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THE EFFECT OF DIFFERENT CONCENTRATIONS OF ETHEPHON AND LACK OF IRRIGATION DURING THE PLANT GROWTH STAGES ON THE CHARACTERISTICS OF GROWTH AND YIELD OF SAFFLOWER PLANTS

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Abstract

The experiment was conducted to study the effect of ethephon and moisture stress at different growth stages on the yield, its components, and the efficiency of water consumption of safflower (Gilla) variety. The experiment was carried out during the winter season 2021-2022 on 11/24/2021 in the Boulatif area, which is 3 km from the governorate center in A farmer's fields in Muthanna Governorate. It was implemented using a split-plot design with three replications, where the first factor included four levels (full irrigation - dropping irrigation at branching - dropping irrigation at the flower bud - dropping irrigation at the filling period), which was symbolized by the symbol. I 1, I 2, I 3, I 4

The second factor: Spraying with ethephon at five levels of 2000-1500-1000-500 - 0 mg/L, with a plant density of 40,000 plants/ha. The results of the experiment showed the superiority of the treatment. The ethephon spray treatment at a concentration of 1500 mg L-1 was superior by giving it the lowest average plant height (107.6) cm and the weight of 500 seeds was (19.31) grams. It was superior by giving it the highest number of branches per plant (267.7) branch plant-1, and the weight of the plant. The dry amounted to (18.33) tons ha-1, the number of heads per plant (213.7) per plant head-1 for the first season, and the number of seeds per head (41.05) per seed head-1, in addition to giving it the highest percentage of stem diameter of (16.95).

The lack of irrigation in the different stages of growth did not significantly affect most of the characteristics of the study, as the lack of irrigation treatments did not differ significantly among themselves in the following characteristics (plant height, number of branches, number of leaves, total chlorophyll content, number of heads, number of seeds per head).

The effect of the interaction between the ethephon spraying treatments and the lack of irrigation treatments was significant in most of the characteristics of the study, as the combination was

superior to the lack of irrigation during branching It gave the highest averages for the mentioned characteristics, which amounted to (282.7 and 247 plant heads-1), (56.67 and 58.33 seeds per head-1), (133.3 and 161.7 g plant-1), (5.333)m

Keywords: safflower, ethephon, water consumption

Introduction

Safflower is an ancient crop that is believed to have a single origin about 4,000 years ago in the Fertile Crescent region, which extends from southern Palestine to western Iraq. Safflower has been grown for centuries in India, China, and North Africa, and the safflower of each region is characterized by different botanical and genetic characteristics (OECD (2020). The Carthamus genus has 24 species, while C. tinctorius is the only cultivated species.

In recent years, the use of plant growth regulators in crop production has increased to enhance plant growth, increase yield, and improve its quality, as well as reduce plant stagnation, in addition to their role in accelerating or delaying germination, growth, flowering, maturity, and withstanding many environmental stresses, such as salt stress, heat stress, water stress, and others, as well as reducing pollution. The environment because it is added in very low concentrations (Zhang et al., 2014).

Growth regulators also increase productivity by modifying plant balance and growth, enhancing crop tolerance against abiotic stress, and reducing plant moisture stress by enhancing the relative water content of the leaf area (Desta and Amare, 2021).

Water shortage is among the most environmental stresses that have a clear impact on crop production, especially in arid and semi-arid areas that are characterized by lack of rainfall and fluctuation in its distribution, which reduces the efficiency of water use and a decrease in productivity. This shortage of water resources, which coincides with an increase in demand for it, calls for attention to growing crops. Tolerates lack of soil moisture At the forefront is safflower, which is known for its sensitivity to increased soil moisture and because safflower is one of the winter oil crops with low water requirements compared to other winter crops, in addition to the summer oil crops that compete for the water share and because of its tolerance to salinity and drought because it is not sensitive to weather temperature due to the capacity of its root system, which compensates for moisture. The lost moisture remains on the plant, preserving its moisture needs, and the waxy surface of the leaves reduces the loss of plant moisture (Hussein and Waheeb, 2010).

The study aims to identify the potential of ethephon in reducing plant size and shortening the vegetative growth period, creating a state of vegetative and fruiting balance.

Determine the best plant growth by reducing the number of irrigations beyond the optimal irrigation.

Materials and methods

The field experiment was carried out during the winter season 2021-2022 on 11/24/2021 in the Boultif region, which is 3 km from the governorate center, in the fields of a farmer, using a split sector design and with three replications. The experiment included two factors: the first factor with four levels.

