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Response of Cucumber Hybrids to Foliar Potassium Application and Its Effect on Vegetative Growth and Yield

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Abstract

The experiment was carried out in the Fallujah region of Iraq during the autumn season of 2024–2025, in a randomized complete blocks design (RCBD) three replications, factorial experiment (7 hybrids × 3 concentrations). The measured characters were leaf area, shoot dry matter, relative chlorophyll content (SPAD), number of fruits, weight of fruits, diameter of fruits and yield of the plant.

Results revealed that maximum leaf area (25.10 dm^2), dry weight (93.81 g), chlorophyll content (50.82 SPAD), fruit number (27.14 fruits $plant^{-1}$) and plant yield (2009.00 g $plant^{-1}$) was recorded under the 500 mg L^{-1} concentration which was significantly higher than the control. Hybrids differed in their performance, hybrid H3 being the best in terms of leaf area (26.25 dm^2), chlorophyll content (49.53 SPAD), fruits $plant^{-1}$ (29.33) and plant yield (2089.19 g $plant^{-1}$); hybrid H2 was the highest in fruit weight (116.82 g), and hybrid H6 was the highest in dry weight (82.88 g). The combination H3K500 gave maximum Leaf area (29.23 dm^2), fruit number (37.00 fruits $plant^{-1}$), fruit diameter (36.63 mm) and plant yield (2885.53 g $plant^{-1}$) which were significant.

Keywords: Cucumber, Foliar application, Potassium sulfate, Hybrids, Vegetative growth, Genetic interaction.

I. Introduction

Cucumber (Cucumis sativus L.) is one of the most important vegetable crops belonging to the family Cucurbitaceae. It holds a prominent economic and nutritional role in many countries around the world because of its short growing period, high economic return, and consumers' preference of its fresh fruits. Cucumber is a crop, which has shown high sensitivity to different types of agricultural practices; high yields and optimal growth requires the provision of essential nutrients in the correct amounts and at the right time of crop growth (Ahirwar et al., 2018).

Over the last several decades, significant advances have been made in cucumber breeding, leading to the creation of a wide variety of commercial cucumber cultivars and hybrids that are highly productive. These hybrids are known for their fast growth, early maturation and high quality fruit. Nevertheless, they can respond differently to fertilisation, which means studies are needed to establish their nutritional needs and to find the optimal fertilisation regimes to maximise productivity (Begna, 2021).

Potassium is a macronutrient essential to plant growth, and is the second most consumed nutrient after N for most horticultural crops. It is involved in a number of physiological processes such as regulation of stomatal opening and closing, activation of many enzymes, increasing the efficiency of photosynthesis and increasing the movement of sugars and assimilates from the leaves to growing tissues and fruits. Moreover, potassium plays a role in enhancing plant tolerance to multiple environmental stresses and is associated with better water-use efficiency. It means that there is a positive effect of providing sufficiency of potassium on vegetative growth, yield and fruit quality (Al-Jaf, 2017).

When the root uptake efficiency is low or during critical growth stages, the foliar fertilization is one of the most efficient ways to supply nutrients to the plants because the nutrients are delivered directly to the leaves where they are quickly absorbed and used. Many reports have been published that potassium compounds applied to the foliage enhance growth and productivity attributes of vegetable crops (Ali et al., 2022). Shehata (2018) found that foliar application of potassium silicate resulted in a significant increase in plant height, number of leaves, chlorophyll content, total yield as well as fruit quality of cucumber when compared to control treatment. Similarly, Al-Saadouni et al. (2024) found that foliar application of potassium nitrate improved growth characteristics, productivity, and yield components of cucumber plants grown under high-temperature conditions, highlighting the importance of potassium in enhancing physiological efficiency and increasing crop productivity.

Potassium is an important element for improving cucumber growth and productivity but the effect of different cucumber hybrids to foliar application of K can differ based on the hybrid's genetic makeup. Thus, more research is needed to determine the efficiency of various cucumber hybrids in the use of potassium applied to the foliage.

