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PRELIMINARY DATA REGARDING THE APPLICATION OF *BACILLUS* SPP. IN THE CULTURE TECHNOLOGY OF PROTECTED TOMATOES IN ORDER TO INCREASE PRODUCTIVITY IN THE BUCHAREST AREA

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Abstract

Now the current trend in agriculture around the world deals with promoting growth and controlling crop diseases and pests organically by reducing or even eliminating the application of chemicals. In the present study, soil and foliar biostimulating products containing Bacillus spp. (Bactilis, Leaf Power, NitroStim and Rizobac) were tested in the greenhouse on three tomato hybrids in order to increase production through a more environmentally friendly technology. The following parameters were monitored: stem diameter in the lower part, the plants height, the sequence of the inflorescences, the number of flowers and fruits on the plant and on the inflorescences, the percentage of fruits on the plant and in inflorescences, the production of fruits on the plant, fruits firmness, total dry matter, total soluble solids, titratable acidity.The results showed that, the application of Rizobac on Kingset and Bucanero hybrids, led to an increase of the number of inflorescences and fruits.. The size of the fruit was most positively influenced by the application of Bactilis fertilizers, the increase being between 6-15% depending on the hybrid. The hybrid-fertilizer combination is important and influences the production obtained.

Key words: *biological, fertilizers, microorganisms, production, PGPR, vegetables.*

INTRODUCTION

Tomatoes (Lycopersicon esculentum Mill) have their origins in South America and, compared to other vegetable species, have the largest cultivation area in the world, being very appreciated by consumers.

The fruits are rich in vitamins, minerals, amino acids and pigments (Dinu, 2017; Soare, 2015) and poor in calories.

Fruits are characterized by high lycopene content, carotene, calcium, magnesium, phosphorus and other elements (Filgueira, 2013), antioxidants (Kalogeropoulos et al., 2012), contributing to prevention of cardiovascular diseases and cancer (Gong et al., 2006) being considered very healthy for the human body.

It is consumed in a wide variety and has a beneficial impact on human health mainly due to the high content of lycopene, folic acid, ascorbic acid, flavonoids, α-tocopherol, potassium and phenolic compounds (Erba et al., 2013).

Tomatoes react very well to various technological interventions, from physical solutions such as more stems to increase yield or the application of biofertilizers, arginine and cysteine (Hoza et al., 2012, 2013, 2018, 2019 and 2022; Apahidean, 2021; Becherescu, 2019).

In recent years, farmers are increasingly interested in good agricultural practices, switching to organic farming and using water and nutrients efficiently. In order to achieve higher quality production there are formulations with bacteria that act as biopesticides, biostimulants or biofertilizers, to increase plant productivity but also to reduce plant residues, thus contributing to consumer protection (Basu, 2021; Chojnacka, 2015), bacteria it is also known for their ability to produce lytic enzyme involved in plant pathogenic inhibition and plant growth. Bacillus spp. was noted both for its positive effects on existing microorganisms in the soil but also for a better assimilation of nutrients, which led to increased productivity by facilitating the absorption of mineral nutrients (Kalam, 2020; Sicuia, 2015).

Bacillus spp., promote plant growth through a better uptake of nutrients such as nitrogen and phosphate, and/or by the production of phytohormones such as auxins, enzymes such as ACC deaminase or volatile organic compounds (VOC) such as 2.3-butanediol and acetoin.

(Asari, 2016; 2017; Borriss, 2016; Fazle Rabbee & Baek, 2020).

Bacillus spp. also improves the main nutrient transport functions from the soil to the plant by solubilizing insoluble zinc compounds and increasing the bioavailability of zinc in the soil (Mumtaz et al., 2017).

Balderas-Ruíz et al., 2021, in theirs study observed that application of *Bacillus* spp. in high concentration influenced tomatoes marketable quantity. The results showed the potential of Bacillus spp. to boost tomato production within the expected range for greenhouse cultivation. Due to the yields and the quality of the fruits obtained, was estimated that the profitability of the treatment was 2.5 times higher than the non-fertilized one.

The application of treatments with *Bacillus* spp. has been shown to be useful during the post-harvest storage period, the application of treatments with Bacillus spp. has been found to delay senescence in cherry tomatoes (Zhu et al., 2021).

