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Impact of Different Zinc Levels and Benzyl Adenine Concentrations Applied as Foliar Spray on the Vegetative Growth of Two *Zinnia elegans* Cultivars.

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ABSTRACT

This study was conducted at the Department of Horticulture, College of Agriculture Engineering Sciences. To investigate the effects of varying Zn concentrations (0, 0.50%, and 0.75%), as well as varying BA concentrations (0.50, and 100) mgl^{-1} on some vegetative traits of two cultivars of Zinnia plant. The results showed that: The mean values showed that the largest plants (90.556 cm) were recorded in the *Zinnia Lavonda* cultivar. Also, the same cultivar shows the highest number of branches, fresh and dry aerial weight, and total carotene reached (8.160, 213.194 g, 11.534 g, and 12.398g), respectively. While another parameter such as leaves number, internodes number, leaf area, and total chlorophyll were observed in the Zinnia rosso scarlatta cultivar and gave the maximum results reached (23.28, 10.79, 19.20, and 30.56), respectively. Also, data reported in the same table reveal that leaves number, branches number, number of internodes, shoot fresh and dry weight, leaf area (cm^2), and finally total carotene increased significantly with a 50 mgl^{-1} concentration of BA for the Zinnia Lavanda cultivar (26.741, 9.296, 12.556, 259.054, 13.829, 24.489, and 14.798 cm^2), respectively, compared to the control. About the three factors, the highest plant high for two cultivars Zinnia Lavanda and Zinnia rosso scarlatta, reached 101.411 cm when spraying the plant by 50 mgl-1 + 0.50% Zn and 96.622 cm at 0.50% Zn alone, respectively, than the control plants (77.856 and 77.356 cm), respectively, were obtained in two cultivars. While the number of leaves, number of branches, number of internodes, and leaf area (cm^2) increased significantly compared to control and other treatments, the main value reached (30.889, 9.778, 15.222, and 33.230 cm^2) respectively, when the Zinnia Lavanda cultivar was spraying with 100 mgl-1BA+ 0.50% Zn. Also, the plant fresh weight, plant dry weight, total chlorophyll, and total carotene give the height value reached (333.080g, 15.680g, 42.714 $mg.g^{-1}$, and 17.90 $mg.g^{-1}$), respectively, when the Zinnia Lavanda cultivar was spraying with 100 mgl-1BA+ 0.75% Zn.

***Keywords*:** Levels of Zn, BA Concentrations, Spraying, Vegetative Growth and Two Cultivars.

INTRODUCTION

Zinnia elegans is native to Mexico and Central America and is a member of the Asteraceae family. Due to its ability to tolerate hot, dry weather, it is widely planted for commercial purposes as a cut flower and bedding plant **[1]**. Zinnia is a crop with economic value as well. Zinnia may be studied to determine its potential as a dry condition cut flower crop because of its natural ability to survive in both dry and humid conditions. Due to the variety of colors and long flowering period, Zinnia elegans is a beautiful ornamental plant that may be utilized in landscape design. **[2].** It grows after the frost season ends and is susceptible to low temperatures. Z. elegans are very easy to propagate by seeds, and it is used as a cut flower [3]. It's one of those plants that's frequently utilized to create flower arrangements in urban landscaping. Zinnias look great when planted alone or in combination with other ornamental annuals **[4, 5].** Furthermore, Zinnia elegant is also suitable for cutting to make bouquets arrangements and for growing in pots and containers **[6, 7].** This plant requires minimal care and blends in perfectly with the current trend of natural gardens. Zinnia *elegant* is a heliophyte that tolerates low air humidity as well as high soil temperatures. Zinnia is a usual long-day plant. **[8, 9, 10, 11]**. Zinnia is the two most promising between 20-30 species **[6],** *Znnia elegans* is the parent plant of many beautiful cultivars, including a wide range of types that are commonly used for their attractive flowers. It grows easily in rock gardens, containers for windows, and beds **[12].** Providing an appropriate amount of nutrition

during the growth season is one of the most crucial aspects of producing cut flowers **[13].** Flowering crops' vase life can be effectively extended by using plant growth regulators, several of which have been shown to increase flower vase life. **[14]**

