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Effect Of Humic Acid Treatment, Acid Addition Periods, And Irrigation Intervales On Growth Characteristics And Mineral Content Of Clandulla Officinalis L

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Absract: *This study was conducted in one of the nurseries in Al-Dour district - Salah Al-Din Governorate for the agricultural season 2024-2025 to study the effect of concentrations of humic acid, periods of its addition and different irrigation intervales on the growth characteristics and mineral content of the chrysanthemum plant Clandulla officinalis L. using plastic pots. The first factor was the addition of humic acid to the anvils at concentrations of 1, 2 and 3 ml, and the second factor was the periods of adding the acid after 20, 40 and 60 days of planting The third factor is irrigation every two, three, and four weeks. Statistical analysis was conducted at a level of (P≤0.05), and the results showed the following:*

The triple interaction(adding 3 ml of Humic acid, adding it after 40 days, and irrigating every two weeks)superior with the highest values for characteristics plant hight, number of branches, , number of leaves per plant,leaf relative water content % and chlorophyll content with ratio reached 15.50 cm,8.90 branch,84.40 leaf, 119.00% and 18.20 mg gm^{-1}.The same interaction superior in the mineral nutrteion concentration Nitrogegen,Phosphor and Potassium.

Key words: *Clandulla officinalis+Humic acid +Irrigation+Growth triats+Mineral*

INTRODUCTIN

Clandula officinalis is a medicinal plant belonging to the Asteraceae family. It is an annual winter herbaceous plant of economic and medicinal importance due to its content of medically active ingredients, its fast growth, and its flowers that are easy to pick and arrange (Badr, 2002). The flowering period of this plant is long, as it opens with sunrise and moves throughout the day (Al-Atraqji, 2019). Its flowers are among the oldest used by ancient herbalists in treatment many diseases to rid the body of harmful toxins. It was grown in homes to get rid of flies (Mahmoud, 2005). The plant is also widely used in medicines because its contents are safe to use (Ishan, 2020). It is used to treat diseases such as infections and wounds (Sharif et al., 2018, Rad et al., 2019). Industrially, some essential oils are used in the manufacture of sweets and pastries, including biscuits, some food products, and dairy products, due to their aromatic smell and distinctive taste (Bhat et al., 2002). The extract of the flower inflorescences is used to color cheeses, as they contain high levels of carotenes. They are also added to fish and bird feed to increase production and improve their quality (Shams El-Din, 2000, Kampuss, Rudite, 2014).

Water scarcity not only affects growth but also leads to poor crop yields and significant financial losses. Even in areas where irrigation water is available year-round, farmers fail to meet optimum requirements due to a lack of knowledge about the quantity and timing of irrigation. Irrigation scheduling is the process of determining the timing and amount of irrigation. Implementing proper irrigation scheduling is essential for the efficient use of water, energy, and other production inputs (Khan et al., 2007).

Humic acid is black in color and odorless organic fertilizer, harmless to humans, plants, and the environment, and has physiological importance for plants and physical, chemical, and biological importance for the soil (Zahwan and Akhorn, 2010 and Abdel-Hafez, 2012). Humic acid is one of the important humic organic acids because it contains many nutritional elements, which prompted researchers to add it to agricultural crops (Berger and Gutjahr, 2021).

In recent years, organic fertilizers such as humic have been used at balanced levels to improve soil properties, plant nutrition, accelerate vegetative growth, and thus increase production (Zidan and Diop, 2005). Humic contributes to maintaining a clean environment by reducing the harmful effects of pesticides, as well as increasing root growth and elongation by increasing the amount of nutrients absorbed from the soil by the roots. Olaetxea et al. (2016)

Materials &Methods: This study was conducted during the agricultural season 2024-2025 in one of the agricultural nurseries in Al-Dour District - Salah Al-Din Governorate) during the period from October 15, 2023 to May 1, 2024. The seeds of the annual winter chrysanthemum plant, SAKATA Japanese variety, which is a mixture of yellow and orange colors, were planted using plastic pots with a diameter of (30) cm, a height of (40) cm, and a weight of (15) kg of soil, with 5 plants in each pot on October 15, 2023. The pots were filled with a mixture of soil and peat moss at a ratio of 2:1. A completely randomized design (CRD) was used with three replicates. With three factors, the first factor is humic acid at three concentrations (1, 2 and 3) ml Ansandana-1, the second factor is adding humic acid at different periods of planting after (20, 40 and 60) days of planting and the third factor is irrigation periods which are every (2, 3 and 4) weeks and thus the number of factors reached 18 treatments in three replicates distributed randomly.

Studiedcharacteristics:

* **Plant height (cm):** The height of the plants taken from the point of contact with the soil to the highest growing tip was measured using a measuring tape. The measurements were recorded and the arithmetic mean was calculated.

* **Number of branches (plant^{-1})**: The number of branches on each of the selected plants was calculated, and the average number of branches per plant was calculated.