In conclusion, *Bacillus* spp. stood out both for its positive effects on existing microorganisms in the soil and for a better assimilation of nutrients, which led to increased productivity and their use can optimize the use of synthetic fertilizers in agriculture (Dragomir & Hoza, 2022).

MATERIALS AND METHODS

The experiment took place in the Research Greenhouse of University of Agronomic Sciences and Veterinary Medicine of Bucharest (USAMV), during 2022. The experiment was organized in randomized blocks, with three replicates on each experimental variants and six plants/repetition, on an area of 200 m^2, with two variable factors, one factor was, the tomato hybrids and the other factor was growth biostimulators.

The main purpose of the experiment was to observe and monitor the main quantitative and qualitative characteristics of hybrids grown in the presence of biostimulating products: Bactilis 5 L/ha, Leaf Power 5 L/ha, NitroStim 5 L/ha and Rizobac 10 L/ha, the control variant was without biostimulats application.

It was used two plant growth stimulating products applied to the soil, respectively Rizobac and Bactilis and foliar, respectively NitroStim and Leaf Power. Two foliar fertilizations were carried out with NitroStim, the first application was made before the appearance of the first inflorescence, and the second one 14 days after it. Fertilization with Leaf Power, Rizobac and Bactillis a wasere carried out eight times during the vegetation period.

Bactilis is a microbial inoculant containing beneficial bacteria in the form of endospores. As soon as Bactilis is applied in the soil, spores quickly germinate and the bacteria that occur start proliferating and colonizing the plant root. In parallel, bacteria start producing substances-metabolites which improve rooting, plant growth and vigour and also improve the resistance of the root system in stressful conditions caused by various biotic and environmental factors (Retrieved from https://www.humofert.gr/en/product/2015-05-29-12-29-20/bactilis-detail.html).

Leaf Power is a composite product that combines the properties of a growth stimulant, an organic foliar fertilizer and a microbial inoculant. Leaf Power contains beneficial microorganisms in the endospore form which exist naturally on the leaves, shoots and the rhizosphere of most plant species (Retrieved from https://www.humofert.gr/en/product/2015-05-29-12-29-20/leaf-power-1-detail.html).

NitroStim is a microbial solution which stimulates plants' growth thanks to the activity of specific beneficial nitrogen fixing bacteria, which are capable of penetrating into the above-ground plants parts (phyllosphere) and of becoming endofytes. Nitrogen fixing phyllosphere endofytes fix atmospheric nitrogen and convert it into a readily assimilable by plants form, ensuring a fast, vivid and balanced growth (Retrieved from https://www.humofert.gr/en/product/2015-05-29-12-29-20/nitrostim-detail.html).

Rizobac is a microbial inoculant, rich in nutrients and beneficial microorganisms which enhances rooting, achieves a rapid establishment of the transplanting crops in the soil and increases the penetration and expansion of the roots for all crops. Rizobac contains beneficial soil bacteria in a total population of 1x1011 cfu (colony forming units) per liter, which create a healthy soil environment, promote the root system growth, contribute to the better plant nutrition and fortify plant resistance against various biotic and abiotic factors. Furthermore, the rich in nutrients substrate of Rizobac, stimulates the microbial activity and contributes to the creation of a strong and voluminous root which supplies and supports the vigorous growth of the plant. Rizobac is suitable for crops cultivated according to the standards of organic, integrated and conventional farming (Retrieved from https://www.humofert.gr/en/product/2015-05-29-12-29-20/biostimulants-1/rooting/rizobac-1-detail.html).

The biological material used was represented by three F1 hybrids, Bucanero, Buffalosun and Kingset.

By combining the 2 factors, 15 variants resulted, each variant having 3 repetitions and 6 plants per repetition, as follows: V1 - Bactilis + Bucanero F1, V2 - Bactilis + Buffalosun F1 , V3 - Bactilis + Kingset F1, V4 - Leaf Power + Bucanero F1, V5 - Leaf Power + Buffalosun F1, V6 - Leaf Power + Kingset F1, V7 - NitroStim + Bucanero F1, V8 - NitroStim + Buffalosun F1, V9 - NitroStim + Kingset F1, V10 - Rizobac + Bucanero F1, V11 - Rizobac + Buffalosun F1, V12 - Rizobac + Kingset F1, V13 - Unfertilized + Bucanero F1, V14 - Unfertilized + Buffalosun F1, V15 - Unfertilized + Kingset F1.