Small quantities of plant growth regulators can modify physiological processes in plants and are essential for elongation and flower formation, among other aspects of plant growth and development. **[15].** When using plant growth regulators, controlling blooming is one of the most crucial practical issues. Plant growth regulators play from seed germination until the stage of senescence **[16].** Cytokinin can be utilized in different applications, such as the treatment of seeds **[17]** to applications during flowering **[18].** Synthetic cytokinin like benzyl adenine (BA) may improve plant development by promoting cell division, breaking dormancy in the buds, and improving the lateral bud development **[19].** When synthetic cytokinin was applied to leaves, it enhanced the production of proteins and photosynthesis pigment in the tissues. **[20].**

Zinc (Zn) is a crucial micronutrient for higher plants, as it is needed for the work of various enzymes (like dehydrogenases and RNA and DNA polymerases), gene expression, the health of bio-membranes, carbon metabolism in photosynthesis, carbohydrate metabolism, and protein production. Additionally, zinc is more important for biomass generation; a zinc deficit may impact on thylakoids' photochemical functions, preventing the biophysical processes of photosynthesis. **[21].** In the case of excess Zn, one way to reduce damage is to prevent the uncontrolled oxidation caused by antioxidant enzymes, which require Fe, Mn, Cu, and Zn as cofactors of metals. With the introduction of micronutrients that are necessary for plant growth, it became achievable to obtain the maximum amount of plant growth **[22]**. Micronutrients greatly impacted plant growth and development, including zinc nutrients. Zinc has a beneficial effect on many ornamental plants and is essential for plant physiology, where it stimulates certain enzymes involved in the metabolism of carbohydrates. **[23].** Zinc sprayed on the foliage increased by 0.5% and had the greatest impact on the size of the increase and vegetative growth **[24].**

The aim of an experiment was to enhance the growth of two cultivars of Zinnia. To investigate the impact of concentrations of synthetic cytokinin BA and Zinc levels alone and their interactions with BA on the growth performance of the two cultivars of the Zinnia plant.

MATERIALS AND METHOD

The study was conducted from April 2024 at the Department of Horticulture's Lath House, College of Agriculture Engineering Sciences, University of Duhok, Kurdistan region, Iraq. The study was arranged in a factorial test with a RCBD design with three factors and three replicates, each replicate consisting of four plants. The different materials used include BA (0, 50, and 100 mgl-1) with ZnSO4 (0, 0.50, and 0.75%), % used alone, and their interaction on the growth of two cultivars of the Zinnia plant (Lavanda and rosso scarlatta). So, the experiment includes (3×3×2×3×4= 216) plants. The Pagano Costantino company in Italy supplied the Zinnia (Zinnia elegans) seeds, which were imported via Kurdistan offices, one of the Duhok's agricultural offices. At the beginning the seeds were sowing in peatmoss. After germination, the seedlings were planted in 24-cm containers in a growth medium that contained peatmoss and river soil at a 2:1 v/v ratio. The pots were placed in a lather with an average day/night temperature of 25°C/18°C. The plants at the four-leaf stage were sprayed individually with different concentrations of this BA and Zn, which are used in foliar application, by spraying the plant three times and 15 days between the sprays. Study parameters: The study assessed various growth parameters, including plant height (cm), leaves number per plant, branches number per plant, internodes number per plant, shoot fresh weight, shoot dry weight, and leaf area (cm^2), total chlorophyll **(mg/100g^{-1} fresh weight)** and total carotene **(mg/100g^{-1} fresh weight)**.

STATISTICAL ANALYSIS

An RCBD design was used to conduct the experiment. Three replications of each treatment were used, with four plants in each replication. Analysis of variance (ANOVA) was performed on the collected data, and the Duncan test was used to determine the mean values at $P < 0.05$ using the SAS program.

RESULTS

Effect of cultivars

The results in Table 1 regarding many vegetative parameters such as plant height (cm), number of leaves. Plant^{-1}, number of branches. Plant^{-1}, number of internodes. Plant^{-1}, aerial fresh and dry weight, leaf area (cm^2), and finally total chlorophyll, total cartoene showed that the effect of zinnia cultivars was non-significant in all traits except the number of branches; it was significant between the cultivars.

