Effect of spraying ethephon on growth and yield of several wheat cultivars, *Triticum aestivum* L.

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1- Abstract

A field experiment was carried out at the Agricultural Research Station of College of Agriculture, University of Basra (30 km north of center of Basra Governorate) during winter season 2021-2022 to know effect of spraying the growth regulator ethephon at a concentration of 2.25 ml l^{-1} in two batches on the growth and yield of ten varieties of bread wheat *Triticum aestivum* L. (Al-Baraka, Al-Rasheed, Ibaa-99, Babel, Mawaddah, Bohouth-22, Bengal, Jad, Wafia and Jihan), a factorial experiment was applied according to a randomized complete block design (RCBD) with three replications. The results showed that there were significant differences between the cultivars in the studied characteristic, where the superiority of Bohouth-22 in grain yield amounted to 5.652 t ha^{-1} as a result of its superiority in tillers number, rate growth of crop, and coefficient of plant lying, which did not differ significantly from the two cultivars Mawaddah and Al-Baraka, which gave an average grain yield of 5.323 and 5.085 t ha^{-1} respectively. The results also show that spraying plants with ethephon had a significant effect on growth characteristics and yield, as the highest mean was recorded for each of the flag leaf area, tillers number, crop growth rate, grain yield, and biological yield, which amounted to 59.45 cm^2, 521.73 tillers m^2, 21.31 g m^2 day^{-1}, 5 .043 t ha^{-1}, and 16.30 t ha^{-1} respectively, the lowest average plant height and lying coefficient were 80.97 cm and 0.30 respectively. The results also showed that there was a significant interaction between two factors of the study in some of the studied characteristics (plant height, flag leaf area, tillers number, coefficient of plant recumbent, while it did not significantly affect the characteristics of the crop growth rate, grain yield, and biological yield.

Keywords: Wheat cultivars; ethephon growth regulator; plant lying
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2- Introduction

Cereal crops are among the oldest crops known to man because they are the main food source (Al-Anbari, 2004). Wheat crop *Triticum aestivum* L. is one of the most important cereal crops in the world and one of the most important strategic crops in the world; it comes first in terms of cultivated area and production. It is the main source of food for more than a third of the world's population, which supplies the human body with about 25% of

components of the crop, and one of the problems that cause losses in the crop by up to 35% is the phenomenon of sluggishness due to the weakness of the stem and the increase of nitrogen in the soil (Al-Ubaidi, 2001) as well as the phenomenon of the emergence of sand for these reasons, several methods have been used to solve these problems, including both encouraging and discouraging growth regulators, as proven by recent studies carried out in different regions of the world because of their significant role in the physiological processes of plants through Modification of photosynthesis and respiration, especially the growth regulator Ethephon, which works to release ethylene gas (C2H4). It is one of the commonly used growth impediments with cereal crops, especially wheat. It has proven its ability and effectiveness in preventing sluggishness and the attendant losses in the yield due to ethylene gas released from ethephon in Plant tissues that inhibit auxin transport in stem tissues and thus reduce the ability to stimulate stem elongation (Al-Naqeeb and Hashem, 2016). Hence, it has a role in reducing the elongation of main stems, providing a greater amount of metabolites and their transport (Dahnous et al., 1982).

Several studies have shown a difference between the cultivars in growth and yield traits. Al-Abdullah (2015) found that wheat cultivars differed significantly in the growth and yield traits, as the Ibaa-99 variety recorded the highest grain yield. Abd al-Razzaq (2016) also found in a study that there is a variation among the cultivars in growth traits and yield components. Ibaa-99 was significantly superior in grain yield, while Hudhali and Al-Hassan (2017) noticed that Bohouth 22 was significantly superior in grain yield over the rest of the cultivars included in the study. Al-Aboudi (2019) indicated a difference in the cultivars under study

calories, carbohydrates, proteins, and some amino acids, and that is why it is called the king of cereal crops (Costa et al. 2013). Its importance is because its grain contains gluten, the basic protein for producing an appropriate flour quality for manufacturing bread. One of the most advantages that made the wheat crop of importance to humans because its grains contain proteins and carbohydrates in a balanced manner, as the high content of gluten is the main reason that makes the dough high elasticity and thus the production of bread with large sizes and high specifications (Peltonen, 1995).

