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Improvement of the productivity of "Caramelo variety" peanuts (Arachis hypogaea) applying different doses of Evergreen biostimulant

Mejora de la productividad del maní "variedad Caramelo" (Arachis hypogaea) aplicando diferentes dosis de bioestimulante Evergreen

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Abstract:
The objective of the present investigation was to determine the increase in the productivity of the peanut crop "Caramelo variety" (Arachis hypogaea), through the use of different doses of Evergreen biostimulant. The investigation was carried out in the Los Ríos province. In order to fulfill the proposed objectives, a randomized complete block experimental design was carried out, with four treatments and four repetitions of 20 square meters each repetition, with a distance of 4x5 m. For the collection of information, six agronomic variables were evaluated, which were taken from each repetition using a sample of 10 peanut plants, and then these averaged data were subjected to ANOVA statistical analysis, and finally a Tukey test was applied to 95% of probability. The results showed that treatment 4 (Evergreen 2 L/ha) had a better effect on the agronomic variables evaluated, where the highest plant height obtained was 32.3 cm, the number of pods per plant was 42.20, the production per plant was 151.43 g/plant, the root length was 21.38 cm, the weight of 100 grains was 85.25 g and the highest yield was 4,403.43 kg/ha.

Keywords: Productivity, doses, economic encome, increase, biostimulant.

Resumen:
El objetivo de la presente investigación fue determinar el incremento de la productividad del cultivo de maní "variedad Caramelo" (Arachis hypogaea), mediante el uso de diferentes dosis de bioestimulante Evergreen. La investigación fue realizada en la provincia de Los Ríos. Para el cumplimiento de los objetivos propuestos se realizó un diseño experimental de bloques completos al azar, con cuatro tratamientos y cuatro repeticiones de 20 metros cuadrados cada repetición, con una distancia de 4x5 m. Para la recolección de la información fueron evaluados seis variables agronómicas, que se tomaron de cada repetición utilizando una muestra de 10 plantas de maní, y luego estos datos promediados fueron sometidos análisis estadístico ANOVA, y finalmente se aplicó una prueba de Tukey al 95% de probabilidad. Los resultados mostraron que el tratamiento 4 (Evergreen 2 L/ha) tuvo mejor efecto so bre las variables agronómicas evaluadas, donde la mayor altura de planta obtenida fue 32,3 cm, y el número de vainas por planta fue 42,20.

Palabras clave: Productividad, dosis, ingresos económicos, incremento, bioestimulante.

1. Introduction

The peanut is an important source of vegetable oil and protein in tropical and subtropical areas [1]. It is native to South America from where it has spread to other countries.

In 2019, a production of 44,041,913 tonnes of peanuts was reported, where China was the world's largest producer with a production volume of 16,685,915 tonnes per year [2].

Peanut cultivation in Ecuador has been a family activity that has not been adequately developed and therefore the average annual yield does not exceed 1,000 kg/ha, which is not enough to meet the needs of domestic consumption, causing a deficit for the country's industry. [3].

In Ecuador, the main peanut plantations are concentrated in the cantons of Portoviejo, Tosagua, Chone, twenty-four de Mayo and part of Rocafuerte. In the country, 20,000 hectares are planted every year: 9,000 are in Manabí, 7,500 in Loja and the rest in various parts of the country, especially where Manabí farmers have emigrated [4].

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Among the varieties of peanuts produced in Ecuador, the Caramelo peanut (Arachis hypogea) is of South American origin, as Spanish and Portuguese explorers found Indians cultivating it on the northeast and east coasts of Brazil, throughout the lowlands of the Rio de la Plata (Argentina, Paraguay, Bolivia, extreme southwest of Brazil) and intensively in Peru. From these regions the peanut was spread to Europe, Africa, Asia and the Pacific Islands; eventually it spread to the United States, but the time and place of its introduction is not documented [5].