Sowing in order to obtain seedlings was carried out on February 15, their replanting after 14 days from germination, and planting in the greenhouse on April 12, at distances of 0.8 m/0.4 m, resulting in 3.2 pl/m2 and 32,000 pl/ha, the age of the seedlings being 56 days.

Flowering in the first inflorescence started about 21-22 days after planting, and the first fruits appeared after 26-27 days. In the following inflorescences, flowering took place at 36-37 days in the second inflorescence, 46-47 days in the third inflorescence and after 55-56 days in the fourth inflorescence. Fruit set was after 41-42 days in the second inflorescence, 51-52 days in the third inflorescence and after 60-61 days in the fourth inflorescence. Fruit harvesting started on July 22.

During the vegetation period, the specific care works to this crop were applied.

When the plants started to grow, measurements were made on stem diameter in the lower part, the height of the plants until the cutting of the growth tip, the sequence of the inflorescences, the number of flowers and fruits on the plant and separately on the inflorescences, the percentage of fruits set on the plant and in inflorescences, the production of fruits on the plant. The tomato plants were led with four inflorescences. At the end of the culture, measurements were made on the length of the stem, the weight by weighing and the volume of the root system of the plants, using a 1 L Class A graduated cylinder, in all experimental variants. Also, determinations were made on the tomato fruits firmness with an electronic penetrometer TR was used with a penetration of Ø 8 mm piston, the average weight by weighing the fruits of each variety and dividing by total number of fruits, four times during harvest, production of tomatoes per hectare, total dry matter by gravimetric method, total soluble solids (% Brix) were determined from tomato juice with refractive device Kruss DR301-95 (% Brix). The titratable acidity (TA) acidity was determined by titration with 0.1N NaOH to pH 8.1. The results been calculated using the following formula and expressed as percentages of citric acid content (Saad et al., 2014):

Percent of titratable acidity = (V x N x 100 x 0.0064)/m, where N is the normality of NaOH, 0.0064 is the conversion factor for citric acid, V is the volume of NaOH used (mL) and m is the mass of tomato sample used (g).

The determinations were made in the Research Center for Studies of Food Quality and Agricultural Products - University of Agronomic Sciences and Veterinary Medicine of Bucharest, laboratories.

Results were interpreted using F-test ($p \leq 0.05$) and T-test ($p \leq 0.05$).

Data values were measured from six replicates and analysed by an F test to establish equal ($P > 0.05$) or unequal ($p < 0.05$) variance and to establish differences of statistical significance the T test $p > 0,05$ not significant, $p < 0.05$ weakly significant, $p < 0.01$ moderately significant, $p < 0.005$ highly significant, $p < 0.001$ very strongly significant $p < 0.0001$ not significant.

RESULTS AND DISCUSSIONS

The application of biostimulating products on the three analyzed hybrids had beneficial effects on the growth and fruiting processes of tomatoes.

Thus, on stem diameter in the lower part varied between 14.28 mm and 10.95 mm. Fertilization caused better growth in all hybrids, the differences in diameter being due to fertilization and less to the hybrid used (Figure 1).

