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EFFECT OF SPRAYING WITH ASCORBIC ACID AND TOCOPHEROL ON THE GROWTH AND YIELD OF BREAD WHEAT, TRITICUM AESTIVUM L.

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Abstract

A field experiment was carried out at the Agricultural Research and Experiment Station affiliated with the College of Agriculture - University of Basra during the winter of 2021-2022. To study the response of growth and yield of bread wheat to spraying with ascorbic acid and tocopherol. The study included spraying four concentrations of ascorbic acid 0.150. 300. 450 mg l^{-1} was given the codes A0, A1, A2, A3, and four concentrations of tocopherol acid were sprayed, which are 0. 100. 200. 300 mg l^{-1} has been given the symbols T0, T1, T2, T3. The experiment was applied according to a randomized complete block design (R.C.B.D) using a factorial experiment method with three replications, where wheat seeds (Bohooth-22) were sown on 15.11.2021 at a seeding rate of 140 kg ha^{-1}. The harvest took place on 15.04.2022. The results of the statistical analysis showed a significant effect of the concentrations of spraying with ascorbic acid at a concentration of 300 mg l^{-1} and a concentration of 450 mg l^{-1} in most growth characteristics and yield, as it recorded the highest average at a concentration of 300 mg l^{-1} in terms of the number of days from 50% flowering to full maturity, the flag leaf area, tillers number, and grains number per spike, which amounted to 46.59 days, 40.47 cm^2, 499.4 tillers m^2, and 44.70 grains of $spike^{-1}$, while the concentration was 450 mg l^{-1} has the highest average characteristic of the number of spikes per square meter and the total grain yield, which amounted to 496 spikes m^2 and 6.14 Meg ha^{-1}. As the results showed, when spraying with tocopherol acid at a concentration of 200 mg l^{-1}, a significant increase in the average number of days from 50% flowering to full maturity, the flag leaf area, tillers number, spikes number of m^2, and grains number per spike, which amounted to 48.25 days, 40.14 cm^2, 509.4 tillers m^2, 469 spikes m^2, and 45.83 grains $spike^{-1}$, while the concentration recorded 300 mg l^{-1} had the highest average grain yield, which amounted to 5.52 Meg ha^{-1}. The interaction between ascorbic acid and tocopherol had a significant effect on some yield characteristics, as it gave at a concentration of 450 mg l^{-1} of ascorbic with a concentration of 200 mg l^{-1} of tocopherol the highest average of the number of spikes per square meter and the total grain yield, which amounted to 536 spikes m^2 and 6.75 Meg ha^{-1}.

Introduction

Wheat crop (*Triticum aestivum* L.) belongs to the Poaceae family. It is one of the important grain crops and is considered one of the most important crops at the global level, as it ranks first in the ranks of food crops, followed by yellow corn and rice. It

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occupies more than half of the cultivated lands, and more than two-thirds of the population depends on it for living in the world; in Iraq, the wheat crop is one of the most important winter crops, as its cultivation is widespread in the northern, central, and southern regions. It is considered the main food for most of the population of Iraq, as it is a major source of carbohydrates because it contains a high percentage of starch. The crop also contains a good percentage of protein, cellulose, and fat. It also contains some mineral elements (Qasim et al., 2019).

Despite the increased demand for the wheat crop due to the increase in the population, and wheat is used in many foods and pastry industries, local production began to shrink and decline due to various environmental stresses such as water stress, salt stress, and oxidative stress, although Iraq is one of the original countries. Due to the emergence of wheat and the availability of factors for the success of cultivation of this crop, productivity is still low compared to global productivity, reaching 3.48 Meg ha^{-1} (USDA, 2020), while in Iraq, it amounted to 2.74 Meg ha^{-1} (Central Organization for Statistics and Technology Information 2019).

