Iraqi Journal for Applied Science (IJAS)
Vol. 2, No. 2, June, 2025, pp. 49-55
ISSN: 3006-5828, DOI: 10.69923/er966f98

Effect of soaking with non-enzymatic antioxidants on Seed germination and growth of Wheat and yellow corn seedling under salt stress

Leqaa Taher Kamel[1], Azhar Lateef Shwish[2], Dorees Taher Hasan[3]
[1,2,3]Department of Biology, College of Education for Pure Science, University of Diyala, Diyala, Iraq.

Article Info

Article history:

Received: 30, 01, 2025
Revised: 29, 04, 2025
Accepted: 03, 05, 2025
Published: 30, 06, 2025

Keywords:

Antioxidants
Salcilyic acid
Ascorbic acid
Vitamin E
Prolin acid
Na Cl
Triticum aestivum L
Zea mays L

ABSTRACT

This study was conducted for period 1 to 20-2025 and aim of studying the effectiveness of soaking with antioxidants and its effect in reducing salt stress on the growth characteristics of Wheat (Triticum aestivum L.) and yellow corn (Zea mays L.) plants. A factorial experiment with five treatments was conducted according to a randomized block design (RCBD). involved with distilled water, salicylic acid at a concentration of 150 mg/l-1, ascorbic acid at a concentration of 150 mg/l -1, vitamin-E at a concentration of 150 mg/l-1, and proline at a concentration150 mg/l -1 .The seeds were obtained from the Diyala Agriculture Directorate with different salt concentrations Nacl, (0,2,4 and 6) , the results showed the absence of significant difference in these transactions in each of the characteristics of root length, shoot length, dry weight, fresh weight, And the relative salinity tolerance index ,However a significant superiority when irrigated with salt concentrations from a solution that included 2NaCl in the average of these characteristics,The results showed a significant difference in the average the interference between the soaking materials and salinity concentrations of irrigation water had, a significant effect on all studied characteristics.

Corresponding Author:

Leqaa Taher Kamel
Department of Biology, College of Education for Pure Science
University of Diyala
Baqubah City, Diyala Governorate, Iraq.
Email: Lekaa.taher@gmail.com

1. INTRODUCTION

The Wheat crop *Triticum aestivum* L. It ranks first in the world in terms of area and production. It is the most important crop among grain crops, because it is a staple food for more than 60 countries in the world, as it meets about 20% of human nutritional needs [1]. Wheat production in Iraq is increasing widely and the reason for this increase in production is due to horizontal expansion, so we need to use Techniques and methods to increase crop production by expanding agricultural areas [2]. Wheat is also a plant of the grass family Poaceae.tricarbon C4 Which is grown for its seeds for food, industry and fodder purposes. Wheat has many varieties. These varieties differ in their tolerance to salinity [3]. This crop also achieves a good balance between carbohydrates and proteins, which is why it is called the queen of crops [4]. Yellow corn is *Zea mays* L. of C4 plants [5]. It is also one of the most important industrial and food grain crops belonging to the Poaceae family. Poaceae is the most important crop in many countries of the world, including Iraq.

This crop ranks third after wheat and rice in terms of area and production [6]. The crop is used to treat some chronic diseases such as chronic inflammation of the kidney, prostate and urinary bladder. It is also used to reduce harmful cholesterol in the blood, and reduce sugar levels, in addition to its anti-proliferation effect on cancer cells [7]. The crop has antioxidant properties, which protect cells from damage resulting from oxidation processes in the body caused by free radicals [8]. And you know Antioxidants They are compounds used in food preservation by tAGood spoiled or rancid or discolored as a result of oxidation [9].

Nutritionally, antioxidants are compounds that are added to food in low concentrations, so that they prevent. It prevents the oxidation of some vital compounds such as fats, carbohydrates and nucleic acids [10]. Antioxidants protect in several ways, either by directly inhibiting Production of active oxygen compounds Reactive Oxygen Species (ROS) or prevent their spread or destruction [11]. The most important feature non-enzymatic antioxidants They have low molecular weights and have the ability to prevent or reduce the damage caused by oxidative stress [12]. The non-enzymatic antioxidants are collected from the ascorbic acid, and alpha-tocopherol (vitamin E) Glutathione plays an important role in inhibiting oxidation and reduction in plant cells [13]. Salicylic acid returns belong to the group of plant phenolic acids, and is one of the plant hormones that have been discovered and are produced by plants [14]. This acid participates in various physiological processes, and this acid also works as an antioxidant [15]. The acid has been studied as a model plant hormone.no It resists many plant pathogens [16]. It has been shown that the acid provides defensive protection against types of environmental stress such as salt stress, heat stress, drought stress and stress resulting from heavy metals [17].

