FINAL REPORT

EVALUATION OF BIOLOGICAL EFFECTIVENESS OF THE PRODUCT BRASINOFORTE (BIO SHOT IN USA), AS A GROWTH REGULATOR, IN CUCUMBER CROP, CARRIED OUT IN THE MUNICIPALITY OF GUASAVE, SINALOA

a) NAME, CURP AND ADDRESS OF THE RESPONSIBLE FOR THE STUDY:

Dr. ALBERTO MARGARITO GARCÍA MUNGUÍA. RESEARCH PROFESSOR.

almagamu@hotmail.com

CURP: GAMA850405HHGRNL08

Km. 3 Carretera a la Posta, Jesús María, Aguascalientes. Mexico. Autonomous University of Aguascalientes

Agricultural Sciences Center

Phytotechnics Department

Jesus Maria, Aguascalientes

CP. 20131

INTERESTED COMPANY : **QUÍMICA LUCAVA, SA de CV** Carretera Panamericana, Km 284, 2da. Fracción de Crespo, CP 38110, Celaya, Gto . Mexico .

b) Institution that will carry out the Biological Effectiveness study.

Autonomous University of Aguascalientes. Agricultural Sciences Center
Jesús María, Aguascalientes, Mexico.

c) Type of Input

()	Organic fertilizer	()	Organic or biological soil improver
(X)	Growth regulator	()	Inoculant
()	Moisturizer	()	Rooting
( )	Nutrient		

d) Report Title:

Evaluation of biological effectiveness of the product BRASINOFORTE, as a growth regulator, in cucumber crop, carried out in the municipality of Guasave, Sinaloa.

e) Introduction

1. Importance of the crop

The crop is important since it occupies the third place in planted area and second as a generator of foreign exchange, it has a high consumption rate in our population, it serves as food both fresh and industrialized, reshowing a production alternative for the Mexican farmer, for domestic market as well as for export purposes (SAGARPA, 2002).

Today it is grown practically all over the world and is one of the most commercially important horticultural crops worldwide. With respect to cucurbits, this vegetable occupies fourth place in our country byr the area planted (Valadez, 1990).

1.1. Production in Mexico

Cucumber production in Mexico is approximately 886,269.76 MT; The main cucumber producer in Mexico is the state of Sinaloa, which produces 361,887.25 MT per year, equivalent to 40.83% of the national production, followed by the state of Sonora with a production of 140,720.76 MT, equivalent to 15.87%; the state of Michoacán produces 11.47% with a production of 101,698.95 MT (Siap , 2016)

e) Objectives:

1. Evaluate the biological effectiveness of the product BRASINOFORTE, as growth regulator , in cucumber crop .

2. Determine the possible phytotoxic effects of the BRASINOFORTE product , as growth regulator in cucumber crop .

f) Commercial and / or experimental name.

- BRASINOFORTE

g) Guaranteed composition:

Guaranteed composition	Concentration
Triacontanol	0.200%
Brassinosteroids	0.005%

MATERIALS AND METHODS

LOCATION OF THE EXPERIMENTAL SITE.

The study was installed in a commercial cucumber plot in Guasave, Sinaloa .

h) Start date of the study: December 8, of 2020

i) Study completion date: February 2, 2021

j) Crop in which the study was carried out :

Cucumber **Variety:** Feisty

k) Phenological (growth) stage of the plant:

Transplanting, vegetative and production stages

l) Trial layout

1. The trial was established under a completely randomized blocks layout, with four replicates.

2. The experimental unit (plot) was comprised by 3 beds (at a distance between beds of 1.5 m) giving 4.5 m width by 5 m length, in total 22.5 m^{-2}, that is, 90 m^{-2} per treatment. Therefore, a total surface area of 360 m^{-2} was used for the study.

3. During the s evaluations, 0.5 m was eliminated between treatments and a bed on each side, leaving the useful (evaluation) plot of 1 row of 1.5 m width by 5 m length, that is, 6.0 m^{-2}.

m) Distribution of treatments

The distribution of treatments in the field after randomization was as follows.

Table 1 . Distribution of treatments in the field

BLOCK I	BLOCK II	BLOCK III	BLOCK IV
T 3	T1	T 5	T2
T 5	T2	T4	T 1
T 2	T 5	T3	T4
T 4	T 3	T1	T 5
T1	T4	T2	T3

Arabic numerals = Treatments

n) Rate, timing and number of applications

The treatments that were evaluated are indicated in Table 2 .

Table 2 . Treatments of BRASINOFORTE as growth regulator, in cucumber crop.

Treat-ment	**Product**	**Rate mL / ha**	
		1st (dipping)	2nd and 3rd (foliar sprays)
1	Absolute control	-	-
2	Brasinoforte	100	100
3	Brasinoforte	150	150
4	Brasinoforte	200	200
5	Vitazyme *	1000	1000

* Commercial or regional control

o) Timing and number of applications

Three applications were made. The first application was made by dipping the roots of the seedlings in trays, for a few seconds, until the air was released.