Although Iraq is one of the original places for the emergence of wheat and one of the countries where the success factors of its cultivation are available, its productivity is still below the required level when compared to global production, as its production rate in Iraq reached 1,930 t ha^{-1}, while the global production rate reached 3.51 t ha^{-1} (USDA, 2022). Since the production rate of the wheat crop is low, we must pay attention to this crop to improve production in quantity and quality through good management of the crop and the introduction of all modern technologies in the field of cultivation and service of this crop, including the introduction of new varieties with high production, and choosing the appropriate varieties for the region is one of the most important techniques that lead To the increase in the proportion of protein, gluten and specific yield of cereals (Al-Ani et al., 2017). The advancement of the reality of crop cultivation requires continuous research in developing varieties and subjecting them to tests to determine their suitability to the environment of the cultivation area.

As well as the treatment of wheat varieties with growth regulators increases the productivity of the crop by improving the growth characteristics and

showed that the spraying of ethephon had a significant effect on growth characteristics and grain yield, and Ahmad et al. The results of Al-Samer's (2022) study on the wheat crop showed that spraying ethephon significantly affected growth characteristics and grain yield.

Because of the low productivity of the wheat crop in Iraq and the lack of studies and research to know the response of wheat varieties to spraying with ethephon, this study was conducted

3- Materials and Methods

A Factorial Experiment was carried out in a randomized complete block design (RCBD) with three replications in the field of the Agricultural Research Station of the College of Agriculture, University of Basra (30 km north of the center of Basra Governorate), which is located at longitude 47.44o in the west and latitude 30.390 north and in clay loam soil whose chemical and physical properties are shown in Table (1) during the winter agricultural season 2021-2022 to know the response of ten varieties of wheat approved by the Ministry of Agriculture are (Al-Baraka, Al-Rasheed, Ibaa-99, Babel, Mawaddah, Bohouth-22, Benkal, Jad, Wafia Jihan) for spraying with ethephon growth regulator. With a concentration of 2.25 ml l^{-1} and no spraying, symbolized by A1 and A0, respectively. The different treatments were randomly distributed within each plot. Thus the number of experimental units became 60 (3 * 10 * 2) with an area of 2 * 3 m. for the experimental unit.

was significant in growth and yield traits. Al-Jabri (2020) also found a significant difference between growth and yield traits between wheat cultivars. And the components of the yield, such as Al-Rasheed cultivar, recorded the highest average for grain yield trait. Several studies indicated a difference between the growth and yield traits of the cultivars. Al-Abdullah (2015) found that the wheat cultivars differed significantly in the growth traits and yield, as the Ibaa-99 variety recorded the highest grain yield. I also found Abdul Razzaq (2 016) in her study indicated that there is a difference between the cultivars in the growth characteristics and yield components, as the cultivar Ibaa-99 was significantly superior in the trait of grain yield, while Hudhali and Al-Hassan (2017) noticed that the Bohouth-22 variety was significantly superior in the trait of grain yield over the rest of the cultivars included in the study. Al-Aboudi (2019) indicated that the cultivars under study differed significantly in growth and yield characteristics, and Al-Jabri (2020) found a significant difference between wheat cultivars in growth and yield characteristics. There was a significant difference in growth characteristics and yield components, as Al-Rasheed cultivar recorded the highest mean for grain yield trait.

As for the effect of ethephon on wheat yield, Safi (2014) indicated during his study that there was a significant difference in growth characteristics and yield components when spraying ethephon on wheat crop. And the study of Jaddoa (2017) on the wheat crop

Table (1) some physical and chemical properties of field soils before planting

Properties		Unit	Value
ECe		ds/m^{-1}	7.16
pH		-	7.45
Organic matter (OM)		g Kg^{-1}	3.8
Available elements	N	Mg Kg^{-1}	49.6

	P		3.07
	K		0.74
	S		89.2
Dissolved positive ions	Ca^{+2}	Mg Kg^{-1}	8.8
	Mg^{+2}		3.7
	Na^{+}		12.5
	K^{+}		0.74
Dissolved negative ions	$SO_4^{=}$	mmol kg-1 soil	5.4
	HCO^{-3}		5
	Cl^{-}		38.7
Soil Separators	Sand	g Kg^{-1}	273.2
	Silt		324.15
	Clay		402.65
Soil texture	–	–	Clay loam

carried out continuously and according to the need of the crop.

