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Impact of humic acid and benzyl adenine Spraying on Coriander Plant Development and yield (*Coriandrum sativum* L.)

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Abstract

A field experiment was carried out in Kirkuk governorate for the agricultural season 2019-2020 to find out the effect of by two concentrations of the growth regulator benzyl adenine level are sprayed (0 and 250 mg L^{-1}) and two concentrations of organic acids (humic acid) (0 and 2 ml L^{-1} (RCBD) as a factorial experiment with three replications, and the results: studied by and gave it the highest average in plant height, number of leaves, number of vegetative branches, fresh weight of the vegetative total, and the yield of the experimental unit, the values were respectively (21.053 cm plant-1) (50.442 leaves plant^{-1}) and (12.330 branches plant^{-1}) and (44.145 g Plant-1) (222.39 kg. dounm^{-1}). While spraying the second level B1 (250 mg L^{-1}) of benzyl adenine achieved a significant increase in plant height, number of leaves, number of vegetative branches, fresh weight of shoots, and yield of the experimental unit, the values were respectively(30.830 cm plant^{-1}) and (41.110 leaves plant $^{-1}$), (10,053 branches plant^{-1}), (32.705 gm plant^{-1}), and (163.53 kg dounm^{-1}). As for the interaction between the two factors, the H1B1 combinatorial treatment (250 mg L^{-1} + 2 ml L^{-1}) achieved a significant increase in plant height (31.663 cm Plant^{-1}), the number of leaves (56.77 leaves Plant^{-1}) and the number of vegetative branches (14,553 branches plant^{-1}), the fresh weight of the shoot was (45.683 gm plant-1), and the yield of the experimental unit was (288.42 kg plant^{-1}). As for the simple correlation, the correlation was significant and positive for most studied traits.

Keywords: coriander plant, benzyl adenine, humic acid, simple binding.

Introduction:

Coriander plant (*Coriandrum sativum L.*) is one of the medical plants used since ancient times. It was found in a cave in Palestine and dates back to 6000 BC. The Assyrians, the ancient Egyptians, and the Chinese used it as food and medicine thousands of years before Christ, and it was used by the ancient Egyptians and pharaohs to expel intestinal gases. Coriander has been used medicinally, aromatically and nutritionally, and among its most important medical uses is that it is a gas repellant, analgesic for colic and pneumonia (Al-Rawi and Jakarta Varty, 1988) and as a treatment for joint pain and rheumatism (The Arab Organization for Agricultural Development, 1988) and a cure for hematuria (Al-Degwi, 1996) and a reduction in blood sugar. (Gray and Flatt, 1999). And aromatically to improve the taste and smell of medicines and to enter the manufacture of cosmetics, perfumes and soaps. As for food, it is used as a seasoning to open the appetite and improve the taste of pastries, sweets and many foods and food products.

And Lieth et al. (2004) conducted a study on Artemisia lactiflora (Guizho) when adding the fascination complex, which consists of the growth regulators gibberellin and benzyl adenine (BA + GA) at a ratio of (1.8 + 1.8) w/w at a concentration of (0.125.250.500 mg L^{-1}, as it obtained in the concentration (250) mg L^{-1} an increase in the average number of branches and reached (34.78) branches plant^{-1} compared to the comparison treatment, which amounted to (18.33) branches plant^{-1}, although it reduced the plant height. Rodrigo and Marcelo (2007)

showed that the effect of humic acid was positive on the growth of some field crops and some other herbaceous plants, including rosemary.

Wuyan et al. (2008) noted that the addition of humic acid to plants of the Umbilaceae family, including Angelica sinensis L., led to an increase in the morphological characteristics of the plant, as it obtained a significant increase in the number of leaves, leaf area, vegetative weight, and dry weight.

As Saleh (2012) showed, when spraying fenugreek plant Trigonella foenum-graecum L. with the growth regulator benzyl adenine at a concentration of (200 mg L^{-1}), the plants excelled in the number of leaves, branches, leaf area, stem diameter, chlorophyll concentration, percentage of dry matter and carotene in the leaves, and the number of Pods, number of seeds, weight of (100) seeds, characteristic of pod diameter, and total yield compared to the comparison treatment.

Amin (2013) when studying star anise plant L. Pimpinella anisum when it was treated with humic acid at a concentration of (6 kg ha^{-1}) obtained a significant increase in the studied characteristics, as the treatment excelled by giving it the highest values for the following characteristics: plant height, number of branches, number of leaves, and percentage of chlorophyll in the leaves and the percentage of dry matter and the concentration of mineral elements in the leaves such as nitrogen, phosphorus and potassium.

