dosis de bioestimulante. El análisis de regresión mostró un aumento del rendimiento y una disminución del porcentaje de pérdidas por saco hasta la dosis de 500 mL ha^{-1} de Estimulante. El fitorremediador es una alternativa eficaz para aumentar la productividad del cacahuete en condiciones de secano, contribuyendo a prácticas más sostenibles y tecnificadas en el cultivo.

Palabras clave: *Arachis hypogaea*. Reguladores del Crecimiento. Productividad. Cultivo de Secano.

1 INTRODUCTION

Peanut (*Arachis hypogaea* L.) is a legume of South American origin widely cultivated in tropical and subtropical regions, where it finds favorable edaphoclimatic conditions for its development. Its agronomic and socioeconomic importance is remarkable, especially in production systems aimed at family farming and agroindustry, since the grain has a high oil content (approximately 50%) and protein (about 25%), being used for human consumption, animal feed, edible oil extraction, and industrialization in various segments (Santos *et al*., 2020; Embrapa, 2022).

In Brazil, peanut cultivation has expanded significantly, especially in the state of São Paulo, responsible for more than 90% of national production, followed by Mato Grosso do Sul and Paraná (CONAB, 2024). This expansion is due, in part, to its use as an alternative crop in rotation systems, especially with sugarcane, a practice that improves the physical structure of the soil, favors the control of pests and diseases, and contributes to breaking the weed cycle (Pereira *et al*., 2021). In addition, peanuts have high rusticity and adaptability to different types of soil when properly managed, characteristics that make them an excellent option for agricultural systems.

However, despite genetic and technological advances, the national average productivity is still lower than the productive potential of the crop, which highlights the need for agronomic strategies that maximize the physiological and productive performance of plants. In this context, the use of biostimulants has gained prominence as a promising tool to increase the productive efficiency of agricultural crops (Duarte *et al*., 2020). Biostimulants are natural or synthetic substances, or even microorganisms, that act on the physiological processes of plants, promoting their growth, development and resistance to biotic and abiotic stresses (Jardin, 2015).

Among the various products available, the biostimulant Stimulate stands out, composed of three phytoregulators: kinetin (cytokinin), gibberellic acid (GA_3) and 4-indole-3-ylbutyric acid (IAA – auxin). These compounds act on different metabolic and physiological pathways of plants, contributing to root development, cell division and expansion, nutrient absorption, flowering, and fruit filling (Stoller, 2024). Several studies have demonstrated the efficiency of these regulators in crops such as corn, soybeans, tomatoes, and beans (Sampaio, 2016; Oliveira, 2022). However, the effects of products such as Stimulate® on peanut crops are still poorly studied, and there is a lack of research that correlates doses, application modes, and specific physiological and productive responses to the crop.

Considering that peanuts have slow initial growth and high energy demand during flowering and fruiting, the use of hormonal biostimulants may represent a viable alternative to anticipate and standardize vegetative development, promote greater floral attachment and improve grain quality and yield. In-depth knowledge about the plant's responses to these substances is essential for the development of sustainable technologies and for the formulation of technical recommendations that optimize the performance of cultivars under field conditions.

Therefore, this study aimed to evaluate the effects of different doses of the biostimulant Stimulate, applied via foliar spraying, on the vegetative development and yield of the peanut cultivar BRS 421 OL, under edaphoclimatic conditions in the region of Nova Alta Paulista. The study aims to contribute to the advancement of scientific knowledge on the use of hormonal biostimulants in legumes of economic importance, providing technical subsidies for the efficient and sustainable management of the crop.

2 METHODOLOGY

2.1 CONDUCTING THE EXPERIMENT

The experiment was conducted from August 2024 to July 2025, in the municipality of Parapuã – SP, in the region of Nova Alta Paulista, at an altitude of 470 meters, at geographic coordinates 21°48'21" S and 50°47'29" W. The climate of the region is classified as Aw, according to Koppen, characterized as tropical with a dry season in winter, with an average annual temperature of approximately 24°C and annual precipitation ranging between 1,000 and 1,400 mm (Climatempo, 2024).