The second and third applications were made by foliar (leaf) spray. The application interval was 21 days between each.

Application methods: The second and third applications were made by foliar (leaf) spray, while the first application was made by dipping the roots of the seedlings in trays, for a few seconds, until the air was released.

Application equipment : A motorized sprayer with adjustable cone nozzle, was used in the 2nd and 3rd (foliar) application.

Volume of water used

1. Dipping : 200 $L.ha^{-1}$
2. Foliar sprays: 400 $L.ha^{-1}$

p) Other inputs used in the evaluation:

No other type of input which could interfere with the development of this trial, was used

r) Variables for estimating biological effectiveness and evaluation method.

1. Phytotoxicity. Assessed at 21, 42 and 56 days after each application by the percentage scale proposed by European Weed Research Society (Table 3).

Table 3 .Percentage scale by the European Weed Research Society, to evaluate the possible phytotoxic effect of the product BRASINOFORTE in growing cucumber..

EFFECTS ON CROP	**Crop Phytotoxicity (%)**
No effect on crop	0.0-1.0
Very mild symptoms	1.1-3.5
Mild symptoms	3.6-7.0
Moderate symptoms, but without effect of yields	7.1-12.5**
Intermediate damage	12.6-20.0
High damage	20.1-30.0
Very high damage	30.1-50.0
Extremely high damage	50.1-99.0
Complete destruction of crop	99.1-100

2. **Stem diameter (mm):** was measured with a vernier in three plants at random per experimental unit (plot), at 14 days after last application. Results are reported in mm.
3. **Plant height (cm):** was measured with a measuring tape in 3 plants at random per experimental unit, at 14 days after the last application. Results are reported in cm.
4. **Number of leaves**: was counted in 3 plants, taken at random per experimental unit, at 14 days after the last application. Results were expressed as numerical value.
5. **Chlorophyll content in leaves:** two leaves were taken in 3 plants per experimental unit, at 14 days after the last application, which were measured by the SPAD method, which determines the relative amount of chlorophyll present through the measurement of the absorption of the leaves. In 2 wavelength regions: in the red and infrared regions. Using these two transmissions, the meter calculates the SPAD numerical value, which is proportional to the amount of chlorophyll present in the leaf and consequently of nitrogen.
6. **Flowers per plant:** the number of flowers of 3 plants, taken at random, per experimental unit, was counted after detecting 20% of total flowering. The results were expressed as a numerical value.
7. **Number of fruits per plant and fruit weight**: the number of fruits per plant were counted and 3 fruits were weighed from 3 plants per plot, at harvest. Variables are expressed in g per fruit and numerical value of number of fruits per plant.
8. **Yield ($kg.ha^{-1}$).** The yield was calculated with the fruit weight and the number of fruits per plant and per experimental unit.

9. **Fruit length (mm):** 3 fruits of 3 plants were measured per experimental unit at harvest. The variable is expressed in mm per fruit.

10. **Fruit diameter (mm):** 3 fruits of 3 plants were measured per experimental unit at harvest . The variable is expressed in mm per fruit.

11. **Brix:** 3 fruits of 3 plants (one per plant) per experimental unit, were measured with a refractometer, at harvest. The variable is shown in %.

s) Evaluation method, which should allow a statistical analysis according to the experimental design.

ANALYSIS OF DATA. From the data obtained from the variables: fruit weight, fruit length, fruit diameter, plant height, stem diameter, flowers per plant, fruits per plant, number of leaves, chlorophyll content, yield and Brix , were statistically analyzed through an analysis of variance and Tukey's mean comparison test (α = 0.05), using the SAS ® statistical package .

t) Sample size and sampling method. The sample size was previously specified for each variable.

u) CALENDAR OF ACTIVITIES. Is shown in Table 4.

Table 4 . Calendar of activities of the evaluation of biological effectiveness of the product BRASINOFORTE in cucumber crop.

ACTIVITY	DATE
1st application (tray dipping) and transplanting	December 8, 2020
2nd application (1st foliar) and phytotoxicity evaluation (21 da1a)	December 29 , 2020
3 ra application (2nd foliar) and evaluation phytotoxicity (42 da1a)	January 19, 2021
Plant height evaluations, stem diameter, number and chlorophyll leaves, number of flowers per plant, phytotoxicity (56 da1a)	February 2 , 2021
Evaluations of number, weight, length, diameter, Brix , and yield at harvest (56 da1a)	February 2 , 2021

da1a. days after the first application and transplanting,

RESULTS AND DISCUSSION

1. Stem diameter

The analysis of variance with the **stem diameter** data in cucumber crop did not show significant differences between the evaluated treatments. This was corroborated by carrying out a comparison of means (with $\alpha = 0.05$). However, numerically and agronomically, a larger diameter was observed where growth regulator was applied.

Table 5 . Evaluation of **stem diameter** variable in cucumber crop .

