Case Study Summary: Jalapeño peppers, Autonomous University of Queretaro, Mexico, 2022

Time

Planting date at Nursery: July 12, 2022
Open sky transplant: September 1, 2022
Harvest: November 16-28, 2022

Place

University of Queretaro, México – Campus Amazcala and Campus Concá.

Details

Researchers: MC. Adán Mercado Luna (Campus Concá), and Dr. Ramón Gerardo Guevara González (Technical support, Campus Amazcala).

Crop: Jalapeño pepper plants (Capsicum annuum).

Area: the scientific trial was conducted in greenhouse, with total area 100 square meters .

Setup: four (4) experimental treatments with 20 plants in each, arranged in a randomized block experimental design; the treatments were as listed below:

TREATMENT	WATERING LEVEL
KPCB* and normal irrigation	100% of Field Capacity (FC)**
Control – Normal	100% of Field Capacity (FC)
KPCB under Water Stress	50% of Field Capacity (FC)
Control – Water Stress	50% of Field Capacity (FC)

*KPCB: Kyminasi Plants – Crop Booster

** Field Capacity (FC) is defined as the water content of a soil after gravitational drainage over approximately one (1) day.

Results

Based on the results detailed below, the researchers concluded that KPCB had biostimulating effects on plant growth variables, yield and resilience to high environmental stress.

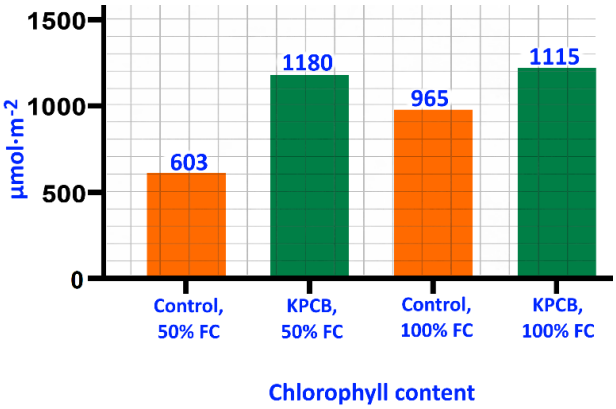


The results on morphological growth variables such as plant height and stem basal diameter (see table below) showed significant increase in plant height compared to the control for both types of irrigation levels evaluated. The researchers found it interesting that the height level of plants irrigated 50% with +KPCB matched the height of plants irrigated 100% without the system.

Peppers	Control, 50% FC	KPCB, 50% FC	Difference	Gain	Control 100% FC	KPCB, 100% FC	Difference	Gain
Stem Height (cm)	37.08	43.14	6.06	16%	38.62	45.44	6.82	18%
Stem Basal Diameter (cm)	10.56	11.47	0.91	9%	12.31	13.98	1.67	14%
Chlorophyll ($\mu mol \cdot m^{-2}$), avg.	603	1180	577	96%	965	1215	250	26%
Fruit Weight per Plant (g), avg.	91.39	117.56	26.17	29%	223.01	299.21	76.2	34%

Root dry weight (g)	Control (25 samples): 169	KPCB (25 samples): 246	Difference: 77	Gain: 46%

The figure clearly shows a biostimulant effect on the amount of **chlorophyll** at both irrigation levels evaluated when the KPCB is used, especially being significant in the case of water stress. Interestingly, the average chlorophyll level with KPCB and 50% reduction in water matched that of KPCB with no reduction, and it was nearly double its control chlorophyll level.



Root dry weight was 46% higher with KPCB, signifying greater carbon sequestration. These results suggest that the Kyminasi system increases the photosynthetic potential and root density of the Jalapeño pepper plant and therefore higher production is expected at the end of the crop.

Yield

The results show significant increases in fruit weight yield per plant for both irrigation levels evaluated in this research: 34% higher yield without water reduction, and 29% with half the water.

Pest, Virus, and Heat Resilience

During the crop cycle, the significantly positive results listed above have been achieved DESPITE high environment stress of numerous types:

- Plants were attacked by several pests that included mainly whiteflies, thrips, and worms.
- Chili producers were affected by a virus that could not be controlled and reduced production, not only in this project but also in a large part of the Concá valley.
- Regarding heat resilience, the researchers stressed that (quote): "It is also VERY IMPORTANT to point out that the planting season of this evaluated crop was carried out during the most complicated time of the year to produce chili peppers in the semi-desert area of Querétaro (place where the Amazcala campus is located), since heat stroke (temperatures which fluctuated between 25-28 degrees Celsius at night and peaks of up to 45-48 degrees during the day, normally make the cultivation of this species very complicated at this time, however, interesting results were obtained on the biostimulant potential of the Kyminasi Plant Booster system."