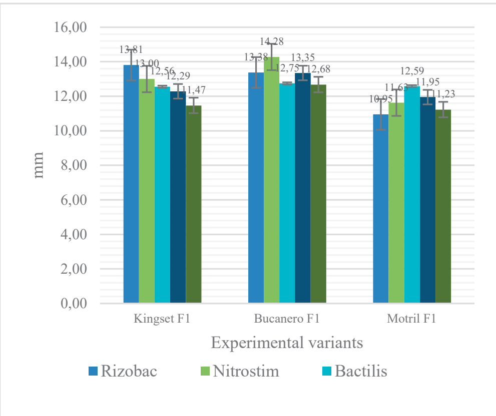
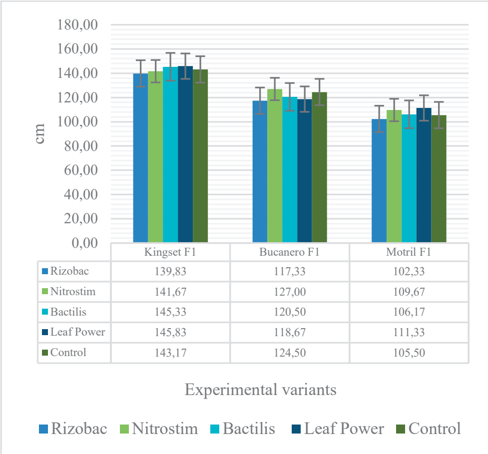


Figure 1. Influence of fertilization on tomato hybrids on the stem diameter in the lower part of the plants, mm

The significantly positively influenced hybrid (P=0.017) was Kingset when Rizobac fertilizer was applied, with an average plant diameter of 13.81 mm (Figure 1).

The height of all hybrids was not significantly influenced by fertilizer application. The highest plant growth in height was in the Kingset hybrid, reaching 145.83 cm when applying Leaf Power, while by applying Bactilis products, NitroStims and Rizobac the plant growth had fairly close values (Figure 2).



	Kingset F1	Bucanero F1	Motril F1
Rizobac	139,83	117,33	102,33
Nitrostim	141,67	127,00	109,67
Bactilis	145,33	120,50	106,17
Leaf Power	145,83	118,67	111,33
Control	143,17	124,50	105,50

Figure 2. Influence of fertilization on tomato hybrids on height of plants, cm

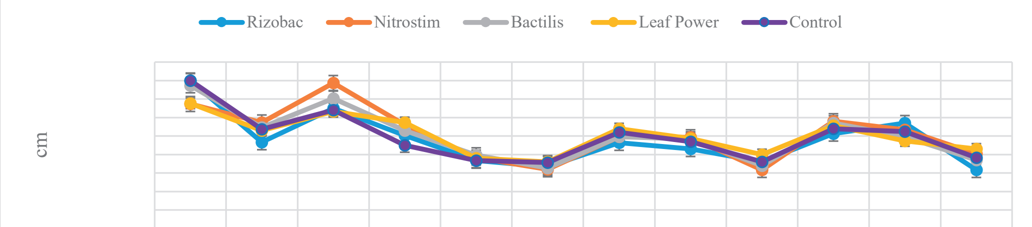
In the Figure 3, can been observe the height of the plants when the third inflorescence appears.

Figure 3. Tomates culture in the greenhouse (USAMV)

Regarding the insertion of the inflorescences on the stem, the application of biofertilizer NitroStim (P = 0.009) and Leaf Power (P = 0.017) on the hybrid Kingset, led to the insertion at 33.67 cm from the base, respectively 33.83 cm compared to the unfertilized variant with 40 cm from the base (Figure 4).

On insertion of the first inflorescence, the only negative value, statistically ensured was when NitroStim was applied to the Motril hybrid, which recorded 39.33 cm compared to the control with 32 cm. The insertion of the second inflorescence was significantly better when NitroStim was applied (p = 0.026) for the Motril F1 hybrid with a value of 16 cm compared to the unfertilized version of 17.83 cm.

In the case of the insertion of the third and fourth inflorescences, the differences were not as great as in the previously analyzed parameters, the ferlilizants had a rather small influence, not statistically ensured (Figure 4).



	Kingset F1	Bucanero F1	Motril F1	Kingset F1	Bucanero F1	Motril F1	Kingset F1	Bucanero F1	Motril F1	Kingset F1	Bucanero F1	Motril F1
Rizobac	40,00	23,33	32,50	25,17	18,33	16,67	23,17	21,50	18,00	25,67	28,50	15,83
Nitrostim	33,67	28,67	39,33	28,00	19,17	16,00	24,83	24,67	15,83	29,00	26,67	20,17
Bactilis	38,67	27,33	35,17	26,50	19,83	16,33	24,83	24,17	17,00	28,50	24,83	18,50
Leaf Power	33,83	26,50	31,67	28,67	19,00	18,00	27,00	24,33	20,00	27,83	23,67	21,50
Control	40,00	26,83	32,00	22,50	18,33	17,83	26,00	23,50	18,00	27,00	26,17	19,17