TREATMENTS	Stem diameter (mm)
T1. Absolute control (Testigo absoluto in graph)	4.7 A
T2. Brasinoforte (100 mL . Ha $^{-1}$)	5.1 A
T3. Brasinoforte (150 mL.ha $^{-1}$)	5.0 A
T4. Brasinoforte (200 mL.ha $^{-1}$)	5.4 A
T5. V itazyme (1000 mL.ha $^{-1}$)	5.4 A

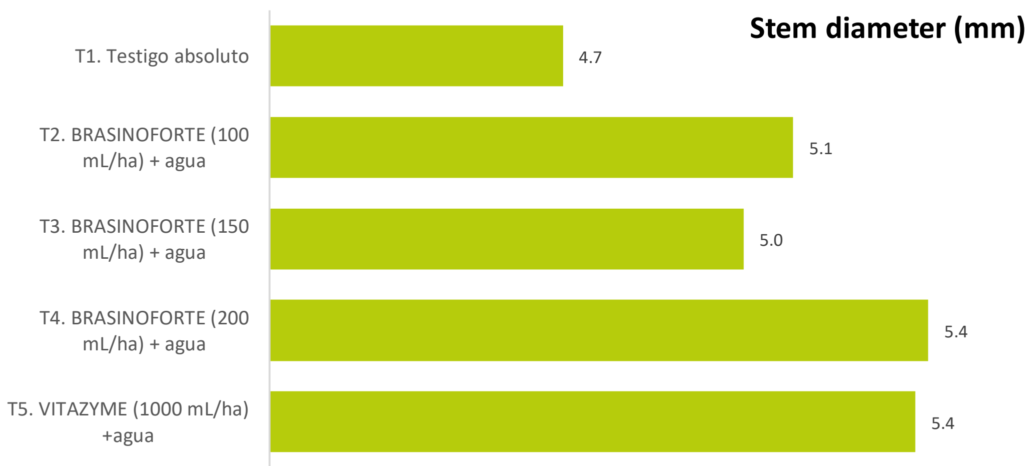

Figure 1. Stem diameter.

2. Plant height

The analysis of variance carried out with **the plant height** data in cucumber crop showed significant differences between the evaluated treatments. This was corroborated by carrying out a comparison of means (with $\alpha = 0.05$).

It was observed that the **height of the plant** was greater where the growth regulator Brasinoforte was applied at a rate of 200 $mL.ha^{-1}$, showing an average of **97.7 cm** , compared to the absolute control that showed an average of **84.3 cm** (Table 6) .

Table 6 . Evaluation of the variable plant **height ,** in cucumber crop .

TREATMENTS	Plant height (cm)
T1. Absolute control (Testigo absoluto in graph)	84.3 B
T2. Brasinoforte (100 $mL.ha^{-1}$)	91.8 A
T3. Brasinoforte (150 $mL.ha^{-1}$)	94.1 A
T4. Brasinoforte (200 $mL.ha^{-1}$)	97.7 A
T5. Vitazyme (1000 $mL.ha^{-1}$)	95.4 A

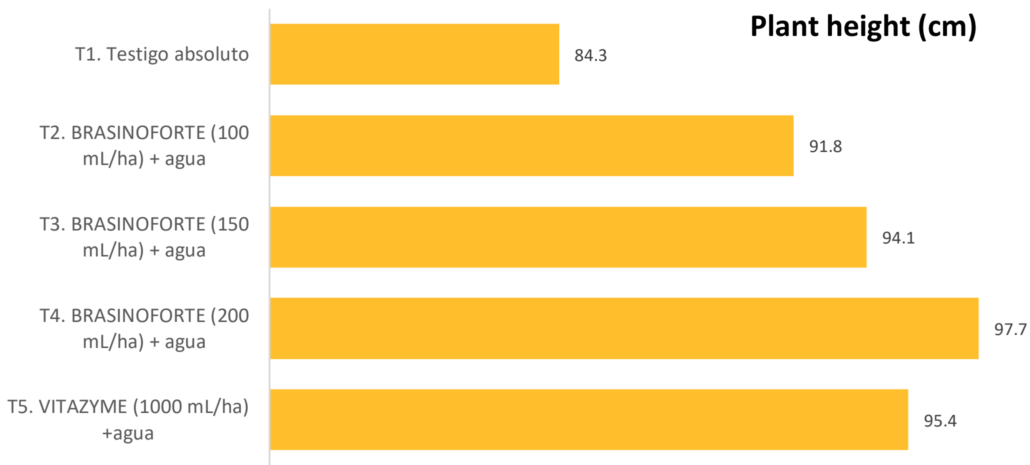

Figure 2. Plant height.

3. Number of leaves

The analysis of variance carried out with the **number of leaves** data in cucumber crop did not show significant differences between the evaluated treatments. This was corroborated by carrying out a comparison of means (with $\alpha = 0.05$).

However, a small increase was numerically observed in all growth regulator treatments.

Table 7 . Evaluation of the variable **number of leaves** in the cucumber crop .

