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RESPONSE OF TOMATO (*LYCOPERSICON ESCULENTUM*) TO NP ORGANIC FERTILIZER (RICH IN PHOSPHORUS) AND CALCIUM

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SUMMARY

This current research proceeded during the growing season of 2021 at the Al-Nakhil Station, Al-Najaf Governorate, Iraq, to evaluate the response of hybrid tomato (*Lycopersicon esculentum*) 'OULA F_1' to foliar application of organic fertilizers NP and calcium. The first factor included spraying phosphorous and nitrogen with three concentrations (0, 1, and 2 $ml.L^{-1}$), while the second consisted of calcium spray with three different concentrations (0, 1.25, and 2.5 $ml.L^{-1}$). The experiment was setup according to the randomized complete block design (RCBD) with three replications in a factorial arrangement. The results showed that the organic fertilizer rich in phosphorus at a concentration of 2 $ml.L^{-1}$ significantly improved the traits, i.e., plant height (49.98 cm), leaf number (34.80 $leaves.plant^{-1}$), leaf area (3775.90 $cm^2.plant^{-1}$), shoot dry weight (156.70 $g.plant^{-1}$), and leaf content of total chlorophyll (183.19 $mg.l00g^{-1}$ FW) in comparison with the control treatment. Also, the same concentration of phosphorus revealed superiority in the percentage of N, P, K, and Ca in tomato leaves and fruit yield per plant (1.79%, 0.71%, 2.23%, 1.69%, and 2.89% $kg.plant^{-1}$, respectively), compared with the control treatment. Moreover, the results further revealed that the organic calcium fertilizer at a concentration of 2.5 ml L^{-1} realized the highest averages for plant height, leaf number, leaf area, shoot dry weight, leaf N percent, leaf P percent, leaf K percent, and fruit yield per plant by 52.39 cm, 35.27 $leaves.plant^{-1}$, 3850.20 $cm^2.plant^{-1}$, 175.73 $g.plant^{-1}$, 1.74%, 0.70%, 2.17%, and 3.12 $kg.plant^{-1}$, respectively. The foliar application of calcium at a concentration of 1.25 $ml.L^{-1}$ provided the maximum total chlorophyll (175.03 $mg.l00g^{-1}$ FW) and Ca (1.74%) in the leaves.

Keywords: Tomato (*Lycopersicon esculentum*), organic fertilizer, phosphorus and nitrogen, calcium, total chlorophyll, growth and yield traits

Key findings: Results showed that the foliar application of organic fertilizers rich in phosphorus and nitrogen (2 $ml.L^{-1}$) and calcium (2.5 $ml.L^{-1}$), individually or in combination, have significantly improved most of the growth and yield traits in the hybrid tomato.

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INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill) is one of the crucial vegetable crops grown for its high nutritional value, occupying a distinguished position in its cultivation and production in all the regions of Iraq. Also, tomato growing in the desert region extends between Najaf and Karbala, a predominant region in terms of area and production

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(Agricultural Statistics - Iraq, 2020). Consuming tomato fruit, either fresh or cooked, has given nutritional benefits to health. In chronic diseases, the lycopene and carotene in tomato fruits help overcome different types of cancers and eliminate free radicals, which lessen cancer (Chaudhary *et al*., 2018). The globally cultivated tomato area reached 5.05 million ha, with a total production of 186.8 million t, whereas tomato production in Iraq reached 754,800 t in 2020 (FAOSTAT, 2022).

Organic fertilizer use has provided an alternative strategy to chemical fertilizers, contributing to environmental pollution reduction, as well as, providing a sustainable ecosystem and improving soil fertility in the long run (Al-Khayri *et al*., 2022; Javed *et al*., 2022). Therefore, efforts have emphasized addressing environmental degradation and producing healthy and safe food by relying on organic fertilizers as an alternative to chemical fertilizers. Recent studies confirmed the role of organic fertilizers compared with synthetic fertilizers in their positive effects in stimulating vegetative growth and improving the production and quality of fruits in many vegetable crops. Foliar application is one of the significant techniques supporting plant intakes of macro and micronutrients, besides its role in increasing the yield, both quantitatively and qualitatively.

