Effect of foliar spraying with ascorbic acid and potassium on vegetative growth and photosynthetic pigments of cowpea plants (Vigna unguiculata L.Walp) grown in southern Iraq

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Abstract

The study was conducted at the Agricultural Research Station affiliated with the College of Agriculture, University of Basrah, in the area of Karma Ali, to study the effect of foliar spraying with different concentrations of ascorbic acid (0, 40, 80) mg L-1 and different concentrations of liquid potassium (0, 1, 2) mL L-1 and their interaction on the vegetative growth and content of leaves of chlorophyll pigments and carotenoids for cowpea plants. The results showed that the plant height, number of leaves, leaf area, number of branches, fresh and dry weight of the plant and total chlorophyll in the leaves increased significantly by spraying with both compounds. In contrast, the content of leaves of carotenoid pigment increased significantly when sprayed with liquid potassium. However, the interaction between the two factors significantly affected all traits in the study, except for the content of leaves of total chlorophyll and carotenoids .

Keywords: Cowpea plant; ascorbic acid; potassium; vegetative growth; photosynthesis pigments.

Introduction

Cowpea (Vigna unguiculata L.Walp) is a summer vegetable crop that belongs to the legume family Fabaceae. It is eaten as tender green pods or dry seeds, which are highly nutritious. In every 100 grams of beans, there are 11 g of water, 61 g of carbohydrates, 22.5 g of protein, 1.4 g of fat, as well as some minerals such as calcium, phosphorus, iron, and vitamins C, B1, B2, and B3[12]. Cowpea also fixes atmospheric nitrogen through bacterial nodules, which increases soil fertility [15]. The area planted with Cowpea in Iraq in 2020 was estimated to be about 29,000 dunums, with a total production of 46,200 tons and a yield of 1.593 tons per dunum [5.[

height, number of leaves, leaf area, fresh and dry weight of the shoot and root, and leaf content of chlorophyll a, b, and carotenoids, compared to the control treatment. [7]obtained similar results when spraying pea plants (Pisum sativum) with different concentrations of ascorbic acid (0, 100, 200, 400) mg L-1 the high concentration of 400 mg L-1 was significantly superior in plant height, number of leaves, number of branches, leaf area, dry matter percentage, and leaf content of chlorophyll a, b,carotenoids. [8] also reported that spraying pea plants with different concentrations of ascorbic acid (0, 100, 150, 200) mg L-1, the concentration 200 mg L-1given resulted in a significant increase in plant height, number of leaves, branches, fresh weight of leaves and stem, dry matter

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percentage in leaves, and relative chlorophyll content (SPAD) for both seasons of the experiment, compared to the control treatment.

Potassium is one of the essential and mobile mineral elements that plants need. Although it does not enter into the plant's body composition, its presence is essential for forming carbohydrates, proteins, cell division, and growth of meristematic tissue. It also plays a role in vital processes such as photosynthesis and respiration and in photophosphorylation, transport, and ATP synthesis. It also affects the stomata's opening and closing and the activity of other nutrients [13]. Because potassium in Iraqi soils is fixed in primary and secondary clay minerals, which leads to the transformation of potassium from the dissolved form to a form that is slow in availability [3], foliar feeding is used to provide plants with up to 85% of their nutrient needs [1 .[

[11]observed that spraying faba bean (Vicia faba) plants with potassium sulfate(K2SO4) at concentrations of (o, 2.5, 5) g L-1 resulted in a significant

The treatments were started three weeks after planting and three times, with two weeks between each spraying.

The experimental measurements included vegetative growth traits, which included plant height, number of leaves, leaf area (dm2) according to the method described by [20], number of branches per plant, fresh and dry weight of the plant, total chlorophyll (mg 100 g-1 fresh weight). Total chlorophyll pigment in green leaves was estimated according to the method described by [10] and carotenoids (mg 100 g-1 fresh weight), as mentioned by [21].

One of the things that contribute to increasing plant productivity is to reduce the environmental and air stresses to which the plant is exposed by using antioxidants, such as ascorbic acid, or mineral elements, such as potassium .

Ascorbic acid (vitamin C),with the chemical formula C6H8O6,acts as an enzyme cofactor in enzymatic reactions of carbohydrate and protein metabolism and is involved in respiration and photosynthesis [18].It also has a role in stimulating cell elongation and division [19].[9]observed that when Cowpea plants were sprayed with ascorbic acid at concentrations of (0,100,150,200)mg L-1. the concentration of 100 mg L-1 Ascorbic acid was significantly superior in plant

increase in leaf area and dry weight of the shoot, while the concentration of 5 g L-1 caused a significant increase in the number of branches. [6] observed that spraying Cowpea plants with potassium chloride (KCl) at a concentration of 2% caused a significant increase in plant height, number of branches, and fresh and dry weight compared to non-sprayed plants. [2] found that spraying faba bean plants with different concentrations of potassium sulfate (0, 10, 20, 30, 40) mgL-1, the concentration of 20 mg L-1 caused a significant increase in the number of leaves, while the concentration of 30 caused the concentration. 30 mg L-1 significantly increased plant height and fresh and dry weight. At the same time, all spray concentrations significantly increased the chlorophyll content of leaves compared to the control treatment .