Suleiman (2015) concluded in a study conducted on the watercress plant, Eruca sativa Mill. Spraying plants with benzyl adenine at a concentration of (150 mg.L-1) led to a significant increase in the studied traits by giving it the highest average values for the following traits: number of leaves, fresh weight of shoots, experimental unit yield of leaves, and plant yield of leaves. The study aimed to know the effect of spraying with acid Humic and benzyl adenines and their interaction in growth and yield of coriander plant.

Materials and methods:

A field experiment was carried out in Kirkuk governorate as a factorial experiment with a randomized complete block design with three replications to study the effect of spraying with humic acid and benzyl adenine on the growth and yield of coriander plant. Second, the growth regulator included benzyl adenine (B), with a concentration of (0 - 250) mg L^{-1}. The experiment included (12) experimental units distributed over three replicates with (4) experimental units for one replicate, so the area of the experimental unit was (0.5*1). (m^2) and left (6 cm) on both sides. The plants were planted in daybreaks, with (3-4) plants in each square, and the seeds germinated after (7-9) days had passed, then they were transferred to the field after a month and a half of planting, where they were planted in a line of 5 square meters. Plants per unit, and the distance between one plant and another is (22 cm), and then the process of thinning the plants was carried out, and one plant was left for each pot, and one tampon was taken after the completion of plant growth. First, the spraying process was carried out for the treatments in the evening to avoid sunlight, and it was sprayed with a 16-liter hand sprayer, with constant pressure, and distributed on treated plants until complete wetness.. The results were analyzed according to the design used and the averages were compared according to Duncan's Multiple Range test under the level of probability of 5% (Al-Rawi Khalafallah, 2000). The vegetative growth characteristics of 3 plants taken from the center of the experimental unit were studied in the pre-flowering stage, before the emergence of flower buds, as the concentration of active substances decreases in the flowering stage (Al-Degwi, 1996). Plant height (cm), number of leaves (leaf $plant^{-1}$), number of branches (branch.$plant^{-1}$), fresh weight of shoots (gm $plant^{-1}$), yield of experimental unit of fresh weight (kg $dunum^{-1}$).

Results and discussion:

Plant height (cm $plant^{-1}$):

Table (1) shows the effect of spraying benzyl adenine and humic acid and the interaction between them on the plant height characteristic. Cells, their breadth and elongation (Hassan and

Issa, 2010). As for humic acid, there were no significant differences between the concentrations used.

Table (1) Effect of spraying benzyl adenine and humic acid and the interaction between them on the height of coriander plant (cm.plant $^{-1}$)

Benzyl adenine / Humic acid	B0	B1	average humic acid concentrations
H0	7.88 b	29.99 a	18.94 a
H1	10.44 b	31.66 a	21.05 a
Average benzyl adenine concentrations	9.16 b	30.83 a	

Similar letters, there are no significant differences between them according to Duncan's multiple range test at the level of 5%.

Number of leaves (leaf plant^{-1}):

Table (2) shows the effect of spraying benzyl adenine and humic acid and the interaction between them on the characteristic of the number of plant leaves, as the results show significant differences between the levels, as the second level was superior in all workers compared to the comparison treatment. As for the interaction coefficients between the levels of benzyl adenine and humic acid, the superiority of the second level of humic acid and benzyl adenine (H1B1), which amounted to (56.777) leaves plant^{-1}. The reason for increasing the number of plant leaves by increasing benzyl adenine may be attributed to the fact that the growth regulator stimulates cell division and expansion as it leads to the formation of vegetative buds (leafy) by stimulating the differentiation of tissues and their development into leaves, in addition to the fact that benzyl adenine thus stimulates the emergence of leafy side buds (Hassan and Issa, 2010).

Table (2) the effect of spraying with humic acid and benzyl adenine and the interaction between them on the characteristic of the number of leaves of the coriander plant (leaf plant^{-1})

Benzyl adenine / Humic acid	B0	B1	average humic acid concentrations
H0	10.99 d	25.44 c	18.22 b
H1	44.10 b	56.77 a	50.44 a
Average benzyl adenine concentrations	27.55 b	41.11 a	

Similar letters, there are no significant differences between them according to Duncan's multiple range test at the level of 5%.