Table (1): Effect of different cultivars on growth characteristics of zinnia plants

Cultivar	plant height (cm)	leaves number. Plant^{-1}	branches number. Plant^{-1}	internodes Number. Plant^{-1}	shoot fresh weight	shoot dry weight	leaf area (cm^2)	total chlorophyll (mg/100g^{-1} fresh weight)	total carotene (mg/100g^{-1} fresh weight)
Zinnia Lavonda	90.556^{a}	22.469^{a}	8.160^{a}	10.691^{a}	213.194^{a}	11.534^{a}	19.177^{a}	25.754^{b}	12.398^{a}
Zinnia rosso scarlatta	90.464^{a}	23.284^{a}	7.185^{b}	10.790^{a}	181.890^{a}	10.075^{a}	19.206^{a}	30.561^{a}	12.093^{a}

The mean values showed that the largest plants (90.556 cm) were recorded in the Zinnia Lavonda cultivar. Also, the same cultivar shows the maximum number of branches, aerial fresh and dry weight, and total carotene reached (8.160, 213.194 g, 11.534 g, and 12.398), respectively. While another parameter such as number of leaves, number of internodes, leaf area, and total chlorophyll were observed in the *Zinnia* rosso scarlatta cultivar and gave the maximum results reached (23.284, 10.790, 19.206, and 30.561), respectively.

Effect of BA concentration on different characteristics of two cultivars of zinnia plants

The data illustrated in Table 2 indicates that rising the BA concentrations significantly increased zinnia parameters such as plant height (cm) and leaves number. Plant^{-1}, branches number. Plant^{-1}, internodes number. Plant^{-1}, shoot fresh and dry weight, leaf area (cm^2), and finally total chlorophyll, total carotin compared to untreated plants. The tallest plants obtained from the treatment of 50 mg^{-1} BA reached 96.556 cm for the Zinnia Lavanda, followed by Zinnia rosso-scarlatta cultivars, whose maximum length reached 25.778 cm at 100 mgl^{-1} BA. About the other characters, data reported in the same table reveal that number of leave, number of branches, number of internodes, plant fresh and dry weight, leaf area (cm²), finally total carotin increased significantly with a 50 mgl-1 concentration of BA for the Zinnia Lavanda cultivar (26.741, 9.296, 12.556, 259.054, 13.829, 24.489, and 14.798), respectively, compared to the control. Furthermore, the highest value of number of leaves. Plant^{-1}, number of branches. Plant^{-1}, number of internodes. Plant^{-1}, plant fresh and dry weight, leaf area (cm²), finally total carotin was recorded for the Zinnia rosso scarlatta cultivar at 100 mgl^{-1}BA with a significant increase compared to the control (25.778, 7.852, 12.370, 203.083, 12.833, 22.930, and 13.863), respectively, compared to the control. Also, 50 mgl^{-1} BA spraying in the Zinnia rosso scarlatta cultivar gave the highest value of total chlorophyll with significant differences compared to the other treatment, and the control reached 34.789.

Table (2): Effect of foliar application of BA concentration on different characteristics of two cultivars of zinnia plants

Cultivar	BA mgl^{-1}	plant height (cm)	leaves number. Plant^{-1}	branches number. Plant^{-1}	internodes Number. Plant^{-1}	shoot fresh weight	shoot dry weight	leaf area (cm^2)	total chlorophyll (mg/100g^{-1} fresh weight)	total carotene (mg/100 g^{-1} fresh weight)
Zinnia Lavanda	0	85.126^{c}	17.185^{b}	6.704^{c}	8.074^{c}	130.661^{b}	7.342^{b}	10.151^{c}	11.901^{c}	8.650^{b}
	50	96.556^{a}	23.481^{a}	8.481^{ab}	11.444^{ab}	249.868^{a}	13.432^{a}	22.892^{a}	32.374^{a}	13.746^{a}
	100	89.985^{abc}	26.741^{a}	9.296^{a}	12.556^{a}	259.054^{a}	13.829^{a}	24.489^{a}	32.987^{a}	14.798^{a}
Zinnia rosso scarlatta	0	88.141^{bc}	21.926^{ab}	6.444^{c}	9.222^{bc}	127.933^{b}	6.689^{b}	16.144^{b}	26.342^{b}	9.564^{b}
	50	89.481^{bc}	22.148^{ab}	7.259^{bc}	10.778^{abc}	214.654^{a}	10.702^{ab}	18.543^{b}	34.789^{a}	12.851^{a}
	100	93.769^{ab}	25.778^{a}	7.852^{abc}	12.370^{a}	203.083^{a}	12.833^{a}	22.930^{a}	30.551^{ab}	13.863^{a}