* **Relative leaf water content** (%)**:** Measured according to the following treatment.

$$RWC = \frac{FW - DW}{TW - DW}$$

RWC = Relative Water Content of Leaves

FW = Fresh Leaf Weight Immediately After Harvest (g)

TW = Weight of Full Leaves (g)

***Number of Leaves per Plant^{-1}:** Calculated for each plant in the pots.

* **Chlorophyll concentration in leaves (mg gm^{-1} wet weight):** The amounts of chlorophyll a, b, and total chlorophyll in the leaves and stems of wheat plants were estimated. Absorbance readings were performed at wavelengths of 645 and 663 nm using a spectrophotometer. The following equations were used to calculate the amount of chlorophyll:

Chlorophyll a = (12.7×A663) - (2.69×A645) × V/(1000×w)

Chlorophyll b = (22.9×A645) - (4.68×A663) × V/(1000×w)

Total chlorophyll = 20.2(A645) + 8.02(A663) × V/(1000×w)

* Estimation of mineral elements (%):

*Nnitrogen concentration (N%): Nitrogen was estimated using a micro-Kjeldahl device according to the method described by (Mulvaney and Bremner, 1982).

*Pphosphorus concentration (P%): Phosphorus was estimated using a spectrophotometer according to the method described by Page et al. (1982).Ppotassium concentration (K%): Potassium was estimated using a flame photometer according to the method described by Page et al. (1982).

The data were analyzed statistically using a computer and depending on the (SAS) program, and the computer means were compared to the multinomial academic characteristics at a probability level of (0.5)% Duncuns Multiple Range Test (Al-Rawi and Khalaf Allah, 2000).

RESULTA&DISCUSSION:

Plant high (cm): The results of Table (1) show that the treatment with humic acid significantly affected the height of chrysanthemum plants. The treatment with a concentration of 3 ml of acid gave the highest height of 17.43 cm, an increase of 112.30% compared to the control treatment (without treatment), which had a plant height of 8.21 cm. The same table results refer that the periods of adding the acid had a significant effect on the plant height trait, as the addition period gave after 40 days, the maximum plant height reached 15.25 cm, an increase of 25.10% compared to the 20-day period, which yielded the lowest height of 12.19 cm, which was not significantly different from the 60-day period., we note that irrigation at different intervals had a significant effect on plant height. Irrigation every two weeks yielded the highest height of 14.9 cm, an increase of 24.48% compared to irrigation every four weeks, which yielded the lowest height of 11.97 cm, while irrigation every three weeks was not significantly different

The two-way interaction between the studied factors had a significant effect on the studied characteristics, the different acid concentrations and application periods was significant, with the 3 ml concentration added every 40 days yielding the highest plant height of 17.98 cm, with an increase rate of 188.60% compared to the 1 ml concentration and application every 20 days, which yielded the lowest height of 6.23 cm, and the interaction between acid addition periods and different irrigation periods also showed a significant effect on plant height, with acid addition every 40 days and irrigation every two weeks yielding the highest plant height of 16.23 cm, with an increase rate of 57.11% compared to addition every 20 days and irrigation every 4 weeks, which gave the lowest height of 10.33 cm, while it did not differ significantly from addition every 40 days and irrigation every 3 weeks, also interaction between acid concentrations and irrigation intervals showed a significant effect on plant height, as the 3 ml acid concentration with irrigation every two weeks resulted in the highest height of 18.20 cm, with an increase rate of 205.36% compared to the 20 ml acid concentration and irrigation every 4 weeks, which gave the lowest height of 5.96 cm, while it did not differ significantly with the 3 ml concentration and irrigation every 3 weeks.

The triple interaction between the three studied factors showed a significant effect on plant height, as the treatment (with a concentration of 3 ml of humic acid, added every 40 days and irrigated every two weeks) outperformed with the highest plant height of 18.50 cm, an increase of 270% compared to (with a concentration of 1 ml, added every 20 days and irrigated every 4 weeks), which gave the lowest value of 5 cm. However, it did not differ significantly from the treatment with a concentration of 3 ml, added after 40 days and irrigated every 3 weeks.

Table (1): Effect of different concentrations of humic acid, treatment periods and irrigation at different intervals on plant high (cm).

Humic acid Conc.	Humic acid Adding perriods(day)	Irrigation intervals(week)			Humic Conc.×Humic adding period	Humic Conc. Mean
		2	3	4		
1	20	6.90k	6.80	5.00m	6.23g	8.21c
	40	12.20g	12.00g	12.20g	10.40e	
	60	10.50i	10.00j	5.90l	8.00f	
2	20	14.90ef	14.70ef	11.00h	15.53b	15.64b
	40	18.00ab	17.86b	16.30d	17.39a	
	60	17.00c	16.80c	14.50f	16.00b	
3	20	17.80b	17.70b	15.00e	16.83a	17.43a
	40	18.50a	18.44a	17.00c	17.98a	
	60	18.30a	18.20ab	16.00d	17.00a	
Irrigation intervals Mean		14.90a	14.72a	11.97b	Humic adding period Mean	

