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Seed treatment with Stimulate® improves the initial development of peanut plants

Jorge González **Aguilera**[1,*], Alana Silva **Rocha**[1], Ana Carolina Vidal do **Nascimento**[1], João Vitor Ferreira Lima **Guedes**[1], Isabella Santos **de Oliveira**[1], Fábio **Steiner**[1], Alan Mario **Zuffo**[2], Daniela Pérez **Hernández**[3], Pavel Vargas **Rodriguez**[3], Diógenes Martins **Bardiviesso**[1]

[1] Department of Agronomy, State University of Mato Grosso do Sul (UEMS), Cassilândia, MS, Brazi.;
[2] Department of Agronomy, State University of Maranhão (UEMA), Balsas, MA, Brazil;
[3] Departamento de Ingeniería Hidráulica, Universidad de Oriente, Santiago de Cuba, Cuba;
* Correspondence: jorge.aguilera@uems.br

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Abstract: Seed treatment with biostimulants may be an option to improve the emergence and initial growth of peanut plants. A pot experiment was conducted to evaluate the effect of using doses of Stimulate® in seed treatment on the initial growth of plants of two peanut cultivars grown in a sandy Cerrado soil. The treatments were arranged in a randomized block design in a 2 × 4 factorial scheme: two peanut cultivars [IAC Tatu ST (upright growth habit) and Runner IAC 886 (prostrate growth habit)] and four doses of Stimulate® (0; 10; 20; and 30 mL kg^{-1} of seeds) applied to seed treatment, with three replications. At 21 days after sowing, plant height (PH), main stem diameter (SD), number of lateral branches (NLB), and main root length (RL) were evaluated. Our results showed that peanut cultivars with different growth habits (erect and prostrate) have different responses to the application of Stimulate® doses on plant development, with the IAC Tatu ST cultivar being more responsive to the application of biostimulant. The application of 20 to 30 mL kg^{-1} of Stimulate® via seed treatment improved initial growth of peanut plants grown in sandy soil of the Cerrado Sul-Mato-Grossense under controlled greenhouse conditions.

Keywords: *Arachis hypogaea*; Biostimulant; Runner 886; IAC Tatu ST.

1. Introduction

Peanut (*Arachis hypogaea* L.) cultivation holds significant importance for both Brazil and the world. Brazil is the second-largest peanut producer and exporter in Latin America (Aparecido et al., 2021). The state of São Paulo concentrates over 90% of the national peanut production (Neves et al., 2023). In the state of Mato Grosso do Sul, peanuts have been used mostly to renew sugarcane fields (Souza et al., 2019; Steiner et al., 2021). The peanut kernels are rich in fats, protein, minerals, vitamins, antioxidants compounds, and health-improving bioactive compounds such as resveratrol, tocopherol, arginine, and hence are touted as functional food (Arya et al., 2016; Bonku & Yu, 2020). Given these unique nutritional properties, peanut cultivation has received greater attention in recent years from researchers and multinational companies.

However, peanut cultivation in Brazil faces several challenges, especially in relation to climate risk, disease occurrence and high production costs (Aparecido et al., 2021; Godoy et al., 2022). These challenges need to be addressed to ensure the sustainable growth of the peanut production sector in Brazil. An alternative to improving the development and yield of peanut crops, increasing plant tolerance to adverse climatic conditions and reducing production costs is the use of biostimulant products. Nevertheless, few studies have evaluated the effects of Stimulate® on early peanut development.

Biostimulants act to improve the physiological, hormonal and nutritional metabolism of plants (Oliveira et al., 2017), and when applied in the initial stages of seedling development, or in seed treatment, biostimulants can stimulate the growth of the root system and act in faster recovery of seedlings in adverse environmental conditions (Oliveira et al., 2016).

The Stimulante® is a product composed of three plant hormones (auxin, gibberellin and cytokinin) that can interfere with the physiological and morphological processes of plants (Binsfeld et al., 2014; Almeida & Rodrigues, 2016; Wylot et al., 2019). The use of Stimulate® via seed treatment was described by Salles et al. (2019) and Oliveira et al. (2021).

This study was conducted with the objective of evaluating the effect of applying doses of Stimulate on the growth of two peanut cultivars grown in sandy soil of the Cerrado Sul-Mato-Grossense under greenhouse conditions.