Number of vegetative branches (branch plant^{-1}):

Table No. (3) Shows the effect of spraying benzyl adenine and humic acid and the interaction between them in the number of branches characteristic. The results showed that the second concentration of benzyl adenine B1 was superior to an average of (10.71) branch.plant-1. The reason for the increase in the number of branches may be attributed to the increase in benzyl adenine according to It was mentioned by (Hassan and Issa, 2010) that benzyl adenine stimulates cell division and expansion as it leads to the formation of leafy buds (vegetative) by stimulating the differentiation of tissues and their development into branches, in addition to that benzyl adenine ends apical dominance and thus stimulates the emergence of leafy side buds.

As for humic acid, the results showed that there were no significant differences for the concentrations used. As for the interaction between the treatments, the treatment (H1B1) excelled significantly with an average of (10.88) branch Plant^{-1}, followed by the treatment (H0B1), which

also showed a significant difference of (10.55) branch plant^{-1}. As for the effect of humic on the number of branches, it may be attributed to the action of humic acid, which improves the chemical, physical, fertility and vitality of the soil, improves the exchange capacity, increases the readiness of nutrients, soil composition and aeration, respiration of the roots and ease of their penetration into the soil, increases the root system, increases the readiness of nutrients and their absorption from the roots of the plant and then Increase vegetative branches of the plant (Garcia et al., 2008).

Table (3) Effect of spraying benzyl adenine and humic acid and the interaction between them on the characteristic of the number of vegetative branches (branch plant^{-1})

Benzyl adenine / Humic acid	B0	B1	average humic acid concentrations
H0	3.30 c	5.55 c	4.42 b
H1	10.10 b	14.55 a	12.33 a
Average benzyl adenine concentrations	6.70 b	10.05 a	

Similar letters, there are no significant differences between them according to Duncan's multiple range test at the level of 5%.

Characteristics of the fresh weight of the vegetative total (kg plant^{-1}):

Table (4) shows the effect of spraying benzyl adenine and humic acid and the interaction between them on the fresh weight characteristic of the shoot group to the superiority of the second level of humic acid H1, which amounted to (44.145) gm plant^{-1} compared to the control treatment, which amounted to (13.163) gm plant^{-1} The increase in humic acid levels may be attributed to the action of humic acid, which improves the chemical, physical, fertility and vitality of the soil, improves the exchange capacity, increases the readiness of nutrients, soil composition, aeration, root respiration, ease of penetration into the soil, an increase in the root system, and increases the readiness of nutrients and their absorption from plant roots, and thus The increase in the vegetative total, which is reflected in the increase in the fresh weight of the vegetative total (Garcia et al., 2008). As for the second factor, benzyl adenine, there were no significant differences between the two levels, despite the increase in the second level compared to the comparison treatment. As for the overlap treatments, the two treatments (H1B1) and (H1B0) were significantly superior to the rest of the treatments, which amounted to (45.683) and (42.107) gm plant^{-1}, respectively, while the comparison treatment had the lowest values, which amounted to (13.163) gm plant^{-1} .

Table (4) Effect of spraying benzyl adenine and humic acid and the interaction between them on the fresh weight of shoots of coriander plant (gm plant^{-1})

Benzyl adenine / Humic acid	B0	B1	average humic acid concentrations
H0	13.16 b	19.72 a	16.44 b
H1	42.10 a	45.68 a	44.14 a
Average benzyl adenine concentrations	27.88 a	32.70 a	

- Similar letters, there are no significant differences between them according to Duncan's multiple range test at the level of 5%.

5- The yield of the experimental unit of fresh weight (kg. dounm-1):

Table (5) shows the effect of spraying benzyl adenine and humic acid and the interaction between them on the characteristic of the yield of the experimental unit of fresh weight, to the superiority of the second level of humic acid H1, which amounted to (222.39) kg. Dounm-1. The rea-

son may be attributed to the increase in the yield of the experimental unit of weight. Softening by increasing the levels of humic acid to the action of humic acid, which improves the chemical, physical, fertility and vitality of the soil, improves the exchange capacity and lowers the pH of the soil, which increases the readiness of nutrients and their absorption from the roots of the plant and thus increases the vegetative system, which is reflected in an increase in the fresh weight of the vegetative group, soil composition, aeration and root respiration. and easy penetration into the soil and increase the root system (Garcia et al., 2008). As for the second factor, benzyl adenine, there were no significant differences between the two levels, despite the increase in the second level compared to the comparison treatment. As for the overlap treatments, the treatment (H1B1) and the treatment (H1B0) were significantly superior to the rest of the treatments, which amounted to (228.42) and (216.37) kg dounm^{-1}, respectively, while the comparison treatment had the lowest values, which amounted to (65.92) kg dounm $^{-1}$.