Thus, the present study was undertaken to assess the effect of selected cucumber hybrids on foliar application of potassium and to establish the response of them to the foliar application and to find out which hybrid had the highest ability to respond to this important nutrient.

II. Materials and Methods

Study Factors

First Factor: Cucumber Hybrids

The first factor consisted of seven cucumber hybrids (H1–H6 plus the standard hybrid Control), which were obtained from the Research Center, Horticulture Directorate, Ministry of Agriculture, Abu Ghraib, Iraq.

Second Factor: Potassium Concentrations

Potassium sulfate (K_2SO_4) was applied at three concentrations: 0, 250, and 500 mg L^{-1}, designated as K0, K250, and K500, respectively.

The experiment was arranged as a factorial experiment (7 × 3 = 21 treatments) within a Randomized Complete Block Design (RCBD) with three replications (Al-Mohammadi and Al-Mohammadi, 2012).

Measured traits

1 .Leaf Area (dm^2)

Leaf area was measured using a Leaf Area Meter (AN-100) manufactured by Science Instruments, England. Measurements were taken from the fifth leaf of five randomly selected plants from each experimental unit (Wallace et al., 2000).

2 .Dry Weight of Vegetative Parts (g $plant^{-1}$)

At the end of the growing season, five plants were randomly sampled from each experimental unit. Roots and fruits were removed, and the vegetative parts were oven-dried at 70°C until a constant weight was achieved, after which they were weighed (Al-Sahaf, 1989).

3 .Relative Chlorophyll Content (SPAD)

Relatie chlorophyll content was determined using a SPAD-502 chlorophyll meter manufactured by Minolta, Japan. Measurements were taken at the middle of the vegetative growth stage from the sixth leaf.

4 .Number of Fruits (fruit plant^{-1})

The total number of fruits harvested from all picking dates within each experimental unit was recorded and divided by the number of plants according to the following equation:

Number of fruits (fruit plant^{-1}) = Total number of fruits ÷ Number of plants

5 .Fruit Weight (g)

Average fruit weight was calculated using the following equation:

Fruit weight (g) = Total yield of the experimental unit (g) ÷ Total number of fruits

6 .Fruit Diameter (mm)

Fruit diameter was determined as the average of ten randomly selected fruits after the third harvest, using a Vernier Caliper. Measurements were taken at the middle portion of each fruit.

7 .Yield per Plant (g plant^{-1})

Yield per plant was calculated by dividing the total yield of the experimental unit by the number of plants according to the following equation:

Yield per plant (g plant^{-1}) = Total yield of the experimental unit (g) ÷ Number of plants

III. Results and Discussion

1. Leaf Area (dm²)

The data given in Table (1) showed significant differences between the cucumber hybrids, potash concentrations and the interaction of the potash and cucumber hybrids for the leaf area.

In the case of the hybrids, the highest mean leaf area of 26.25 dm² was observed for H3, followed by H2 with a mean of 23.97 dm², while the lowest mean leaf area of 21.71 dm² was observed for H5.

For potassium levels, foliar application at K500, resulted in the highest mean of 25.10 dm² followed by K250 with mean of 23.45 dm². The lowest mean leaf area (20.79 dm²) was observed for control treatment (K0).

This trait was also significantly influenced by the interaction of the two study factors. H3K500 was the most effective treatment with the highest measure of leaf area, 29.23 dm², while H4K0 and H1K0-8 had the lowest 19.13 and 19.93 dm², respectively.

This advantage of hybrid H3 in leaf area could be due to the genes it possesses and to its ability to grow and spread its leaf area, thereby increasing the photosynthetic area. Moreover, the positive effect of potassium application, especially at K500 concentration, can be attributed to the important role of potassium in the stimulation of cell elongation, cell division and photosynthetic activity and its contribution to assimilate translocation to the growing parts of plants. These physiological functions promote leaf growth and growth in general. The hybrid x potassium interaction indicates that some hybrids may be more efficient in the use of potassium than others; H3 did seem to be most responsive to foliar potassium application.