Tomato (*L. esculentum*) plant is a voracious feeder of nitrogen, phosphorus, and potassium elements due to its quick and high biomass accumulation capacity thus, it responds considerably to macronutrient fertilization (Xiukang and Yingying, 2016). Fertilization with phosphorus has a substantial role in plant growth and productivity through its role in vital processes, such as, carbon metabolism, sugar metabolism, energy storage and transfer, and cell division and elongation. It also increases the absorption efficiency of water and nutrients, such as nitrogen, helps plants adapt to environmental stresses, and accelerates the process of flowering, ripening, and seed formation (Almagrebi, 2014). Moreover, calcium is one of the macronutrients with numerous physiological functions crucial for plant growth and development. Calcium helps form the cell structure and serves as the main component of the middle lamella in the form of calcium pectate, which is necessary for cell division and expansion, and cell hydrolysis (Bothwell and Ng, 2005). It also delays leaf senescence and reduces the abscission of flowers and other plant parts (Öpik and Rolfe, 2005). Further, calcium enhances plant absorption of more nutrients from the soil and overcomes environmental stresses, such as drought, cold, and high salinity (Reddy *et al*., 2011). Hence, one of the main tasks of the present research seeks to identify these indicators of endogenous nutrients in tomato plant leaves.

An exogenous application on the plant surface is one of the most efficient ways to treat nutrient deficiencies hence, avoiding the obstacles faced by nutrients in the soil (Ali, 2012). Therefore, based on the above discussion, the latest study aimed to evaluate the response of hybrid tomato (*L. esculentum*) plants to foliar application of organic liquid fertilizers rich in phosphorus and calcium in improving the growth and yield parameters.

MATERIALS AND METHODS

Experimental site and plant material

The present research took place in the field during the growing season of 2021 at Al-Nakhil Station located in Najaf District, Al-Najaf Governorate, Iraq. The evaluation of tomato hybrid (OULA F_1) proceeded with a foliar application of organic liquid fertilizers rich in phosphorus and calcium with different concentrations for growth and yield traits. Before transplanting the tomato plants in the field, 10 random soil samples at different depths (0–30 cm) were taken from the experimental field, then mixed to make one sample for soil analysis in the laboratory (Table 1).

Field management and transplanting

Field management consisted of plowing, harrowing, and leveling, then planting tomato seedlings in terraces at the 4-5 true leaves stage in the second week of April 2021. For each experimental unit, the terraces measured 75 cm wide and 5 m long, with an area of 14 m^2 and a total experiment area of 378 m^2. Each experimental unit included two planting lines, a line containing 10 plants, 50 cm between the lines and plants, and a distance of 75 cm as paths among the terraces. A drip irrigation system for water supply irrigated the experimental field. All the recommended field management practices, such as, hoeing, irrigation, weeds, and pest control, continued the same for all treatments until the end of tomato crop season in August 2021.

Table 1. Chemical and physical properties of the soil used in the experiment.

Soil Parameter	Unit	Value
Clay	$g.kg^{-1}$	13.24
Silt	$g.kg^{-1}$	72.11
Sand	$g.kg^{-1}$	914.65
Soil Texture: Sandy		
Cation Exchange Capacity (CEC)	$Cmol.kg^{-1}$	4.70
pH	---------	7.04
Electric Conductivity (EC)	$dS.m^{-1}$	6.40
N	ppm	7.27
P	ppm	4.86
K	ppm	128.85
Ca	ppm	1152.00
Na	ppm	546.90
Organic matter (OM)	%	1.58

Experiment factors and spray procedures

The said experiment included nine treatments obtained by a combination of two factors. The first factor comprised spraying of organic liquid NPK (18:44:0) fertilizer rich in phosphorus with three concentrations (0 - distilled water only, 1, 2 $ml.L^{-1}$), and the second factor included foliar spray of calcium (160 g of $Ca.L^{-1}$) with three concentrations (0 - distilled water only, 1.25, 2.5 $ml.L^{-1}$). The foliar spray of both liquid fertilizers ensued in the early morning when the plants were completely wet, especially after one day of irrigation, to enhance the efficiency of the plants for absorbing the organic fertilizers (Al-Sahaf, 1989).

Experiment design and data analysis

The conduct of the experiment used a randomized complete block design (RCBD) with three replications in a factorial arrangement. A two-way analysis of variance (ANOVA) and the least significant difference test (LSD) for the mean separation and comparisons followed at the probability level of 0.05 using Statistix 10 (Analytical Software, Tallahassee, FL).