Athephon was sprayed at two stages of formation of tillers ZG25 and beginning of elongation ZG30 (Zadoks et al., 1974), using a 16-liter portable sprinkler, with a diffuser (bright cleaning solution) was added to it at a rate of 1.5 cm 3 per 10 liters of solution. As for the comparison treatment, it was sprayed with distilled water only, and the spraying process was carried out in the early morning to avoid the rise in temperatures, a nylon barrier was used between the plates during spraying to prevent the transfer of the solution between the experimental units. The plants were harvested when they reached the stage of full maturity with different dates according to the variety and treatment, as it extended from 15.04.2022 to 01.05.2022.

Studied characteristics:

Plant height (cm): The average height of ten plants taken randomly from each experimental unit in flowering stage was calculated.

Flag leaf area (cm^2): It was calculated as an average of ten leaves taken randomly from each experimental unit in the flowering stage and based on the following equation: (Thomas, 1975).

The soil allocated for cultivation was prepared, then divided according to the design used; the planting was done on lines with a distance between one line and another of 20 cm, meaning that the number of lines is 10 lines with a length of 3 m. A distance of 1 m was left between an experimental unit and another, and a distance of 2 m between plots. The seeds of wheat cultivars were sown on 15.11. 2021 with a seeding rate of 120 kg ha^{-1} (Abu El-Eis, 2004). Urea fertilizer (46% N) was used as a source of nitrogen fertilizer with an amount of 120 kg N ha^{-1} (Al-Abdullah, 2015) added in two batches (half of the amount after seedling emergence and the other half at the elongation stage (Davis et al., 2002). Phosphate fertilizer was also added with an amount of 100 kg P2O5 ha^{-1} in the form of triple super phosphate fertilizer (20% P) in one batch when planting (Jdoua, 1995), and potassium fertilizer was added at a rate of 120 kg K in the form of potassium sulfate (K2O 52%) in the form of two batches The first is after the emergence stage and the second is at the elongation stage (Al-Abedy, 2011) Weeding operations were carried out to remove the growing bush in the field during the season for several times whenever the need arises. Irrigation was

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4- Results and discussion

4-1- plant height (cm)

Table (2) shows the significant difference between the cultivars. Al-Rasheed cultivar gave the highest average plant height of 103.43 cm, with a significant difference from all other cultivars, with an increase of 18.79% compared to Jihan cultivar, which recorded the lowest average for this trait of 87.07 cm. The differences among the cultivars are due to the characteristic of plant height due to their difference in the number of internodes and the length of one internode, especially the upper ones. (Al-Salami, 2021).

The results of Table (2) showed that there was a significant difference between the plants that were sprayed with ethephon and the plants that were not sprayed with ethephon. The first recorded the lowest average plant height of 80.97 cm and a decrease of 33.33% compared to the plants not sprayed with ethephon, with the highest average height of 107.96 cm. The reason for the decrease in the height of plants sprayed with ethephon may be attributed to the effect of ethylene freed from ethephon on increasing the size of cells in the horizontal direction and reducing cell division and elongation in the subapical meristem region and growth in the vertical direction and thus reducing the elongation of the stem (Shekoofa and Emam, 2008), and this result agreed. To what he reached (Al-Samer, 2022). It is noted from Table (2) that there is a significant interaction between the cultivars and the spraying of plants with ethephon. The Babel cultivar, which sprayed its plants with ethephon, recorded the lowest average for this trait, which was 71.88 cm, with a significant difference from all combinations between the cultivars and ethephon, while the Mawaddah cultivar, which did not spray its plants with ethephon, recorded the highest height it averaged 117.12 cm.

Flag leaf area (cm^2)=Length of flag leaf (cm) width of the widest area (cm) x 0.95

Tillers number (tillers m^2): The number of plant tillers was calculated after harvesting an area of square meters of median lines from each experimental unit.

Crop growth rate (CGR): (g m2 day^{-1}): The growth rate was calculated by harvesting a sample of plants from an area of 600 cm2 in the elongation phase and the full flowering phase, and after recording the readings, the following equation was applied:

CGR= 1 / A * W2 – W1 / T2 - T1 (1982 , Hunt)

As:

A: The land area occupied by a sample of plants in m2.