2. Material and Methods

Pot experiments were carried out in a greenhouse in Cassilândia, Mato Grosso do Sul, Brazil (19º05'20" S, 51º48'24" W, and altitude of 490 m) from October to November 2023. The soil used in the experiment was collected from the plough layer of a Neossolo Quartzarênico Órtico latossólico with 120 g kg^{-1} of clay, 30 g kg^{-1} of silt, and 850 g kg^{-1} of sand. 30 days after liming, the soil had the following properties: pH in CaCl2 0.01 mol L^{-1} of 5.8, 12 g dm^{-3} organic matter, 11 mg dm^{-3} P (Mellich^{-1}), 19 mmolc dm^{-3} Ca, 4 mmolc dm^{-3} Mg, 1.1 mmolc dm^{-3} K, 19 mmolc dm^{-3} H+Al. All the soil chemical properties were analyzed according to Raij et al. (2001). Then, the soil was fertilized with applying 50 mg kg^{-1} of N (urea), 250 mg kg^{-1} of P (simple superphosphate), 100 mg kg^{-1} of K (potassium chloride), 15 mg kg^{-1} of S (gypsum), 5 mg kg of Cu (copper sulfate), 5 mg kg^{-1} of Zn (zinc sulfate), 1 mg kg^{-1} of Mo (ammonium molybdate), and transferred to 8-L plastic pots.

The treatments consisted of growing two peanut cultivars [IAC Tatu ST (upright growth habit) and Runner IAC 886 (prostrate growth habit)] and treatment of seeds with four doses of biostimulant Stimulate® (0, 10, 20 and 30 mL kg^{-1} of seeds)). Treatments were arranged in a randomized block design in a 2 × 4 factorial scheme with three replicates. Each experimental unit consisted of a pot containing five plants, totaling 24 pots in the experiment. The Stimulate® is composed of 0.09 g L^{-1} of kinetin, 0.05 g L^{-1} of gibberellic acid (GA3) and 0.05 g L^{-1} of 4-(indol-3-yl) butyric acid.

Ten peanut seeds were sown in each 8-L pot, and seven days after emergence, seedlings were thinned down to five per pot. Soil water content was monitored daily and maintained close to field capacity through daily irrigation using a microsprinkler system.

At 21 days after sowing, plant height (PH, cm), main stem diameter (SD, mm), number of lateral branches (NLB), and main root length (RL, cm) were evaluated. Plant height and main root length were measured using a tape measure, while the diameter of the main stem was measured with a digital caliper.

The data were subjected to analysis of variance (ANOVA), and the means were compared using the Tukey test at 5% probability. Regression analysis was used for the Stimulate® application doses and significant equations (F test, $P \leq 0.05$) with the highest coefficients of determination were adjusted. The analyses were performed using RBio® software for Windows (Bhering, 2017), and the graphs were generated using SigmaPlot software, version 11.0.

3. Results and Discussion

Analysis of variance reported that the effects of peanut cultivars and Stimulate® doses were significant on plant height and main root length. Interaction between peanut cultivar and

Stimulate® dose showed significant effect ($p < 0.05$) on number of lateral branches and main root length (Table 1).

The IAC Tatu ST cultivar has a greater plant height and main root length when compared to the Runner IAC 886 cultivar (Table 1). This result is associated with the erect growth habit of the IAC Tatu ST cultivar, which results in peanut plants with greater height when compared to cultivars with a prostrate growth habit, such as Runner IAC 886. The values of stem diameter and number of lateral branches were similar between the two peanut cultivars (Table 1).

Table 1. Effect of cultivars and biostimulant application doses on the plant height (PH), main stem diameter (SD), number of lateral branches (NLB), and main root length (RL) of peanut plants (*Arachis hypogaea* L.) grown in sandy soil of the Cerrado Sul-Mato-Grossense under controlled greenhouse conditions

Peanut cultivars	PH (cm)	SD (mm)	NLB	RL (cm)
IAC Tatu ST	13.2 a	2.68 a	3.20 a	9.58 a
Runner IAC 886	10.9 b	2.52 a	2.32 a	6.80 b
Sources of variation	F Value			
Cultivars (C)	22.25 **	0.19 ^{NS}	4.66 ^{NS}	46.26 **
Biostimulant doses (D)	43.32 **	0.19 ^{NS}	5.79 ^{NS}	9.73 **
Interaction (C × D)	4.37 ^{NS}	0.40 ^{NS}	7.78 *	5.46 *
CV (%)	27.56	23.48	19.73	49.12

Means followed by different letters in the columns show significant differences by Tukey's test at significance level of 0.05. ^{NS}: not significant. * and ** Significant at 5% and 1% by F test, respectively. CV: coefficient of variation.

Plant height increased progressively with increasing doses of Stimulate® applied to seed treatment. Plant height increased from 9.26 cm in control plants without biostimulant application to a maximum of 14.69 cm with the application of 30 mg kg^{-1} of Stimulate, indicating an average increase of 59% (Figure 1A). The doses of Stimulate® applied to peanut seeds significantly affected ($p < 0.05$) the number of lateral branches in the IAC Tatu ST cultivar; however, it had no significant effect ($p > 0.05$) on the number of lateral branches of the peanut cultivar Runner IAC 886 (Figure 1B). The number of lateral branches in the IAC Tatu ST cultivar increased from 0.86 branches in plants without biostimulant application to a maximum of 4.59 branches with the application of 26.5 mL kg^{-1} of Stimulate®, indicating an average increase of 434% (Figure 1B).