Irrigation treatments (full irrigation - dropping an irrigation when branching - dropping an irrigation at the flower bud - dropping an irrigation at the filling period) which are symbolized by the symbol. I 1, I 2, I 3, I 4

The second factor: spraying with ethephon at five levels 0-500-1000-1500-2000 mg/L

After carrying out all the soil preparation operations for planting, as the soil was mixed, the field was divided into three sectors. Each sector contained 20 experimental units with an area of 3*4 m2, leaving a distance of 2 m between the experimental units and 4 m between the sectors. Each experimental unit contained 8 lines. Nitrogen fertilizer was also added at a rate of 160 kg N ha-1, triple superphosphate at a rate of 100 kg P ha-1, and potassium sulfate at a rate of 60 kg K ha-1. Finally, the data was collected and statistically analyzed using the Genstst program under a significance level of 0.05.

Studied characteristics:

Five plants were taken from the midlines in the flowering stage and the following traits were calculated from them

Plant height (cm):

Use a measuring tape to calculate the height of plants, starting from the soil surface to the end of the plant top.

Number of total branches (plant branch-1):

The total number of branches of the random sample plants was calculated for each experimental unit.

Total number of leaves on the plant:

Calculate the total number of leaves for the sample of five plants taken randomly for each experimental unit, then extract the average number of leaves per plant.

Guide to Total Chlorophyll Pigments (SPAD)

This characteristic was estimated using a Japanese device (Chlorophyll Meter SPAD model-502), taking three readings from the five random sample plants.

Leg diameter (mm)

The stem diameter of ten heads was calculated and their average was taken using the VERNIER MICROMETER.

Number of heads (plant/head^{-1})

The heads of five plants were collected from the middle lines.

Number of seeds (head seed^{-1})

Ten disks were taken randomly from the random samples, the number of seeds in each disk was counted, and then the average was calculated.

Weight of 500 seeds (g)

The weight of 500 seeds was taken randomly from each experimental unit using the DIAMOND MODEL 500 sensitive balance.

Seed yield (ton.ha^{-1})

Extract from the product of multiplying the average seed yield per plant (g) * the number of plants per hectare.

Results and discussion

Plant Height(cm):

The results of Table (1) showed a significant effect of ethephon concentrations on plant height, while the deficiency irrigation factor was not significant.

The results indicate that increasing the concentration of ethephon had a significant effect in reducing plant height in the safflower crop, as the plants treated with the concentration of 1500 mg/L (1500) gave the lowest average plant height of 107.60 cm compared to the other concentrations in which the average plant height was 118.90 cm. 119.80 cm, 123.30 cm, 125.40 cm) for transactions that are coded (500, 2000, 0, 1000) sequentially.The reason for the decrease in plant height may be due to the action of ethylene released from ethephon in the plant tissues, which works to inhibit the transfer of auxin in the stem tissues and thus reduce the ability to elongate the stem and show apical dominance. It also encourages an increase in cell size in the horizontal direction and affects the rate of cell division. It prevents longitudinal growth, as it causes a decrease in cell elongation in the subapical meristem area, thus reducing stem elongation (Nashkani, 2007).

The competition of the side branches of the main branch for nutrients may have a role in cell division and elongation in the subapical meristem area, thus reducing the height of the plant. This

is consistent with the findings of Kaya (2004), who indicated that spraying ethephon with different concentrations led to a significant decrease. In the height of safflower crop plants.

Deficient irrigation did not have a significant effect on this trait. As for the interaction, the results of Table (1) indicate that the combination (1000*I3) recorded the highest average plant height, amounting to 135.6 cm, while the interaction treatment (1500*I2) gave the lowest average, amounting to 99.3 cm.

Table No. (1) The effect of ethephon, lack of irrigation, and their interaction on plant height (cm)

2022-2021						
average Lack of irrigation	**Ethephon**					**Lack of irrigation**
	2000	**1500**	**1000**	**500**	**0**	
122.6	119.2	120.7	120.9	117.7	134.7	**I1**
116.8	118.6	99.3	113.3	128.7	124.1	**I2**
116.3	112.3	102.1	135.6	118.1	113.3	**I3**
120.4	129.1	108.4	131.7	111.3	121.3	**I4**
	119.8	107.6	125.4	118.9	123.3	**average Concentrations Ethephon**
Interference 15.39	**Lack of irrigation N.S**		**Ethephon 7.40**		**L.S.D $_{0.05}$**	