W2: the dry weight of the plant sample in the period T2

W1: the dry weight of the plant sample at time T1

T1: the period from planting to the first cut (elongation stage)

T2: the period from planting to the second mowing (full flowering stage).

The lying coefficient: Record the reclining coefficient after flowering, based on the scale of Wiersma et al. (1986) by applying the following equation:

Recumbent coefficient =S * I * 0.2

As:

S = recumbent area (no recumbent 1 =, total recumbent = 9)

I = recumbent intensity (upright = 1, recumbent = 5)

0.2 = correction factor

Grain yield (t ha^{-1}): the weight of the ton ha^{-1} of the grains taken from each experimental unit and the weight of the grain for the area harvested based on (t ha^{-1}).

Biological yield (t ha^{-1}): The biological yield is estimated from the weight of the whole harvested plants (grain + straw) above the soil surface from the area of square meter for each experimental unit and converted based on (t ha^{-1}).

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Table (2) Effect of cultivars, ethephon, and their interaction on plant height (cm)

cultivar	Ethephon levels ml l^{-1}		cultivar average
	A0	A1	
Al-Baraka	106.31	83.70	95.01
Al-Rasheed	115.39	91.28	103.43
Ibaa-99	107.67	82.11	94.89
Babel	110.63	71.88	91.26
Mawaddah	117.12	83.12	100.12
Bohouth-22	105.16	81.04	93.10
Benkal	106.67	78.66	92.67
Jad	112.48	79.37	95.92
Wafia	102.05	80.49	91.27
Jihan	96.08	78.05	87.07
Ethephon average	107.96	80.97	
			Lsd $_{0.05}$
cultivar	Ethephon levels		Interaction
2.898	1.296		4.098

treatment of not spraying plants with ethephon recorded the lowest average for this trait amounted to 48.87 cm^2, and the reason may be due to the increase in leaf area The science is about the decrease in plant height. Table (2) as ethephon has a role in reorganizing the growth and development of plants by inhibiting apical dominance and reducing plant height. And then, the factors that encourage growth tend to activate cell division and increase the period of vegetative growth through increasing physiological processes and thus will help to increase the number of leaves and the area of one leaf (Al-Darraji and Al-Jumaili, 2020). This result matched the findings of Safi (2014), Jaddoa et al. (2017), and Al-Samer, (2022) that adding ethephon increases the flag leaf area.

The results of Table (3) showed that there was a significant difference between the interaction between the cultivars and spraying with ethephon in the characteristic of flag leaf area, as the Babel cultivar sprayed with ethephon recorded the highest average of 89.32 cm^2

4-2- Flag leaf area (cm^2)

The results of Table (3) indicated that there was a significant difference between the cultivars for flag leaf area, as the Babel cultivar recorded the highest average amounted to 89.32 cm^2, with a significant difference among all cultivars, while the Bengal cultivar gave the lowest average for this trait, which reached 31.37 cm^2, which may be attributed to the reason for its superiority Babel was classified according to the efficiency of its genetic and physiological ability to obtain better growth requirements, which was reflected in the increase in the area of the flag leaf as well as the difference in its genetic composition, which leads to a difference in its growth. This result agreed with the findings of Al-Aboudi, (2019) and Al-Jabri, (2020); there is a significant difference between the cultivars in this trait. The results of Table (3) showed that spraying plants with ethephon had a significant effect on the trait of flag leaf area, as the treatment of spraying with ethephon recorded the highest average of 59.45 cm^2, while the comparison

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cultivar recorded the lowest average of its plants with ethephon at 30.31 cm^2.

and a significant difference from all other combinations, while the unsprayed Bengal

Table (3) Effect of cultivars, ethephon, and their interaction on Flag leaf area (cm^2)

cultivar	Ethephon levels ml l^{-1}		cultivar average
	A0	A1	
Al-Baraka	70.96	78.23	74.59
Al-Rasheed	51.77	78.77	65.27
Ibaa-99	47.56	63.40	55.48
Babel	74.98	89.32	82.15
Mawaddah	43.97	50.77	47.37
Bohouth-22	41.50	51.02	46.26
Benkal	30.31	32.42	31.37
Jad	46.31	55.48	50.90
Wafia	39.81	44.98	42.39
Jihan	41.58	50.10	45.84
Ethephon average	48.87	59.45	
			Lsd $_{0.05}$
cultivar	Ethephon levels		Interaction
2.81	1.256		3.973