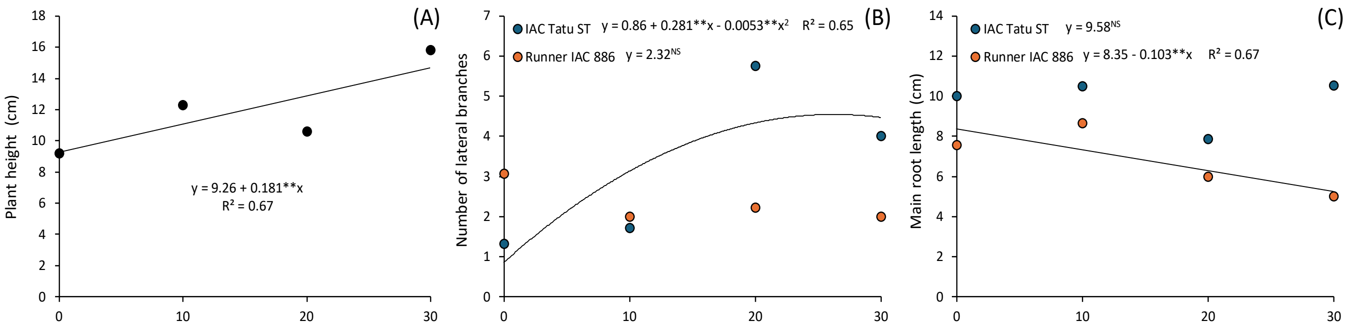

Figure 1. Effect of Stimulate® doses on the plant height (A), number of lateral branches (B), and main root length (C) of peanut plants (*Arachis hypogaea* L.) grown in sandy soil of the Cerrado Sul-Mato-Grossense under controlled greenhouse conditions. ** significant at 1% probability of error.

The doses of biostimulant applied to the seeds negatively affected ($p < 0.05$) the root growth of the peanut cultivar Runner IAC 886 (Figure 1C). Root length reduced from 8.35 cm in plants without application of biostimulant to a minimum of 5.26 cm with the application of 30 mL kg^{-1} of Stimulate®, indicating an average reduction of 37%. In the cultivar IAC Tatu ST, the average root length was 9,58 cm in all doses of biostimulant applied to the seeds (Figure 1C).

Similar work testing the effect of biostimulants on crops such as *Acacia mangium* (Carvalho et al., 2018) and *Zea mays* (Neta et al., 2022) has been reported. This has shown that generally a positive increase is obtained in the growth of roots other than the two promoted in this work. This makes us think about what further work needs to be done to elucidate the better behavior of the Amendoim cultivars used and the doses of biostimulants used.

The application of Stimulate to peanut seeds has a beneficial effect on plant growth; however, peanut cultivars have different responses to the application of biostimulant, with the cultivar IAC Tatu ST being more responsive when compared to the cultivar Runner IAC 886. The Stimulate doses resulted in better shoot development of peanut plants of the IAC Tatu ST cultivar, especially with the application of 20 to 30 mL kg^{-1} of Stimulate® (Figure 1).

Studies using Stimulate® were carried out by Oliveira et al. (2021) in peanuts and by Wylot et al. (2019) in common bean and showed beneficial effects of the application of Stimulate® on the initial development of plants, which enhanced the adequate establishment of plants in the field. However, Salles et al. (2019) reported that the application of Stimulate® did not improve the initial growth of peanut plants. In the present study, we found beneficial effects of the use of Stimulate® on the shoot development of the plants, but there was a null response on the root growth of the cultivar IAC Tatu ST and a negative effect on the root growth of the cultivar Runner IAC 886.

The use of two contrasting cultivars with an erect and prostrate growth habit showed that peanut cultivars have different responses to the doses of biostimulant applied, with better shoot development of the crop, mainly for the IAC Tatu ST cultivar.

Peanut is a crop very responsive to biostimulants (Almeida & Rodrigues, 2016; Oliveira et al., 2020, 2021). The composition of biostimulants balances the hormonal composition of plants, and as a consequence increases plant growth and development by stimulating cell division, in addition to increasing the absorption of water and nutrients by plants (Vieira & Castro, 2001, Oliveira et al., 2020, 2021).

Oliveira et al. (2017) found that the use of Stimulate® induced the initial growth of physic nut plants. Similarly, Oliveira et al. (2016) reported that seed treatment with Stimulate® at doses ranging from 10 to 15 mL kg^{-1} of seeds stimulated the growth of popcorn plants. Aguilera et al. (2024) reported that the application of 9 mL kg^{-1} of the biostimulant Seed+ in seed treatment stimulated the initial development of peanut plants grown in sandy soil. These results show that seed treatment with biostimulant guarantees rapid initial plant growth in the field.

4. Conclusion

The application of 20 to 30 mL kg^{-1} of Stimulate® via seed treatment improved initial growth of peanut plants grown in sandy soil of the Cerrado Sul-Mato-Grossense under controlled greenhouse conditions.

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.6. Additional Information

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6.3 Interest conflicts

We declare there is no conflict of interest.