Ascorbic acid is a sugar acid, it plays an effective role in transporting electrons across the plasma membrane, in addition to its role in cell elongation and division, as it controls cell growth [18]. This acid plays a role in protecting crops from exposure to stresses such as salt stresses, so it can be described as an antioxidant in the plant [19]. The concentration of ascorbic acid is high in the chloroplasts, where its primary role is to protect against the effects of free radicals [20]. Ascorbic acid works as Auxinic is an anti-toxin and plays an important role in increasing the flower cluster and productivity [21]. Alpha-tocopherol, also known as Vitamin-E is a fat-soluble antioxidant compound, present in high proportions at the membrane level and inhibits the chain of lipid peroxidation reactions [22]. It protects the plant from the effects of oxidative stress resulting from salt stress, and also protects the cell membrane, as it maintains its structure and functions against active oxygen species during stress, which in turn increases the absorption of nutrients [23]. Proline is an important amino acid that exists in a free form and contains a secondary amino group attached to it. This feature distinguishes it from other amino acids [24]. It accumulates due to the inability of plant tissues to build protein, as well as demolition processes [25] [26], .and Maintains colloidal properties for intracellular protoplasm [27]. It maintains the enzymes present in the mitochondria [28]. The aim of the study is to compare the effect of soaking with antioxidants on the growth of wheat and yellow corn plants and reducing salt stress.

2. METHOD

This study was conducted in the laboratories of the Department of Life Sciences - College of Education for Pure Sciences / University of Diyala from the period (1-1-2025) and until (15-1-2025). The study included agriculture. In petri dishes in order to study the effectiveness of soaking with antioxidants and its effect in reducing salt stress on the growth characteristics of the plant Wheat. *Triticum aestivum* L. And yellow corn Zea mays L. Table (1) shows Physical properties and chemistry for study soil.

The tests were conducted. Soil Chemistry and Physics at Diyala University / College of Agriculture, Department of Soil and Water Resources / Postgraduate Laboratories, I took sandy texture soil free of salts from the nursery and the reading was EC 441 ds.m^{-1}, then air dried and passed through a sieve with holes' diameter of 2.5 mm. The soil was well homogenized. A factorial experiment was carried out. five Transactions according to a randomized complete block design RCBD with three replicates, the first factor is soaking. With distilled water and the second factor is soaking with salicylic acid. Focus150 mg/L^{-1}, and the factor Third: Soaking with ascorbic acidFocus150 mg/L $^{-1}$.

The fourth factor is soaking. With Vitamin-E at a concentration of 150 mg/L^{-1}, and the factor Fifth Soaking with proline acid concentration150 mg. L^{-1} and irrigation with salt concentrations including 2, 4 and 6 of sodium chloride solution NaCl. The characteristics of root length, shoot length, dry weight, fresh weight and relative salinity tolerance index were studied.

Table ((1) Physical and chemical properties of the study soil:

Unity	Measurement	Attributes		T
-	8.22	PH of saturated soil paste extract		1
Dessy Siemens M^{-1}	441	EC for soil		2
Micro Siemens .CM^{-1}	1.61	EC for distilled water		3
Micro Siemens .CM^{-1}	105.1	EC 2 NaCL g		4
Micro Siemens .CM^{-1}	713	EC 4 NaCL g		5
Micro Siemens .CM^{-1}	1162	EC 6 NaCL g		6
Sadness.kg $^{-1}$	958	Sand	Separated soil	7
Sadness.kg $^{-1}$	40	Green		
Sadness.kg $^{-1}$	2	Clay		
Sandy			soil texture	8

3. Studied characteristics

3.1 Root length (cm).
The root length was measured using a tape measure on the tenth day from the beginning of the experiment.
3.1.1 Length of the rod (cm).
The length of the rudder was measured using a tape measure on the tenth day from the beginning of the experiment.
3..1.2 Fresh weight for the root and the rod (g)
The fresh weight of the root was calculated using a sensitive balance on the tenth day from the beginning of the experiment.
3.1.3 Relative Salinity Tolerance Index
The relative salinity tolerance index was calculated based on: [29].
Relative salinity tolerance index = Total number of seeds germinating under a given salt concentration / Total number of seeds germinating in distilled water.
3.2 Statistical analysis
The obtained data were analyzed according to the analysis of variance method for the completely randomized design using the ready-made statistical program (SPSS) version 22, and the test was selected Duncan's comparison of means and probability level 0.05 [30].

4. RESULTS AND DISCUSSION

4.1 Root length (cm).

The table shows (1) There were significant differences in the averages of the root length trait of wheat (cm), as the treatment with salicylic acid gave the lowest average for this trait, reaching 8.417 cm, compared to the control treatment, which gave an average of 11.833 cm. Significant differences were observed in the salinity concentrations of irrigation water, as the concentration of 2NaCl g.L^{-1} gave the highest average of 13.400 cm, compared to the control treatment. The concentration of 4NaCl g.L^{-1}gave an average of 10.100 cm, compared to the control treatment which gave an average of 13.167 g.L^{-1}, while the concentration of 6NaCl g.L^{-1}gave the least significant difference for this trait, reaching 7.500 cm. The decrease may be attributed to the negative effect of salinity and the concentration of ions in it, which causes toxicity and affects the process of mineralization and photosynthesis and thus the availability of elements. This result is consistent with what was mentioned by [31] [32]. The results showed an interaction between the soaking materials and the salt concentrations, and the highest average interaction was with proline acid, which amounted to 15.667 Irrigation with distilled water, and the lowest average interference with salicylic acid at a concentration of 4NaCl g.L^{-1}.The table shows (1) There were no significant differences in the averages of the root length trait of yellow corn, while significant differences were observed in the averages of irrigation water salinity concentrations, as the concentration of 6NaCl g.L^{-1} gave the lowest average for this trait, reaching 4.800 cm, compared to the control treatment with distilled water, which reached 9.467 cm, and this may be attributed to The reason is that the increase in the concentration of salts in irrigation water and its effect on plant growth and root growth in it causes disturbances in metabolic processes such as photosynthesis, protein and carbohydrate synthesis, etc., and all the vital processes that take place inside the plant, which is greatly reflected in root growth, and this result is consistent with [33].