Total number of branches

The results of Table (2) show that there are significant differences between the concentrations of ethephon in the average number of branches per plant. The ethephon spray treatment with a concentration of 1500 mg L-1 achieved the highest average of 267.7 branches per plant-1, thus superior to all concentrations, while the difference was not significant between The concentrations 2000 and 1000 compared to the two treatments (500 , 0), which were significantly superior to the concentrations 500 and 0, whose The reason for the superiority of plants sprayed with a concentration of 1500 mg L-1 may be attributed to giving them the lowest average plant height

(Table 2), as the process of the emergence and development of lateral branches in the plant is linked to the phenomenon of apical dominance, which is under the control of plant hormones, especially auxins, and here the physiological effectiveness of the obstacles is highlighted. Growth factors, including ethephon, when sprayed at the appropriate concentration, act as anti-auxin compounds by reducing levels of the non-polar amino acid tryptophan, which is the basic building block in the biosynthesis of auxin (Suh and Lee, 1997). This result is consistent with the findings of Devi et al. (2011), Sahane et al. (2015a), and Kaur et al. (2015), who indicated a significant effect of ethephon spray concentrations on the number of branches of soybean plants.averages reached (191.2,175.2) plant branch^{-1}.There was no significant difference in the factor of lack of irrigation for the first season, but the interaction was significant. The interference treatment (1500*I2) gave the highest average for this trait, reaching 330 branches. Plant-1, while the interference treatment (1500*I4) gave the lowest average, amounting to 151 plant branches. 1.

Table No. (2) The effect of athephon, lack of irrigation, and their interaction on the number of branches

2022- 2021						
average Lack of irrigation	**Ethephon**					**Lack of irrigation**
	2000	**1500**	**1000**	**500**	**0**	
228.9	255	295	235	202.3	157	**I1**
199.4	156.3	330	166	162.7	182	**I2**
239.3	274	294.7	252.3	176.3	199	**I3**
216.6	272.3	151	273	159.7	227	**I4**
	239.4	267.7	231.6	175.2	191.2	**average Concentrations Ethephon**
Interference= 88.44	**N.S=Lack of irrigation**		**=Ethephon 26.29**			**L.S.D (0.05)**

Number of total plant leaves

The results of the statistical analysis shown in Table (3) showed that there were significant differences between the average number of leaves due to the effect of the concentrations of added

ethephon, as the treatment (3(E) concentration of 1500 mg.l-1 gave the highest average number of leaves, reaching 1974 leaves.plant-1, which did not differ. The treatment (2000) with a concentration of 2000 mg.l-1, which reached 1,532 leaves.plant-1, while the concentration of ethephon (500) gave the lowest average for these treatments. The trait reached 1448 leaves. Plant-1. The reason for the superiority of plants sprayed with a concentration of 1500 mg L-1 may be attributed to their giving the highest results for the number of branches in the plant (Table 2) and the positive effect of this in increasing the number of leaves in the plant.

. As for the lack of irrigation, it was not significant in the first season. As for the interaction between them, the interaction treatment (1500*I2) excelled in giving the highest average of 2678 leaves.plant-1, without a significant difference with a number of combinations, while the interaction treatment (2000) gave *I2) The lowest average was 1160 leaves.plant-1, which did not differ significantly from some combinations.

Table No. (3) The effect of ethephon, lack of irrigation, and their interaction on the number of leaves

2022-2021						
average Lack of irrigation	**Ethephon**					**Lack of irrigation**
	2000	**1500**	**1000**	**500**	**0**	
1556	1854	1862	1267	1627	1170	**I1**
1690	1160	2678	1763	1156	1690	**I2**
1808	1950	2162	2037	1312	1577	**I3**
1599	1166	1194	2575	1698	1364	**I4**
	1532	1974	1911	1448	1451	**average Concentrations Ethephon**
Interference 734.2	**Lack of irrigation N.S**		**Ethephon 415.9**		**L.S.D (0.05)**	

Chlorophyll in plants

The results of the statistical analysis, as shown in Table No. (4), showed that the factor ethephon and lack of irrigation were not significant, but the interaction was significant, as the average of the highest treatment reached 53.95, while the lowest average of the interaction reached 38.83.