For the installation of the experiment, a chemical analysis of the soil was carried out, followed by the correction of acidity, exchangeable aluminum and nutrients, according to the technical recommendations for the crop. Subsequently, the soil was prepared by means of a cultivator. The cultivar used was the Runner type peanut, commercially known as BRS 421 OL, which has an average cycle of 140 days. The spacing adopted was 0.90 meters between rows, with a distribution of 20 seeds per linear meter, resulting in an average final population of 13.5 plants per meter, which corresponds to 67.5% of the final stand in relation to the initial planting.

The crop treatments, including the application of pesticides, fertilizers and correctives, were carried out according to the needs of the crop, following the technical recommendations of Santos *et al.,* (1996). The experiment was conducted under rainfed conditions, in which the plants suffered considerable water deficit.

2.2 EXPERIMENTAL DESIGN

The experimental design adopted was completely randomized (DIC), consisting of five treatments and six replications, totaling 30 experimental units. Each experimental plot was composed of 1 linear meter, respecting the border of 1 linear meter, avoiding any interference. The treatments corresponded to the following doses of the biostimulant Stimulate, applied via foliar spraying: T1 - control (0 mL ha^{-1}) ; T2 - 250 mL ha^{-1}; T3 - 500 mL ha^{-1}; T4 - 750 mL ha^{-1} and T5 - 1000 mL ha^{-1}.

The applications were carried out from the phenological stage V5 (22 days after planting - DAP), totaling four consecutive weekly applications (figures 01 and 02). The sprays were carried out with a 1.5-liter manual sprayer, equipped with a cone-type nozzle. The Stimulate product has, in its composition, 0.09 g L^{-1} of kinetin, 0.05 g L^{-1} of gibberellic acid (GA3) and 0.05 g L^{-1} of 4-indole-3-ylbutyric acid (IAA).

Figure 1

Experiment area, after bioregulator spraying.

Source. Authors themselves (2024).

Figure 2

Plant during the vegetative stage V5

Source. Authors themselves (2024).

2.3 STATISTICAL ANALYSIS

Harvesting was carried out in the R8 reproductive phase, followed by plant drying and, subsequently, evaluations, which were conducted considering the useful area of each experimental unit. The analyses followed commercial standards, using the weight per 25 kg bag as a reference.

The variables evaluated were:

- Weight of shelled and shelled peanuts: determination of the total weight of pods and shelled grains per experimental unit;
- Yield per bag (%): Refers to the percentage of use of healthy grains in a standard 25 kg bag, considering the quality losses caused by stained, burnt, moldy, sprouted, and immature grains, obtained through the formula: 100 - [(Weight of healthy grains ÷ Total weight with husk) × 100] = Loss per bag.
- Commercial classification of grains (38/42, 40/50, 50/60, 60/70 and 70/80): percentage distribution among the classes, with emphasis on class 38/42, which corresponds to the commercial standard of the BRS 421 cultivar.

The analyses were carried out in a specialized laboratory, equipped with forced air circulation ovens, precision scales and other instruments necessary to conduct the physical and commercial evaluations of the grains (figures 03 and 04).

The data obtained were submitted to analysis of variance (ANOVA) by the F test. When statistical significance was found, the means of the treatments were compared by Tukey's test, at the level of 5% probability (Ferreira, 2000). To verify the behavior of the biostimulant doses, regression analysis was applied.

Figure 3

Evaluation of grain pattern (38/42; 40/50; 50/60; 60/70 and 70/80)

Source. Authors themselves (2024).

Figure 4

Seeds separated by default after yield and quality evaluations

Source. Authors themselves (2024).

3 RESULTS

The spraying of the biostimulant positively influenced the agronomic performance of the peanut mound, presenting results superior to the control in all the variables analyzed (Table 01), evidencing the beneficial effect of the biostimulant on the reproductive development of the crop.