Due to the need for studies on the effect of ascorbic acid and potassium on the growth of cowpea seedlings under the conditions of the city of Basra, this study was conducted.

Material and Methods

The field experiment was conducted at the Agricultural Research Station affiliated to the College of Agriculture, University of Basrah, Karma Ali site, on 01.05.2023. The planting

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was done after preparing the land and preparing it. The experiment was implemented according to the randomized complete block design (RCBD), which included two factors. The first factor included spraying with three concentrations of ascorbic acid: (0, 40, 80) mg L-1. The second factor included spraying with three concentrations of liquid potassium: (0, 1, 2) mL L-1. This resulted in 9 treatment combinations, which were the interaction between three concentrations of foliar spraying with ascorbic acid and three concentrations of liquid potassium with three replications, for 27 experimental units .

The mean results were statistically analyzed using the Gestate statistical program, and the least significant differences (LSD) test was used to compare the means at a probability level of 0.05 [4.[

Table 1 Some chemical and physical characteristics of the study soil

Attribute		Value	Unit
Ph		7.7	
ECe		5.22	ds m-¹
Available Phosphorus		38.8	mg kg-¹
Total Nitrogen		0.23	g kg-¹
Ready Potassium		101.20	mg kg-¹
solube positive ions	Calcium	16.5	millimoles l-¹
	Magnesium	11	
	Sodium	21.3	
	Bicarbonates	13.6	
	Sulfates	18.5	
	Chlorides	28.0	
Soil separators	Sand	593	G kg-1
	Silt	271.5	
	Clay	135.5	
Soil texture		sandy loam	

The Results and Discussions

Table (2) shows that the factors of the study and their interaction had a significant effect on all the traits under study. The plants sprayed with ascorbic acid at a concentration of 80 mg L-1 significantly increased the plant height by 18.37% compared to the control treatment. They did not differ significantly from the concentration of 40 mg L-1. The concentration of 40 mg L-1 caused a significant increase in the number of leaves by 18.47% and 29.22% compared to the control treatment and the concentration of 80 mg L-1 and the control treatment respectively. Both concentrations achieved a significant increase in leaf area compared to the control treatment, with an increase of 51.46% and 71.55%, respectively. The concentration of 40 mg L-1 significantly exceeded the control treatment in the number of branches by 33.24%, and the concentration of 80 mg L-1 did not differ significantly. The significant superiority of ascorbic acid concentrations can be attributed to its physiological roles in stimulating active growth, as it acts as an enzyme cofactor in enzymatic reactions of carbohydrate and protein metabolism and has a role in the

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processes of respiration and photosynthesis [18]These results are consistent with those of [19, 9, 7,8.[

The plants sprayed with potassium at a concentration of 1 mL L-1 significantly exceeded the concentrations of 2mL-1 and the control treatment in plant height by 28.88% and 41.14%, in the number of leaves by 39.31% and 53.65%, and in leaf area by 52.62% and 55.23%, respectively. Both concentrations significantly increased the number of branches compared to the control treatment, with an increase of 24.71% and 34.26%, respectively .

The increase in vegetative growth indicators can be attributed to the active role of potassium in many vital processes, resulting from its stimulating effect on a large number of enzymes, including enzymes of photosynthetic pigments and those associated with energy transfer, in addition to its role in regulating osmotic pressure, which helps to improve and increase plant growth [14]. These results are consistent with [11,6,2.[

The same table shows that the interaction significantly affected all the traits under study. The plants sprayed with ascorbic acid at a concentration of 80 mg L-1 and potassium at a concentration of 1 mL L-1 gave the highest values for plant height (233.7 cm), number of leaves (67.67 leaves), and leaf area (114.7 dm2). Meanwhile, the plants sprayed with ascorbic acid at 40 mg L-1 and potassium at 2 mL L-1 gave the highest number of branches, reaching 6.0 branches. The control treatment, which was not sprayed with either compound, gave the lowest values for the number of leaves (27.0 leaves), leaf area (42.0 dm2), and number of branches (3.0 branches). The highest height was found in the plants not sprayed with ascorbic acid but with potassium at a concentration of 2 mL L-1, reaching 121.3 cm

