IOP Conference Series:
Earth and
Environmental Science

PAPER • **OPEN ACCESS**

Effect of Foliar Application with Calcium, Arginine and Glycine on Vegetable and Flowering Traits of Chili Pepper Grown in Plastic House

To cite this article: Adnan Ghazi Salman Alnussairawi and Hussain Sabah Ali Alnadawy 2024 *IOP Conf. Ser.: Earth Environ. Sci.* **1371** 042015

Effect of Foliar Application with Calcium, Arginine and Glycine on Vegetable and Flowering Traits of Chili Pepper Grown in Plastic House

Adnan Ghazi Salman Alnussairawi[1] and Hussain Sabah Ali Alnadawy[2]

[1,2]Department of Horticulture and Landscape Gardening, College of Agriculture, University of Diyala, Diyala, Iraq.

[1]E-mail: adnanghazi@uodiyala.edu.iq
[2]E-mail: agr22hortihh6@uodiyala.edu.iq

Abstract. The effects of spraying chili peppers with different concentrations of calcium (0, 500, and 1000 mg L^{-1}) and the amino acids arginine and glycine (0, 100, and 200 mg L^{-1}) on their vegetative growth and flowering traits were studied in a field experiment that took place during the 2022–2023 agricultural season at the Research Station of the at College of Agriculture / University of Diyala. The experiment was conducted using a randomized complete block design (RCBD) and analyzed using SAS. Dunkin's multinomial test was used to evaluate the average attributes at a probability threshold of 0.05. Here is what the results revealed: At a rate of 1000 mg L^{-1}, calcium spraying produced superior results in terms of plant height, leaf area, leaf chlorophyll content, fruit setting percentage, and nitrogen, potassium, and calcium percetage in the leaves. The number of flowers (102.89 total) and the percentage of fruit that set were both improved by spraying with a calcium concentration of 500 mg L^{-1}. There was an improvement in both the quantity of leaves and the nitrogen % when arginine was sprayed at a dosage of 200 mg L^{-1}. At 100 mg L^{-1}, glycine was the most effective in increasing flowering time, but at 200 mg L^{-1}, it outperformed at the same concentration in terms of plant height, leaf area, chlorophyll content, fruit setting %, and leaf calcium and potassium percentages.

Keywords. Chili pepper, Calcium, Arginine, Glycine growth, Flowering.

1. Introduction

One economically significant crop that belongs to the solanaceae family is the chili pepper (Capsicum frutescens L.). In addition to the potentially beneficial pigments chlorophyll, anthocyanin, and lutein, chili peppers also have vitamins, minerals, flavonoids, carotenoids, capsaicinoids, and capsaicin, among other amazing chemical substances. Research has shown that the primary active ingredient in these species, which gives them their distinctively pungent flavor, actually has beneficial effects on human health [1]. Because of its function in constructing the cell wall, triggering the process of cell division, and enzymes, calcium is an essential plant nutrient that is utilized to treat numerous physiological diseases by limiting decay and to make fruits more firm [2]. The percentage of fruits that set on chili pepper plants and other vegetative development features were both enhanced by treatments of calcium chloride at concentrations of 0, 1000, and 2000 mg L^{-1}. Increases in plant height, flower number, fruit setting, and N, P, and K content were seen after foliar spraying with 2000 mg L^{-1} of calcium chloride [3]. In both its free and bound forms, arginine is an essential amino acid that plants rely on for a wide variety of tasks throughout their life cycles. It is also a component of numerous coenzymes and nucleotide syntheses [4]. The effects of arginine on chili pepper plants were studied in a field experiment with a dosage of 200 mg. L^{-1}. The plants treated with arginine demonstrated superior growth in terms of both plant height and leaf area [5]. A potato field experiment was carried out to investigate the effects of spraying arginine concentrations ranging from 300 to 200 mg. The greatest percentage of chlorophyll was found in plants sprayed with 300 mg L^{-1} of leaves, and arginine at 200 mg L^{-1} was found to be superior in terms of plant height [6]. The purpose of the experiment was to examine the effect of 50 and 100 mg of arginine on garlic growth and yield. L^{-1} applied topically to leaves. Treatment with a 100 mg foliar spray of arginine. The plant with the highest value, the most leaves per plant, and the highest total chlorophyll content was L^{-1}, which reached a value of [7]. In a 2017 fall experiment, sweet pepper plants (Capsicum annuum L.) were sprayed with aginine at dosages of 0, 75, and 150 mg in a plastic housing.The plant height was significantly improved as a result of L^{-1}. The quantity of flowers was outstripped by the concentration of 75 mg L^{-1} [8]. Amino chelates primarily utilize glycine, the most basic amino acid, to create chelated fertilizers [9]. In a field experiment, cucumber plants grown in a plastic house were exposed to foliar applications of glycine at concentrations of 250, 500, and 1000 mgL^{-1}. The results demonstrated that all glycine treatments resulted in an increase in plant height, leaf area, and N, P, and K content in the leaves [10]. The objective of this research is to find out how the amino acids arginine and glycine, as well as the mineral calcium, affect the vegetative and floral development of chili pepper plants housed in a plastic container.