Table No. (4) The effect of ethephon, lack of irrigation, and their interaction on the character of chlorophyll

2022-2021						
average Lack of irrigation	**Ethephon**					**Lack of irrigation**
	2000	**1500**	**1000**	**500**	**0**	
44.84	40.35	44.1	44.17	45.95	49.65	**I1**
46.82	43.8	53.95	46.63	42.2	47.5	**I2**
46.24	46.2	48.15	47.2	49.23	40.4	**I3**
44.51	44.35	46.65	45.15	47.57	38.83	**I4**
	43.67	48.21	45.79	46.24	44.10	**average Concentrations Ethephon**
Interference 6.543	**Lack of irrigation N.S**		**Ethephon N.S**		**L.S.D (0.05)**	

Leg diameter (mm)

The results in Table (5) indicate that increasing the concentration of ethephon had a significant effect on increasing the stem diameter of the safflower crop, as the plants treated with the concentration of 1500 mg/L (1500) gave the highest average stem diameter characteristic of (16.95) (17.23) respectively. As for the rest of the experimental treatments, the average stem diameter was (14.8 mm, 15.75 mm, 16.23 mm, 15.43 mm) for the treatments that were coded (0, 500, 1000, 2000, respectively).

The reason for the increase in stem diameter may be due to the role of ethylene released from ethephon, which works to inhibit the transfer of auxin in the stem tissues. It also encourages an

increase in cell size in the horizontal direction and affects the rate of cell division, thus increasing the diameter of the stem (Nashkani, 2007) and directing growth factors towards activating Cell division and increasing the necessary physiological activities responsible for increasing vegetative growth, such as increasing the diameter of the stem. According to the principle of compensation, the treatment that gave the highest diameter of the stem is the same that gave the lowest height of the plant.

It is also noted from the results of Table (5) that there is no significant effect on the second factor (deficient irrigation). However, the interaction between the effect of ethephon and lack of irrigation was significant, as the combination (1500*I2) gave the highest average of 22 mm, while the combination (1500*I4) gave The lowest average was 12.67 mm.

Table No. (5) The effect of ethephon, lack of irrigation, and their interaction on stem diameter (mm)

2022-2021						
average Lack of irrigation	**Ethephon**					**Lack of irrigation**
	2000	**1500**	**1000**	**500**	**0**	
16.27	13.7	17.72	21	16.67	12.24	**I1**
15.95	14.33	22	17.1	13.33	12.97	**I2**
15.55	18.67	15.42	12.33	16.67	14.67	**I3**
15.57	15	12.67	14.5	16.33	19.33	**I4**
	15.43	16.95	16.23	15.75	14.8	**average Concentrations Ethephon**
Interference 1.593	**Lack of irrigation 0.200**		**Ethephon 1.142**		**L.S.D (0.05)**	

Characteristics of the number of heads in the plant

The results of the table show that there are 4 significant differences between the concentrations of practical ethephon 2021-2022 and the number of heads in plants. The profit of ethephon at a concentration of 1500 mg L-1 achieved the highest average for the trait, which

amounted to 213.7 heads. Plant-1, with a total increase rate of (32.61%), with a concentration of 500 mg L^{-1}, achieved the lowest average for the trait and reached 144 heads. The reason for this may be due to giving it the highest number of branches, which led to an increase in the plants' photosynthetic effects and their metabolic products, thus increasing the ready-made elements in Table 2 and influencing the drive to increase the number of attractive plants in the plant.

This result is consistent with the results of Kaya (2004) and the reason for this may be due to the role of growth obstacles in regulating plant growth by reducing the height of the plant and increasing the number of branches, which led to an increase in the number of flowers in the plant as well as the division of the products of photosynthesis in a balanced manner between the parts. Different plants, and what confirms this result is that the number of heads in the plant was significantly positively correlated with the number of branches in the plant. The factor of lack of irrigation was not significant in the first season, while the interaction was significant, as the interaction treatment (1500*I2) gave an average of 282.7 heads. Plant-1 was significantly superior to the intervention treatment (0*I1), which gave an average of 110 heads. Plant-The results presented in Table (3) support the existence of a significant positive correlation between the number of total branches and the number of heads formed on the plant.