Figure 4. Influence of fertilization on tomato hybrids distances between

The productive capacity of the tomato plants was influenced by the hybrid, but also by the application of biofertilizers, which led to a visible improvement in the number of flowers, the number of fruits and the fruit set percentage. In the plants belonging to the Kingset F1, when applying Rizobac, the average number of flowers in inflorescence I increased from 5.8 flowers in the control, to 9.4 flowers and the fruit set percentage was very significantly higher (P = 0.008). The number of flowers in inflorescence IV increased from 7.6 flowers to 10.8 flowers/inflorescence (P = 0.002) (Table 1). The influence of Rizobac can also be seen in the total number of flowers/plant of 34.2 and the number of fruits/plant of 18 compared to control, one of 22.6 flowers and 12.8 fruits respectively. The differences being strongly significant P = 0.003 and very strongly significant P = 0.001. Under the conditions of this experiment, the highest production of flowers/plant was recorded when NitroStim fertilizer was applied, 34.8 and the number of fruits/plant was 16.2 (Table 1).

Table 1. The number of flowers, fruits and the fruit set percentage in the Kingset hybrid, on fertilization variants

Fertilizers	Kingset F1										
	Inflorescence I		Inflorescence II		Inflorescence III		Inflorescence IV		Total		
	Total flowers	Fruit Set	Total flowers	Fruit Set	Total flowers	Fruit Set	Total flowers	Fruit Set	Total flowers	Total fruit	% set fruit
Rizobac	9.4	3.4	7.4	4.4	6.6	4.8	10.8	5.4	34.2	18	53.32 %
T test	0.034	0.008	0.359	0.524	0.106	0.053	0.002	0.191	0.003	0.001	0.765
NistroStim	6.6	2.2	9	4.2	9.6	4	9.6	5.8	34.8	16.2	47.58 %
T test	0.517	0.251	0.079	0.792	0.063	0.201	0.095	0.243	0.0047	0.011	0.317
Bactilis	6.2	2.8	4.8	3.8	5.6	3	6.4	3.8	23	13.4	60.50 %
T test	0.778	0.453	0.656	0.856	0.369	0.809	0.246	0.849	0.907	0.812	0.742
Leaf Power	5	3	4.4	2.6	3.6	1.2	5	2.6	18	9.4	53.32 %
T test	0.475	0.056	0.522	0.025	1.000	0.032	0.023	0.230	0.059	0.047	0.637
Control	5.8	2	5.6	4	3.6	2.8	7.6	4	22.6	12.8	57.07 %

The application of Leaf Power led to a weaker fruit set in inflorescence II (P = 0.025) and Inflorescence III (P = 0.032) and in inflorescence IV the number of flowers was lower than in the control, of 5 flowers respectively 7.6 flowers. The total number of fruits per plant was also influenced by 9.4 fruits/plant compared to 12.8 fruits/plant for control.
In the case of the fruit set percentage, the differences were not so great, the influence being rather small, not statistically ensured (Table 1). Regarding the Bucanero F1, the number of flowers in inflorescence IV was positively influenced by the application of Rizobac fertilizer, as well as fruit set. In inflorescence II, a better influence of Bactilis fertilizer was recorded, with 6.6 flowers and 5 tied fruits, instead in inflorescence IV, a slight decrease (P = 0.048) in the number of flowers can be observed compared to control (Table 2).
The application of NitroStim (P = 0.034) and Leaf Power (P = 0.008) led to a weaker fruit set in inflorescence III, 2.2 and 1.6 respectively comparison with control 3.6 fruits.
The total number of flowers, fruits and the percentage of binding on the plant did not register considerable differences, the influence being quite small. not statistically ensured (Table 2).