Traits measured

Plant height (cm) measurement transpired for five tomato plants, taken randomly from each experimental unit, and then averaged. The total number of leaves (leaves $plant^{-1}$) calculation for five plants, also taken randomly from each experimental unit, went on, followed by averaging the number of leaves per plant. Plant leaf area (cm^2 $plant^{-1}$) was measured according to Nguyen *et al*. (2022) using the Image J software (version 1.51; National Institutes of Health, Bethesda, MD, USA), and then averaged the leaf area per plant. Shoot dry weight (g) measuring for each sample used stalks + leaves after desiccating in an oven at a temperature of 75°C for 48 h until attaining a fixed weight (Hocking *et al*., 1997). Total chlorophyll pigment in leaves as fresh weight ($mg.100g^{-1}$ FW) estimation followed the methodology of Goodwin (1976). The estimation of N, P, K, and Ca percentages in the leaves applied the method according to Cresser and Parsons (1979) by taking the leaves from the fifth node from the apex (Al-Sahaf, 1989). Fruit yield per plant ($kg.plant^{-1}$) measurement used the following equation:

$$\text{Yield per plant }(\text{Kg. plant}^{-1}) = \frac{\text{Yield per experimental unit}}{\text{No. of plants per experimental unit}}$$

RESULTS

The analysis of variance revealed significant differences in growth and yield-related characteristics of tomato hybrid under different concentrations of organic NPK fertilizer rich in P and the liquid organic Ca fertilizer, except their interaction for shoot dry weight (Table 2). The results indicated that tomato hybrid treatments with foliar spray fertilizers of different doses of P and organic calcium fertilizer Ca, individually and in their interaction, showed significant differences in the vegetative growth and leaf chlorophyll content (Table 3). Specifically, the tomato hybrid with organic NPK fertilizer rich in phosphorus at a concentration of 2 $ml.L^{-1}$ has significantly increased the shoot growth parameters represented by plant height (49.98 cm), leaves per plant (34.80), leaf area (3775.90 $cm^2.plant^{-1}$), shoot dry weight (156.70 $g.plant^{-1}$), and total chlorophyll content in the leaves (183.19 mg.100 g^{-1} FW) compared with the control treatment (spraying with distilled water only).

Table 2. Analysis of variance for vegetative growth, leaf nutrients, and fruit yield traits of the tomato hybrid plants under foliar application of organic liquid fertilizers rich in phosphorus and calcium.

Source	d.f.	Plant height (cm)	Leaf number ($leaf.plant^{-1}$)	Leaf area ($cm^2.plant^{-1}$)	Shoot dry weight (g)	Total chlorophyll in leaves ($mg.100g^{-1}$ FW)
Blocks	2	0.13	0.69	7569.00	3.23	77.46
P	2	84.19*	168.86*	2810164*	874.21*	4367.47**
Ca	2	225.37*	145.42*	2507251*	6559.76*	2741.06**
P*Ca	4	9.22*	23.31*	357191*	57.63ns	1017.39**
Error	16	0.46	0.29	3167.00	57.08	244.35
Total	26	-	-	-	-	-
Source	d.f.	N in leaves (%)	P in leaves (%)	K in leaves (%)	Ca in leaves (%)	Fruit yield per plant ($kg.plant^{-1}$)
Blocks	2	0.0101	0.0003	0.1751	0.1391	0.0024
P	2	0.6280*	0.0857*	1.0429*	0.3297*	0.4451*
Ca	2	0.5065*	0.0648*	0.7803*	0.7654*	1.5559*
P*Ca	4	0.1468*	0.0069*	0.3354*	0.1696*	0.6063*
Error	16	0.0397	0.0020	0.0354	0.0218	0.0058
Total	26	-	-	-	-	-

Table 3. Effect of foliar application of organic liquid fertilizers rich in phosphorus and calcium on growth traits of the tomato hybrid plants.