Cellular-Level Validation of the Biostimulant Potential of KPCB

Indicators of immunity and biostimulation were measured at the level of antioxidant enzymatic activities at the level of plant tissues such as superoxide dismutase[1] (SOD) and catalase[2] (CAT), whose results indicated that their activity levels correlate with adequate maintenance of stress levels. Oxidative that favor growth (biostimulation), in both treatments evaluated in comparison with their respective controls despite the aforementioned climatic conditions.

Researchers' Conclusions

The biostimulant effect of the KPCB system was shown both in greenhouse and open-air tests. Induction of plant immunity indicators (antioxidant enzymes) was shown, as well as a better development of the plant compared to the control.

The KPCB system WORKS AS A BIOSTIMULANT and probably as an elicitor (vaccine) for the plants, the latter based on the result that was observed in the open on production under virus conditions in the Concá region, which caused lower yield, but no production in the area based on reports from other producers in the region who had to abandon their cultivation due to this situation.

[1] Superoxide dismutase (SOD) is an enzyme found in all living cells. It helps break down potentially harmful oxygen molecules in cells.
[2] Catalase (CAT) is an enzyme found in plants that protects cells from oxidative damage by breaking down hydrogen peroxide (H2O2) into water and oxygen.

Technical Report of the evaluation as a plant biostimulant in jalapeño pepper plants (C. annuum L.) of the Kyminasi Plant Booster system for the company ValleyHerbal Inc.

Place of execution of the project:
Autonomous University of Querétaro – Campus Amazcala and Concá

Participants:
MC. Adán Mercado Luna (Campus Concá)
Dr. Ramón Gerardo Guevara González (Technical support, Campus Amazcala)

Background of the proposal

This proposal was developed during the months of January to June 2022 in order to evaluate possible biostimulant effects on the growth and development of jalapeño pepper plants (Jalapeño IV variety) when subjected to irrigation with a commercial system (Kyminasi Plant Booster – KPCB) based on low frequency radio waves that are injected into the irrigation system. The idea is to corroborate at the greenhouse level in the facilities of the Amazcala and Concá campuses of the Faculty of Engineering of the Autonomous University of Querétaro, the possible biostimulant effect on the growth and development of plants, using chili as a model in this case. It should be noted that this system has been successfully evaluated in other plant species such as dragon fruit, orange, potato, watermelon, pepper, Thompson grapes, lentils, asparagus, almond trees, at the open sky level.

Setting up the experiment at Campus Amazcala
Objective: To evaluate the biostimulant effect of the KPCB system on chili plants grown in greenhouses.

The study was carried out in a 100 square meter greenhouse-type hall. The greenhouse has an automated irrigation system. At the outlet of the irrigation system, the Kyminasi Plant Booster device was connected so that the irrigation water contained the radio waves generated by the equipment and to evaluate effects on the chili crop under study. The controls included an irrigation system without the Kyminasi Plant Booster system, plus the tubing was lined with aluminum foil to prevent radio waves from being "transferred" from the test system to the control. Basic Steiner solution was used as crop fertilizer and water came from the 2 aforementioned sources with or without the test system. Four experimental treatments with 20 plants each were designed, arranged in a randomized block experimental design:

a) Irrigation at 100% field capacity (Normal irrigation control)
b) Irrigation at 100% field capacity (normal irrigation + Kyminasi Plant Booster)
c) Irrigation at 50% field capacity (Control of water stress)
d) Irrigation at 50% field capacity (Control of water stress + Kyminasi Plant Booster)

Measurements of morphological and biochemical variables and at the end of the cultivation of fruit yield were carried out weekly. The results were processed by one-way analysis of variance and, where appropriate, the Tukey test (P=0.05) was performed to review differences between treatments at a statistical level.

Results and discussions

The results on morphological growth variables such as plant height (panel A) and stem basal diameter (panel B) are shown in figure 1. It can be seen in the figure that the Kyminasi system significantly increases plant height compared to the control for both types of irrigation levels evaluated (Panel A). Interestingly, the height level of plants irrigated 50% + Kyminasi system matched the height of plants irrigated 100% without the system (Panel A). This indicates a biostimulating effect of the Kyminasi system on this growth variable. For the basal stem diameter, no significant differences were observed with or without the Kyminasi system for the 4 treatments (Panel B).