2. Materials and Methods

In order to study the effects of spraying calcium CaO2 at three different concentrations (0, 500, and 1000 mg L^{-1}) and two amino acids, arginine and glycine, at concentrations (0, 100, and 200 mg L^{-1}) in a plastic house at the research station of the Department of Horticulture and Landscape Engineering / College of Agriculture, during the winter agricultural season of 2022–2023. Three repetitions of a randomized complete block design (RCBD) were used for the factorial experiment. The plastic house was used to plant chili pepper seedlings, namely hybrid Barbarian F1. There were four sprays of water on the plants. There were 45 experimental units in total across all industries.

Table 1. Physical and chemical characteristics of the field soil used in the study.

Soil texture	salty sand
pH	7.2
EC (dS/m)	0.911
Total N $(mg/kg)^{-1}$	14.81
Extractable P $(mg/kg)^{1-}$	6.98
Extractable K $(mg/kg)^{-1}$	155.32
CaCO3 $(g/kg)^{-1}$	236.32
Organic matter(%)	0.91

2.1. Measurements

- Plant height : was measured by choosing five plants and the average was taken.
- Number of leaves: was taken from five plants and the average was taken.
- Leaf area of Plant : was determined for a single leaf using leaf area meter [11], by recording the area of 3–4 leaves randomly was selected for five plants.
- Number of flowers: was accaunted randomly for five plants and the average was taken.
- Total chlorophyll content in the leaves : was estimated by the method was described by Goodwin [12].
- Fruit setting %: was estimated by using the equation below:

Fruit set % = (Number of setting fruits / Total number of flowers) ×100

- Leaf content of N, Ca and K (%)

• The micro Kjeldahl method was described for determining the nitrogen percentage in dry leaves [13].
• Leaves calcium concentration In line with Braye Cheng's technique [14].
• The proportion of potassium (K) in the leaves was estimated using the method described in [15].

3. Results and Discussion

3.1. Plants Height (cm)

Table 2 showed there was a significant superiority of spraying with calcium at 1000mg L^{-1} which recorded 101.51 cm compared to control treatment which gave 95..91cm . Glycine at 200 mg L^{-1} was superior of plant height reached 105.42 cm, compared to control 89.82 cm. The interaction treatment showed a significant increase of plant height was 109.59 cm compared to control which gave lowest plant height of 85.30 cm.

Table 2. The effect of spraying with calcium and amino acids arginine and glycine on plant height of chili pepper plants (cm).

Amino acids treatments Mg L^{-1}	Calcium treatments mg L^{-1}			Average of amino acids
	Control	500	1000	
Control	85.30 f	91.91 e	92.24 e	89.82 d
Arginine 100	95.50 de	97.16 cde	101.00 bcd	97.88 c
Arginine 200	99.66 bcd	100.58 bcd	103.46 b	101.93 b
Glycine 100	96.25 de	95.41 de	101.25 bcd	97.63 c
Glycine 200	102.83 bcd	103.83 b	109.59 a	105.42 a
Average of calcium	95.91 b	97.78 b	101.51 a	

3.2. Number of the Leaves

Table (3) showed that calcium at 500 mg L^{-1} caused a significant increase of leaves number reached 416.93 leaves. compared to control treatment that reached a 374.70 leaves. Arginine at 200 mg L^{-1} caused significant increase of plant leaves reached 404.02 leaves compared to control that reached a 335.17 leaves. The interaction treatment between calcium at 500 mg L^{-1} and glycine at 200 mg L^{-1} was superior by giving greater number of leaves plant. reached 474.20 leaves. compared to control treatment which gave 337.80 leaves.

Table 3. Effect of spraying with calcium and two amino acids arginine and glycine on the leaves number of chili pepper plants (leaves).