Treatments ($ml.L^{-1}$)		Plant height (cm)	Leaf number ($leaf.plant^{-1}$)	Leaf area ($cm^2.plant^{-1}$)	Shoot dry weight (g)	Total chlorophyll in leaves ($mg.100g^{-1}$ FW)
		Effect of organic NPK fertilizer rich in phosphorus				
P0 (Control)		43.89	26.40	2711.70	137.00	139.78
P1		47.44	32.47	3539.40	146.40	167.97
P2		49.98	34.80	3775.90	156.70	183.19
$LSD_{0.05}$		0.68	0.54	56.24	7.55	15.62
		Effect of organic calcium fertilizer				
Ca 0 (Control)		42.44	27.23	2796.70	122.34	143.56
Ca 1.25		46.48	31.16	3380.20	142.03	175.03
Ca 2.50		52.39	35.27	3850.20	175.73	172.36
$LSD_{0.05}$		0.68	0.54	56.24	7.55	15.62
		Effect of the interaction				
Ca 0	P0	41.42	23.94	2458.60	109.15	125.67
Ca 1.25	P0	42.65	25.97	2666.50	130.10	131.33
Ca 2.50	P0	47.61	29.31	3010.20	171.74	162.33
Ca 0	P1	42.03	24.85	2551.60	123.09	154.33
Ca 1.25	P1	46.60	34.46	3814.60	143.59	178.25
Ca 2.50	P1	53.68	38.09	4252.00	172.51	171.33
Ca 0	P2	43.87	32.91	3379.70	134.78	150.67
Ca 1.25	P2	50.19	33.06	3659.50	152.41	215.50
Ca 2.50	P2	55.88	38.42	4288.60	182.92	183.42
$LSD_{0.05}$		1.18	0.93	97.40	N.S.	27.06

The number of leaves and leaf area comprised the most important plant organs for photosynthesis and other physiological processes to function, such as, transpiration and gas exchange. The exogenous nutrition applied to the plant foliage stimulates carbohydrate compounds and many other vital and organic compounds, such as vitamins, enzymes, and growth regulators, in addition to the root nutrition that provides the plant with mineral elements and water. This nutrition together is the essence of plant life. The idea of green leaf canopy gives a perception of the effectiveness and intensity of growth and development.

Further results revealed a significant superiority of the tomato hybrid plants spraying with organic calcium fertilizer, especially at a high concentration of 2.5 $ml.L^{-1}$, which provided the highest average plant height, the number of leaves per plant, leaf area, shoot dry weight at 52.39 cm, 35.27 leaves $plant^{-1}$, 3850.20 $cm^2.plant^{-1}$, and 175.73 $g.plant^{-1}$, respectively. However, the calcium fertilizer foliar application at a concentration of 1.25 ml. L^{-1} achieved the maximum average

Table 4. Effect of foliar application of organic liquid fertilizers rich in phosphorus and calcium on leaf nutrients and fruit yield traits of the tomato hybrid plants.

Treatments ($ml.L^{-1}$)		N in leaves (%)	P in leaves (%)	K in leaves (%)	Ca in leaves (%)	Fruit yield per plant ($kg.plant^{-1}$)
		Effect of organic NPK fertilizer rich in phosphorus				
P0 (Control)		1.28	0.52	1.73	1.60	2.49
P1		1.42	0.66	1.58	1.32	2.85
P2		1.79	0.71	2.23	1.69	2.89
$LSD_{0.05}$		0.20	0.04	0.19	0.15	0.08
		Effect of organic calcium fertilizer				
Ca 0 (Control)		1.26	0.54	1.60	1.20	2.30
Ca 1.25		1.50	0.66	1.77	1.74	2.82
Ca 2.50		1.74	0.70	2.17	1.67	3.12
$LSD_{0.05}$		0.20	0.04	0.19	0.15	0.08
		Effect of the interaction				
Ca 0	P0	0.92	0.37	1.16	1.20	1.78
Ca 1.25	P0	1.47	0.56	1.69	2.09	3.02
Ca 2.50	P0	1.46	0.64	2.34	1.50	2.66
Ca 0	P1	1.06	0.59	1.32	1.06	2.48
Ca 1.25	P1	1.43	0.71	1.43	1.35	3.00
Ca 2.50	P1	1.77	0.69	1.99	1.56	3.08
Ca 0	P2	1.81	0.65	2.32	1.34	2.63
Ca 1.25	P2	1.58	0.72	2.18	1.77	2.42
Ca 2.50	P2	1.98	0.77	2.19	1.96	3.62
$LSD_{0.05}$		0.34	0.08	0.33	0.26	0.13

total chlorophyll content in leaves (175.03 mg. 100 g^{-1} FW).