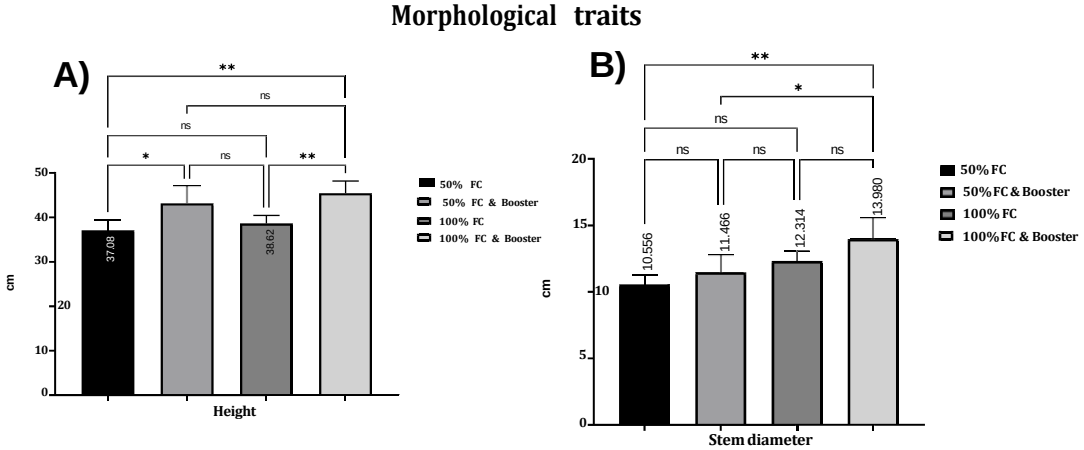


Figure 1. FC: Field Capacity as the water content of a soil after gravitational drainage over approximately a day. Significant differences (**) among means used a p-value of ($P < 0.05$). Mean values were compared among an ordinary one way ANOVA. Fir data analyze, five independent individuals were used for tukey test. Quadrant A shows height of plants and quadrant B shows their stem diameter.

Figure 2 shows the effects of the Kyminasi system on the amount of chlorophyll in plants. This variable indicates photosynthetic potential of the plants and therefore final productive potential translated in practical terms into crop yield.

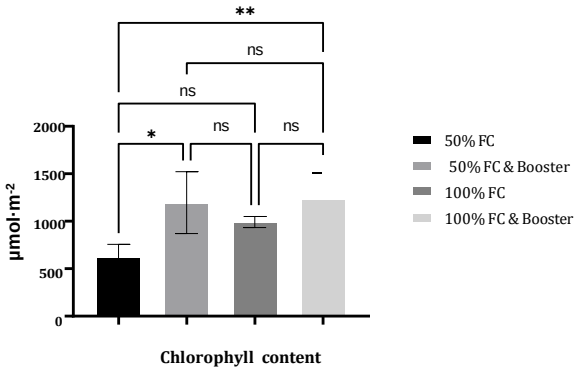
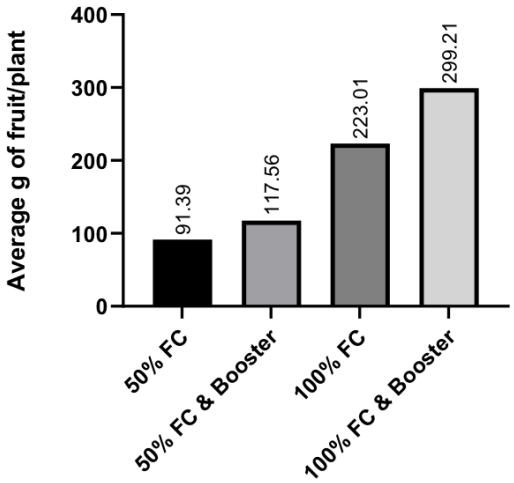


Figure 2. FC: Field Capacity as the water content of a soil after gravitational drainage over approximately a day. Significant differences (**) among means used a p-value of ($P < 0.05$). Mean values were compared among an ordinary one way ANOVA. Fir data analyze, five independent individuals were used for tukey test.

Figure 2 clearly shows a biostimulant effect on the amount of chlorophyll at both irrigation levels evaluated when the Kyminasi system is used, especially being significant in the case of water stress. These results suggest that the Kyminasi system increases the photosynthetic potential of the chili plant and therefore higher production is expected at the end of the crop.

Regarding fruit yield per plant, the results show significant increases in fruit weight yield per plant for both irrigation levels evaluated when using the Kyminasi Plant Booster system.

A



B

Figure 3. Yield based on weight of fruits per plant in chili crops subjected to water stress (50% FC irrigation) or normal irrigation (100% FC irrigation), in the presence of water from the Kyminasi Plant Booster system (panel A) . Typical image of plant with fruits produced in the crop with 100 % irrigation + Kyminasi system (panel B).