Humic adding period.×Irrigation intervals	20	13.230b	13.06b	10.33c	12.19bc
	40	16.23a	16.10a	13.43b	15.25a
	60	15.26ab	15.00ab	12.13bc	13.66b
Humic Conc. ×Irrigation intervals	1	9.86d	9.60d	5.96e	
	2	16.63b	16.46b	13.93c	
	3	18.20a	18.11a	16.00b	

***Similar letters in the table mean no significant difference at the 5% probability level.**

***Number of branches plant^{-1}**:The results in Table (2) indicate a significant effect by treatment with different concentrations of humic acid on the number of branches plant^{-1}. The 3 ml concentration of humic acid gave the highest value reaching 6.54 branches with an increase rate of 64.73% compared to the 1 ml concentration of acid which gave the lowest number reaching 3.97 branches plant^{-1}, However it did not differ significantly from the 2 ml concentration. Also the table shows that the average periods of acid addition had a significant effect on the number of branches per plant. The period of addition every 40 days gave the highest number of branches, reaching 6.42 branches, with an increase rate of 35.15% compared to the period of acid addition every 20 days, which gave the lowest value of 4.75 branches, while it did not differ significantly from irrigation every three weeks , also from the table results we note that irrigation at different intervals has a significant effect on the number of branches per plant. Irrigation every two weeks gave the highest value of 6.17 branches, with an increase rate of 26.69% compared to irrigation every four weeks, which gave the lowest value of 4.87 branches.

The two-way interaction between the studied factors had a significant positive effect on the number of branches trait. The different acid concentrations and acid addition periods had a significant effect on the number of plant branches. The concentration of 3 ml added every 40 days was higher reaching 7.93 branches, with an increase rate of 133.23% compared to the concentration of 1 ml and the addition every 20 days which gave the lowest value for the mentioned interaction, was 3.40 branches. also the interaction between the acid addition periods and the different irrigation periods showed a significant effect on the number of plant branches trait, as the acid addition every 40 days and irrigation every two weeks gave the highest value for the number of plant branches, which amounted to 6.93 branches, with an increase rate of 654.0% compared to the addition every 20 days and irrigation every 4 weeks, which gave the lowest value, which amounted to 4.50 branches, and the interaction between acid concentrations and periods showed a significant effect on the number of plant branches, as the concentration of 2 ml of acid with irrigation every two weeks gave the highest value of 7.17 branches and an increase rate of 93.78% compared to the concentration of 1 ml of acid and irrigation every 4 weeks, which gave the lowest value of 3.70 branches, while it did not differ significantly with the concentration of 3 ml and irrigation every two weeks.

Interaction between the three studied factors showed a significant effect on the number of branches trait, as the treatment (at a concentration of 3 ml of humic acid, added every 40 days and irrigated every two weeks) had the highest value of 8.90 branches per plant^{-1}, with an increase rate of 187.09% compared to a concentration of 1 ml of acid, added every 20 days and irrigated every 4 weeks, which gave the lowest value of 3.10 branches per plant^{-1}.

Table (2): Effect of different concentrations of humic acid, treatment periods and irrigation at different intervals on branvh number plant^{-1}.

Humic acid Conc.	Humic acid Adding perriods(day)	Irrigation intervals(week)			Humic Conc.×Humic adding period	Humic Conc. Mean
		2	3	4		
1	20	3.60m	3.50m	3.10n	3.40f	3.97b
	40	4.40k	4.30k	4.00l	4.23e	

	60	4.50k	4.40k	4.00l	4.30e	
2	20	6.13g	6.00g	4.50k	5.54b	6.44a
	40	7.90c	7.60d	5.80h	7.10b	
	60	7.50d	7.00e	6.60hl	6.70ab	
3	20	5.50i	4.45i	5.00j	5.32d	6.54a
	40	8.90a	8.10b	6.80f	7.93a	
	60	7.10e	7.00e	5.00e	6.37c	
Irrigation intervals Mean		6.17a	5.93a	4.87b	Humic adding period Mean	
Humic adding period.×Irrigation intervals	20	6.20ab	6.03ab	4.63c	5.62ab	
	40	6.93a	6.46ab	5.46bc	6.29a	
	60	5.37bc	5.28bc	4.50c	5.05b	
Humic Conc. ×Irrigation intervals	1	4.16c	4.07c	3.70c		
	2	7.17a	6.87a	5.30b		
	3	4.16a	6.85a	5.60b		

***Similar letters in the table mean no significant difference at the 5% probability level.**

***Number of leaves plant^{-1}:**From table (3) it is clear that there is a significant effect of treatment with humic acid on the number of leaves plant^{-1}, as the concentration of 3 ml of acid gave the highest value of 69.57 leaves plant^{-1} with an increase rate of 13.39% compared to the concentration of 1 ml of humic acid, which gave the lowest value of 61.35 leaves plant^{-1} , while it did not differ significantly from the concentration of 2 ml.From the same table we note that the average acid periods showed a significant effect on the trait of the number of leaves plant^{-1} as the period of adding acid every 40 days gave a value of 72.29 leaves per plant-1, with an increase rate of 18.60% compared to the period of adding acid every 20 days, which gave the lowest value of 60.95 leaves per plant^{-1}< and we note from the table that the average of the different irrigation periods has a significant effect on the number of leaves plant^{-1} as irrigation every two weeks gave the highest value of 69.60 leaves plant^{-1} and an increase of 14% compared to irrigation every 4 weeks which gave the lowest value of 61.05 leaves plant^{-1}, while it did not differ significantly from irrigation every 3 weeks.