Results also revealed that the interaction between fertilizers (P × Ca) significantly influenced the studied parameters of the tomato hybrid where the combined treatment of P and Ca at 2 $ml.L^{-1}$ and 2.5 $ml.L^{-1}$, respectively, realized the maximum average of plant height (55.88 cm), the number of leaves (38.42 $leaves.plant^{-1}$), and leaf area (4288.60 $cm^2.plant^{-1}$) (Table 3). However, the total chlorophyll content in the leaves reached the highest average (215.50 mg.100 g^{-1} FW) through the combination treatment of P and Ca at the rate of 2 $ml.L^{-1}$ and 1.25 $ml.L^{-1}$, respectively. In contrast, the interaction treatment for the control gave the minimum average of plant height (41.42 cm), the number of leaves (23.94 $leaves.plant^{-1}$), leaf area (2458.60 $cm^2.plant^{-1}$), shoot dry weight (109.15 $g.plant^{-1}$), and total chlorophyll content in the leaves (125.67 mg.100 g^{-1} FW).

The tomato hybrid with NP and Ca treatments and their interaction effects revealed significant variations in the parameters of leaf macronutrients and fruit yield (Table 4). The foliar spray of P at a concentration of 2 $ml.L^{-1}$ exhibited superiority in the percentage of the nutrients, i.e., N, P, K, and Ca in tomato hybrid leaves and fruit yield per plant by 1.79%, 0.71%, 2.23%, 1.69%, and 2.89 kg. $plant^{-1}$, respectively. Contrarily, the control treatment (spraying distilled with water only) gave the lowest values of N and P in the leaves and fruit yield per plant (1.28%, 0.52%, and 2.49 $kg.plant^{-1}$), respectively. However, the lowest percent K (1.58%) and Ca (1.32%) in leaves occurred by applying 1 $ml.L^{-1}$ of organic liquid fertilizer rich in phosphorus and nitrogen.

It appears that endogenous accumulation of leaf nutrients in percentages and the plant fruit yield positively gained ($P<0.05$) from different organic Ca supply concentrations (Table 4). The 2.5 $ml.L^{-1}$ foliar supply of Ca resulted in the highest values for N, P, K, and fruit yield (1.74%, 0.70%, 2.17%, and 3.12 $kg.plant^{-1}$), respectively. Further, the maximum percentage of calcium (1.74%) in tomato leaves reached as sprayed by the Ca fertilizer at the rate of 1.25 ml. L^{-1}. However, without Ca supply, the control treatment was significantly lower and gave the minimum percent of N, P, K, and Ca in leaves and plant fruit yield (1.26%, 0.54%, 1.60%, 1.20%, and 2.30 $kg.plant^{-1}$), respectively.

Tracking the level of available nutrients and some indicators in leaf tissues during the study is one of the correct basic data that needs accessing to properly visualize the management of nutrients and organize the processes of organic fertilization. Moreover, the findings further demonstrated that the interaction between fertilizers P × Ca had a relevant impact on the studied parameters (Table 4). Similarly, the combination of N, P, and Ca organic liquid fertilizers at the rate of 2 ml.L^{-1} and 2.5 ml.L^{-1} displayed the highest average for leaf nutrients, i.e., N (1.98%), P (0.77%), and Ca (1.96%), and fruit yield per plant (3.63 kg.plant^{-1}), except K, significantly high (2.34%) in the combined application of P and Ca fertilizers at the concentrations of 0 ml.L^{-1} and 2.5 ml.L^{-1}. However, the interaction treatment of the control had the lowest average for the studied parameters, i.e., N (0.92%), P (0.37%), K (1.16%), Ca (1.02%), and fruit yield per plant (1.78 kg.plant^{-1}).

DISCUSSION

Results enunciated that the improvement in growth indicators could come from the effects of phosphorus and nitrogen with P as one of the major nutrients and also called the life key because phosphorus serves as the basic component of nucleic acids, lipids, and ATP - a compound responsible for energy transfer. Furthermore, phosphorus plays a vital role in various physiological processes and increases photosynthesis and metabolism (Fageria, 2016; Bastani and Hajiboland, 2017). The formation of energy compound ATP and NADP plus NAD coenzymes, through the contribution of phosphorus, serves as the basis for many crucial physiological processes in plants, such as, photosynthesis, respiration, and glycolysis (Taiz and Zeiger, 2010).