tillers m^2, with an increase of 33.03% compared with the non-sprayed plants, which recorded the lowest average of 392.20 tillers m^2. The reason may be due to the role of ethephon, which releases ethylene gas inside the plant tissues, which inhibits the apical dominance as a result of impeding the diffusion of auxins, and at the same time, they collect at the base of the stem and contribute to stimulating the buds to grow and the formation of new, advanced tillers. These results consist of Al-Zubaidi, (2016) and Al-Samer, (2022) that treating plants with ethephon increases tillers' number. It was noticed from the results of Table (4) that there was a significant difference in the interaction between the cultivars and ethephon, as the bohos-22 variety sprayed its plants with ethephon recorded the highest mean for tillers number amounted to 630.33 tillers m^2, with a significant difference from the rest of the combinations, while the al-Baraka cultivar whose plants were not sprayed recorded

4-3- Tillers number (tiller. m^2)

The results of Table (4) showed a significant effect between the cultivars in the trait of tillers number, as Bohouth-22 recorded the highest average for this trait amounted to 516.33 tillers m^2, with a significant difference from all cultivars, with an increased rate of 47.31% compared with cultivar Al-Rasheed, which gave the lowest average reached 350.50 tillers m^2. The difference in cultivars in tillers number is attributed to the genetic factor, which determines the cultivar's ability to cleave and thus leads to the varietal variation in tillers number. This result is consistent with what was reached by Al-Aboudi, (2019), Al-Jabri, (2020), and Al-Salami, (2021), who showed that the cultivars differ in the character of tillers number as a result of their different genetic structures.

Table (4) results confirmed that the wheat plants sprayed with ethephon significantly outperformed the plants not sprayed with ethephon, with an average of 521.73

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304.00 tillers m^2. With ethephon, the lowest average was

Table (4) Effect of cultivars, ethephon, and their interaction on tillers number (tiller. m^2)

cultivar	Ethephon levels ml l^{-1}		cultivar average
	A0	A1	
Al-Baraka	304.00	473.33	388.67
Al-Rasheed	315.00	386.00	350.50
Ibaa-99	462.67	488.00	475.33
Babel	324.67	504.67	414.67
Mawaddah	465.00	554.00	509.50
Bohouth-22	402.33	630.33	516.33
Benkal	422.67	528.33	475.50
Jad	449.00	560.33	504.67
Wafia	381.67	545.33	463.50
Jihan	395.00	547.00	471.00
Ethephon average	392.20	521.73	
			Lsd $_{0.05}$
cultivar	Ethephon levels		Interaction
6.102	2.729		8.629

the crop growth rate. It was noticed from Table (5) that the plants sprayed with ethephon significantly outperformed, as they recorded the highest mean for the characteristic of crop growth rate of 21.31 g m^2 day^{-1}, while the non-spray treatment gave the lowest rate for this trait, with an average of 19.09 g m^2 day^{-1}. The reason may be the increase in dry matter due to spraying ethephon plants, which helped to increase tiller number of plants (Table 4). This result is consistent with what was reached by Safi (2014), Jaddoa (2017), and Al-Samer, (2022). It was not clear in Table (5) any significant interaction between the experimental factors, cultivars, and ethephon.

4-4- Crop growth rate (g m^2 day^{-1}):

The results of Table (5) showed that the cultivars differed significantly in the growth rate of crop, as Bohouth-22 recorded the highest rate for this trait, with an average of 25.67 g m^2 day^{-1}, and it did not differ significantly from the two cultivars Jad and Ibaa-99 whose averages reached 23.75 and 23. 28 g m^2 day^{-1}, respectively, while Babel cultivar gave the lowest growth rate, with an average of 12.24 g m^2 day^{-1}. The reason may be the difference in cultivars in the number of pelargonium (Table 4). Therefore the vegetative total of the cultivated cultivars varies. The result, with what was reached by Jadoa (2017) that the cultivars differ among themselves in the characteristic of

Table (5) Effect of cultivars, ethephon, and their interaction on Crop growth rate (g m^2 day^{-1})

cultivar	Ethephon levels ml l^{-1}		cultivar average
	A0	A1	
Al-Baraka	20.69	21.70	21.19
Al-Rasheed	20.19	21.74	20.97