Amino acids treatments (mg L^{-1})	Calcium treatments mg L^{-1}			Average of amino acids
	Control	500	1000	
Control	337.80 cde	382.00 bc	285.70 ef	335.17 c
Arginine 100	395.20 bc	383.45 bc	382.50 bc	387.05 ab
Arginine 200	433.50 ab	462.50 a	316.05 de	404.02 a
Glycine 100	317.00 de	382.50 bc	369.00 cd	356.17 bc
Glycine 200	390.00 bc	474.20 a	258.55 f	374.25 ab

Amino acids treatments (mg L^{-1})	**Calcium treatments mg L^{-1}**			**Average of amino acids**
	Control	**500**	**1000**	
Average spraying with calcium	374.70 b	416.93 a	322.36 c	

3.3. leaf Area dm^2 plat^{-1}

Table 4 shows that the control treatment had a leaf area of 86.66 dm^2 Plant^{-1}, whereas the calcium spraying treatment at 1000 mg L^{-1} resulted in the greatest leaf area of 104.26 dm^2 plant^{-1}. Glycine at a dosage of 200 mg is also shown in the table. With 120.63 dm^2 plant^{-1}, L^{-1} had the largest leaf area, surpassing the control treatment's 73.33 dm^2 plant^{-1}. When compared to the control treatment, which resulted in a leaf area of 65.35 dm^2 plant^{-1}, the interaction between spraying calcium at 1000 mg L^{-1} and arginine at 200 mg L^{-1} was superior, leading to the maximum leaf area of 124.10 d cm^2 plant^{-1}.

Table 4. Effect of spraying with calcium and two amino acids arginine and glycine on the leaf area of chili pepper plants (dm^2 plant^{-1}).

Amino acids treatments (mg L^{-1})	**Calcium treatments mg L^{-1}**			**Average of amino acids**
	Control	**500**	**1000**	
Control	65.35 h	75.72fg	78.92 ef	73.33 d
Arginine 100	79.65 ef	75.86 fg	105.08 c	86.86 c
Arginine 200	100.42 d	83.26 e	106.04 c	104.26 b
Glycine 100	71.77 g	106.33 c	107.18 c	95.09 c
Glycine 200	116.13 b	121.67 a	124.10 a	120.63 a
Average of calcium	86.66 c	92.56 b	104.26 a	

Table 5 shows that compared to the control treatment, which had a chlorophyll content of 1.44 mg L^{-1}, the calcium spraying at a concentration of 1000 mg L^{-1} resulted in a total of 1.68 mg L^{-1} in the leaves. In comparison to the control treatment, which had a concentration of 1.29 mg g^{-1} of arginine, treatments with a concentration of 200 mg L^{-1} were superior, yielding 1.69 mg g^{-1}. The interaction treatment including 1000 mg g^{-1} of calcium and 200 mg g^{-1} of glycine yielded 1.82 mg g^{-1} of chlorophyll content in the leaves, which was substantially higher than the control treatment's 1.16 mg g^{-1}.

Table 5. Effect of spraying with calcium and amino acids arginine and glycine on chlorophyll content in pepper plants leaves (mg g^{-1}).

Amino acids treatments (mg L^{-1})	**Calcium treatments mg L^{-1}**			**Average of amino acids**
	Control	**500**	**1000**	
Control	1.16 e	1.21 e	1.51 bcd	1.29 c
Arginine 100	1.34 de	1.41 cde	1.59 abcd	1.45 b
Arginine 200	1.56 abcd	1.60 abcd	1.74 ab	1.63 a
Glycine 100	1.58 abcd	1.62 abcd	1.73 ab	1.64 a
Glycine 200	1.58 abcd	1.69 abc	1.82 a	1.69 a
Average of calcium	1.44 b	1.50 b	1.68 a	

3.4. Number of Flowers

According to Table 6, there was no discernible effect of calcium spraying on the quantity of blooms produced by the plants. 106.35 blooms were produced as a result of a glycine spraying treatment at 200 mg L^{-1}. $Plant^{-1}$, in contrast to the 91.33 blooms produced by the control group of plants. Tree one. The number of flowers increased to 108.40 when calcium and glycine were treated together at 1000 mg L^{-1} and 200 mg L^{-1}, respectively. $Plant^{-1}$, with 85.13 blooms being the lowest rate obtained by the control treatment. One plant.

Table 6. Effect of spraying with calcium, the two amino acids arginine, and glycie on a number of flowers of chili pepper (Flower $Plant^{-1}$).