Ascorbic acid is one of the antioxidants that reduce environmental stress and increase plant tolerance to salinity, drought, and cold, which effectively affects the functional and structural fields in the plant (Helal et al., 2005) and protects the plant from photo-oxidation and its participation in the construction of ethylene, gibberellins, and anthocyanins. Moreover, because of the role that ascorbic acid can play in increasing the efficiency of the photosynthesis process and reducing respiration, its effective role in protecting chloroplasts, and its effective role in resisting free radicals ROS, especially H2O2, which are produced during the process of carbohydrate metabolism, Cell structure and its ability to expand and delay the onset of aging (Barth Conklin, 2006). The use of acid has increased spraying on the vegetative system of plants because it is an antioxidant that encourages the vegetative and fruitful growth of different plants, in addition to its role in reducing various stresses and stimulating respiration and cell division processes, from the harmful effects of drought by improving the plant content of carbohydrates, proteins, chlorophyll pigment, soluble sugars, carbohydrates, nitrogen elements, phosphorus and potassium (Hussein and Khursheed, 2014). Research also indicates the role of ascorbic in improving quality characteristics (Al-Rubaie, 2019).

Tocopherol is an important antioxidant that protects plants from environmental stresses, especially photo-oxidation, drought, low-temperature damage, and heavy elements. It also plays a major role in breaking the dormancy phase and seed germination (Celia, 2011), as tocopherol plays an important role in transmitting signals between cells by regulating the amounts of jasmonic acid in the leaves by modifying lipid peroxidation and gene expression, which affects plant development and its response to stress, control of the degree of lipid oxidation in chloroplasts, and determination of the accumulation of lipid hydroperoxides. Tocopherol also has an important role in protein synthesis by regulating gene transcription, mRNA stability, and protein translation. It is also believed that tocopherol increases the activity of

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enzymes, including those responsible for signal transduction, by affecting membrane proteins (Fryer, 1992).

Due to the lack of studies on this topic in local conditions, this study was conducted, which included the response of growth, yield, and quality of bread wheat to spraying with ascorbic acid and tocopherol due to the lack of local production of wheat per unit area compared to global productivity and finding solutions to reduce the salt and water stress that the wheat crop is exposed to with the aim of:

1- Increasing wheat crop productivity and their tolerance to salt stress.

2 - Improving the quality and productivity of the wheat crop.

Materials and Methods

A field experiment was carried out at the Agricultural Research and Experiment Station affiliated with the College of Agriculture - University of Basra, which is 30 km north of the governorate, during the winter season 2021-2022, in loamy soil to study the response of growth, yield and quality of bread wheat to spraying with ascorbic acid and tocopherol. The complete random block design was followed by a factorial experiment method with three replications. The area of the experimental unit was $4m^2$ with dimensions (2×2m), and it contained ten lines, the distance between one line and another was 20 cm inside one board. Then the cultivar (Bohooth-22) was planted on 15.11.2021. The soil was fertilized by adding nitrogen fertilizer at a rate of 120 kg N ha^{-1} (Al-Abdullah, 2015) in the form of urea (46% nitrogen) and added in two batches, the first after the emergence of seedlings and the second in the elongation stage. Phosphate fertilizer, triple superphosphate (20)% at a rate of 120 P_2O_5 ha^{-1} (Al-Halfi 2015) in one batch before planting, then the rest of the soil and crop service operations were carried out according to scientific recommendations. The data were analyzed according to the analysis of variance using GenStat software; then, the mean was compared using the least significant difference of 0.05.

Results and discussion

1- Days number from 50% flowering to full maturity (day)

The arrival of plants to the flowering stage is one of the important stages in the plant's life cycle. The analysis results in Table (1) indicated significant differences in the concentrations of ascorbic acid and tocopherol and the interaction between them in the number of days from 50% flowering to full maturity.

It is noted from the results of Table (1) that spraying ascorbic acid with concentration A2 led to a significant superiority in the number of days from 50% flowering to full maturity, which amounted to 46.59 days, compared to the comparison treatment A0, which recorded the lowest rate in the number of days amounted to 44.87 days, and this is consistent with what Neelambari reached it., (2016) in his study on the wheat plant. As for the effect of tocopherol acid, it was also significant, as the treatment of tocopherol with concentration T2 recorded the highest average number of days from 50% flowering until full maturity reached 48.25 days, compared to the lowest number of days recorded at Treatment with tocopherol at T0 concentration, which reached

41.11 days. The reason is attributed to the fact that the addition of tocopherol increases the building of phenolic compounds that are important in regulating the metabolism of the wheat plant, as it is considered an interaction material for many enzymatic antioxidants and its action with other enzymatic antioxidants, which contributes to increasing the stability of the cell membrane and thus affects the balance of absorption of important nutrients and then increases The speed of growth and the speed of flowering days, as well as its vital role for many plant hormones, including gibberellins, which encourage the flowering process.