Effect of Zinc level on different characteristics of two cultivars of zinnia plants

The data regarding some growth parameters are shown in Table 2. The results showed that such as plant height (cm) and number of leaves. Plant^{-1}, number of branches. Plant^{-1}, number of internodes. Plant^{-1}, plant fresh and dry weight, leaf area (cm^2), and finally total chlorophyll and total carotin were significantly affected by zinc application. The results indicated that Zn levels significantly varied the whole parameter of two Zinnia cultivars compared to the control. The main values of the data showed greater plant height and number of leaves. Plant^{-1}, number of branches., number of internodes, plant fresh and dry weight, leaf area (cm^2), and finally total chlorophyll, total carotin (94.837, 26.444, 8.333, 12.481, 262.440, 12.149, 24.817, 32.20, and 14.562), respectively, were recorded for Zinnia Lavanda cultivar with application of Zn at the rate 50% and (94.156, 26.889, 7.741, 12.593, 244.617, 11.908, 26.134, 39.749, and 14.145) respectively, were recorded for Zinnia rosso scarlatta cultivar with application of Zn at the rate 100%.

Table (3): Effect of foliar application of Zn % on different characteristics of two cultivars of Zinnia plants

Cultivar	Zn%	plant height (cm)	leaves number. Plant^{-1}	branches number. Plant^{-1}	internodes Number. Plant^{-1}	shoot fresh weight	shoot dry weight	leaf area (cm^2)	total Chlorophyll (mg/100g^{-1} fresh weight)	total Carotene (mg/100g^{-1} fresh weight)
Zinnia Lavanda	0.00	84.470^{c}	16.296^{b}	7.519^{ab}	7.926^{b}	143.869^{c}	9.372^{ab}	8.491^{b}	13.147^{c}	8.527b
	0.50	94.837^{a}	26.444^{a}	8.333^{a}	12.481^{a}	262.440^{a}	12.149^{a}	24.817^{a}	32.208^{b}	14.562^{a}
	0.75	92.359^{ab}	24.667^{a}	8.630^{a}	11.667^{a}	233.274^{ab}	13.082^{a}	24.224^{a}	31.907^{b}	14.105^{a}
Zinnia rosso scarlatta	0.00	86.177^{bc}	16.741^{b}	6.630^{a}	8.296^{b}	141.797^{c}	6.876^{b}	9.214^{b}	14.812^{c}	9.652^{b}
	0.50	91.059^{abc}	26.222^{a}	7.185^{ab}	11.481^{a}	159.258^{bc}	11.441^{ab}	22.269^{a}	37.122^{a}	12.482^{a}
	0.75	94.156^{a}	26.889^{a}	7.741^{ab}	12.593^{a}	244.617^{a}	11.908^{a}	26.134^{a}	39.749^{a}	14.145^{a}

Effect of BA concentration and Zn% on different characteristics of two cultivars of zinnia plants

The variability of growth parameters of zinnia cultivars in response to BA concentrations and Zn % foliar application is shown in table 4. In terms of the maximum plant height for two cultivars of (Zinnia Lavanda and Zinnia rosso scarlatta), the higher values reached 101.411 cm when spraying the plant by 50 mgl^{-1} + 0.50 % Zn and 96.622 cm at 0.50 % Zn alone respectively than the control plants (77.856 and 77.356 cm) respectively were obtained in two cultivars. While number of leaves, number of branches, number of internodes and leaf area (cm^2) increased significantly compared to control and other treatment, the main value reached (30.889, 9.778, 15.222 and 33.230 cm^2) respectively when the Zinnia Lavanda cultivar spraying with 100 mgl^{-1}BA+ 0.50% Zn. Also, the plant fresh weight, Plant dry weight, total chlorophyll and total carotin give the height value reached (333.080, 15.680, 42.714 and 17.90) respectively, when the Zinnia Lavanda cultivar spraying with 100 mgl^{-1}BA+ 0.75% Zn.