TREATMENTS	Number of leaves
T1. Absolute control (Testigo absoluto in graph)	36.3 A
T2. Brasinoforte (100 mL.ha $^{-1}$)	39.3 A
T3. Brasinoforte (150 mL.ha $^{-1}$)	38.4 A
T4. Brasinoforte (200 mL.ha $^{-1}$)	39.8 A
T5. Vitazyme (1000 mL.ha $^{-1}$)	38.8 A

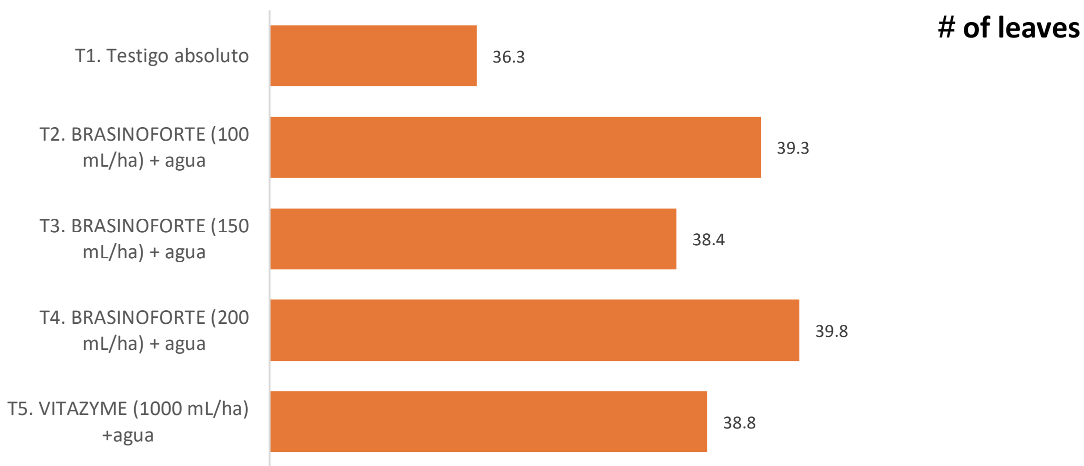

Figure 3. Number of leaves

4. Chlorophyll content

The analysis of variance carried out with the **chlorophyll content** data in cucumber crop did not show significant differences between treatments. This was corroborated by carrying out a comparison of means (with $\alpha = 0.05$).

Table 8 . Evaluation of variable **chlorophyll content (SPAD units) ,** in cucumber crop.

TREATMENTS	SPAD
T1. Absolute control (Testigo absoluto in graph)	53.8 A
T2. Brasinoforte (100 mL.ha $^{-1}$)	54.8 A
T3. Brasinoforte (150 mL.ha $^{-1}$)	53.8 A
T4. Brasinoforte (200 mL.ha $^{-1}$)	54.0 A
T5. Vitazyme (1000 mL.ha $^{-1}$)	53.2 A

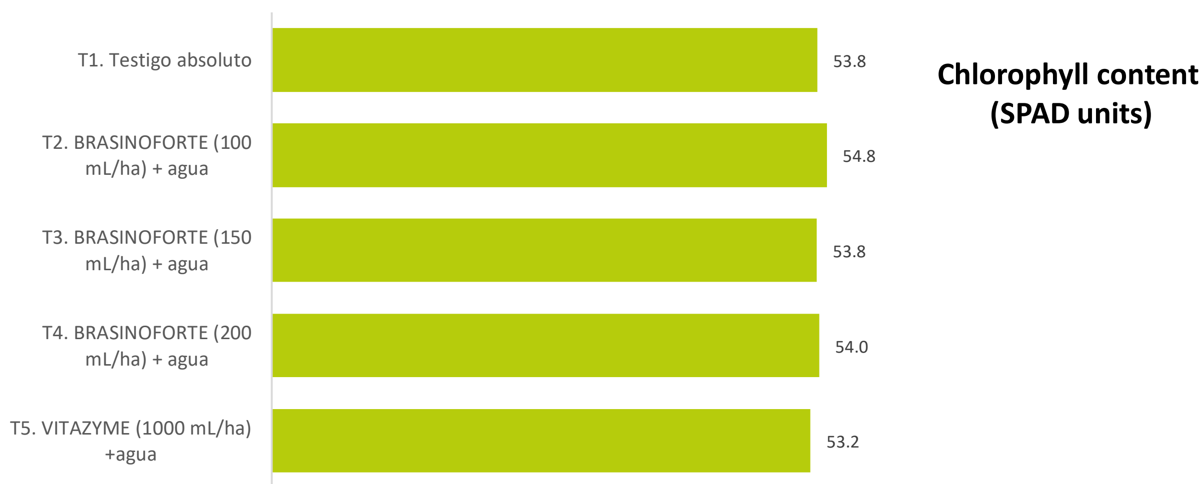

Figure 4 . Chlorophyll content .