The variables related to yield (weight in shell and weight without shell) showed the highest yields at the dose of 500 mL ha^{-1} of the biostimulant Stimulate, 1,788.1 and 1,410.6 kg $^{ha-1}$, respectively, significantly differentiating from the control, but not from the other treatments. The second highest yield was found at the dose of 250 mL ha^{-1}, which also statistically differentiated from the control. On the other hand, the doses of 750 and 1000 mL ha^{-1} did not significantly differ from the control for the weight with peel. In the unpeeled weight, only the dose of 1000 mL ha^{-1} did not differ from the control.

By means of regression analysis (Figures 07 and 08), an increase in productivity was observed up to the dose of 500 mL ha^{-1} of the biostimulant Stimulate, gradually decreasing at higher doses.

Table 1

Means of the variables analyzed in relation to the doses of biostimulant Stimulate1

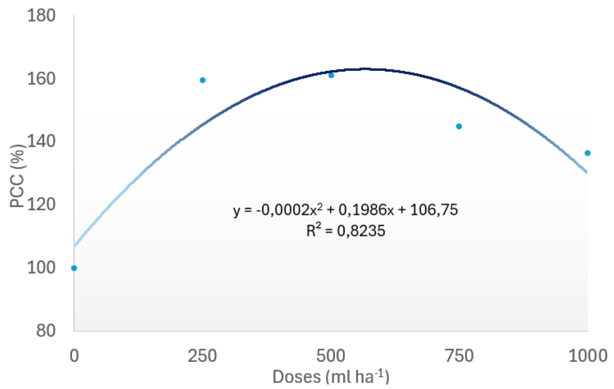
Doses of Biostimulant Stimulate	Weight with husk (kg ha-1)	Weight without shell (kg ha-1)	Loss per 25 kg bag (%)	Grain Pattern 38/42 (%)
Witness	1,110.9 b	866.7 b	16.33 to	95.33 to
250 mL ha⁻¹	1,771.1 to	1,387.4 to	12.33 to	97.67 to
500 mL ha⁻¹	1,788.1 to	1,410.6 to	7.75 to	96.75 to
750 mL ha⁻¹	1,608.9 abs	1,283.9 to	8.00 to	95.50 to
1000 mL ha⁻¹	1,514.8 abs	1,186.7 ab	9.33 to	97.00 to

[1] Means followed by the same letter do not differ from each other by Tukey's test at 5% probability.
Source. Authors themselves (2025).

For the percentage of loss per bag and the pattern of the grains, there was no significant difference between the doses of biostimulant. There was a downward trend in the percentage of loss per bag up to the dose of 500 mL ha⁻¹ (Figure 07), from then on, an increase in the percentage of loss was observed. For the grain pattern, no trend was observed (Figure 08).

Figure 5

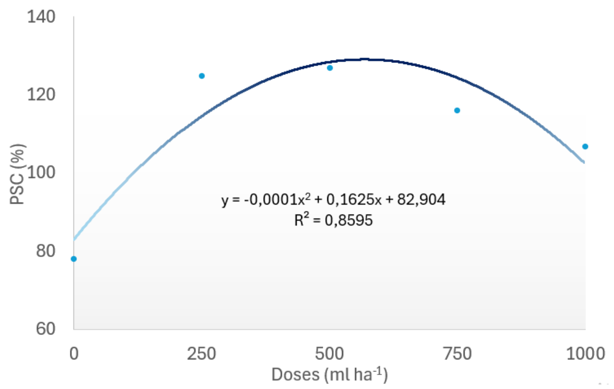
Regression analysis under the weight with shell (PCC) variable



Source. Authors themselves (2024).

Figure 6

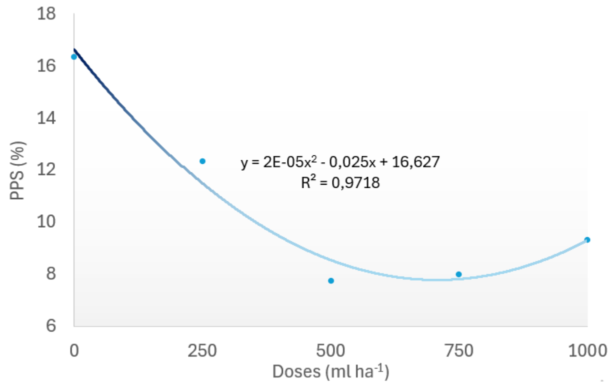
Regression analysis under the unpeeled weight (PSC) variable



Source. Authors themselves (2024).