The two way interaction between the studied factors had significant effect on leaf number,the different concentrations of acid and the periods of its addition showed a significant effect on the number of leaves plant^{-1}, as the concentration of 3 ml added every 40 days gave the highest value of 77.63 leaves plant^{-1}, with an increase rate of 46.36% compared to the concentration of 1 ml added every 20 days, which gave the lowest value of 53.04 leaves plant^{-1}.The same table shows that the interaction between the acid addition periods and the different irrigation periods showed a significant effect on the number of leaves plant^{-1} trait, as the addition of acid every 40 days and irrigation every two weeks gave the highest value of 77.93 leaves per plant-1, with an increase rate of 41.58% compared to the addition every 20 days and irrigation every 4 weeks, which gave the lowest interaction value of 55.04 leaves plant $^{-1}$.and the interaction between acid concentrations and irrigation intervals showed a significant effect on the number of leaves plant $^{-1}$, as the concentration of 3 ml and irrigation every two weeks yielded the highest value of 73.63 leaves plant^{-1}, or an increase of 27.58% compared to the concentration of 1 ml of acid and irrigation every 4 weeks which yielded the lowest value of 57.71 leaves plant^{-1}, while it did not differ significantly with the concentration of 3 ml and irrigation every three weeks.

The interaction of the three factors showed a significant effect on the number of leaves trait, as the treatment (concentration 3 ml of acid, addition every 40 days, and irrigation every two weeks) had the highest value of 84.40 leaves per plant^{-1} or an increase of 69.39% compared to (concentration 1 ml every 20 days and irrigation every 4 weeks) which gave the lowest value for this triple interaction of 50.04 leaves plant $^{-1}$.

Table (3): effect of different concentrations of humic acid, treatment periods and irrigation at different intervals on leaf number plant^{-1}.

Humic acid Conc.	Humic acid Adding perriods(day)	Irrigation intervals(week)			Humic Conc.×Humic adding period	Humic Conc. Mean
		2	3	4		
1	20	55.00m	54.00n	51.12o	53.04d	
	40	74.00d	72.00e	55.00m	67.00bc	
	60	55.00m	69.00f	68.00g	64.00c	
2	20	68.40g	66.00i	60.00i	64.80c	
	40	75.40d	74.33d	67.00h	72.24b	
	60	78.00c	72.00e	65.00j	71.67b	
3	20	70.10f	70.00f	55.00m	65.03c	
	40	84.40a	80.30b	68.20g	77.63a	
	60	66.10i	65.50ij	61.10k	64.23c	
Irrigation intervals Mean		69.60a	69.24a	61.05b	Humic adding period Mean	
Humic adding period.×Irrigation intervals	20	64.50bc	63.33c	55.04d	60.95c	
	40	77.93a	75.54a	63.40c	72.29a	
	60	66.36b	68.83ab	62.03c	66.63b	
Humic Conc. ×Irrigation intervals	1	61.33bc	65.00c	57.71c		
	2	73.53a	70.78a	64.00b		
	3	73.63a	71.83a	61.43bc		

***Similar letters in the table mean no significant difference at the 5% probability level.**

***Relative water content of leaves** (%)**:**The results in Table (4) showed a significant effect of the different concentrations of humic acid on the relative water content of leaves. The 3 ml concentration gave the highest value of water content, reaching 109.22%, with an increase of 17.02% compared to the 1 ml concentration of acid which gave the lowest value of water content reaching 93.33%. However, it did not differ significantly from the 2 ml concentration.

The average periods of humic acid addition had a significant effect on the relative water content of leaves, as the 40-day addition period had the highest value of 105.22 %, with an increase of 4.64 % compared to the 20-day addition period, which gave the lowest value of 100.55% of the relative water content of leaves,and the average irrigation intervals showed a significant effect on the relative water content of leaves, as irrigation every two weeks gave the highest value of 107.67 %, with an increase of 12.53 % compared to irrigation every four weeks, which gave the lowest value of 95.68 %, while it did not differ from irrigation every three weeks,also the interaction of the table between the different concentrations of acid and the periods of acid addition led to a significant effect on the relative water content of the leaves, as the concentration of 3 ml and the period of addition every 40 days gave the highest value of 112.00 % and an increase of 20.85 % compared to the concentration of 1 ml and the addition every 60 days, which gave the lowest value of 92.67%.