This result is consistent with what was observed in the morphological and chlorophyll measurements previously presented. In other words, the Kyminasi Plant Booster system generates a biostimulating effect on the growth and development of the plant, which is even reflected at the level of fruit yield per plant.

Additional Notes:

It is important to point out that the yields obtained in this experiment imply levels of 1.5 tons per hectare in this evaluated condition; It is only that it is not possible to compare this level of production obtained in this experiment with levels of production at the open sky level (where the production is between 10-15 tons per hectare in a suitable weather season) and with horticultural management since in this work Horticultural management was not given to the crop, it was only left to see the effect of the system as a biostimulant. It is also **VERY IMPORTANT** to point out that the planting season of this evaluated crop was carried out during the most complicated time of the year to produce chili peppers in the semi-desert area of Querétaro (place where the Amazcala campus is located), since heat stroke (temperatures which fluctuated between 25-28 degrees Celsius at night and peaks of up to 45-48 degrees during the day, normally make the cultivation of this species very complicated at this time, however, interesting results were obtained on the biostimulant potential of the Kyminasi Plant Booster system.

Finally, indicators of immunity and biostimulation were measured at the level of antioxidant enzymatic activities at the level of plant tissues such as superoxide dismutase (SOD) and catalase (CAT), whose results indicated that their activity levels correlate with adequate maintenance of oxidative stress levels that favor growth (biostimulation), in both treatments evaluated in comparison with their respective controls despite the aforementioned climatic conditions.

Part 2: Technical report of the open-air experiment at Campus Concá

Objective: To evaluate if the KPCB system is capable of biostimulating a chili pepper (C. annuum L.) crop in the open sky.

This part of the project was carried out at the Autonomous University of Querétaro Campus Concá located in the municipality of Arroyo Seco, Qro. Taking place in the agricultural module of the campus, under open field conditions.

SEEDLING

Variety: MIXTECO F1 (HARRIS MORAN SEED COMPANY)

Planting date: July 12, 2022

Seed quantity: 60000 seeds

Planting was carried out with personnel from the agricultural area of the campus, the materials used for planting were a mixture of peat moss, perlite and vermiculite, adding water in combination with liquid rooting agent (0.5 ml / lt of water), the seeds were placed in polystyrene trays with 200 and 288 cavities, with a previous disinfection with quaternary ammonium salts.

NURSERY

Extended date: July 16, 2022

Germination percentage: 97% germination

Irrigation: sprinkler irrigation was applied in the mornings and afternoons.

Fertilization: From the two true leaves, which was applied daily until the transplant date, using poly feed 19-19-19, alga root and poly feed 12-43-12 as a fertilization source.

Sanitation: Weekly applications of fungicide (Previcur, i.a. propamocarb + fosetil) were made to avoid the presence of fungi, as well as the application of natural repellents to avoid the presence of insects.

GROUND PREPARATION

For the preparation of the land, the operator of the agricultural area carried out the following activities with the campus tractor:

ACTIVITY	QUANTITY	PHOTOGRAPHIC EVIDENCE
Dredge	2	
sil	1	
Fallow	2	
Furrow	1	
Lodging	1	
Mulching	1	

TRASPLANT

Open sky transplant date: September 1, 2022

Density: 40 cm between plant and plant in double row.

The activity was carried out with the help of workers in the agricultural area and students of the agro-industrial engineering career and the degree in sustainable agricultural production.

CROP MANAGEMENT

Fertilization

Fertilization was carried out together with irrigation every third day throughout the crop cycle, using the following sources:

NAME	SOURCES
Poly Feed 19-19-19	• Nitrogen • Phosphorus • Potassium
Poly Feed 10-10-43	• Nitrogen • Phosphorus • Potassium
Poly Feed 12-43-12	• Nitrogen • Phosphorus • Potassium
Multi-npK 13-2-44	•
MAP 11-52-00	• Nitrogen • Phosphorus
Calcium Nitrate 15.5-0-0-26.5	• Nitrogen • Calcium
Magnesium Nitrate 11-0-0-16	• Nitrogen • Magnesium

Phosphonitrate	• Nitrogen • Phosphorus
Potassium phosphite, goldengrowzinc, Ferti Khor, Calcium-Boron, fattening (Foliar fertilizers)	They were used as nutrient compensation for the plant for its development and production.