Concerning the combination of the three factors BA concentration and Zn% on different characteristics of Zinnia rosso scarlatta it was demonstrated that the Zinnia rosso scarlatta cultivar under spraying in 100 mgl^{-1}BA and 0.75 % Zn, which recorded the maximum value for number of branches, number of internodes, plant fresh weight, leaf area (cm^2) and total carotin reached (9.444, 14.556, 342.507, 29.690 and 17.112) respectively. However, the maximum number of leaves and Plant dry weight (30.667 and15.003) was noticed at 100 mgl^{-1}BA and 0.50 % Zn application, The total chlorophyll generally increased, but 50 mgl^{-1}BA and 0.50 % Zn concentrations in different concentrations had no statistically significant effect on the total carotin

Table (4): Effect of foliar application of BA concentrations and Zn% on different characteristics of two cultivars of zinnia plants

Cultivar	BA mgl^{-1}	Zn%	plant height (cm)	leaves number. Plant^{-1}	branches number. Plant^{-1}	internodes Number. Plant^{-1}	shoot fresh weight	shoot dry weight	leaf area (cm^2)	total chlorophyll (mg/100 g^{-1} fresh weight)	total carotene (mg/100g^{-1} fresh weight)
Zinnia	0	0.00	77.856^{de}	12.667^{e}	5.333^{f}	6.111^{d}	113.620^{c}	6.253^{ab}	8.735^{e}	8.689^{d}	7.486

Lavanda		0.50	90.311 a-d	19.333 cd e	6.889 b-f	9.667 a-d	137.233 c	7.793 ab	9.555 e	13.506 d	9.539
		0.75	87.211 b-e	19.556 b-e	7.889 a-f	8.444 cd	141.130 c	7.980 ab	12.163 de	13.508 d	8.926
		0.00	89.711 a-e	17.111 de	8.667 a-d	8.889 bcd	176.653 bc	10.430 ab	8.930 e	15.736 d	9.441
	50	0.50	101.411 a	29.111 ab c	8.333 a-e	12.556 abc	347.337 a	14.280 ab	31.667 a	41.886 ab	16.317 ab
		0.75	98.544 ab	24.222 a-d	8.444 a-e	12.889 abc	225.613 abc	15.587 a	28.080 ab	39.499 ab c	15.482 ab
		0.00	85.844 b-e	19.111 cd e	8.556 a-d	8.778 bcd	141.333 c	11.433 ab	7.808 e	15.015 d	8.654 c
	100	0.50	92.789 abc	30.889 a	9.778 a	15.222 a	302.750 ab	14.373 a	33.230 a	41.231 ab c	17.831 a
		0.75	91.322 abc	30.222 a	9.556 ab	13.667 abc	333.080 a	15.680 a	32.429 a	42.714 ab	17.907 a
		0.00	77.356 e	17.111de	5.667	7.778 bcd	112.053 c	4.853 b	8.433 e	10.221 d	9.457 c
	0	0.50	96.622 abc	22.889 a-d	7.000 a-f	8.889 bcd	122.463 c	7.233 ab	18.023 cd	34.497 bc	9.289 c
		0.75	90.444 a-d	25.778 a-d	6.667 c-f	11.000 a-d	149.283 bc	7.980 ab	21.975 bc	34.309 bc	9.947 c
		0.00	85.256 cde	16.000 de	7.889 a-f	8.111 a	177.400 bc	7.117 ab	9.574 e	16.415 d	9.668 c
Zinnia rosso scarlatta	50	0.50	87.167 b-e	25.111 a-d	6.778 a-f	12.000 a-d	224.503 abc	12.087 ab	19.319 c	44.715 a	13.507 b
		0.75	96.022 abc	25.333 a-d	7.111 a-f	12.222 abc	242.060 abc	12.903 ab	26.737 ab	43.239 ab	15.377 ab
		0.00	95.920 abc	17.111 de	6.333 def	9.000 bcd	135.937 c	8.657 ab	9.635 e	17.800 d	9.830 c
	100	0.50	89.389 a-e	30.667 a	7.778 a-f	13.556 abc	130.807 c	15.003 a	29.464 a	32.155 c	14.648 ab
		0.75	96.000 abc	29.556 ab	9.444 abc	14.556 ab	342.507 a	14.840 a	29.690 a	41.698 ab	17.112 ab