The two-way interactionamong the three studied factors had asignificant effect on studied traits,the interaction between acid addition periods and different irrigation periods showed a significant effect on the relative water content of leaves, where acid addition every 40 days and irrigation every two weeks gave the highest value of 109.66% and an increase of 16.25 % compared to addition every 20 days and irrigation every 4 weeks, which gave the lowest value of 94.33 %, while it did not differ significantly from addition every 40 days and irrigation every 3 weeks.The results of the table indicate that the interaction between acid concentrations and irrigation periods showed a significant effect on the relative water content of leaves, as the concentration of 3 ml of humic acid with irrigation every two weeks showed the

highest value reaching 115.00% and an increase rate of 26.84% compared to the concentration of 1 ml of acid and irrigation every 4 weeks, which reached 90.66 %.

The triple interaction between the studied factors showed a significant effect on the relative water content of leaves, as the treatment (3 ml concentration of humic acid, addition every 40 days and irrigation every two weeks) gave the highest value of water content, reaching 119.00%, with an increase of 32.22 % compared to the treatment (1 ml concentration, addition every 20 days and every 60 days and irrigation every 4 weeks), which gave the lowest value, reaching 90.00 %.

Table (4): effect of different concentrations of humic acid, treatment periods and irrigation at different intervals on relative water content of leaves (%).

Humic acid Conc.	Humic acid Adding perriods(day)	Irrigation intervals(week)			Humic Conc.×Humic adding period	Humic Conc. Mean
		2	3	4		
1	20	94.00ef	95.00e	90.00f	93.00d	93.33c
	40	95.00e	96.00de	92.00f	94.33d	
	60	94.00ef	94.00ef	90.00f	92.67d	
2	20	112.00bc	100.00d	96.00d	102.67c	106.6b
	40	115.00ab	114.00bc	99.00d	109.33ab	
	60	114.00bc	113.00bc	97.00d	108.00ab	
3	20	111.00bc	110.00c	97.00d	106.00bc	109.2a
	40	119.00a	117.00a	100.00d	112.00a	
	60	115.00ab	114.00bc	100.00d	109.67ab	
Irrigation intervals Mean		107.67a	105.89a	95.68b	Humic adding period Mean	
Humic adding period.×Irrigation intervals	20	105.66b	101.66c	94.33e	100.55b	
	40	109.66a	109.00a	97.00d	105.22a	
	60	107.66ab	107.00ab	95.66d	103.44ab	
Humic Conc. ×Irrigation intervals	1	113.66ab	95.00e	90.66f		
	2	115.66a	109.00b	97.33de		
	3	115.00a	106.00c	98.56de		

***Similar letters in the table mean no significant difference at the 5% probability level.**

***Total chlorophyll content (mg gm^{-1} wet weight):**The results shown in table (6) indicate that different humic acid concentrations had a significant effect on the total chlorophyll content of leaves. The 3 ml concentration yielded the highest value, reaching 16.91 mg gm^{-1} wet weight, an increase of 43.54 % compared to the 1 ml acid concentration, which yielded the lowest value, reaching 11.78 mg/gm^{-1} wet weight.The different periods of humic acid addition also showed a significant effect on the content, as the period of addition every 40 days gave the highest value of 15.46 mg gm^{-1} of wet weight, with an increase of 8.26 % compared to the period of addition every 20 days, which gave the lowest value of 14.28 mg.g-1 of wet weight, while it did not differ significantly from the period of addition every 60 days,and the same table showed that different irrigation intervals had a significant effect on the total chlorophyll content of leaves. It showed that irrigation every two weeks gave the highest value of 15.50 mg gm^{-1} of fresh weight, an increase of 15.32% compared to irrigation every four weeks, which gave the lowest value of 13.44 mg gm^{-1} of fresh weight.

From the same table it is clear that the two-way interaction between three studied factors had significant effect on chlorophyll percentage. Different concentrations of humic acid and acid addition periods had a significant effect on the total chlorophyll content, as the concentration of 3 ml and the addition every 40 days gave the highest value of 17.90 mg gm^{-1} wet weight, an increase of 60.25 % compared to the

concentration of 1 ml and the addition every 20 days, which gave the lowest value of 11.17 mg gm^{-1} wet weight,and the interaction between the acid addition periods and the different irrigation periods had a significant effect on the total chlorophyll content. The addition every 40 days and irrigation every two weeks gave the highest value of 16.23 gm-1 of fresh weight, with an increase of 31.26% compared to the addition every 20 days and irrigation every four weeks, which gave the lowest value of 12.33 mg gm^{-1} of fresh weight.,Also the results of the table indicate that the two-way interaction between humic acid concentrations and irrigation periods has a significant effect on the total chlorophyll content of leaves, as the concentration of 3 ml of acid and irrigation every two weeks gave the highest value of 17.57 mg gm^{-1} of fresh weight with an increase of 72.76 % compared to the concentration of 1 ml of acid and irrigation every four weeks, which gave the lowest value of 10.17 mg gm^{-1} of fresh weight.

The triple interaction of the studied factors showed a significant effect on the total chlorophyll content in the leaves, as the interaction (3 ml concentration of humic acid, added every 40 days and irrigated every two weeks) was superior, giving the highest value of 18.20 mg.gm^{-1} of wet weight, with an increase of 102.22% compared to the interaction (1 ml concentration of acid, added every 20 days and irrigated every 4 weeks), which gave the lowest value of 9.00 mg gm^{-1} of wet weight.