The interaction had a significant effect, so the interaction treatment A3 T3 achieved the highest number of days from 50% flowering to maturity, amounting to 49.33 days, while treatment A0 T0 recorded the lowest amount to 38.13 days. Cellular metabolism results in excess sugars that are ready to promote flowering growth. These results are consistent with what Abbas (2014) concluded in his study on the bean plant.

Table (1) Effect of concentrations of ascorbic acid, tocopherol, and their interaction on days number from 50% flowering to full maturity (day)

Tocopherol acid concentration (ppm)	Ascorbic acid concentration (ppm)				Average tocopherol
	A0	A1	A2	A3	
T0	38.13	42.33	42.00	42.00	41.11
T1	47.00	45.67	47.33	45.67	46.42
T2	47.33	48.33	49.00	48.33	48.25
T3	47.00	47.00	48.05	49.33	47.84
Average ascorbic	44.87	45.83	46.59	46.33	
0.05<L.S.D	Ascorbic 0.050		Tocopherol 0.050		Interaction 0.101

2- Flag leaf area (cm²)

The leaf is the main plant in the process of carbon metabolism and manufacturing food for the plant. The greater the leafy area of the plant reflects positively the increase in the interception of solar radiation and the increase in the total dry matter, which works to prolong the period of filling the grain and increase its weight, which leads to an increase in yield, and that measuring the area foliar is an important factor for analyzing physiological growth and is necessary to highlight the productive capacity of the crop. The increase in the leaf area is also a result of the efficient carbonization of sunlight and the accumulation of dry matter, thus increasing plant productivity. The results of Table (2) show the significant effect of the concentrations of ascorbic acid and tocopherol acid and the interaction between them on the characteristic of the flag leaf area.

Table (2) showed that spraying ascorbic acid with concentration A2 recorded the highest area of the flag leaf, amounting to 40.47 cm², while concentration A0 recorded the lowest area of the flag leaf, amounting to 29.20 cm². The reason for the increase in

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ascorbic acid is that the acid activates the processes of photosynthesis and is an important regulator of oxidation states. The reduction of the protoplasm affects the oxidation and activity of enzymes inside the plant and is involved in the transfer of hydrogen ions from NADPH to oxygen and has a role in reducing stress resulting from temperature and stimulating respiration and cell division processes and enters the electronic transport system and preserves chloroplasts from oxidation as it has a role in stimulating side buds and thus The leaf area increased. These results agreed with the results obtained by Al-Samarrai and Hassan (2016) in their study on maize.

It is noted from Table (2) that spraying wheat with concentration T2 recorded the highest area of the flag leaf, amounting to 40.14 cm², while the comparison coefficient recorded the lowest area for this characteristic, amounting to 29.43 cm². The flag leaf is responsible for fixing the important carbon filling the ears. These results agreed with the results obtained by Farouk (2011) in his study on the wheat plant. The interaction between the concentrations of ascorbic acid and tocopherol acid was significant, and the interaction treatment T2 A2 achieved the highest mean of the flag leaf area of 50.57 cm², while the interaction treatment To Ao recorded the lowest average for this trait, amounted to 18.79 cm².

Table (2) Effect of concentrations of ascorbic acid, tocopherol, and their interaction on flag leaf area (cm²)

Tocopherol acid concentration (ppm)	Ascorbic acid concentration (ppm)				Average tocopherol
	Ao	A1	A2	A3	
To	18.79	24.92	31.49	42.55	29.43
T1	37.91	28.34	46.61	30.08	35.73
T2	31.05	40.27	50.57	38.67	40.14
T3	29.04	39.67	33.21	41.14	35.76
Average ascorbic	29.20	33.30	40.47	38.11	
0.05<L.S.D	Ascorbic 0.042		Tocopherol 0.042		Interaction 0.085

3- Tillers number (tillers m²)

The production of tillers is a desirable characteristic in grain crops, and agricultural operations such as fertilization affect the growth and formation of tillers, as they are linked to one of the important components of yield, which is the number of spikes per unit area. The results of Table (3) confirmed the highly significant effect of the concentrations of ascorbic acid and tocopherol and the interaction between them on the character of the number of tillers of the wheat crop. The results in Table (3) show that spraying with ascorbic acid concentration A2 gave the highest average number of strokes of 499.4 tillers m², compared to the control treatment Ao, which gave the lowest average number of strokes of 426.8 tillers m².