Table 2. The number of flowers, fruits and the fruit set percentage in the Bucanero hybrid, on fertilization variants

Bucanero F1											
Fertilizers	Inflorescence I		Inflorescence II		Inflorescence III		Inflorescence IV		Total		
	Total flowers	Fruit Set	Total flowers	Fruit Set	Total flowers	Fruit Set	Total flowers	Fruit Set	Total flowers	Total fruit	% set fruit
Rizobac	5.6	4.8	4.6	3.6	4.8	3.8	5.6	3.2	20.6	15.4	76.21 %
T test	1.000	0.535	0.587	0.667	0.846	0.784	0.046	0.029	0.340	0.213	0.787
NistroStim	6.2	5.4	4.4	3.6	3.8	2.2	3	1.8	17.4	13	76.74 %
T test	0.305	0.724	0.521	0.545	0.467	0.034	0.195	1.000	0.794	0.493	0.903
Bactilis	6.4	4.4	6.6	5	5.8	3.6	2.6	1.6	21.4	14.6	68.67 %
T test	0.252	0.242	0.014	0.040	0.442	1.000	0.048	0.667	0.205	0.656	0.211
Leaf Power	4.4	4	3.4	3	2.6	1.6	3.2	2	13.6	10.6	73.76 %
T test	0.343	0.362	0.760	0.842	0.108	0.008	0.308	0.694	0.151	0.202	0.714
Control	5.6	5.2	3.8	3.2	4.6	3.6	4	1.8	18	13.8	77.71 %

The application of the products on the Motril hybrid, recorded the lowest values in the experiment regarding the number of flowers in inflorescence I and II, but also the total number of flowers on the plant when applying Bactilis and Leaf Power (Table 3).

Table 3. The number of flowers, fruits and the fruit set percentage in the Motril hybrid, on fertilization variant

Motril F1											
Fertilizers	Inflorescence I		Inflorescence II		Inflorescence III		Inflorescence IV		Total		
	Total flowers	Fruit Set	Total flowers	Fruit Set	Total flowers	Fruit Set	Total flowers	Fruit Set	Total flowers	Total fruit	% set fruit
Rizobac	6.2	2.6	8	4.2	7	4	6.8	4	28	14.8	55.27 %
T test	0.010	1.000	0.620	0.557	0.796	0.764	0.070	0.147	0.515	0.326	0.050
NistroStim	7.4	1.2	4.8	3.6	4.4	1.8	6.8	3.8	23.4	10.4	44.49 %
T test	0.071	0.156	0.027	0.861	0.175	0.205	0.339	0.340	0.080	0.472	0.217
Bactilis	6.2	3.2	3.2	2.6	3.4	2.2	5	2.8	17.8	10.8	62.47 %
T test	0.003	0.494	0.008	0.506	0.078	0.301	1	0.829	0.012	0.570	0.017
Leaf Power	6.4	2.4	5.2	3.2	5.6	3.8	4.8	2.8	22	12.2	55.73 %
T test	0.041	0.766	0.044	0.870	0.359	0.885	0.792	0.803	0.0497	1.000	0.0004
Control	9.4	2.6	9.4	3.4	7.6	3.6	5	2.6	31.4	12.2	38.09 %

The percentage of fruit set was higher when the product was applied and for two of them it was significantly higher Bactilis and Leaf Power of 62.47% and 55.73% in comparison with control of 38.09% (Table 3).
The firmness was not influenced by the application of the products, the recorded values being similar and insignificant from a statistical point of view. The highest value was for the Motril F1, reaching 12.05 N when applying NitroStim and the lowest value was for the Bucanero F1 reaching 4.47 N when applying Leaf Power (Figure 5).