Table (5): effect of different concentrations of humic acid, treatment periods and irrigation at different intervals on total chlorophyll mg gm^{-1} wet weight.

Humic acid Conc.	Humic acid Adding perriods(day)	Irrigation intervals(week)			Humic Conc.×Humic adding period	Humic Conc. Mean
		2	3	4		
1	20	12.50g	12.00g	9.00i	11.17e	11.78c
	40	13.50f	12.50g	10.50h	12.17d	
	60	12.50g	12.50g	11.00h	12.00d	
2	20	16.50cd	16.50cd	14.00f	15.67c	15.89b
	40	17.00b	17.00b	15.00e	16.33bc	
	60	16.00d	16.00d	15.00e	15.67c	
3	20	17.00b	17.00b	14.00f	16.00bc	16.91a
	40	18.20a	18.00a	17.50ab	17.00a	
	60	17.50ab	17.00b	16.00d	16.83b	
Irrigation intervals Mean		15.50a	15.00ab	13.44b	Humic adding period Mean	
Humic adding period.×Irrigation intervals	20	15.33b	15.16b	12.33d	14.28b	
	40	16.23a	15.83ab	14.33c	15.46a	
	60	15.33b	15.16b	14.00c	14.83ab	
Humic Conc. ×Irrigation intervals	1	12.83e	12.33e	10.17f		
	2	16.50b	16.50b	14.67d		
	3	17.57a	17.33a	15.83c		

***Similar letters in the table mean no significant difference at the 5% probability level.**

***Nitrogen concentration** (%)**:**From figure (1), we note that the triple interaction between the studied factors had a significant effect on the percentage of nitrogen in the vegetative system, as the interaction (3 ml of acid concentration added every 40 days and irrigation every two weeks) outperformed the other triple interactions, yielding the highest concentration of 2.47%, with an increase of 27.31% compared to the triple interaction (1 ml of acid concentration added after 20 days and irrigation every four weeks), which yielded the lowest concentration of 1.94%.

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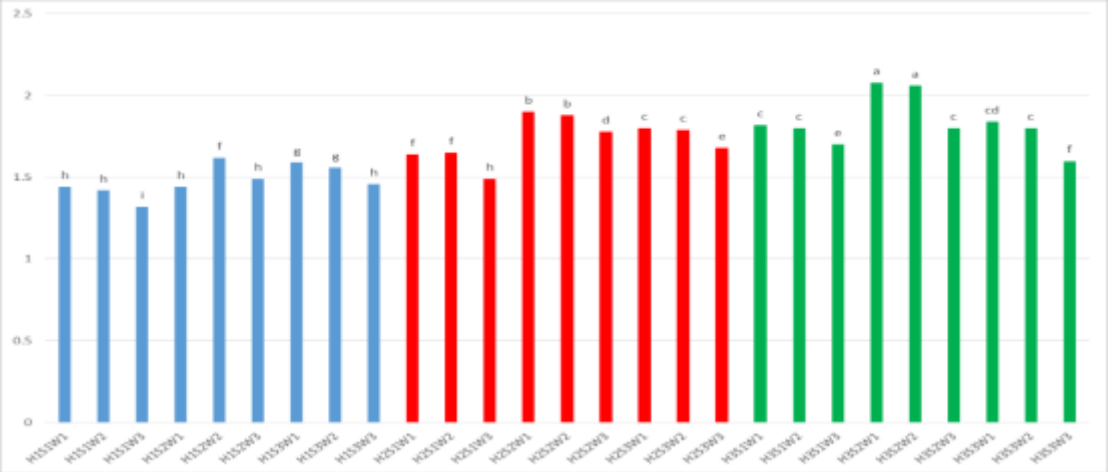

Figure (1): Effect of treatment with different concentrations of humic acid, periods of adding the acid, and irrigation intervals on the concentration on Nitrogen concentration (%).

***Phosphorus** (%)**:**From figure (2), we note that the triple interaction between the studied factors had a significant effect on the percentage of phosphorus (%) in the vegetative group, as the interaction (3 ml of acid concentration added every 40 days and irrigation every two weeks) outperformed the other triple interactions, yielding the highest concentration of 0.49%, with an increase of 122.72% compared to the triple interaction (1 ml of acid concentration added after 20 days and irrigation every four weeks), which yielded the lowest concentration of 0.22%.