Plagues and diseases

For the management of pests and diseases the following products were used:

NAME	ACTIVE INGREDIENT	PLAGUE OR DISEASE
Movento (insecticide)	i.a: Spirotetramat	• Aphid • Whitefly • Thrips
Jiro (insecticide)	i.a: Garlic and neem extract	• Whitefly • Thrips
Grandevo (insecticide)	i.a: *Chromobacterium Subtsugae*	• Thrips • Red spider • Paratriosis • Armyworm
Bacilus Hd (insecticide)	i.a: *Bacillus thuringensis*	• Diamondback Moth • Armyworm
Denim (insecticide)	i.a: emamectin benzoate	• Armyworm
Belt (insecticide)	i.a: Flubendiamide	• Armyworm
Muralla (insecticide)	i.a: Imidacloprid	• Aphid • Thrips • Whitefly
Evisect (insecticide)	i.a: Thiocyclam hydrogen oxalate	• Whitefly • Thrips
Imiland (insecticide)	i.a: Imidacloprid + Lambda Cyhalothrin	• Whitefly • Thrips
Abacitric (insecticide)	i.a: Abamectin	• Red spider • White aphid
Código (insecticide)	i.a: Thiamethoxam	• Whitefly
Confidor (insecticide)	i.a: imidacloprid	• Whitefly • Aphid • Thrips
Singular (insecticide)	i.a: imidacloprid	• Whitefly • Aphid • Thrips
Previcur (fungicide)	i.a: propamocarb + fosetyl	• Damping off
STAR TALL (fungicide)	i.a: metalaxyl	• Damping off
Intermicim (bactericide)	i.a: Streptomycin + Oxytetracycline	• Firebrand
Terra Q (bactericide)	i.a: Oxytetracycline	• Firebrand

It should be noted that the products were used as preventives and for control, rotating products to avoid pest resistance. During the crop cycle, the main pests that occurred were whiteflies, thrips, and worms.

HARVEST

Harvest start date: November 16, 2022

Harvest end date: December 28, 2022

The following shows the record of harvests that were carried out during the production cycle:

HARVEST RECORD OF CHILE JALAPEÑO PROJECT - AUTONOMOUS UNIVERSITY OF QUERÉTARO CAMPUS CONCA				
DATE	AMOUNT OF BURRIES	WEIGHT PER BURRY (KG)	TOTAL WEIGHT (KG)	FREIGHT PAYMENT ($)
18/11/2022	18	30 kg	540 kg	$800
20/11/2022	98	30 kg	2940 kg	$5200
02/12/2022	30	30 kg	900 kg	$1600
07/12/2022	45	30 kg	1350 kg	$2400
09/12/2022	55	30 kg	1650 kg	$2915
15/12/2022	29	30 kg	870 kg	$1537
22/12/2022	40	30 kg	1200 kg	$2120
28/12/2022	34	30 kg	1020 kg	$1800
		TOTAL	10470 kg	$18372

OBSERVATIONS

It should be noted that the yield was not as expected since the crop was affected by virus problems, so production was reduced, not only in this project but also in a large part of the Concá valley, chili producers were affected by this disease that could not be controlled.

IMAGE GALLERY

Seedling


Crop Development






Harvests




Difference of Using KPCB

No KPCB

These images show that without the KPCB, the plant roots were smaller, both in length and dry weight.

With KPCB

Here the roots of the plants where the KPCB was used are shown, in which it can be noticed that there are more presences of absorbent hairs, that is, the KPCB system turned out to be a biostimulant of root development in the chili pepper plants evaluated.

Root dry weight

With KPCB	
Plant No.	Weight (g)
1	6
2	4
3	10
4	11
5	13
6	10
7	14
8	7
9	10
10	11
11	9
12	8
13	13
14	10
15	11
16	16
17	7
18	10
19	11
20	7
21	15
22	10
23	9
24	5
25	9

No KPCB	
Plant No.	Weight (g)
1	6
2	8
3	16
4	5
5	7
6	6
7	4
8	7
9	8
10	6
11	8
12	4
13	7
14	5
15	5
16	13
17	7
18	7
19	4
20	6
21	6
22	9
23	5
24	6
25	4

Total:	246g	Total:	169g
Gain:	**46%**		

Calculated by Harvest Harmonics' Science Dept.

Project conclusion:

The biostimulant effect of the KPCB system was shown both in greenhouse and open-air tests. Induction of plant immunity indicators (antioxidant enzymes) was shown, as well as a better development of the plant compared to the control.

The KPCB system WORKS AS A BIOSTIMULANT and probably as an elicitor (Vaccine) for the plants, the latter based on the result that was observed in the open on production under virus conditions in the Concá region, which caused lower yield, but no production. in the area based on reports from other producers in the region who had to abandon their cultivation due to this situation.

SINCERELY,

Dr. Ramón Gerardo Guevara González
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