The main characteristics of this variety are: creeping growth, Days to flowering are between 33 and 36, days to harvest between 130 and 140, Pods per plant are 14 to 28, Grams per plant are 25 to 35, Grams per pod are at 2, Vaneage is 4 to 8%, Husk/seed ratio is between 25 and 35%, 100 kernel weight is between 50 and 60, and average yield is 3341 kg·ha^{-1} [6] [7].

Agricultural inputs, known as agricultural biostimulants, are used to improve crop production. These biostimulants include various formulations of compounds, substances, and other products, which are applied to plants or soils to regulate and improve the physiological processes of the crop, making them more efficient. Biostimulants act on plant physiology, through different pathways than nutrients, in order to improve crop vigor, increasing yield and crop quality [8].

For their part, [9], they argue that biostimulants are a tool that can provide benefits such as reducing stress, improving the quality of the harvested product, and providing greater resistance to pests and diseases.

Plant biostimulants contain substances and/or microorganisms whose function is to stimulate natural processes to improve nutrient uptake, assimilation and efficiency, abiotic stress tolerance, and crop quality [10].

For [11] biostimulants are micro-organisms designed to be applied to plants or soils to increase crop vigor, improve the quality of the resulting product or increase plant tolerance to different types of abiotic stress (lack of water, soils with too many salts, etc.)[12].

For the application of these biostimulants, they suggest the combined application of two or more biostimulants because they increase vegetative development more than when applied individually [13].

For these purposes, the biostimulant Evergreen has been used, for its application the following composition has been recommended: Nitric nitrogen content 7.000%, assimilable phosphorus (P2O5) 7.000%, soluble potassium (K2O) 7.000%, Cytokinins 90 ppm, Gibberellins 40 ppm, Auxins 40 ppm, Humic acid 3. 76%, Boron 0.0024%, Copper 0.0013%, Iron EDTA 0.050%, Manganese EDTA 0.018%, Choline 750 ppb, Thiamine 50 ppb, Niacin 90 ppb, Pantothenic Acid 12 ppb, Folic Acid 1 ppb, Nicotinamide 2 ppb and Riboflavin 1.5 ppb [14].

In view of the above, the aim of this study was to evaluate the effect of the biostimulant Evergreen on the development and production of the peanut crop "Caramelo variety" (Arachis hypogaea L.a).

2. Materials and methods

The present research will be conducted in the province of Los Ríos, and in order to fulfil the proposed objective, the quantitative method will be used, and the experimental design of randomised complete blocks will be used, with four treatments and four replications (Table 1). For data collection, six agronomic variables will be evaluated from each replicate, using a sample of 10 plants. In the statistical analysis of the treatment averages, the Tukey test will be used at 95% probability [15].

Figure 1 shows the flow of the process used in the planning and execution of the experimental activities [16].

Firstly, the management of the trial is conducted, where the different tests to be conducted and the materials required are planned, in order to guarantee that the expected results are obtained. The productive variables selected for the evaluation will be the dependent variables: "Plant height" and "Pods per plant", and the independent variable is the different doses of the Evergreen biostimulant.

To conduct the experiment, a total of four treatments and four replicates each will be established. The treatments will be: the control (T1) will not apply the product; the second treatment (T2) consists of applying a dose of 0.5 L/ha of the biostimulant; the third treatment will have a dose of 1 L/ha, and the fourth treatment (T4) will have a dose of 2 L/ha of the biostimulant.

The establishment of the crop requires land preparation, which will be conducted mechanized with the use of a tractor.

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Sowing of the crop will be done manually, and weed control will be done manually and with a machete.

Phytosanitary control will be conducted with a 20-litre manual knapsack sprayer, and harvesting will be conducted manually.

For the evaluation of the data, a database will be created with the results obtained in the experiment. The results will be analyzed using a Tukey test at 95% probability, which will compare the effect of each dose on the dependent variables "plant height" and "pods per plant".