5. Flowers per plant

The analysis of variance carried out with the **flowers per plant** data in cucumber crop showed significant differences between the evaluated treatments. This was corroborated by carrying out a comparison of means (with $\alpha = 0.05$).

It was observed that the **number of flowers** per plant was higher where Brasinoforte growth regulator was applied at a rate of 200 mL .ha^{-1}, showing an average of **26.2 flowers** , compared to the absolute control that showed an average of **16.6 flowers** (Table 9).

Table 9 . Evaluation of the variable **flowers per plant ,** in the cucumber crop

TREATMENTS	**# Flowers**
T1. Absolute control (Testigo absoluto in graph)	16.6 B
T2. Brasinoforte (100 mL.ha $^{-1}$)	19.3 B
T3. Brasinoforte (150 mL.ha $^{-1}$)	23.2 A
T4. Brasinoforte (200 mL.ha $^{-1}$)	26.2 A
T5. Vitazyme (1000 mL.ha $^{-1}$)	24.3 A

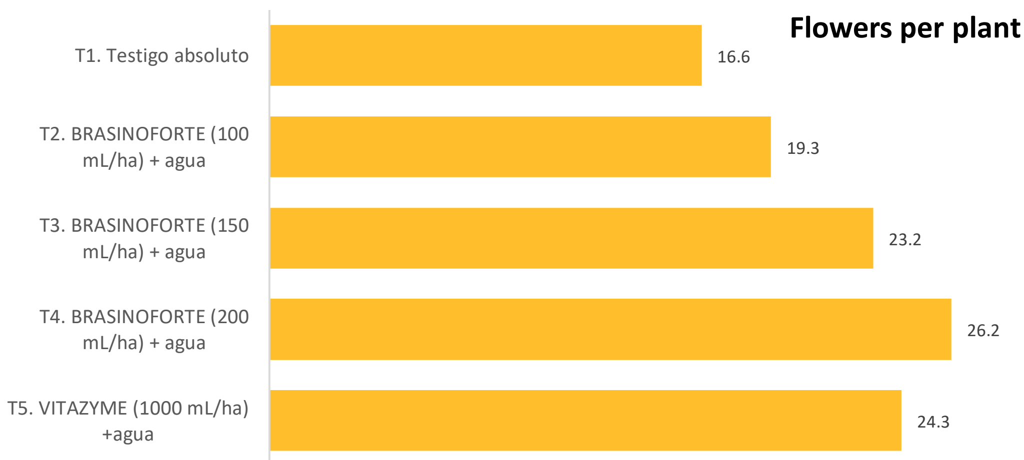

Figure 5. Flowers per plant

6. Number of fruits

The variance analysis conducted with **number of fruits** data in the cucumber crop showed significant differences between treatments. This was corroborated by carrying out a comparison of means (with $\alpha = 0.05$).

It was observed that the **number of fruits** per plant was higher where the growth regulator Brasinoforte was applied at the rate of 150 and 200 mL .ha^{-1}, showing an average of **7.1 and 7.2 fruits** , respectively, compared to the absolute control that showed an average of **5.1 fruits** (Table 10).

Table 10 . Evaluation of the variable **number of fruits per plant** in cucumber crop

TREATMENTS	# fruits/plant
T1. Absolute control (Testigo absoluto in graph)	5.1 B
T2. Brasinoforte (100 mL.ha $^{-1}$)	6.8 AB
T3. Brasinoforte (150 mL.ha $^{-1}$)	7.1 A
T4. Brasinoforte (200 mL.ha $^{-1}$)	7.2 A
T5. Vitazyme (1000 mL.ha $^{-1}$)	5.9 AB

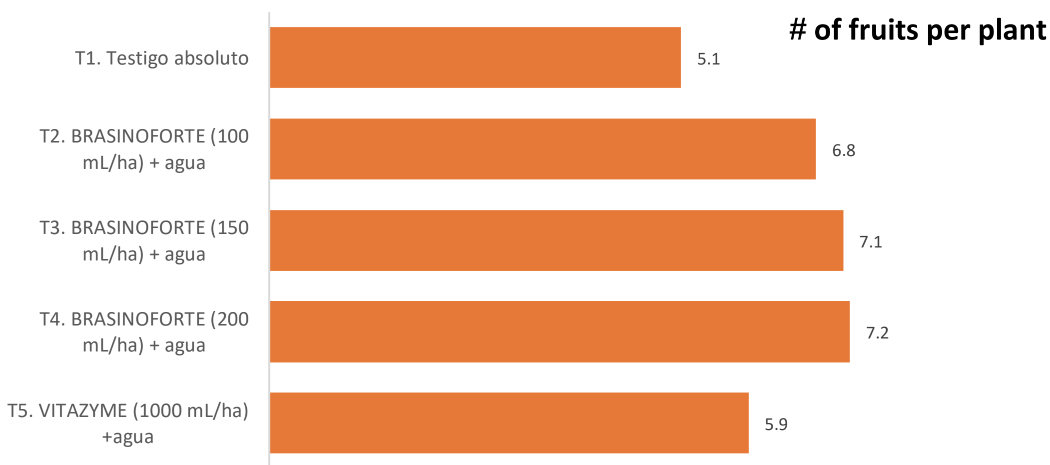

Figure 6. Number of fruits .