Amino acids treatments (mg L^{-1})	Calcium mg L^{-1}			Average of amino acids
	Control	500	1000	
Control	85.13 c	97.00 abc	91.86 abc	91.33 b
Arginine 100	88.40 bc	103.53 ab	98.86 abc	96.93 ab
Arginine 200	107.86 ab	101.13 abc	104.86 ab	104.62 a
Glycine 100	102.26 ab	108.40 a	108.40 a	106.35 a
Glycine 200	104.06 abc	104.40 ab	102.00 abc	103.48 a
Average of calcium	97.54 a	102.89 a	101.20 a	

3.5. Fruits Setting Ratio (%)

According to Table 7, the control treatment only managed to achieve 51.98 percent fruit setting ratio, whereas calcium spraying at a concentration of 1000 mg L^{-1} significantly outperformed it, reaching 60.53 percent. The results demonstrated that glycine spraying was more effective than the control treatment, yielding a higher value of fruits setting (60.94% vs. 52.80%). The fruit setting ratio increased significantly to 72.40% in the interaction treatment that included spraying with 1000 mg L^{-1} of calcium and 200 mg L^{-1} of glycine, as compared to the control treatment, which resulted in the lowest value of this feature at 47.11%.

Table 7. Effect of spraying with calcium and the two amino acids arginine and glycine on the fruits setting ratio (%).

Amino acids treatments (mg L^{-1})	Calcium treatments mg L^{-1}			Average of amino acids
	Control	500	1000	
Control	47.11 e	52.17 bcde	59.12 bc	52.80 bc
Arginine 100	54.41 de	47.87 de	55.12 bcde	52.47 bc

Amino acids treatments (mg L^{-1})	Calcium treatments mg L^{-1}			Average of amino acids
	Control	500	1000	
Arginine 200	52.62 bcde	58.52 bcd	62.82 b	57.98 ab
Glycine 100	51.70 cde	48.11 de	53.18 bcde	51.00 c
Glycine 200	54.09 bcde	56.33 bcde	72.40 a	60.94 a
Average of calcium	51.98 b	52.60 b	60.53 a	

3.6. Nitrogen Content in the Leaves (%)

Table 8 shows that the nitrogen percentage was 2.76 percent in the calcium treatment group and 2.27% in the control group, with the calcium treatment group receiving 1000 mg L^{-1} of calcium. The nitrogen percentage of the leaves was 2.97% after arginine spraying at a 200 mg L^{-1} concentration, which was higher than the control treatment's 1.75%. Compared to the control treatment, which produced a nitrogen percentage of 1.57% in the leaves, the interaction treatment with 1000 mg L^{-1} of calcium and 200 mg L^{-1} of arginine achieved the highest nitrogen percentage, reaching 3.67%.

Table 8. Effect of spraying with calcium and the two amino acids arginine and glycine and on the percentage of nitrogen in the leaves (%).

Amino acid treatments (mg L^{-1})	Calcium treatments mg L^{-1}			Averages of amino acids
	Control	500	1000	
Control	1.57 e	1.75 de	1.92 cde	1.75 b
Arginine 100	2.10 bcde	2.10 bcde	2.45 bcd	2.21 b
Arginine 200	2.27 bcde	2.97 ab	3.67 a	2.97 a
Glycine 100	2.62 bcd	2.62 bcd	2.80 bc	2.68 a
Glycine 200	2.80 bc	2.80 bc	2.97 ab	2.85 a
Average of calcium	2.27 b	2.45 ab	2.76 a	

3.7. Calcium Content in the Leaves (%)

According to Table 9, the control treatment only produced 0.79% calcium, while the two calcium treatments at 500 and 1000 mg L^{-1} achieved a maximum percentage of 0.93%. Additionally, the same table shows that the percentage of calcium in the leaves was greatly raised when amino acids were sprayed on. The greatest percentages obtained were 0.90, 0.90, 0.87, and 0.82%, respectively, while the control treatment yielded the lowest percentage of calcium, at 0.73%.When compared to the control treatment, which produced 0.63% calcium content in the leaves, the interaction spraying treatment involving 500 mg L^{-1} of calcium and 100 mg L^{-1} of glycine produced the greatest content, 1.13 mg L^{-1}.

Table 9. Effect of spraying with calcium and the two amino acids arginine and glycine and on the calcium content in the leaves (%).