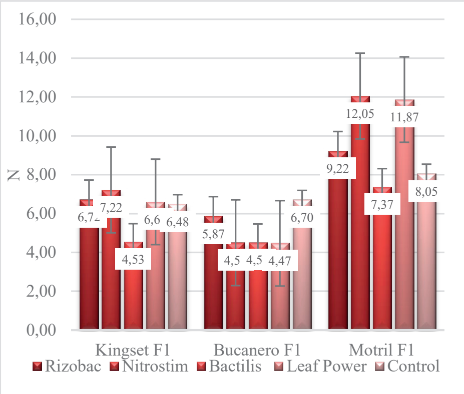


Figure 5. Effect of fertilization on the firmness (N) of tomatoes

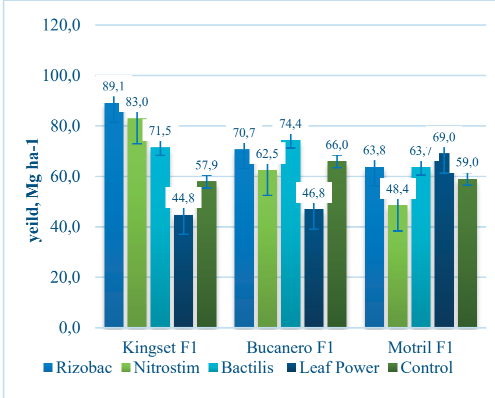
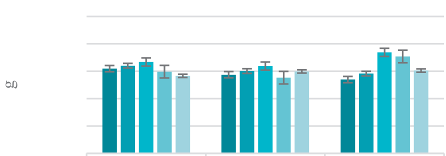


Figure 7. Influence of fertilization on tomato average production, (Mg ha^{-1})

Regarding the average weight of the fruits, the differences were not as great as in the previously analyzed parameters.



	Kingset F1	Bucanero F1	Motril F1
Rizobac	154,70	143,65	134,74
Nitrostim	160,11	150,31	145,64
Bactilis	166,85	159,40	184,47
Leaf Power	149,18	138,22	176,93
Control	141,57	149,65	151,23

Rizobac Nitrostim Bactilis Leaf Power Control

Figure 6. Average weight of tomatoes varieties (g)

The fertilisants had a rather small influence, not statistically ensured. The average fruit weight was between 141.57 g and 166.85 g for the Kingset F1, between 138.22 g and 159.40 g for the Bucanero F1 and between 134.74 g and 184 g for the Motril F1 (Figure 6).

Maximum fruit production was achieved when tomato plants were fertilized with Rizobac and increased by 27% for Kingset F1 compared to the unfertilized control version. Bucanero F1 response better to Bactilis with 11% more that control and hybrid Motril to Leaf Power with an increased by 15% more that control.

The total dry matter content, regarding the Kingset hybrid, was influenced by the application of the following products: NitroStim recorded a value of 4.94%, Bactilis 5.23% and Leaf Power recorded the value of 5.03%, all values being significantly higher than the unfertilized value of 4.62% (Table 4).

Table 4. Analysis total dry matter content in three tomato hybrids (DM%)

Total dry matter (DM %)			
	Kingset F1	Bucanero F1	Motril F1
Rizobac	5.05	5.30	4.40
T test	0.107	0.661	0.0005
NistroStim	4.94	5.00	4.83
T test	0.0444	0.1155	0.7570
Bactilis	5.23	4.91	4.69
T test	0.001	0.135	0.116
Leaf Power	5.03	5.78	4.81
T test	0.025	0.082	0.883
Control	4.62	5.39	4.82

Regarding the Bucanero F1 and Motril F1 the values obtained after applying the products were similar and insignificant from a statistical point of view (Table 4).

Sugar content was not influenced by the application of the fertil, the recorded values being similar and insignificant from a statistical point of view (Figure 8). The values obtained was between 4.80% and 3.90% being in accordance with those obtained by (Dobrin et al., 2019).

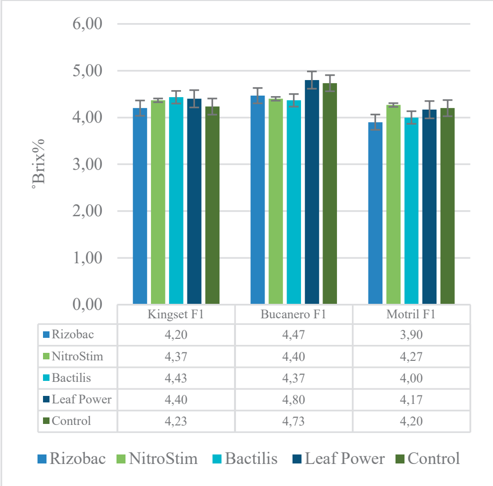


Figure 8. Effect of fertilization on sugar content (°Brix%)

The application of the Rizobac fertilizer led to considerable changes in terms of total titratable acidity for all the hybrids used, ensured from a statistical point of view, thus the Kingset F1 had a higher acidity than its unfertilized version and the Bucanero F1 and Motril F1 had a lower acidity than their unfertilized variants (Table 5).
The NitroStim fertilizer had for Bucanero F1 total titratable acidity = 0.30% lower than the variant unfertilized with 0.36 % (Table 5).