DISCUSSION

Zinnia seedlings, when treated with varying concentrations of BA and ZnSO4, showed increases in several growth measurements presented in Tables 2, 3, and 4. Regarding the main impact of varying BA rates on plant growth parameters, show when the plants were sprayed with BA and give much higher vegetative growth traits than the control treatment. Spraying plants with BA at 100 mgl^{-1}gave the highest mean values of plant height, branches number per plant, leaf area, shoot fresh and dry weights per plant during the study for two cultivars compared to the control treatments. However, there was no significant difference recorded between the two concentrations of BA (50, and 100 mgl^{-1}) in branches number per plant and leaf area. In general, BA has the ability to promote cell division and elongation may account for its greater impact on vegetative development metrics. **[25, 26]**, which leads to stimulation of primordial production and partially intermodal elongation on the apex **[27],** which is reflected in the increase of plant height. Cytokinins are essential for preventing or reducing apical dominance and promoting the release of axillary buds from apical dominance. **[28, 29 ,30]** which lead to an increase in branches number and leaves number per plant. The results obtained are comparable with those obtained by **[25]** on *Codiaeum variegatum* L. Cytokinin is a growth-control hormone that stimulates the production of proteins, cell division, expansion, and the mobilization of nutrients **[31]**. Also, exogenous applications of BA are made to promote cell expansion which leads to increasing the leaf area **[32]**. The general increase in leaf area because of BA treatments agrees with the findings of **[33]** on *Helleborus Oriental*, **[34]** on *Echinacea Hybrids* and **[35]** on the aster plant

The positive effect of BA on shoot fresh and dry weights could be interpreted by the findings of **[36]** who believed that BA functions in promoting xylem differentiation and vascular strand development, which in turn led to more absorption of water and nutrients from the soil and. which was reflected in higher growth and may account for the greatest fresh weight also it could be attributed to the increment in plant height and branches number because of

overcoming the apical dominance of the plant leading to the formation of more leaves. The effect on shoot fresh and dry weights was authenticated by may authors. **[37]** on *Polianthus tuberosa* and **[38]** on *Calandula officinalis* concluded that BA application increased the shoot fresh and dry weights. **[39]** reported that the maximum values of shoot fresh and dry weights of some ornamental plants resulted from BA at 25 mgl^{-1}. These results obtained by **[40]** on Coroton plant, and **[41]** on gladiolus.

On the other hand, the effect of different rates of Zn spraying on plant growth parameters, show in Table (2, 3 and 4) indicated that spraying zinnia plants with different levels of Zn significantly increased vegetative growth parameters compared to control treatment. Spraying plants with Zn at 0.75 % gave the highest values of plant height, branch number per plant, leaf area, and shoot fresh and dry weights per plant during the study on the two cultivars compared to the control treatments. One of the reasons plants grow taller than untreated plants is because zinc has an advantageous impact on the biosynthesis of auxin hormones, which can promote cell division and elongation **[42]** reported that the positive effect of Zn on plant growth may be due to its roles in auxin biosynthesis through the amino acid tryptophan. Moreover, **[43]** and **[44]** demonstrated that the rise in internode length caused by the enlargement of protoplasm in cell wall material proportion and consequently, the resulting increase in cell size that showed up as intermodal elongation may be the main reason for an increase in shoot height after zinc treatment.