Amino acid treatments ($mg\ L^{-1}$)	Calcium treatments $mg\ L^{-1}$			Average of amino acids
	Control	500	1000	
Control	0.63 c	0.88 abc	0.86 abc	0.79 b
Arginine 100	0.64 c	0.87 abc	1.11 a	0.87 a
Arginine 200	0.84 abc	0.90 abc	0.83 abc	0.82 a
Glycine 100	0.70 c	1.13 a	0.87 abc	0.90 a
Glycine 200	0.86 abc	0.86 abc	1.00 ab	0.90 a
Average spraying with calcium	0.73 b	0.93 a	0.93 a	

3.8. Potassium Content in the Leaves (%)

Table 10 showed that calcium treatment spraying with at a concentration of 1000 $mg\ L^{-1}$ achieved the highest percentage of 2.19% compared to the lowest percentage of 1.58% in the control treatment. Arginine and glycine at a concentration of 200 $mg\ L^{-1}$ were superior by giving higher percentage of potassium, amounting to 2.12 and 2.08%, respectively, compared to the control treatment which gave 1.40%. The interaction spraying treatment between calcium at a concentration of 1000 $mg\ L^{-1}$ and with arginine at a concentration of 200 $mg\ L^{-1}$ was superior by giving highest value, which amounted to 2.73%, compared the control treatment, which gave 1.04%.

Table 10. Effect of spraying with calcium and the two amino acids arginine and glycine on the potassium content in the leaves (%).

Spraying with amino acids ($mg\ L^{-1}$)	Calcium $mg\ L^{-1}$			Spraying mediums with amino acids
	Control	500	1000	
Control	1.043 e	1.623 cde	1.553 de	1.406 c
Arginine 100 $mg\ L^{-1}$	1.686 bcd	1.713 bcd	2.140 abcd	1.846 b
Arginine 200 $mg\ L^{-1}$	1.726 bcd	1.793 bcd	2.736 a	2.085 a
Glycine 100 $mg\ L^{-1}$	1.693 bcd	1.870 bcd	2.226 abc	1.930 b
Glycine 200 $mg\ L^{-1}$	1.760 bcd	2.303 ab	2.300 ab	2.121 a
Average spraying with calcium	1.582 c	1.860 b	2.191 a	

4. Discussion

The physiological roles of calcium (Ca_2), an essential macronutrient for plant growth and development, include mediating responses to hormones, a variety of developmental processes, stress signals, and as an activator. Additionally, it is an essential component of the middle lamella in the structure of cell walls and for the formation of cell membranes, which affect normal cell division by maintaining cell integrity and membrane permeability. This study found that spraying calcium onto chili peppers improved their vegetative growth and flowering traits [16,17].

One possible explanation for arginine's effect on flower production is that it increases mineral nutrient concentration in leaves. Another possible explanation is that arginine helps plants grow stronger, which in turn improves flowering growth indicators. Lastly, amino acids can make plants bigger, which means they produce more flowers. Furthermore, amino acids play a function in enhancing nutritional balance, which in turn stimulates floral buds, controls bloom rate, and regulates solubility transfer, mineral element accumulation, and accumulation in flowers [18]. According to the findings, [19] is correct. There was agreement between the two sets of arginine results [20,21]. The amino acids enhanced plant nutrition, leading to an increase in the concentration of nitrogen in the leaves, and arginine acid is itself a source of nitrogen, so it stands to reason that plants sprayed with arginine would have an advantage. In addition to facilitating faster nitrogen absorption from leaves and enhanced digestion and storage in the plant, the acid played a role in these processes.

Conclusion
It was determined that the quantity of flowers, fruit setting, and vegetative growth parameters (N, Ca, k) of chili pepper plants cultivated in plastic houses were promoted by foliar applications of calcium, arginine, and glycine.