Table (1). Effect of Foliar Potassium Application, Cucumber Hybrids, and Their Interaction on Leaf Area (dm^2)

Potassium Concentrations	Hybrids							Average
	Control	H1	H2	H3	H4	H5	H6	
K0	20.64	19.93	22.07	22.96	19.13	18.21	22.60	**20.79**
K250	21.47	22.65	21.47	26.57	25.78	22.94	23.28	**23.45**
K500	23.93	22.15	28.37	29.23	23.30	23.99	24.75	**25.10**
Average	**22.01**	**21.57**	**23.97**	**26.25**	**22.73**	**21.71**	**23.48**	
LSD 0.05	**Hybrid**		**Concentrations**		**Interference**			
	6.33		**4.80**		**8.31**			

2. Dry Weight (g):

Table (2) showed that the cucumber hybrids significantly differed in the results, The interaction between potassium concentrations and the interaction between the potassium and the plant dry weight. Hybrid H6 had the highest average dry weight (82.88 g) followed by hybrid H1 with an average of 82.24 g, while hybrid H4 had the lowest average (69.24 g).

Regarding the potassium concentrations, spray with potassium concentration K500 produced more significant increase in dry weight with highest average of 93.81 g followed by K250 with an average of 75.84 g and K0 as the lowest average of 63.56 g. This trait also varied significantly with the interaction analysis of the two factors, and the H2K500 treatment recorded the highest dry weight of 115.10 g and the H1K0 treatment the lowest dry weight of 52.16 g.

Table (2): Effect of foliar potassium application on cucumber hybrids and their interaction on dry weight (g).

Potassium Concentrations	Hybrids							Average
	Control	H1	H2	H3	H4	H5	H6	
K0	69.88	52.16	53.15	59.15	59.89	79.55	71.17	**63.56**
K250	79.65	91.30	70.44	73.28	61.52	71.31	83.43	**75.84**
K500	84.71	103.28	115.10	79.90	86.31	87.34	94.04	**93.81**
Average	**78.05**	**82.24**	**79.56**	**70.77**	**69.24**	**79.40**	**82.88**	
LSD 0.05	**Hybrid**		**Concentrations**		**Interference**			
	5.37		**4.07**		**7.05**			

3. Chlorophyll Content (SPAD):

Table (3) showed that there were significant differences between the different cucumber hybrids, potassium concentrations, and between cucumber hybrids and concentration with respect to chlorophyll content.

H3 had the highest mean chlorophyll content among the hybrids with a value of 49.53 SPAD, followed by H4 with a mean value of 48.20 SPAD and the lowest mean value was offered by H1 with 45.51 SPAD.

In terms of potassium concentration, foliar application of K500 gave the highest mean chlorophyll content (50.82 SPAD) whereas K0 gave the lowest mean chlorophyll (43.73 SPAD). The interaction between the two study factors also showed significant differences in this trait. The combination H4K500 achieved the highest chlorophyll content of 52.80 SPAD, whereas H5K0 recorded the lowest value of 40.60 SPAD.

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Table (3). Effect of Foliar Potassium Application on Cucumber Hybrids and Their Interaction on Chlorophyll Content (SPAD).

Potassium Concentrations	Hybrids							Average
	Control	H1	H2	H3	H4	H5	H6	
K0	42.60	46.33	46.40	46.60	41.40	40.60	42.20	**43.73**
K250	43.80	43.40	43.00	49.60	50.40	50.60	44.30	**46.44**
K500	51.60	46.80	48.20	52.40	52.80	52.20	51.80	**50.82**
Average	**46.00**	**45.51**	**45.86**	**49.53**	**48.20**	**47.80**	**46.10**	
LSD 0.05	**Hybrid**		**Concentrations**		**Interference**			
	1.25		**0.95**		**1.65**			

4. Number of Fruits (fruit plant⁻¹):

Table (4) indicated that there were significant differences among the cucumber hybrids, potassium levels, and their interaction for number of fruits per plant.

In the case of hybrids, H3 recorded the highest mean 29.33 fruits plant^{-1}, followed by control hybrid with a mean of 25.33 fruits plant^{-1} while H1 appeared to have the lowest mean of 12.66 fruits plant^{-1}.