Figure 7

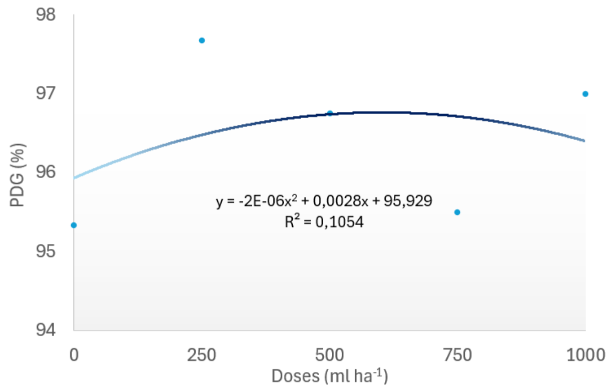
Regression analysis under the variable loss per bag (PPS)



Source. Authors themselves (2024).

Figure 8

Regression analysis under the grain standard variable (PDG)



Source. Authors themselves (2024).

4 DISCUSSION

The results obtained show the efficacy of the biostimulant Stimulate as a tool for the productive increase of peanut crops, especially when used in moderate doses and at the appropriate time of development. The phenological stage V5, corresponding to the beginning of the formation of reproductive structures, is a period sensitive to water stress, a frequent situation in rainfed cultivation. Under these conditions, there is an increase in the production of inhibitory hormones such as ethylene and abscisic acid (ABA), which promote the abscission of flowers and pods, in addition to compromising vegetative development and final yield (Taiz; Zeiger, 2013).

The application of Stimulate, composed of auxin (IAA), gibberellin (GA_3), and kinetin, can promote hormonal rebalancing and modulate physiological characteristics, providing desirable agronomic characteristics, such as: cell growth, root development, nutrient absorption, and the maintenance of reproductive structures (Stoller, 2024; Sampaio, 2016). Auxin and cytokinin, for example, are associated with flower retention and branching stimulation, while gibberellin stimulates cell elongation and fruit filling. This beneficial hormonal balance explains the better results observed at doses of 250 and 500 mL ha^{-1}, as these concentrations seem to have promoted a balanced physiological stimulus without causing adverse effects of overstimulation.

The absence of statistical significance for the variables of grain commercial pattern and yield per bag does not invalidate the influence of the biostimulant, since the regression analysis indicated positive trends in these parameters. This reinforces that the application of Stimulate contributed to the standardization of the set and the reduction of losses, even if in a subtle way or not captured by average analyses. This effect can be explained by the hormonal balance promoted by the growth regulator, the proper development of plants can promote a better seed pattern and uniformity, directly influencing grain quality (Fagan *et al.,* 2015).

In addition, although the experiment did not directly measure physiological variables, such as photosynthetic activity or endogenous hormone content, it is plausible to assume that the effects observed in the productive variables are associated with improved tolerance to water stress, increased root development and greater use of resources, as already reported by Soares *et al.* (2023) and Oliveira *et al.* (2020) in other crops.

5 CONCLUSION

Under the conditions studied, the use of the biostimulant Stimulate positively influenced the development and yield of peanut cultivar BRS 421 OL, especially at doses of 250 and 500 mL ha^{-1}, which presented the best results for weight with shell and without shell. However, it is noteworthy that the dosage of 250 mL $^{ha-1}$ was the most economically advantageous, presenting good results, with better application cost.

Although some variables did not present statistically significant differences, from the regression analysis, there was a trend of improvement in the yield per bag up to the dose of 500 mL $^{ha-1.}$ Thus, the use of Stimulate proved to be an effective and sustainable strategy for peanut cultivation under rainfed conditions. However, it is recommended that new studies be carried out with the purpose of validating the results obtained in this work.

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