References
[1] Hernández Pérez, T., Gómez-García, M. D. R., Valverde, M. E., & Paredes-López, O. (2020). Capsicum annuum (hot pepper): An ancient Latin-American crop with outstanding bioactive compounds and nutraceutical potential. A review. Comprehensive Reviews in Food Science and Food Safety, 19(6), 2972-2993.
[2] Hassan, H S A, Sarrwy, S M A, Mostafa, EAM.2010. Effect of foliar spraying with liquid organin fertilizer, some micronutrients and gibberellins on leaf mineral content, fruit set, yield and fruit quality of Hollywood plum trees. Agriculture and Biology Journal of North America, 1(4):638-643
[3] Salim, B. B. M., El-Gawad, A., Gamal, H., El-Yazied, A., & Hikal, M. (2019). Effect of calcium and boron on growth, fruit setting and yield of hot pepper (Capsicum annuum L.). Egyptian Journal of Horticulture, 46(1), 53-62.
[4] Taain, D.A. 2011 Effect of Storage Temperatures and Postharvest Calcium Salts Treatments on Storability of Jujube Fruits (Zizphus mauritiana Lam.cv.Tufahi). Annals of Agri. Sci. J., Moshtohor, 49(4):447-453
[5] Fadala, L. T., Taain, D. A., & Hassan, F. A. (2023, September). Role of humic acid and some spraying treatments in improving vegetative growth parameters, chemical components of leaves and yield of hot pepper plants (Capsicum annuum L.) planted in unheated plastic houses conditions. In AIP Conference Proceedings (Vol. 2845, No. 1). AIP Publishing.
[6] AL-Shammary, A. m., Akram, Z. h., & Khmias, A. A. (2017). Effect Of Genotype And Spraying Leaves With Arginine And Yeast In Some 1 - Vegetative Growth Characteristics of Potatoes (Solanum tuberosum L.). DASJ, 9(2), 158–169.
[7] Al-Gumally, M. O. S. (2016). Effect of Water Stress and Spraying Amino Acids Valine, Arginine in Growth and Yield of Garlic (Allium sativum L.). Diyala Journal for Pure Science, 12(3-part 1).
[8] Al-Hassani, F & M, Bayan. (2019). EFFECT OF ARGININE, CHITOSAN AND AGRYL MULCHING ON THE GROWTH AND YIELD OF PEPPER PLANT UNDER THE CONDITIONS OF UNHEATED GREENHOUSES. 10.13140/RG.2.2.14283.95527.
[9] Souri, M.K. (2016). Aminochelate fertilizers: the new approach to the old problem, a review. Open Agri. 1: 118123.
[10] Zargar Shooshtari, F., Souri, M. K., Hasandokht, M. R., & Jari, S. K. (2020). Glycine mitigates fertilizer requirements of agricultural crops: case study with cucumber as a high fertilizer-demanding crop. Chemical and Biological Technologies in Agriculture, 7, 1-10.
[11] Sadik, K. S: al-Taweel; N.S. Dhyeab and Kalaf M. Z. 2011. New computer program for estimating leave area of several vegetable crops. American Eurasian Journal of Sustainable Agriculture. 5(2):304-309.
[12] A.O.A.C. (2000) “Official Methods of Analysis”, 17th ed., Association of Official Analytical Chemists, Gaithersburg, MD, Washington, USA.
[13] Goodwin, T. W. 1976. Chemstry and Biochemistry of plant pigment. 2nd Academic. Press. Landon, Newyork. San Francisco: 373. Growth and stress tolerance. Proceedings 612, York, UK:
[14] Cheng, K.L. and Bray R.H..(1951).soil and plant material. Soil Sci., 72: 449-458.W.
[15] Eppendrof, N. and Hing, G. (1970) Interaction manual of flame photometer B 700-E. Measuring method, Description of the apparatus and Instructions for use.
[16] White, P.J and Broadley, M.R. (2003). Calcium in Plants. Annals of Botany, 92, 487- 511.

[17] Jain, V.K. (2007) Mineral nutrition of plants, fundamentals of plant physiology. S. CHAND& Company Ltd., Ramnagar, New Delhi-110055, pp. 100-110

[18] Abdul Hafez and Al-Yazeed, A.A. (2006). The use of amino acids and vitamins in the improvement and performance, growth and quality of plant crops under Egyptian conditions. United for Agricultural Development (UAD).

[19] Faraj, A.H. and Abdul Wahab, A.R.S. Effect of the addition of amino acids in the tolerance of tomato plant for salt stress. Journal of Iraqi Agriculture Research (Special Issue). Folder: 16 Issue 2.

[20] El–Bassiouny, H.M.S.; Mostafa, H.A.; El–Khawas, S.A.; Hassanein, R.A.; Khalil, S.I. and Abd El–Monem, A.A. (2008). Physiological responses of wheat plant to foliar treatments with arginine or putrescine. Austr. J. of Basic and Applied Sci., 2(4): 1390-1403.

[21] Ghoname, A.A.; Mona, G.; Dawood; Mervat Sh. Sadakand Amira M.A.Hegazi. 2010. Improving nutritional quality of Hot pepper (Capsicum annuum L.) plant via foliar application with Arginine or Tryptophan or Glutathione. J. Biol. Chem. 5(1): 409- 429.