Also, increasing the chlorophyll content, leaf area, and another parameter by applying zinc sulfate can improve photosynthesis and enhance dry matter accumulation and lead to increased shoot dry weights, which will result in increasing the vegetative growth. Foliar zinc has significantly affected the leaf area which might be due the fact that zinc activated different types of enzymes which ultimately increased the leaf area of zinnia plant. These results are in line with **[45].** The foliar application of zinc was significantly increasing development growth and size of spike of gladiolus plant **[24].** Foliar zinc application significantly affected the leaves number also; zinc might be activated by different types of enzymes which increase the number of leaves and leaf area. These results are in line with **[46]** who reported that zinc application significantly increased plant height, number of leaves and leaf area of gladiolus plant.

CONCLUSION

In conclusion, the present study indicated that the growth parameters of two cultivars of zinnia plants were highly enhanced by spraying different concentrations of BA and varied levels of zinc. 100 mgl^{-1} is considered the best treatment to produce admirable vegetative parameters of zinnia plants under the environmental conditions of this study. As well as the zinc application levels increasing growth, based on the experimental results, the following conclusions were obtained: number of leaves, number of branches, number of internodes, leaf area (cm^2) and plant height performed better with foliar Zn application of 0.50 and 0.75 percent combined with 100 mgl^{-1} **at BA** .

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تأثير مستويات مختلفة من الزنك والبنزيل الأدينين عن طريق الرش على النمو الخضري لصنفين من نبات الزينيا*Zinnia elegan*.

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الخلاصة
أجريت هذه الدراسة في مشتل قسم البستنة، كلية علوم الهندسة الزراعية، جامعة دهوك. إقليم كردستان، العراق، للفترة من 5 2024 لدراسة تأثير مستويات مختلفة من الزنك (0، 0.50، و 0.75) وتركيزات مختلفة من ***BA*** (0 ، 50و 100) ملغم/لتر على بعض المعايير الخضرية لصنفين من نبات الزينيا. وكانت النتائج كما يلي: أظهرت القيم المتوسطة أن أكبر النباتات (90.556 سم) تم تسجيلها في صنف ***Zinnia Lavonda***. كما أظهر نفس الصنف أقصى عدد من الفروع والوزن الطازج والجاف والكاروتين الكلي الذي بلغ (8.160، 213.194 غم، 11.534 غم، و 12.398) على التوالي. بينما كانت نتائج عدد الأوراق، وعدد السلاميات، ومساحة الورقة، والكلوروفيل الكلي، في صنف ***Zinnia rosso scarlatta*** ، حيث بلغت أعلى النتائج (23.284، 10.790، 19.206، و30.561) على التوالي. حول العوامل الثلاثة، أقصى ارتفاع للنبات لصنفين ***Zinnia Lavanda*** و***Zinnia rosso scarlatta*** ، وصلت القيم الأعلى إلى 101.411 سم عند رش النبات بـ 50 ملغم/لتر-1 + 0.50% زنك و96.622 سم عند 0.50% زنك على التوالي، مقارنة بمعاملة المقارنة التي بلغت (77.856 و77.356 سم) على التوالي. بينما زاد عدد الأوراق وعدد الفروع وعدد العقد ومساحة الورقة (سم²) بشكل ملحوظ مقارنة معاملة المقارنة والمعاملات الأخرى، وصلت القيمة الرئيسية إلى (30.889 و778.9 و15.222 و33.230 سم²) على التوالي، عند رش صنف ***Zinnia Lavonda*** بـ 100 ملغم/لتر ***BA*** + ***0.50%*** زنك. كما أن الوزن الطازج للنبات، والوزن الجاف للنبات، والكلوروفيل الكلي، والكاروتين الكلي أعطت اعلى القيم التي تم الوصول إليها (333.080، 15.680، 42.714، و17.90) على التوالي، عند رش صنف ***Zinnia Lavanda*** بـ 100 ملغم/لتر ***BA*** + ***0.75%*** زنك.

الكلمات المفتاحية: مستويات الزنك، تركيزات (BA)، الرش، النمو الخضري، صنفين من نبات الزينيا.