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Table 2. effect of spraying with ascorbic acid and liquid potassium and their interaction on some vegetative growth indicators of cowpea plants

Treatments			plant height cm)(	Total number of leaves (leaf. plant^{-1})	Leaves area (dm2)	Number branches side (branch plant^{-1})
Average effect of ascorbic acid mg.l-1		0	139.3	44.11	44.3	3.76
		40	159.6	57.00	76.0	4.89
		80	164.90	48.11	67.1	4.22
LSD 0.05			16.7	3.47	9.8	0.83
The average effect of liquid potassium mL-1		0	132.2	41.00	52.5	3.56
		1	186.6	63.00	81.5	4.78
		2	145.0	45.22	53. 4	4.44
LSD 0.05			16.7	3.47	9.8	0.83
Interaction between Ascorbic acid And	0	0	131.0	27.00	42.0	3.00
		1	165. 7	56.67	42.5	4.00
		2	121.30	48.67	48.4	4.00
	40	0	136.70	43.00	55.2	3.33
		1	160.3	64.67	87.3	5.33

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potassium		**2**	**181. 7**	**63.33**	**85.4**	**6.00**
	80	**0**	**129.00**	**53.00**	**60.1**	**4.33**
		1	**233.7**	**67.67**	**114.7**	**5.00**
		2	**132.0**	**23.67**	**26.4**	**3.33**
LSD 0.05			**28.9**	**6.02**	**17.1**	**1.43**

The increase in fresh and dry weight can be attributed to the role of ascorbic acid in increasing the secretion of organic acids from the roots to the soil, which leads to increased solubility of most nutrients released slowly in the rhizosphere that plants absorb. In addition, ascorbic acid preserves chlorophyll from oxidation as an antioxidant [17]. These results are consistent with those of [7,8,9]. The same table shows that foliar application of potassium caused a significant increase in all the traits under study .

Potassium also plays a role in stimulating and activating many enzymes, including enzymes that stimulate photosynthetic pigments [14]. These results are consistent with those of [11,6,2. [

The interaction between the two factors significantly affected the fresh and dry weight of the plant. The plants sprayed with ascorbic acid at 80 mg L-1 and potassium at 1 mL L-1 gave the highest values, reaching 684 and 119.0 g, respectively.

Table (3) shows that the study's two factors significantly affected the fresh and dry weight of the plant and the total chlorophyll in the leaves. The plants sprayed with ascorbic acid at a concentration of 40 mg L-1 significantly increased the fresh weight by 19.01% and 89.01%, the dry weight by 21.98% and 53.45%, and the total chlorophyll by 12.0% and 13.46% compared to the concentration of 80 mg L-1 and control treatment respectively. Ascorbic acid did not significantly affect the carotenoids in the leaves.

The plants sprayed with a concentration of 1 mL L-1 significantly increased the fresh weight of the plant by 49.85% and 67.77%, the dry weight of the plant by 36.67% and 69.70%, the total chlorophyll in the leaves by 10.51% and 16.21%, and the carotenoids by 12.32% and 13.69% compared to the concentration of 2 mLL-1 and control treatment respectively. The significant superiority of foliar application of potassium can be attributed to its physiological roles, including cell division and expansion of meristematic cells through achieving ideal cell wall expansion [16], which causes an increase in fresh and dry weight.

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Table 3. Effect of spraying with ascorbic acid and liquid potassium and their interaction on fresh and dry weight, chlorophyll and carotene pigments in the leaves

Treatments			dry weight g)(	fresh weight g)(	Total chlorophyll in leaves (mg 100g fresh weight)	Carotene in leaves (mg 100g fresh weight)
Average effect of ascorbic acid mg.l-1		0	255	59.3	8.39	0.155
		40	482	91.0	9.52	0.165
		80	405	74.6	8.5	0.156
LSD 0.05			55	10.4	0.76	NS
The average effect of liquid potassium mL-1		0	301	57.1	8.08	0.146
		1	505	96.9	9.39	0.166
		2	337	70.9	8.93	0.164
LSD 0.05			55	10.4	0.76	0.017
Interaction between Ascorbic acid And potassium	0	0	201	41.6	7.33	0.134
		1	268	74.3	8.93	0.167
		2	297	62.1	8.90	0.164
	40	0	328	61.1	8.60	0.158
		1	562	97.3	10.50	0.165
		2	556	114.4	9.45	0.172
	80	0	374	68.6	8.30	0.146
		1	684	119.0	8.75	0.166
		2	157	36.0	8.44	0.155
LSD 0.05			96	18.0	NS	NS

Conclusion

Can conclude from this study that ideal growth of cowpea plants was achieved by spraying the plants with ascorbic acid at a concentration of 40 mg L-1 and with potassium at a concentration of 1 ml L-1.