7. Fruit weight

The analysis of variance carried out with the **fruit weight** data in cucumber crop showed significant differences between the evaluated treatments. This was corroborated by carrying out a comparison of means (with $\alpha = 0.05$).

It was observed that the **weight of the fruit** was greater where the growth regulator Brasinoforte was applied at a rate of 200 mL .ha^{-1}, showing an average of **84.1 grams** , compared to the absolute control that showed an average of **55.5 grams** (Table 11).

Table 11 . Evaluation of the variable **fruit weight (g),** in cucumber crop.

TREATMENTS	Fruit weight (g)
T1. Absolute control (Testigo absoluto in graph)	55.5 C
T2. Brasinoforte (100 mL.ha $^{-1}$)	69.5 B
T3. Brasinoforte (150 mL.ha $^{-1}$)	82.0 A
T4. Brasinoforte (200 mL.ha $^{-1}$)	84.1 A
T5. Vitazyme (1000 mL.ha $^{-1}$)	82.0 A

Figure 7. Fruit weight .

8. Yield

E l analysis of variance carried out with the **yield** data in cucumber crop showed significant differences between treatments. This was corroborated by carrying out a comparison of means (with $\alpha = 0.05$).

It was observed that the **yield** was higher where the growth regulator Brasinoforte was applied at a rate of 200 mL .ha^{-1} , showing an average of **12184 kg.ha**$^{-1}$, compared to the absolute control, that showed an average of **5674.9 kg.ha**$^{-1}$, from a single picking (Table 12).

Table 12 . Evaluation of the **yield** variable (kg/ha) in cucumber crop.

TREATMENTS	Yield (kg / ha)	Yield Increase	
		(kg / ha)	%
T1. Absolute untreated control	5674.9 B	-	-
T2. Brasinoforte (100 mL.ha $^{-1}$)	9489.4 AB	3814.5	67
T3. Brasinoforte (150 mL.ha $^{-1}$)	11679.7 A	6004.8	106
T4. Brasinoforte (200 mL.ha $^{-1}$)	12184.0 A	6509.1	115
T5. Vitazyme (1000 mL.ha $^{-1}$)	9632.9 A	3958.0	70

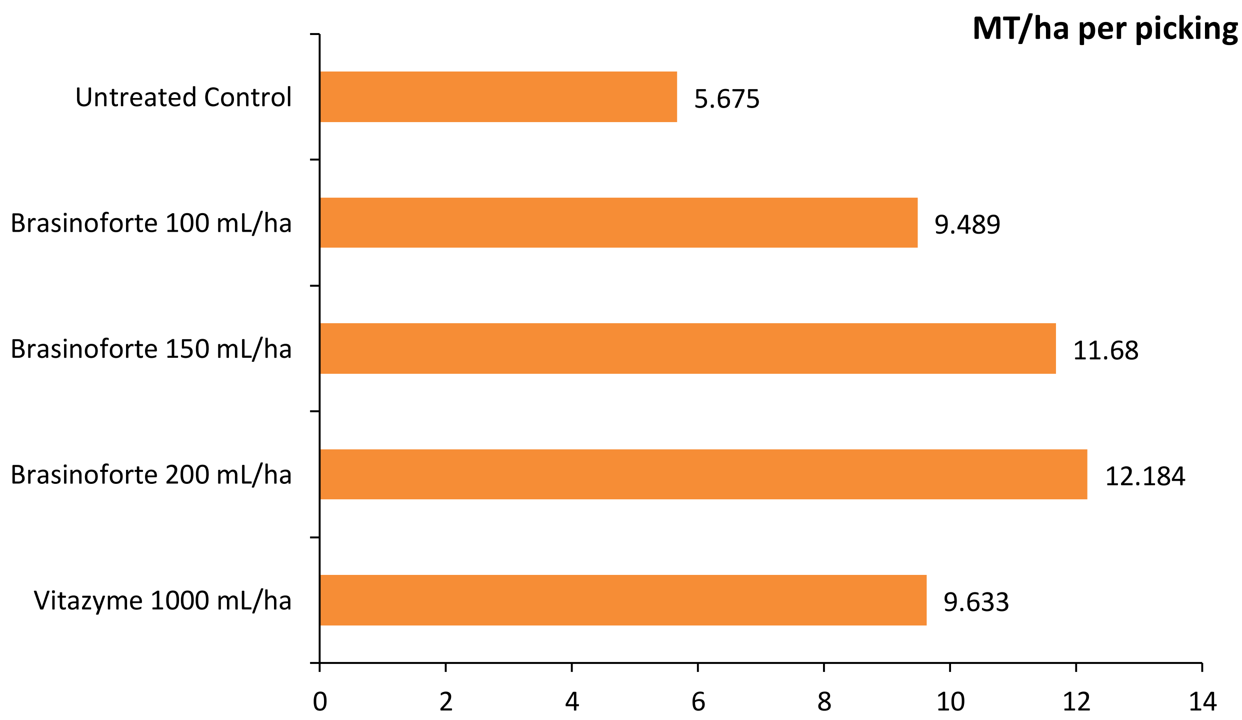

Figure 8. Cucumber Yield per single picking.