The latest results also authenticate the past findings by using the foliar application of phosphorus with different concentrations (0, 100, 200, 300, 400, and 500 ppm) on the *Vicia faba* and the highest concentrations (400 and 500 ppm), which achieved a significant increase in plant height, the number of leaves and branches, leaf area, and the dry matter (Qader, 2019). Phosphorus plays an important role in carbohydrate metabolism and the formation of compounds resulting from photosynthesis, consequently enhancing the vegetative and root weights (Al-Aamry and Matloub, 2012).

The increment in tomato growth parameters can refer to the crucial role of calcium in cell division and development, reflecting a positive impact on the expansion of the leaves and an increase in leaf number (Mengel and Kirkby, 2012). Besides, calcium is a vital component of the cell wall and elongation. The existing results gave similar findings from past studies in which the foliar application of calcium improved the growth, yield, and quality of tomato cultivars (Sajid *et al*., 2020). Calcium also has an essential function in the process of meristematic cell division and assimilating the carbon dioxide during photosynthesis and then enhancing the number of leaves and leaf area (Al-Sahaf, 1989; Haleema *et al*., 2018). The positive effects of P and Ca on tomato growth parameters improved cell division, hormonal balance, photosynthetic activities, and carbohydrate metabolism, thus increasing the accumulation of dry matter and proliferation of plant tissues (Kazemi, 2014).

Foliar application of nutrients has a great role in increasing the metabolism process leading to a state of nutritional balance in the crop plants (Jasim *et al*., 2015). Reports also stated that a foliar spray of phosphorus led to an increase in the uptake of magnesium, which constructs the chlorophyll molecule (Blevin, 2001), as well as, its role in increasing the absorption of the nitrogen that associates with the composition of the chlorophyll molecule (Loubser and Human, 1993). Moreover, this increment in leaf macronutrients indicates the role of the organic fertilizers rich in phosphorus in strengthening and revitalizing the root system of plants and thus increasing the absorption of nutrients, including phosphorus and potassium, which can accumulate in leaves and improve the availability of other nutrients (Havlin *et al*., 2005).

Additionally, it is noteworthy that phosphorus contributes to early flowering, increasing the number of flowers, improving the fruit set, and transferring the metabolites from the leaves to the fruits, thus boosting early maturity with good yield (Al-Sahaf, 1989). Nonetheless, the appropriate and balanced supply of phosphorus stimulates vegetative and root growth, which positively reflects the increase in nutrient absorption and its translocation to the fruits, in turn, improves tomato plant yield (Azarpour *et al*., 2012; Qader, 2019). An adequate calcium supply can significantly boost nutrient absorption and enhance the distribution ratio of nitrogen, phosphorus, and potassium in mature pods of peanuts (Shi *et al*., 2018). The latest results also resembled the past findings as they confirmed that adding calcium sulfate to nutrient solution significantly enhanced the accumulation of N, K^+, and Ca^{2+} in the tomato plant leaves (Azarpour *et al*., 2012; Ashraf *et al*., 2019).

Foliar application of Ca increased the accumulation of calcium and phosphorus in crop plants (Niu *et al*., 2018). Calcium's effect in increasing fruit yield may be attributed to its role in increasing the characteristics of vegetative growth (Table 3), as well as, the absorption of macronutrients (Table 4). Also, the Ca element can improve the plant's efficiency for carbon dioxide assimilation and increase the accumulation of carbohydrates in the plant leaves. Subsequently, these factors both improve plant growth and finally increase plant yield. In this context, the effect of phosphorus and calcium fertilizers in increasing the content of macronutrients in tomato leaves, as well as, improving plant yield, ascribe to the availability of phosphorus in appropriate quantities that helps the absorption of other nutrients necessary for the plant (Al-Sahaf and Abu-Al-Saad, 1999). Probably, the increase in the number of flowers in the flower cluster of plants treated with calcium fertilizer at a concentration of 2.5 ml.L^{-1} resulted from the direct effect of the nutrients released from the organic fertilizer, especially N, P, K, and Ca nutrients, which reflected the accumulation of carbon metabolism products and enhanced plant flowering and fruit set (Turan *et al*., 2007; Rab and Haq, 2012).

CONCLUSIONS

Organic fertilizer rich in phosphorus and calcium at a concentration of 2 ml.L^{-1} and 2.5 ml.L^{-1}, respectively, individually and in interaction, has improved most growth traits and fruit yield in the tomato hybrid. Moreover, the study suggests continued research to set several environments with different tomato cultivars to validate the recommendations.

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