Ibaa-99	22.91	23.66	23.28
Babel	11.34	13.14	12.24
Mawaddah	17.29	22.96	20.12
Bohouth-22	24.98	26.36	25.67
Benkal	18.87	21.63	20.25
Jad	21.76	25.73	23.75
Wafia	15.00	17.72	16.36
Jihan	17.90	18.46	18.18
Ethephon average	19.09	21.31	
			Lsd $_{0.05}$
cultivar	Ethephon levels		Interaction
3.483	1.557		N. S

with ethephon recorded the lowest mean of 0.30, while the plants of the non-sprayed cultivars recorded the highest mean of this trait amounted to 1.38. Plants lie down to the role of ethephon in increasing the strength and stiffness of the stems by increasing the dry matter in the plant structure and regulating the deposition of cellulose, thus increasing the diameter of the stem (Zhang et al. 2019). In addition to the role of ethephon in reducing plant height (Table 2), the result is consistent with what was found by Ahmad et al. (2020) and Al Samer (2022).

Table (6) results indicated a significant difference in the interaction between the cultivars and the spraying of plants with ethephon for the characteristic of lying down index. The plants that were sprayed with ethephon, namely (Ibaa-99, Babel, Mawaddah, Buhouth-22, Jad, and Wafia Jihan) recorded the lowest average for this characteristic of 0.20 for all the mentioned cultivars, while the unsprayed Ibaa-99 gave its plants with ethephon the highest mean for this trait it reached 3.73.

4-5- Lying down index

Table (6) shows significant differences between the cultivars in the character of lying down index, as the two cultivars Bohuth-22. Jihan gave the lowest average for this trait, which amounted to 0.50 for both. It did not differ significantly from the cultivars Wafia, Jad, Mawaddah, Babel, and Benkal, whose averages were 0.57, 0.67, 0.70, 0.73, and 0.83, respectively. In contrast, the cultivar Ibaa-99 recorded the highest average for the characteristic of the lying index of 1.97. The reason for the differences in the varietal in lying down index may be their difference in the genotypes of the morphological and physiological characteristics of plants grown in the same environmental conditions, such as plant height and thickness of the stem, the size of the vegetative group, and the size of the root system, and this result is consistent with what was reached Al-Dahri, (2020).

Table (6) showed a significant difference in the character of lying down index between plants, as the cultivars sprayed

Table (6) Effect of cultivars, ethephon, and their interaction on Lying down index

cultivar	Ethephon levels ml l^{-1}		cultivar average
	A0	A1	
Al-Baraka	1.40	0.40	0.90
Al-Rasheed	1.47	0.60	1.03

Ibaa-99	3.73	0.20	1.97
Babel	1.27	0.20	0.73
Mawaddah	1.20	0.20	0.70
Bohouth-22	0.80	0.20	0.50
Benkal	1.07	0.60	0.83
Jad	1.13	0.20	0.67
Wafia	0.93	0.20	0.57
Jihan	0.80	0.20	0.50
Ethephon average	1.38	0.30	
			Lsd $_{0.05}$
cultivar		Ethephon levels	Interaction
0.3912		0.1749	0.5532

(2019) and Al-Jabri, (2020) that the cultivars differ in the character of the grain yield due to their difference in the genetic structures responsible for the components of the yield of plants.

It was observed from Table (7) that there was a significant difference in the yield of grains between the treatment of spraying with ethephon and the treatment of no spraying for the cultivated wheat cultivar. The plants sprayed with ethephon outperformed by recording the highest average for this trait, amounting to 5.043 t ha^{-1} with an increase of 9.39%, while the treatment of no spraying recorded the lowest average, amounting to 4.610 t ha-1. The reason for the increase in grain yield may be attributed to the increase in tillers number (Table 4) due to spraying ethephon; this result agrees with what was reached by Safi (2014), Al-Zubaidi et al. (2016), Jaddoa (2017), Ahmad et al., (2020) and Al Samer, (2022). Table (7) showed no significant effect of interaction between cultivars and treatment of plants with ethephon for grain yield.