9. Fruit length

The analysis of variance carried out with **Fruit length** data in cucumber crop showed significant differences between treatments. This was corroborated by carrying out a comparison of means (with $\alpha = 0.05$).

It was observed that the **Fruit length** was greater where the growth regulator Brasinoforte was applied at a rate of 200 $mL.ha^{-1}$, showing an average of **107.1 mm** , compared to the absolute control that showed an average of **88.8 mm** (Table 13).

Table 13. Evaluation of the **fruit length** variable **in** cucumber crop

TREATMENTS	Fruit length (mm)
T1. Absolute control (Testigo absoluto in graph)	88.8 B
T2. Brasinoforte (100 $mL.ha^{-1}$)	91.7 B
T3. Brasinoforte (150 $mL.ha^{-1}$)	97.9 AB
T4. Brasinoforte (200 $mL.ha^{-1}$)	107.1 A
T5. Vitazyme (1000 $mL.ha^{-1}$)	97.2 AB

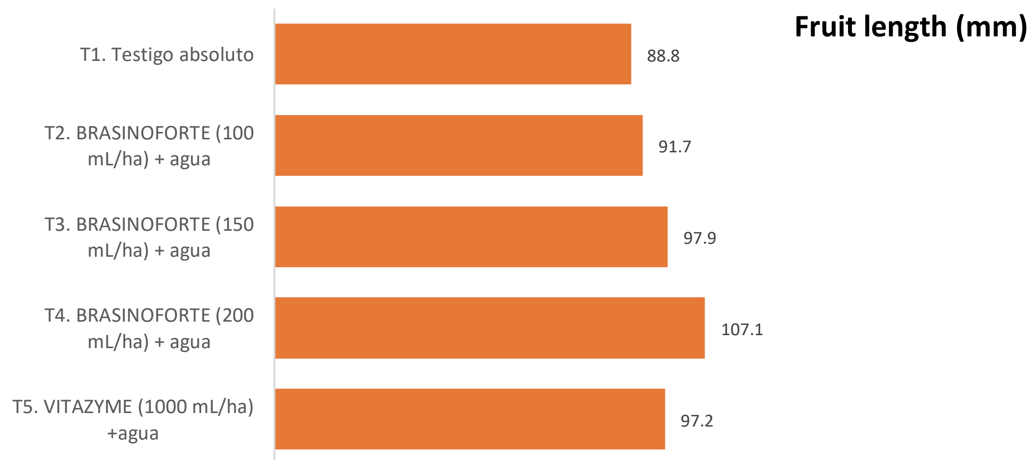

Figure 9. Fruit length

10. Fruit diameter

The analysis of variance performed with the **fruit diameter** data in cucumber crop showed significant differences between treatments. This was corroborated by carrying out a comparison of means (with $\alpha = 0.05$).

It was observed that the **fruit diameter** was greater where the growth regulator Brasinoforte was applied at a rate of 200 mL .ha^{-1}, showing an average of **32.6 mm**, compared to the absolute control that showed an average of **29.2 mm** (Table 14) .

Table 14 . Evaluation of the **fruit diameter** variable in cucumber crop

TREATMENTS	Fruit diameter (mm)
T1. Absolute control (Testigo absoluto in graph)	**29.2 C**
T2. Brasinoforte (100 mL.ha $^{-1}$)	**31.6 AB**
T3. Brasinoforte (150 mL.ha $^{-1}$)	**31.5 AB**
T4. Brasinoforte (200 mL.ha $^{-1}$)	**32.6 A**
T5. Vitazyme (1000 mL.ha $^{-1}$)	**30.4 BC**