As regards potassium concentrations, there were the highest mean number of fruits per plant (K500, 27.14 fruits/plant) followed by K250 (22.14 fruits/plant) and the lowest mean value of K0 (16.28 fruits/plant).

The two study factors also interacted and resulted in significant differences for this trait. The highest fruits per plant (37.0) was obtained for the combination H3K500 while the lowest was for the combination H1K0 (11.0).

Table (4). Effect of Foliar Potassium Application on Cucumber Hybrids and Their Interaction on Number of Fruits (fruit plant^{-1}).

Potassium Concentrations	Hybrids							Average
	Control	H1	H2	H3	H4	H5	H6	
K0	12.00	11.00	13.00	22.00	21.00	12.00	23.00	**16.28**
K250	33.00	12.00	21.00	29.00	22.00	14.00	24.00	**22.14**
K500	31.00	15.00	24.00	37.00	27.00	31.00	25.00	**27.14**
Average	**25.33**	**12.66**	**19.33**	**29.33**	**23.33**	**19.00**	**24.00**	
LSD 0.05	**Hybrid**		**Concentrations**		**Interference**			
	0.46		**0.30**		**0.80**			

5. Fruit Weight (g):

The data presented in Table (5) showed that the fruit weight differed significantly among the cucumber hybrids, potassium concentrations and their interaction.

The highest mean fruit weight in the hybrids was recorded for H2 with 116.82 g, the lowest mean was recorded for H3 with 70.87 g while the control hybrid recorded 89.98 g.

As far as potassium concentration is concerned, the highest mean fruit weight was observed in control treatment K0 (90.76 g) followed by K250 (85.31 g) and the lowest mean fruit weight was obtained in K500 (78.01 g).

There were also significant differences in this trait due to the interaction between the two study factors. The highest fruit weight was obtained by the combination H2K0 (161.62 g) while the lowest was obtained by the combination H3K0 (41.61 g).

Table (5). Effect of Foliar Potassium Application on Cucumber Hybrids and Their Interaction on Fruit Weight (g).

Potassium Concentrations	Hybrids							Average
	Control	H1	H2	H3	H4	H5	H6	
K0	130.90	73.52	162.40	42.66	80.40	68.63	76.80	**90.76**
K250	66.15	67.46	99.65	89.70	81.65	111.10	81.51	**85.31**
K500	72.90	85.11	88.41	80.26	68.10	71.43	79.87	**78.01**
Average	**89.98**	**75.34**	**116.82**	**70.87**	**76.71**	**83.72**	**79.39**	
LSD 0.05	**Hybrid**		**Concentrations**		**Interference**			
	2.82		**2.14**		**3.70**			

6. Fruit Diameter (mm):

The fruit diameter data in Table (6) indicated that cucumber hybrids, potassium concentrations and the interaction between cucumber and potassium had significant differences.

In comparison, hybrids H3 had the highest mean fruit diameter (32.90 mm), while hybrid H5 had a mean fruit diameter of 31.70 mm, and the control hybrid had the lowest mean (28.11 mm).

In the case of potassium concentration, the mean fruit diameter of K500 (31.48 mm) was found to be similar to that of K250 (31.18 mm) and higher than the control (K0) (28.52 mm).

Also, the presence or absence of the two study factors significantly affected this trait. The highest fruit diameter was obtained from the combination of H3K500 with 36.63 mm while the lowest fruit diameter of 26.46 mm was obtained from Control K0.

Table (6). Effect of Foliar Potassium Application on Cucumber Hybrids and Their Interaction on Fruit Diameter (mm).