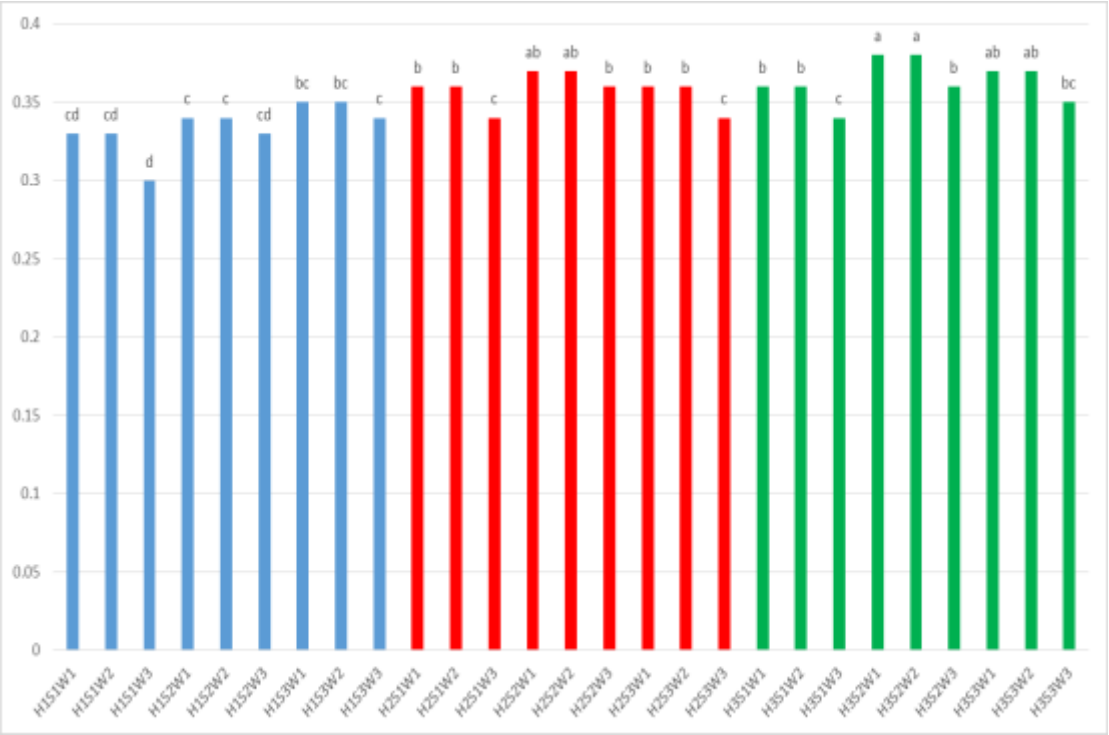

Figure (2) effect of treatment with different concentrations of humic acid, periods of adding the acid, and irrigation intervals on the concentration on Phosphor concentration (%).

***Potassium** (%)**:**From figure (3) we note that the triple interaction between the studied factors had a significant effect on the percentage of potassium (%) in the vegetative group, as the interaction (3 ml of acid concentration added every 40 days and irrigation every two weeks) outperformed the other triple interactions, yielding the highest concentration of 1.84 %, with an increase of 30.49 % compared to the triple interaction (1 ml of acid concentration added after 20 days and irrigation every four weeks), which yielded the lowest concentration of 1.41 %.

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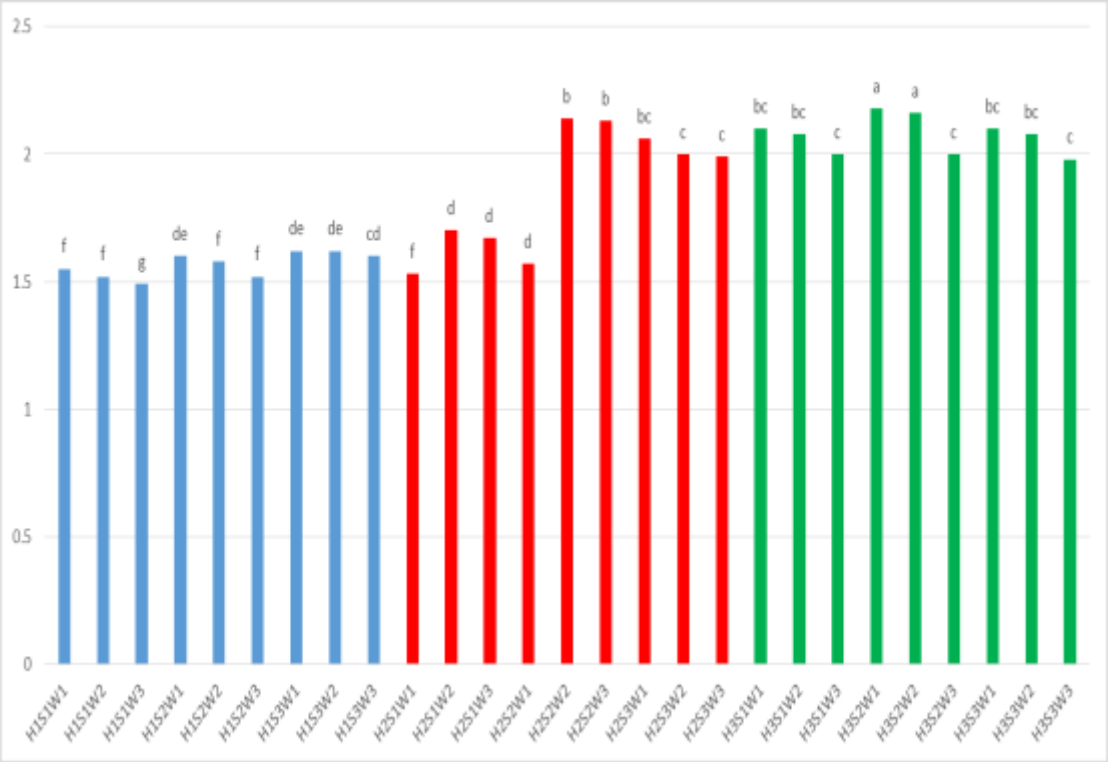

Figure (3) effect of treatment with different concentrations of humic acid, periods of adding the acid, and irrigation intervals on the concentration on potassium concentration (%).