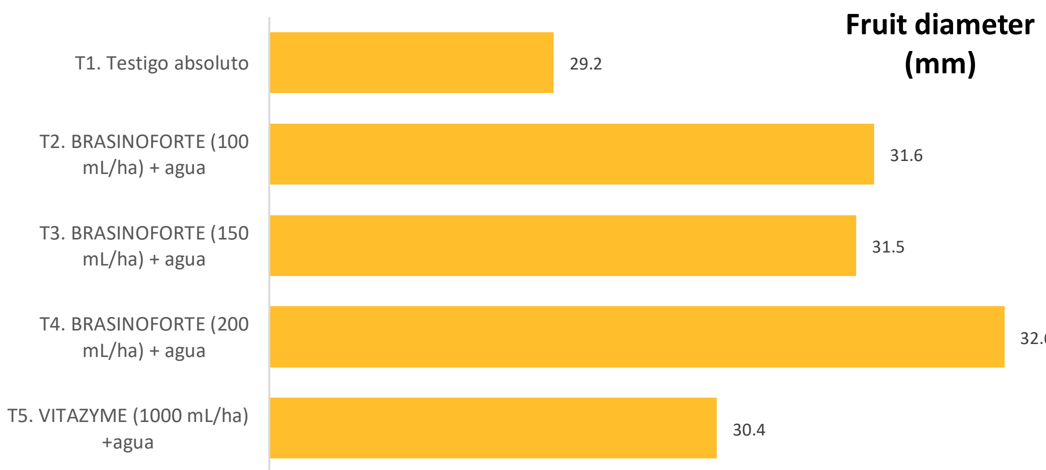

Figure 10. Fruit diameter

11. Brix

The analysis of variance performed with the **Brix** data in cucumber crop did not show significant differences between treatments. This was corroborated by carrying out a comparison of means (with $\alpha = 0.05$).

Table 15 . Evaluation of the variable **Brix** in cucumber crop.

TREATMENTS	Brix %
T1. Absolute untreated control	3.1 A
T2. Brasinoforte (100 mL.ha $^{-1}$)	3.3 A
T3. Brasinoforte (150 mL.ha $^{-1}$)	3.2 A
T4. Brasinoforte (200 mL.ha $^{-1}$)	3.2 A
T5. Vitazyme (1000 mL.ha $^{-1}$)	3.1 A

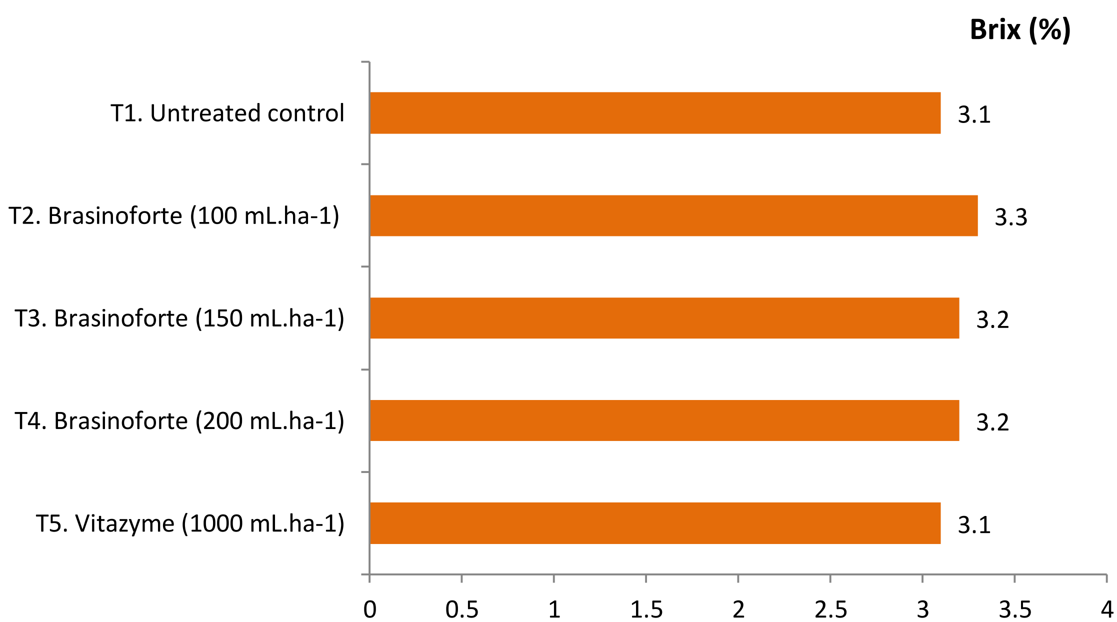

Figure 11. Brix

PHYTOTOXICITY

The growth regulator Brasinoforte at application rates of 100, 150 and 200 $mL.ha^{-1}$ in dipping + foliar application, not were phytotoxic s in cucumber crop.

CONCLUSIONS

The growth regulator Brasinoforte in rates of 100, 150 and 200 mL /ha (dipping + two foliar sprays), produced a positive effect in the growth, production and quality stages of cucumber crop , by generating marked increases above an untreated control in variables: stem diameter, plant height, number of leaves and flowers per plant, fruit number, weight, diameter and length, as well as in yields.

RECOMMENDATION

In summary, the recommendation for the product Brasinoforte is as follows:

Crop	Application Rate	Observations
Cucumber	100 - 200 $mL.ha^{-1}$ (seedling root dip)	Carry out the first application by dipping of seedling roots in trays, using a water consumption of 200 $L.ha^{-1}$. The second and third applications to be made by foliar spray, with an interval of 21 days between each, using a volume of water of 400 $L.ha^{-1}$.
	100 - 200 $mL.ha^{-1}$ (foliar sprays)	