Table No. (6) The effect of athephon, lack of irrigation, and their interaction on the number of heads

2022-2021						
average Lack of irrigation	Ethephon					Lack of irrigation
	2000	1500	1000	500	0	
184	211	219	212	168	110	I1
161.2	132.3	282.7	142.3	129.7	119	I2
178.3	179.3	220	173.3	147.3	171.7	I3
171.9	231.3	133	177.7	131	186.7	I4
	188.5	213.7	176.3	144.0	146.8	average Concentrations Ethephon
Interference 70.95	Lack of irrigation N.S		Ethephon 25.58		L.S.D (0.05)	

Number of seeds per head

The results of table (7) showed that there were significant effects of ethephon concentrations and lack of irrigation on the number of seeds per head, while the interaction was not significant.It is clear from the results of table (7) that there is a significant difference between the concentrations of ethephon in the average number of seeds per head, as the ethephon spraying treatment with a concentration of 1500 mg L-1 gave the highest average for the trait, amounting to (41.05) seeds per head, compared to the spraying treatment with a concentration of 500 mg. L-1, which gave the lowest average for the trait for both seasons as well, amounting to (27.36) seed head-1The reason for the increase may be due to the role of growth inhibitors, including ethephon, when sprayed at the appropriate concentration, in regulating plant growth and reducing competition between different plant parts for metabolic products by redistributing them in a balanced manner between the vegetative and reproductive parts. The positive effect of this is in increasing the fertility rate and then the number of Seeds in the head (Al-Jumaili, 2014). This result is consistent with the findings of Devi et al. (2011) who indicated that there was a significant effect of ethephon spray concentrations on the number of seeds per pod of soybean plants.The second factor was not significant for both seasons, while the interaction was also non-significant.

Table No. (7) The effect of athephon, lack of irrigation, and their interaction on the number of seeds per head

2022-2021						
average Lack of irrigation	**Ethephon**					**Lack of irrigation**
	2000	**1500**	**1000**	**500**	**0**	
33.19	26.33	43	36	35.3	25.33	**I1**
32.11	25.67	56.67	26.83	19.2	32.2	**I2**
33.74	39	39.53	33.33	26.6	30.23	**I3**
33.99	33.33	25	40.63	28.33	42.67	**I4**
	31.08	41.05	34.2	27.36	32.61	**average Concentrations Ethephon**
Interference 5.919	**Lack of irrigation N.S**		**Ethephon 2.888**		**L.S.D (0.05)**	

Weight of 500 seeds (g)

The results of Table (8) indicate that there is a significant difference between the concentrations of ethephon sprays in the average weight of 500 seeds in . The ethephon spray treatment with a concentration of 1000 mg L-1 achieved the highest average for the trait, amounting to 23.53 g, compared to the treatment with 1500 mg L-1. Which gave the lowest average weight of 500 seeds, which amounted to 418.9 g, The highest average amounted to 22.58 grams for the ethephon spray treatment at a concentration of 1000 mg L-1, which did not differ significantly from the ethephon spray treatment at a concentration of 2000, which gave The average was 22.08. The reason for the increase in the weight of 500 seeds in plants sprayed with a concentration of 1000 mg L-1 may be due to giving them a lower number of heads and a lower number of seeds per head , which led to an increase in seed weight .This result is consistent with the findings of Devi et al. (2011) and Kaur et al. (2016) who indicated a significant effect of ethephon spray concentrations on the weight of 100 seeds. This indicates that these plants have invested their inherent ability and available growth factors towards increasing the capacity of the outlets at the expense of the number of outlets. This is consistent with what was stated by Saxena et al. (2007) who indicated that increasing seed weight can be achieved by reducing the number of outlets in the plant or something. It is called Reproductive load ,The opposite occurred in plants sprayed with ethephon at the beginning of flowering, in which the reason for the decrease in the weight of 100 seeds may be attributed to the sensitivity of the plant tissue and the speed of its response to ethephon led to the modification of plant growth by increasing the number of branches (Table 2) and fragmenting and distributing the products of photosynthesis. On a larger number of estuaries, this has a positive impact on an increase in the number of heads and seeds and thus a decrease in seed weight (Saxena et al., 2007). As for the second factor, it was also significant, and the I2 treatment outperformed, with the highest average for the characteristic reaching 21.22 for , while the lowest average was 19.369 . This increase was consistent with the principle of compensation in the components of the outcome, as the results mentioned in the two tables (6) (7) indicate the superiority of the May withholding treatment. Irrigation during the flower bud stage in the two components of seed yield (the number of heads of the plant and the number of seeds per head) and that this superiority was negatively reflected in the value of the average seed weight. The coincidence of seed filling and maturation, which extends 30-35 days after flowering, with conditions of water stress may cause damage to the ovaries. A decrease in the number of normal embryonic sacs and fertilized florets, and a deformation of the florets formed as a result of their reduced supply of representative materials (Herdrich, 2001). The effect of the interaction between the concentrations of ethephon spray and the spraying stage was significant in the weight of 500 seeds. The treatment (I2*1500) gave the highest average interaction in the first season, amounting to (25.555), while the lowest average interaction in the first season amounted to (16,667) for the treatment (I1*500).