This increase may come due to the increase in the flag leaf area, which leads to an increase in food production, which affects the number of shoots, while the two

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treatments, A1 and A3, did not differ significantly. Moreover, the energy required and the increase in the amount of carbohydrates and their transfer to the active areas, which in turn leads to an increase in the number of foragers, and these results are consistent with the results reached by Al-Hamdani and Al-Jubouri, (2020) in their study on the wheat plant. Table (3) results indicate that the concentration T2 of tocopherol acid recorded the highest number of shoots, which amounted to 509.4 strands m^2, while the comparison treatment recorded the lowest value, which amounted to 437.0 tillers m^2. The reason may be due to the increase in the water content of plant cells and the stability of their cell membranes, thus maintaining the number of Al-Eshtaa agreed with (Ali and Ahmed, 2017) when they studied the wheat plant.

The interaction between the two study factors was significant in its effect on this trait, as the overlap treatment A2 T2 was significantly superior to the rest of the treatments, and the highest interaction for the trait was recorded, amounting to 600.7 tillers m^2, compared to the least effect of the interference was when the treatment factor A0 T1, which amounted to 354.7 tillers m^2.

Table (3) Effect of concentrations of ascorbic acid, tocopherol, and their interaction on tillers number (tillers m^2)

Tocopherol acid concentration (ppm)	Ascorbic acid concentration (ppm)				Average tocopherol
	A0	A1	A2	A3	
T0	420.0	418.7	447.3	462.0	437.0
T1	354.7	438.7	426.3	494.0	428.4
T2	477.3	488.3	600.7	471.3	509.4
T3	455.3	460.7	523.3	477.7	479.2
Average ascorbic	426.8	451.6	499.4	476.2	
0.05<L.S.D	Ascorbic 29.74		Tocopherol 29.74		Interaction 59.48

4- Spikes number m^2 (spikes m^2)

The number of spikes is an important component of the yield and is often positively correlated with the grain yield. The difference in this characteristic is due to the differences in their ability to produce and maintain offshoots. The analysis results, Table (4), indicated that there was a significant effect of ascorbic acid while spraying with tocopherol acid did not have a significant effect, but the interaction between the two acids was significant in this characteristic. It was observed from the results of Table (4) that the number of spikes per square meter increased significantly when spraying ascorbic acid with concentration A3, as the highest average in the number of spikes was 496 spikes m^2, compared with comparison treatment A0, which gave the lowest average of 381 spikes m^2.

The reason for the increase may be due to its role in increasing the outputs of photosynthesis, resulting in more sugars that are ready and available to enhance flowering growth, as it affected the number of spikes per square meter, and these results agreed with the findings of Al-Halfi and Zaboun (2016) in their study on the wheat plant. As for the effect of tocopherol, the treatment of plants with tocopherol increased spikes. The average number of spikes in the T2 treatment was 469 spikes m2 compared to the comparison treatment, which amounted to 450 spikes m^2; this increase was not significant according to the statistical analysis. As for the interaction between the two workers, the treatment T2A3 excelled and achieved the highest number of spikes, amounting to 536 spikes m^2, while the treatment transaction T0A0 recorded the lowest value, amounting to 335 spikes m^2.

Table (4) Effect of concentrations of ascorbic acid, tocopherol, and their interaction on spikes number (spikes m^2)

Tocopherol acid concentration (ppm)	Ascorbic acid concentration (ppm)				Average tocopherol
	A0	A1	A2	A3	
T0	335	482	485	500	450
T1	392	397	412	415	404
T2	400	465	477	536	469
T3	397	411	495	534	459
Average ascorbic	381	438	467	496	
0.05<L.S.D	Ascorbic 58.4		Tocopherol N.S		Interaction 116.9

5- Grains number per spike (grains spike^{-1})

The number of grains is one of the most important components of the yield, which is greatly affected by environmental factors. Table (5) results indicated significant differences between ascorbic acid and tocopherol and the interaction between them in this characteristic.