DISCUSSION

The superiority achieved in plant height from the use of humic acid is attributed to the acid's role in increasing the plant's biological activity and the rate of absorption of nutrients, which in turn leads to an increase in the plant's growth rate. The reason may also be due to the fact that humic acid has a hormonal effect, as it affects the cell's protoplasm and cell wall, which leads to rapid cell division and growth, thus increasing ,the plant's height. also decrease in plant height due to water stress during the vegetative growth stage may be attributed to the negative effect of water deficiency on the division and elongation of stem cells, and that the spacing of irrigation periods leads to a decrease in the number of days in reaching the stages of crop growth due to water deficiency, especially in the elongation and lining stages (Al-Haidari, 2012).

The superiority achieved in growth characteristics, including the number of tillers and the accompanying positive moral effect resulting from the use of humic acid is attributed to the fact that humic acid stimulates and encourages vegetative growth and the accompanying absorption of nutrients, and that humic acid has important effects on the absorption of nutrients by the plant. Stimulating the absorption of nutrients by humic acid contributes to increasing the activity of vital activities, which increases growth, including the number of tillers (Abdel-Mawgoud et al., 2007).

The reason for the decrease in the number of tillers as a result of the long irrigation intervals is the reduction in the products of photosynthesis, which caused competition between the stem, which began to elongate quickly, and the production of tillers, as well as between the tillers themselves for these (Atiya and Jadou, 1999).

The superiority of plants treated with humic acid in their relative water content is due to the role of organic fertilizers (humates) in improving the physical and chemical properties of the soil through the interaction of these compounds with soil minerals and thus improving its water and air properties as well

as the capacity to absorb nutrients (Mataroiev, 2002). The relative water content in high moisture stress was low and this may be attributed to low soil moisture content and low soil potential due to scarcity of irrigation water (Fiez, 1995) as well as to the evapotranspiration requirements during daytime caused by high temperature and solar radiation which coincides with active plant growth in the early stages of plant life (Zhang and Kirham, 1994).

The reason for the decrease in leaf area due to the effect of moisture stress is attributed to the decrease in the relative water content of the plant, which leads to a decrease in the growth rate of the vegetative parts, and the important role of water in the process of cell division and elongation, the abundance of nutrients in the soil and the ease of their absorption, and then the decrease in the process of photosynthesis, which in turn leads to a decrease in leaf area (Hsaio,1973). The reason is due to the increase in leaf area resulting from treatment with a high concentration of humic acid is due to the effect of humic acid, which contributed to providing a large amount of necessary nutritional elements that are transferred to the leaves, which in turn positively impacted the increase and expansion of leaf cells, and consequently the increase in leaf area (Ameen,2023)

Humic acid is a supplementary source of polyphenols in the early stages of plant growth, which acts as a respiratory chemical mediator. This in turn leads to increased plant bioactivity, as the effectiveness of the enzyme system increases, cell division and development increases, and the root system develops. The production of dry matter of humic acid increases with the activation of chemical processes in the plant, such as photosynthesis and chlorophyll (Akinremi et al. 2000), adding humic acid to the soil led to the accumulation of phosphorus and potassium (Figure 2 and 3) (Islam and Monda, 2012) as the accumulation of elements such as phosphorus, nitrogen and manganese helps in increasing the production and percentage of chlorophyll Borde et al,2010 and Javid 2005).

The decrease in plant height due to water stress during the vegetative growth stage is attributed to the effect of water deficiency on the division and elongation of stem cells, and that the spacing of irrigation periods leads to a decrease in the number of days in reaching the stages of crop growth due to water deficiency (Al-Haidari, 2012) and that water is one of the necessary factors for the division and elongation of plant cells (Al-Maamari, 1989).

The relative water content in high moisture stress was low and this may be attributed to the low soil moisture content and low soil potential due to scarcity of irrigation water (Fiez,1995) as well as the evaporation requirements during the daytime caused by high temperature and solar radiation which coincides with active plant growth in the early stages of its life (Zhng and Kirham, 1994). This result is consistent with (Al-Fatlawi, 2013) which indicated that moisture ,tress affected the relative water content,the decrease in water potential also accelerates the vital processes in the plant and reduces the components of dry matter, which includes the plant height and leaf area, and thus negatively affects the period from planting until the flowering of the ears (Hashem and Al-Haidari, 2012).

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