Table No. (8) The effect of athephon, lack of irrigation, and their interaction on the weight of 500 seeds

2022-2021						
average Lack of irrigation	Ethephon					Lack of irrigation
	2000	1500	1000	500	0	
19.95	17.9	20.9	22.95	16.67	21.33	I1
21.22	20	18.33	25.55	20.86	21.33	I2
19.37	19.33	17.33	23.16	17.7	19.33	I3
21.02	21.62	19.18	22.47	20.77	21.08	I4
	19.71	18.94	23.53	19	20.77	average Concentrations Ethephon
Interference 1.868	Lack of irrigation 0.769		Ethephon 1.204		L.S.D (0.05)	

Seed yield (ton.ha^{-1})

Seed yield represents the result of several components, namely the number of heads in the plant, the number of seeds in the head, and the weight of the seed. These components are the final result of the biochemical activities occurring within the plant during its life cycle, and are affected by various genetic and environmental factors. Plants on which ethephon was sprayed were produced at concentrations of 1500 and 1000 mg per liter. 1 - The highest averages for seed yield, which were significantly similar to the total seed yield, as the average plant production of the total seed yield reached (4.082) tons.ha-1.

The total yield of the plants decreased when treated with ethephon spray at a concentration of 2000, and the decrease in the number of plant heads was reflected when treated with Spraying ethephon at concentration 1000 and the average seed weight when treated with spraying ethephon at concentration 1500 was negative in the total seed yield .

Both the number of heads and seed weight are components of seed yield, especially the number of heads, which is the main component of seed yield in safflower plants, and they are among the traits with a high positive correlation with yield (Bahman et al., 2010). These results are consistent with the results reached by Mahmoud (2016). Through his study, he concluded that spraying rape crops with ethephon has an effective effect in increasing the yield and its components.

The factor of lack of irrigation during different periods of the plant's life is significant, as the treatment plants that were withheld from irrigation during the seed-filling period gave the lowest average total seed yield, as seed yield is closely linked to a number of physiological processes that are greatly affected by the availability of moisture in the environment in which it grows. The plant during its various stages of development, and exposing plants to high water stress during the filling stage and the stage that precedes it negatively affects the total seed yield.

Also, the decrease in productivity of plants in the control treatment, even though their plants were not exposed to moisture stress at any stage of their growth, is due to the sensitivity of safflower plants to excess water. It was found that rainfall at rates ranging between 400 - 580 mm exceeds the plant's actual need (Bassil and Kaffkak, 2002) The results of Őztűrk et al. (2008) support the ineffectiveness of irrigating safflower plants in climatic conditions in which there is an amount of rain of 255.05 mm and a relative humidity of 50.40%, as the average yield when irrigating several varieties reached 1028.95 kg/ha compared to their yield when not irrigated (1033.95 kg/ha) respectively. In the same direction, Esendal et al. (2009) found that the highest seed yield (4.05 tons/ha) was obtained when three irrigations were given in each of the stages of vegetative growth, flowering, and seed filling, and it was significantly similar to the productivity of plants that were given two irrigations at the different stages of growth. Wisely and Barker (2002) also stated that plants that have the ability to protect their cell membranes and enzymes and regulate the osmosis of their roots when exposed to moisture stress are able, under these conditions, to increase the flow of assimilated materials into the outfalls and thus enhance their seed yield.The effect of the interaction between ethephon spray concentrations and the stage of withholding irrigation water was significant on the total seed yield. The combination (1500*I2) gave the highest average grain yield, while the combination (1500*I4) gave the lowest average grain yield.

Table No. (9) The effect of ethephon, lack of irrigation, and their interaction on grain yield characteristics

2022-2021						
average Lack of irrigation	Ethephon					Lack of irrigation
	2000	1500	1000	500	0	
3.804	2.462	4.191	4.873	4.066	3.427	I1
3.702	3.004	5.333	4.107	3.32	2.746	I2
3.336	3.947	4.267	3.094	3.044	2.329	I3
3.428	3.287	1.827	4.253	3.224	4.55	I4

	3.175	**3.905**	**4.082**	**3.413**	**3.263**	**average Concentrations Ethephon**
Interference 0.8101	**Lack of irrigation 0.4291**		**Ethephon 0.4877**		**L.S.D (0.05)**	

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