References

Abdul, K. S. 1988 .The Physiology of Nutrient Elements in Plants, Dar Al-Kutub Directorate for Printing and Publishing, Ministry of Higher Education and Scientific Research, Saladin University, Iraq. .Physiologia plantarum,54(4):402-408. [1]

[2]Al-Jubouri, M. S., and Walaa, M. S. 2019 . The effect of spraying with potassium and the growth of bean plants Vicia faba L. . Kirkuk University Journal of Scientific Studies 14(3):174-187.

[3]Al-Naimi, S. N. A. 1999 . Fertilizers and Soil Fertility, Ministry of Higher Education and Scientific Research, University of Mosul, Iraq.

[4]Al-Rawi, K. M., and Abdulaziz, M. K. A. 1980.Design and Analysis of Agricultural Experiments, Dar Al-Kutub Printing and Publishing Establishment. University of Mosul, Iraq, 488 pages.

[5]Central Statistical Organization. (2021). Agricultural Statistics, Ministry of Planning, Iraq. [12]

ISSN 2072-3857

Imungi,J.K. and N.N Potter. 1983 .Nutrient contents of raw and cooked cowpea leaves. Journal of Food Science,48(4):1252-1254.

[13]I.P.I (International Potash Institute). 2000 . potassium in plant production, Base Switzerland.

[14]Krauss,A. 1993 .Role of potassium in fertilizer nutrient efficiency cited by K. Mengel and A. Krauss 1993.Availability of soils in West Asia and North Africa.Status and perspectives Basel, Switzerland:39-57.

[15]Matlop, A. N., Ezzedine, S. M., and Karim, S. A. 1989. Vegetable Production, Ministry of Higher Education and Scientific Research, University of Mosul, Iraq, 336 pages.

[16] Mengel,K.and W.W.Arneke. 1982. Effect of Potassium on the water potential The osmotic potential and cell elongation in leaves of phaseolus vulgarisi plantp hysiologia plantarum,54:402–408 .

[6]Dey,S.;S. Prased; P. Tiwari and P. Sharma. 2017 .Effect of urea,kcl, zink placement spray on the growth of cowpea.Journal of pharmacognosy and phytochemistry, SP1: 971–973.

[7]El-Saady, W.A and M.K.Rakha. 2018 . Foliar application of ascorbic acid combined with nitrogenous fertilizer positively enhanced the response of pea plants. Journal of plant production 9(12):1189–1196.

[8]El-Sawy S.M., Z.F. Fawzy, A.M. El-Bassiony and S.M. Mahmoud 2019 .Effect of Nano bio-selenium and mineral selenium, ascorbic acid and salicylic acid on vegetative growth and fruit yield of pea plants grown under sandy soil conditions. Int. J. Environ., 8(4):210-221.

[9]Gharib. F.A, I.M. Zeid; Ghazi and E.Z. Ahmed. 2018 . The physiological effect of ascorbic and garlic acids on growth and metabolic activities of cowpea (Vigna unguiculata L .)Plants.J.plant Physiol Pathol,6(4)1000138

[10]Goodwin ,T.W. 1976 .Chemistry and biochemistry of plant pigments, Academic Press.

[11]Hussain, Maha Ali 2011.The effect of spraying with some nutrients on the growth and life of the flower and the early and total yield of the peas Vicia faba .Master thesis-Faculty of Agriculture-University of Baghdad / Iraq.

[17]Olalekan, O. 2017 .Growth and yield of cucumber (Cucumis sativus L.) as influenced by complimentary use of organic sources and mineral fertilizers in Makuardi, Benue state Nigeria inter.J.Agric Envirn.Biors.2(4):14–24.

[18]Robinson,F.A.1973 .Vitamins in phytochemistry,3:195-220.Lawrence P. Miller (Ed)Van-Nostrand Reinhold Co., New York.

[19]Smirnoff, N. And G.L. Wheeler. 2000 . Ascorbic acid in plant: Biosynthesis and function.Biochem.Mol.Biol.,35(4):291–314.

[20]Watson, D.J. & M.Watson. 1953.Comparative physiological studies on the growth of field crops 111-Effect of in fraction with Beet yellow.Ann.Appl. Bio,40:1-18.

[21]Zaehringer,M.V.;K.R.Davis and L.L.Dean.1974. Persistent.Green color snap beans (phaseolus vulgaris) color related constituents and Quality of cooked fresh beans.J.Amer.SOC.Hort.Sci.,99:89-892.

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