Potassium Concentrations	Hybrids							Average
	Control	H1	H2	H3	H4	H5	H6	
K0	26.46	29.28	30.60	27.30	26.18	33.26	26.60	**28.52**
K250	27.33	32.43	30.20	34.77	30.60	31.40	31.55	**31.18**
K500	30.55	32.39	30.66	36.63	30.40	30.44	29.30	**31.48**
Average	**28.11**	**31.36**	**30.48**	**32.90**	**29.06**	**31.70**	**29.15**	
LSD 0.05	**Hybrid**		**Concentrations**		**Interference**			
	1.18		**0.90**		**1.55**			

7. Plant Yield (g plant^{-1}):

Table (7) showed that there were highly significant differences among the cucumber hybrids, potassium concentrations and their interaction for yield of the plant.

H3 had the highest mean yield of 2089.41 g plant^{-1} followed by H2 with 1978.09 g plant^{-1} and H1 showed the lowest mean yield of 885.84g plant^{-1} among the hybrids.

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Concerning the concentration of potassium, the highest mean concentration (2009.00 g plant-1) was found in the treatment K500, followed by K250 (1758.65 g plant-1) and the lowest mean concentration (1291.25 g plant-1) was observed in the treatment K0 (control).

There were also significant differences between the interaction of the two study factors in this trait. H3K500 gave the highest plant yield (2885.53 g plant^{-1}) while H1K0 and H1K250 had the lowest yield (724.91 and 740.82 g plant^{-1}).

Table (7). Effect of Foliar Potassium Application on Cucumber Hybrids and Their Interaction on Plant Yield (g plant^{-1}).

Potassium Concentrations	Hybrids							Average
	Control	H1	H2	H3	H4	H5	H6	
K0	1483.58	724.91	1938.88	872.84	1607.93	740.88	1669.77	**1,291.25**
K250	2085.24	740.82	1972.66	2509.88	1695.30	1431.10	1875.60	**1,758.65**
K500	2160.70	1191.79	2022.73	2885.53	1745.94	2141.78	1914.55	**2,009.00**
Average	**1909.84**	**885.84**	**1978.09**	**2089.41**	**1683.05**	**1437.92**	**1819.97**	
LSD 0.05	Hybrid		Concentrations		Interference			
	99.78		91.88		104.31			

IV. Discussion

The data of Tables (1, 2, 3, 4 and 7) showed that foliar application of potassium significantly improved most vegetative growth and yield attributes of cucumber plants. The K500 concentration performed better than the control treatment in all the tested parameters: leaf area, dry weight, chlorophyll content, number of fruits and yield of the plant. This improvement is largely due to the fact that potassium is a key element in the activation of many enzymes critical for photosynthesis, respiration, protein synthesis, and carbohydrate metabolism, as well as in the regulation of the movement of water and solutes across plant cell walls (Taiz et al., 2018).

Chlorophyll accumulation could be linked to the function of K in chloroplast efficiency, stomatal regulation and water use efficiency, which in turn would increase the rates of photosynthesis and the production of carbohydrates that plants need for growth (Marschner, 2012). This was observed as an increase in leaf area and dry weight due to an increase in cell division and cell elongation, and an increase in dry matter content of plant tissues (Hawkesford et al., 2012; Marschner, 2012).

This might be due to the positive effect of K on the translocation of photosynthates and sugars to reproductive organs, which leads to increased fruit set, decreased flower and young fruit drop and increased overall productivity efficiency (Pettigrew, 2008).

The results agree with those of Shehata et al. (2018) and Abdelaziz & Abdeldaym (2018) who reported that foliar application of potassium resulted in increased chlorophyll content, vegetative growth, fruit number and yield of cucumber. Moreover, Zhang et al. (2024) found that proper potassium supply could help to improve the efficiency of photosynthesis and promote better water and nutrient uptake, thereby boosting growth and yield.

This is because hybrids showed genetic differences in nutrient uptake efficiency, photosynthetic capacity and vigor of vegetative and root growth which led to varying response to the foliar potassium application (Kumar et al., 2024).

Finally, foliar application of potassium had a significant effect on improving vegetative growth and yield characteristics of cucumber. The K500 treatment was best in most traits than the control and significant differences were found among the hybrids with H3 performing best in several traits.