Bactilis, had better results regarding the Kingset F1, compared to the unfertilized version.

Table 5. The effect of applying biofertilizers on the total titratable acidity (% citric acid)

Total titratable acidity (% citric acid FW)			
	Kingset F1	Bucanero F1	Motril F1
Rizobac	0.298	0.296	0.303
T test	0.001	0.002	0.004
NistroStim	0.318	0.291	0.245
T test	0.000	0.001	0.373
Bactilis	0.324	0.350	0.308
T test	0.001	0.261	0.000
Leaf Power	0.361	0.329	0.370
T test	0.000	0.106	0.058
Control	0.276	0.343	0.351

Regarding the root growth parameters the Bactilis fertilizer stands out positively and statistically significantly in the case of all analyzed parameters root length, root weight and root volume. The root length being greater for the Kinset F by 12.1 cm compared to the non-fertilized version. the root weight was greater in Kingset F1 and Bucanero F1 by 17.75 g. respectively 5 g compared to the non-fertilized version and the volume of the roots was more high when applying the fertilizer compared to the non-fertilized version. thus Kingset F1 with 15.83 cm^3. Bucanero F1 with 3 cm^3 and Motril F1 with 4.83 cm^3.

Table 6. Length, weight and root volume

	Root length (cm)			Root weight (g)			Root volume (cm^3)		
	Kingset F1	Bucanero F1	Motril F1	Kingset F1	Bucanero F1	Motril F1	Kingset F1	Bucanero F1	Motril F1
Rizobac	42.03	43.72	37.42	19.51	25.30	20.59	24.67	29.67	25.83
T test	0.007	0.723	0.102	0.175	0.789	0.316	0.477	0.505	0.001
NistroStim	31.28	46.42	25.75	14.97	32.33	18.31	19.17	32.33	16.67
T test	0.204	0.306	0.179	0.044	0.265	0.816	0.552	0.194	0.167
Bactilis	38.43	41.42	35.33	40.82	31.39	18.35	38.00	29.33	17.50
T test	0.008	0.448	0.343	0.003	0.001	0.726	0.003	0.009	0.010
Leaf Power	34.00	37.42	37.48	21.35	22.93	19.70	23.33	22.83	19.17
T test	0.100	0.466	0.272	0.630	0.453	0.422	0.795	0.538	0.0496
Control	26.33	41.42	31.50	23.07	26.39	17.66	22.17	26.33	12.67

CONCLUSIONS

The present research showed that genotype has a large influence and is manifested specifically for all traits related to productivity. Regarding on stem diameter in the lower part, fertilization with Rizobac gave the best results for Kingset hybrid compared to the control. About the insertion of the inflorescences on the stem, the application of biofertilizer NitroStim and Leaf Power on the hybrid Kingset, led to a better insertion, compared to the unfertilized variant.

The application of Rizobac fertilizer to the Kingest hybrid give rise to an increased number of flowers from 5.8 in the control, to 9.4 flowers and the fruit in the first inflorescence also set percentage was very significantly higher which led to an increased productions by 27% more than control variant.
The total dry matter content, regarding the Kingset hybrid, was influenced by the application of NitroStim which recorded a value of 4.94% and Leaf Power recorded the value of 5.03%, all values being significantly

higher than the unfertilized value of 4.62%.The NitroStim fertilizer had for Bucanero F1 total titratable acidity = 0.30% lower than the variant unfertilized with 0.36%.

Regarding the root growth parameters the Bactilis fertilizer stands out positively and statistically significantly in the case of all analyzed parameters root length, root weight and root volume.

The results obtained demonstrated that biofertilizers application on tomato crops in controlled environment, can be a sustainable and organic technology in reducing or even eliminating the application of conventional chemicals.

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