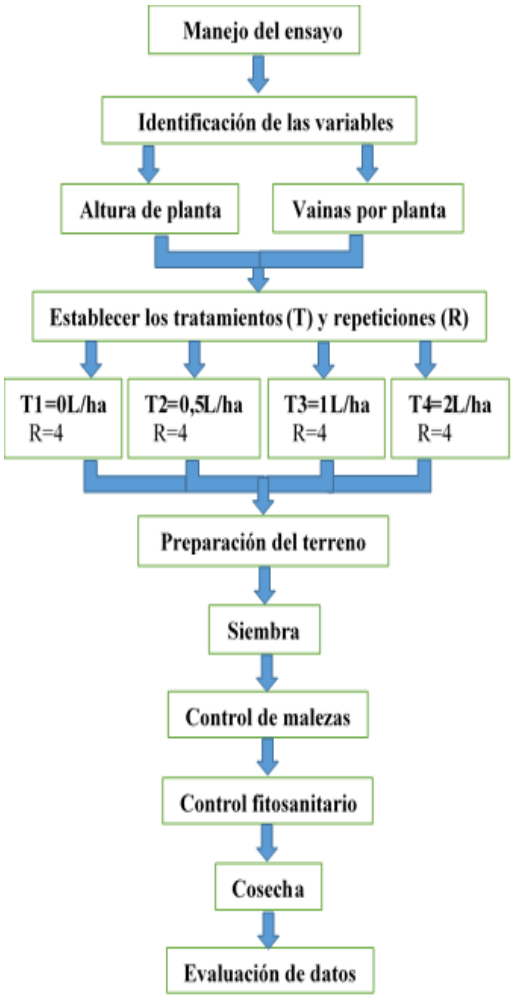

Figure 1. Process flow diagram of the process used for the experiment.

Table 1 shows the different treatments, the dosage to be used for each treatment and the time of application or stage of crop development. The control treatment will serve as a reference for the experiment and will be used for comparison with the other treatments. The treatments will be applied during the development and elongation phase of the crop, corresponding to the beginning of flowering of the plant, due to the high impact of this phase on agricultural productivity. The doses of the biostimulant will be applied to the entire leaf surface of the plant, with the aim of achieving product coverage throughout the crop cycle.

Table 1. Treatments, biostimulant dose and time of application in peanut crop.

Treatment	Dosage L/ha	Time of application
T1	0 L	Control
T2	0,5 L	At development and elongation beginning of flowering
T3	1,0 L	At development and elongation at start of flowering
T4	2,0 L	At development and elongation at start of flowering

Figure 2 shows the distribution of the planned treatments and replicates in the experiment, in order to obtain the required data [17].

In this study, a randomized complete block experimental design was used, with four treatments and four replicates. Tukey's test at 95% probability was used to compare the averages of the treatments.

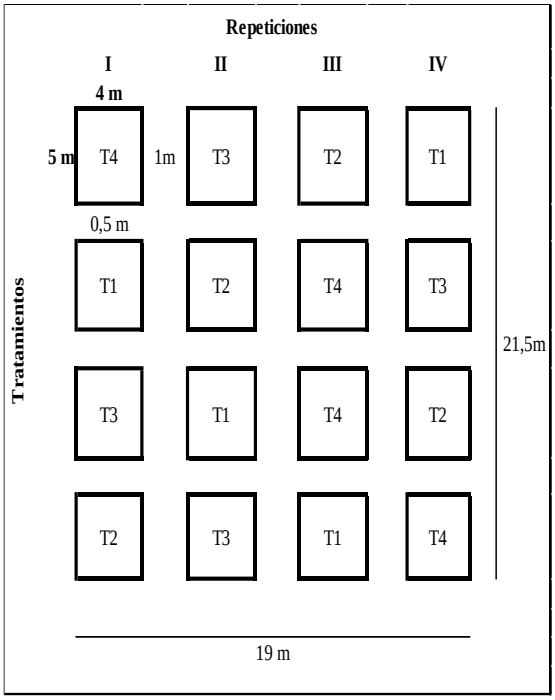

Figure 2. Distribution of treatments and field replicates for the sowing of the peanut crop.