4-6- grain yield (tons.ha^{-1})

Table (7) showed through its data that there was a significant difference between the cultivars in the trait of grain yield, as Bohouth-22 outperformed by recording the highest average for this trait, amounting to 5.652 t ha^{-1}, and it did not differ significantly from the two cultivars Mawadda and Al-Baraka, whose averages reached 5.323 and 5.085 t ha^{-1} sequentially and with an increase of 36.36, 28.42 and 22.68%, respectively, compared to the Jihan cultivar, which gave the lowest average for grain yield, which amounted to 4.145 t ha^{-1} and did not differ significantly from the cultivars Babel, Benkal, Jad and Al-Rasheed, whose averages reached 4.217, 4.485 and 4.605 and 4.700 t ha^{-1} respectively. The reason for the increase in grain yield of Bohuth-22 may be due to the relative increase in the number of spikes as a result of its superiority in the characteristic of tillers number (table 4) resulting from the difference in genotypes between the cultivars and this result matched what Abdul-Razzaq found it, (2016), Al-Aboudi,

Table (7) Effect of cultivars, ethephon, and their interaction on grain yield (t ha^{-1})

cultivar	Ethephon levels ml l^{-1}		cultivar average
	A0	A1	
Al-Baraka	4.96	5.21	5.085
Al-Rasheed	4.57	4.83	4.70

Ibaa-99	4.91	5.15	5.03
Babel	3.86	4.573	4.217
Mawaddah	5.03	5.62	5.32
Bohouth-22	5.38	5.92	5.65
Benkal	4.22	4.75	4.485
Jad	4.4	4.81	4.605
Wafia	4.86	5.18	5.02
Jihan	3.91	4.38	4.145
Ethephon average	4.61	5.043	
			Lsd $_{0.05}$
cultivar	Ethephon levels		Interaction
0.5833	0.2609		N. S

It was noticed from Table (8) that the plants sprayed with ethephon significantly outperformed the biological yield in comparison with the non-spray treatment, as the sprayed plants recorded the highest average of 16.30 t ha^{-1} with an increase of 10.96%, while the non-sprayed plants recorded the lowest biological yield, with an average of 14.69 t ha^{-1}. The reason for the increase in the biological yield of plants treated with ethephon may be attributed to its role in increasing the growth rate (CGR) Table (5) and increasing the leaf area represented by flag leaf area Table (4) in addition to the role of ethephon in increasing the grain yield Table (7), which It is considered the main determinants of increasing the biological yield. This result is consistent with the findings of Al-Safi, (2014), Jaddoa et al. (2017), and Al-Samer, (2022). Table (8) showed no significant interaction between the cultivar factor and the ethephon spray factor in the biological yield.

4-7-Biological yield (t. ha^{-1})

The results of Table (8) showed that there was a significant difference in the bio-yield trait between the cultivars, as Mawadda cultivar had a higher average of 17.34 t ha^{-1} and no significant difference than the Bohouuth-22 cultivar, which averaged 16.10 t ha^{-1}, with an increase of 18.36 and 9.9%, respectively, in comparison with Al-Rasheed cultivar, which recorded the lowest average of 14.65 t ha^{-1} . The reason for the superiority of the above two cultivars is their superiority in grain yield Table (7). Cultivars varied in the character of the biological yield due to their difference in the leaf area represented by flag leaf area Table (3) and tillers number table (4). In addition to the grain yield Table (7), this result agrees with the findings ofHadhili and Al-Hassan, (2017), Al-Aboudi, (2019), and Al-Salmi, (2021) that the cultivars differ in the character of the biological yield.

Table (8) Effect of cultivars, ethephon, and their interaction on Biological yield (t. ha^{-1})

cultivar	Ethephon levels ml l^{-1}		cultivar average
	A0	A1	
Al-Baraka	14.34	16.54	15.44
Al-Rasheed	14.12	15.17	14.65
Ibaa-99	15.18	16.42	15.80
Babel	14.44	15.61	15.02

Mawaddah	17.06	17.62	17.34
Bohouth-22	15.78	16.43	16.10
Benkal	13.86	15.69	14.77
Jad	14.34	16.95	15.64
Wafia	14.16	16.42	15.29
Jihan	13.61	16.12	14.86
Ethephon average	14.69	16.30	
			Lsd $_{0.05}$
cultivar	Ethephon levels	Interaction	
1.351	0.604	N. S	

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5- Conclusions

The study shows the difference in response of wheat cultivars to spraying with ethephon by improving growth characteristics and thus increasing the yield.

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