Table (5) Effect of spraying benzyl adenine and humic acid and the interaction between them on the experimental unit yield of fresh weight of coriander plant (kg dounm $^{-1}$)

Benzyl adenine / Humic acid	B0	B1	average humic acid concentrations
H0	65.92 b	98.63 b	82.28 b
H1	216.37 a	228.42 a	222.39 a
Average benzyl adenine concentrations	141.14 a	163.63 a	

- Similar letters, there are no significant differences between them according to Duncan's multiple range test at the level of 5%.

6-Correlation values for the studied traits:

Table (6) shows the effect of spraying benzyl adenine and humic acid and the interaction between them on the value of the simple correlation of the studied characters, as it was found that the correlation was significant and positive for the characteristic of plant height with the number of leaves, the number of branches, fresh weight, and the yield of the experimental unit at the level of probability of 5%, and for the characteristic of the number of leaves, the correlation was significant With the number of branches, fresh weight, and the yield of the experimental unit at the level of probability 1%. As for the characteristic of the number of branches, the correlation was also significant with the characteristics of the fresh weight and the yield of the experimental unit at the level of probability 1%. 1% probability.

Table (6) Effect of spraying benzyl adenine and humic acid and the interaction between them on the simple correlation value of the studied traits

traits	plant height	number of sheets	Number of branches	soft weight	The yield experimental unit
plant height	1	.514	.496	.322	.311
number of sheets		1	.968**	.926**	.930**
Number of branches			1	.934**	.933**
soft weight				1	.999**

Conclusions:

As spraying with benzyl adenine at the second concentration B1 (250 mg L^{-1}) led to superiority in plant height, number of leaves and number of branches. Spraying with humic acid led to significant differences in the number of leaves, the number of vegetative branches, the fresh

weight of the shoot group, and the experimental unit yield of the fresh weight of the plant. The interaction between the second level of benzyl adenine and humic acid (B1H1) (250 mg L^{-1} + 2 ml L^{-1}) was better in improving all studied traits.

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تأثير الرش بحامض الهيوميك والبنزيل ادنين في نمو وحاصل نبات الكزبرة (*Coriandrum sativum* L.)

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الخلاصة

نفذت تجربة حقلية في محافظة كركوك للموسم الزراعي ٢٠١٩-٢٠٢٠ لمعرفة تأثير الرش بتركيزين من منظم النمو بنزيل ادنين بمستوى (٠ و ٢٥٠ ملغم لتر-١) وتركيزين من المادة العضوية. أحماض (حامض الهيوميك) (٠ و ٢ مل لتر-١ (RCBD) تجربة عاملية بثلاثة مكررات، وكانت النتائج: تمت دراستها وأعطتها أعلى متوسط في ارتفاع النبات، عدد الأوراق، عدد الأفرع الخضرية، الطازجة وزن المجموع الخضري وحاصل الوحدة التجريبية كانت القيم على التوالي (٢١.٠٥٣ سم نبات-١) (٥٠.٤٤٢ ورقة نبات-١) و (١٢.٣٣٠ فرع نبات-١) و (٤٤.١٤٥ جم نبات-١) (٢٢٢.٣٩) كغم.دونم-١) بينما أدى رش المستوى الثاني B1 (250ملغم لتر-١) من بنزيل أدنين إلى زيادة معنوية في ارتفاع النبات وعدد الأوراق وعدد الأفرع الخضرية والوزن الطري للأفرع وحاصل التجربة التجريبية. للوحدة، كانت القيم على التوالي (٣٠.٨٣٠ سم نبات-١) و (٤١.١١٠ ورقة نبات-١)، (١٠.٠٥٣ فرع نبات-١)، (٣٢.٧٠٥ غم نبات-١)، و (١٦٣.٥٣ كغم دونم-١). أما بالنسبة للتفاعل بين العاملين فقد حققت المعاملة التوافقية H1B1 (250 ملغم لتر-١ + ٢ مللتر-١) زيادة معنوية في ارتفاع النبات (٣١.٦٦٣ سم نبات-١) وعدد الأوراق (٥٦.٧٧ ورقة نبات- ١) وبلغ عدد الفروع الخضرية (١٤,٥٥٣ فرع نبات-١)، وبلغ الوزن الرطب للمجموع الخضري (٤٥.٦٨٣ غم نبات-١)، وبلغ حاصل الوحدة التجريبية (٢٨٨.٤٢ كغم نبات-١). أما بالنسبة للارتباط البسيط فقد كان الارتباط معنوياً وإيجابياً لأغلب الصفات المدروسة.

الكلمات المفتاحية: نبات الكزبرة، بنزيل أدنين، حامض الهيوميك، الارتباط البسيط.