3. Results

Plant height

Regarding this variable, it can be seen that treatment 4 (Evergreen 2 L/ha) reached the greatest plant height (32.3 cm), being superior to the other treatments; however, the control treatment was inferior to all the others, reaching 24.3 cm in stem height (Table 2).

The statistical analysis showed that there were statistical differences with high significance at 99%, for treatment 4 with a dose of 2 L/ha with respect to treatment 1 (control) with a dose of 0 L/ha. The coefficient of variation obtained was 6.0%.

The results of this variable coincide with those reported by who show that biostimulants improve the agronomic characteristics of crops, increasing their yields. For his part, he found that the use of biostimulants stimulates cell elongation and increases the absorption of water and nutrients from the soil, making them more resistant to attack by pests and diseases, resulting in higher yields.

Table 2. Results of the measurement of the variable plant height subjected to the Tukey 95% probability test.

Treatment	Description	Dosage L/ha	Averages
1	Control	0	24,33 c
2	Evergreen biostimulant	0,5	28,10 b c
3	Evergreen biostimulant	1	31,68 a b
4	Evergreen biostimulant	2	32,30 a
CV			6,0
Average			29,1
Significance			**

Ns = No significance

* = *Significance (95%)*

** = *High significance (99%)*

Number of pods per plant

In table 3, it can be observed that treatment 4 (Evergreen 2 L/ha) reached the highest number of pods per plant, being superior to the other treatments, as in the previous one, the control treatment was inferior to all the other treatments.

The statistical analysis of the number of pods per plant showed that there are statistical differences with high significance at 99%, of treatment four (T4) with a dose of 2 L/ha with respect to treatment one (control) with a dose of 0 L/ha. The coefficient of variation obtained was 11.32%.

The results of this variable show a similar trend to those obtained by [16], who found that biostimulants have a positive effect on the agronomic characteristics of crops, improving yields. These results also coincide with those reported by [17], since the application of this type of biostimulant increases the process of absorption of water and nutrients from the soil and generates higher crop yields.

Table 3. Results of the measurement of the number of pods per plant subjected to the Tukey 95% probability test.

Treatment	Description	Dosage L/ha	Averages

1	Control	0	27,65 b
2	Evergreen biostimulant	0,5	33,48 a b
3	Evergreen biostimulant	1	37,93 a
4	Evergreen biostimulant	2	42,20 a
CV			11,32
Average			35,31
Significance			**

Ns = No significance

* = *Significance (95%)*

** = *High significance (99%)*

Discussion

Once the results of the doses of Evergreen biostimulant applied were analysed, it was possible to confirm what was stated by [11] in his research, where he stated that plant biostimulants, regardless of their nutrient content, contain substance(s), compound(s), and/or microorganisms, which improve plant or rhizosphere development, vigour, yield and/or quality, by stimulating natural processes that benefit growth and responses to biotic stress.

In the research it was observed that the higher dose of biostimulant gave better results, however, further research will be needed to corroborate the findings of [13], [18], who state that the use of the biostimulants Vitazyme, Bayfolan Forte and Enerplant produced positive effects on the quality and appearance of the fruits by producing peppers of greater weight, diameter and length. These parameters demonstrated better land use efficiency and better utilisation of the nutrients applied.

4. Conclusions

- The variables evaluated plant height and number of pods per plant showed significant statistical differences at 99% with the application of treatment 4 (dose of 2 L/ha) with respect to the other treatments, showing its effectiveness.
- The Evergreen biostimulant treatment at a dose of 2 L/ha achieved a plant height of 32.3 cm, higher than the control treatment 0 L/ha (24.33 cm).
- The higher number of pods per plant indicated that the application of Evergreen biostimulant at a dose of 2 L/ha allows to obtain up to 42.2 pods on each plant compared to the control treatment 0 L/ha which obtained (27.65).

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