It was noted from the results in Table ((5) that spraying wheat with ascorbic acid concentration A2 gave the highest average number of grains per spike, which amounted to 44.70 grains of spike^{-1}, compared with the comparison treatment with concentration A0, which gave the lowest average of 38.92 grains of spike^{-1}. The reason for the increase is that ascorbic acid has an important role In plant growth and development, being a catalyst and accompanying factor for several enzymes and in the bio-representation of several hormones, including gibberellins, which leads to the elongation of cells and thus increased the outputs of the photosynthesis process, which increased fertilization rates and decreased seed abortion, which positively affected the number of grains in the spike. These results agreed with Abdel-Azim Ahmed (2013) in their study on the wheat plant.

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The results of Table (5) showed that spraying wheat plants with tocopherol acid at a concentration of T2 gave the highest average number of grains per spike, which amounted to 45.83 grains of spike^{-1}, compared to the comparison treatment T0, which gave the lowest value of the average number of grains of the crop, which amounted to 39.76 grains of spike^{-1}. The interaction between the two study factors had a significant effect on this trait, as the overlap treatment A2 T2 was significantly superior to the rest of the interactions and gave the highest value of 48.15 grains of spike^{-1} compared to the least effective when the treatment factor of interference A0 T0 amounted to 27.56 grains of spike^{-1}.

Table (5) Effect of concentrations of ascorbic acid, tocopherol, and their interaction on grains number per spike (grains spike^{-1})

Tocopherol acid concentration (ppm)	Ascorbic acid concentration (ppm)				Average tocopherol
	A0	A1	A2	A3	
T0	27.56	44.91	43.52	43.05	39.76
T1	43.12	43.22	43.56	45.42	43.83
T2	43.76	45.04	48.15	46.36	45.83
T3	41.26	43.46	43.56	42.62	42.72
Average ascorbic	38.92	44.16	44.70	44.36	
0.05<L.S.D	Ascorbic 0.034		Tocopherol 0.034		Interaction 0.068

6- Grains yield (Meg ha^{-1})

The characteristic of grain yield per unit area is the outcome of some components or attributes dependent on physiological processes and the extent of overlap and interaction between them during the stages of plant growth. The table results for the characteristic of grain yield (6) showed a significant effect of ascorbic acid and the interaction between it and tocopherol acid on grain yield, while spraying with tocopherol acid had no significant effect on this characteristic. The average grain yield amounted to 6.14 Meg ha^{-1}, while the control treatment A0 recorded the lowest grain yield of 4.53 Meg ha^{-1}. Agreed with what Al-Dulaimi and Al-Rawi (2017) stated in their study on the broad bean plant. The reason may be due to the accumulation of photosynthesis, which positively affected the accumulation of dry matter in the grain yield and increased the number of grains per spike per plant.

It was noted from the results of Table (6) that spraying with tocopherol acid was not significant in its effect on the grain yield characteristic of the wheat crop if the treatment T3 gave the highest value of 5.52 Meg ha^{-1} compared to the non-spraying treatment T0 that gave the lowest value of 5.38 Meg ha^{-1} As for the treatments T1 and T2, they did not differ significantly. They agreed with Al-Halfi and Zaboun (2016) in

their study on the wheat plant and Ali and Ahmed (2017) in their study on the wheat plant.

As for the effect of the interaction between ascorbic acid and tocopherol, there was a significant effect. The treatment A3 T2 was significantly superior to the rest of the treatments, as it recorded the highest grain yield of 6.75 Meg ha-1, while the interaction treatment To Ao was recorded, which amounted to 4.47 Meg ha-1.

Table (5) Effect of concentrations of ascorbic acid, tocopherol, and their interaction on grains yield (Meg ha-1)

Tocopherol acid concentration (ppm)	Ascorbic acid concentration (ppm)				Average tocopherol
	Ao	A1	A2	A3	
To	4.47	5.51	5.69	5.87	5.38
T1	4.70	4.97	4.88	5.65	5.05
T2	4.31	4.75	5.86	6.75	5.42
T3	4.64	5.36	5.81	6.28	5.52
Average ascorbic	4.53	5.15	5.56	6.14	
0.05<L.S.D	Ascorbic 0.926		Tocopherol N.S		Interaction 1.853

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