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Increasing milking frequency from once to twice daily significantly increased daily and total milk yield. Fat percentage was higher in cows milked once daily. However, fat, protein, and lactose yields were significantly higher in cows milked twice daily.An inverse relationship was observed between milk yield and fat percentage, while a positive relationship was found between milk yield and fat, protein, and lactose yields.

V. References

Abdelaziz, M. E., & Abdeldaym, E. A. (2018). Cucumber growth, yield and quality of plants grown in peatmoss or sand as affected by rate of foliar applied potassium. *Bioscience Research, 15*(3), 2871–2879.

Ahirwar, C. S., & Singh, D. K. (2018). Assessment of genetic variability in cucumber (Cucumis sativus L.). *International Journal of Current Microbiology and Applied Sciences, 7*(3), 1272–1279.

Ali, N. D. S., Allawi, M. M., & Majid, N. H. (2022). *Rhizosphere management and agricultural sustainability*. Ministry of Higher Education and Scientific Research, University of Baghdad, College of Agricultural Engineering Sciences, Iraq.

Al-Jaf, I. H. M. S. (2017). *Study of the genetic dimension of some cucumber varieties using molecular genetics techniques and the genetic behavior of their hybrids under potassium influence*. PhD thesis, Department of Horticulture and Landscape Engineering, College of Agriculture, University of Baghdad, Iraq.

Al-Mohammadi, S. M., & Al-Mohammadi, F. M. (2012). *Statistics and experimental design*. Dar Osama for Publishing and Distribution, Amman, Jordan.

Al-Sahaf, F. H. (1989). *Plant nutrition (Applied)*. Ministry of Higher Education and Scientific Research, Higher Education Press, Iraq.

Awad-Allah, M. M. A., Alotaibi, M. M., El Nagy, M. M. M., Almuziny, M., Alsubeie, M. S., Abo-Zeid, A. A. I., et al. (2024). The effect of foliar application with naphthalene acetic acid and potassium nitrate on the growth, sex ratio, and productivity of cucumbers (Cucumis sativus L.) under high temperatures in semi-arid areas. *Agronomy, 14*(6), 1202. https://doi.org/10.3390/agronomy14061202

Begna, T. (2021). Role and economic importance of crop genetic diversity in food security. *International Journal of Agricultural Science and Food Technology, 7*(1), 164–169.

Hassan, A. A. (2024). *Advances in vegetable breeding studies for improving quality traits* (1st ed.). Cairo, Egypt: Author. (Series: Advances in Vegetable Studies, No. 9).

Hawkesford, M., Horst, W., Kichey, T., Lambers, H., Schjoerring, J., Skrumsager Møller, I., & White, P. (2012). Functions of macronutrients. In P. Marschner (Ed.), *Marschner's Mineral Nutrition of Higher Plants* (3rd ed., pp. 135–189). Academic Press.

Kumar, S., Singh, P., Bhardwaj, A., Kumari, S., et al. (2024). Performance of parthenocarpic cucumber genotypes under protected cultivation for yield and horticultural traits. *Emergent Life Sciences Research, 10*(1), 72–77. https://doi.org/10.31783/elsr.2024.1017277

Marschner, P. (2012). *Marschner's Mineral Nutrition of Higher Plants* (3rd ed.). Academic Press.

Pettigrew, W. T. (2008). Potassium influences on yield and quality production for maize, wheat, soybean and cotton. *Physiologia Plantarum, 133*(4), 670–681.

Shehata, S. A., Abdel-Azem, H. S., Abou El-Yazied, A., & El-Gizawy, A. M. (2018). Effect of foliar spray with potassium silicate on growth, yield and quality of cucumber plants. *Annals of Agricultural Science, Moshtohor, 56*(2), 385–396.

Wallace, B., Ebel, R., & Kemble, J. (2000). Imidacloprid effect on root growth, photosynthesis, and water use of cucumber in the greenhouse. *HortScience, 35*(5), 953.

Zhang, Y., Wang, J., Liu, X., Li, Q., & Chen, Z. (2024). Potassium management improves growth, yield and resource use efficiency of cucumber (Cucumis sativus L.). *Scientia Horticulturae, 330*, 113025.