Table (1) The effect of soaking with some acids and irrigation with increasing concentrations of table salt on the average root length. (cm) For wheat and yellow corn seedlings.

Soaking materials						Irrigation water salinity concentrations	Plant
Average	Proline acid 150 mg/L^{-1}	Vitamin E 150 mg/L^{-1}	Salicylic acid 150 mg/L^{-1}	Ascorbic acid 150 mg/L^{-1}	Distilled water		
13.167 A	15.667 a	13.667 abc	9,000 bg	12.667 d	14.833 a	Distilled water	Wheat
13.400 A	13,333 ads	14,500 ab	12,000 af	14.333 ab	12,833 a	2NaCl g/L^{-1}	
10.100 B	11,000 ag	10.667 ab	5.667 g	11,500 af	11.667 af	4NaCl g/L^{-1}	
7,500 C	7.833 dg	8,000 cg	7,000 efg	6.667 fg	8,000 cg	6NaCl g/L^{-1}	
	11.958 A	11.708 A	8.417 B	11.292 A	11.833 A	Average	
9.467 A	9,500 abc	8,333 ads	9,000 ads	9,000 ads	11,500 a	Distilled water	Yellow corn
7.233 B	7.333 AED	6.167 be	6.833 be	10.833 ab	5,000 b	2NaCl g/L^{-1}	
5.667 BC	5.667 cde	6.667 be	4.667 cde	5.667 cde	5.667 c	4NaCl g/L^{-1}	
4.800 C	3.333 e	5,000 cde	4.167 de	5.667 cde	5.833 f	6NaCl g/L^{-1}	
	6.458 A	6.542 A	6.167 A	7.792 A	7,000 A	Average	

Means with similar letters within columns of single factors or overlapping means do not differ significantly from each other at the probability level.0.05 according to Duncan's multiple range test.

4.2 Length of the rod (cm).

The table shows (2) There were significant differences in the averages of the frond length trait for wheat, as the treatment with proline acid gave the highest average for this trait, reaching 10.125 cm. This is due to The accumulation of proline in the cytoplasm of the cell increases the negativity of the osmotic potential of the cell, which increases its ability to draw water from the cells and the surrounding environment. This will lead to the entry of water and thus to a reduction in the stress conditions that affect Plant [34], Treatment with salicylic acid had the lowest average for this trait 6.250 cm, while the irrigation water salinity concentration of 6NaCl g/L $^{-1}$gave the lowest average of 7.467 cm compared to the control treatment with distilled water, which reached 9.367 cm. The increase in salt concentration has a direct effect on the plant through its effect on the roots and then on the shoots.

The results in the same table also show differences in the averages of the interaction between the soaking materials and the salinity concentrations of the irrigation water, as the highest average interaction was with the soaking materials with proline acid.11.333 cm and irrigation with distilled water, and the lowest average interference with salicylic acid soaking materials was 4.833 cm at a concentration of 6NaCl g.L^{-1}.

Table (2) The effect of soaking with some acids and irrigation with increasing concentrations of table salt on the average length of the rod (cm) for wheat seedlings and yellow corn

Soaking materials							
Average	Proline acid 150 mg/L^{-1}	Vitamin E 150 mg/L^{-1}	Salicylic acid 150 mg/L^{-1}	Ascorbic acid 150 mg/L^{-1}	Distilled water	Irrigation water salinity concentrations	Plant
9.367 A	11.33 a	10.33 abc	6.667 efg	9,667 ads	8.833 e	Distilled water	Wheat
9.100 A	10.66 ab	8.333 be	7.833 cf	9.333 AED	9.333 e	2NaC l gm.L^{-1}	
8.367 AB	9,667 a	9,000 ab	5.667fg	9,500 ads	8,000 bf	4NaCl gm.L^{-1}	
7.467 B	8.833 g	9.333 a	4.833 g	7,000 dg	7.333 dg	6NaCl gm.L^{-1}	
	10.15A	9.250 AB	6.250 C	8.875 B	8.375 B	Average	
4.400 A	4,500 ab	4,000 abc	4,500 ab	3,500 ads	5,500 a	Distilled water	Yellow corn
2.967 B	3,500 ads	3.333 bcd	2.833 be	3.833 abc	1.333 de	2NaCl gm.L^{-1}	
2.700 B	2.833 be	2,500 be	2.333 be	2.833 be	3,000 bcd	4NaCl gm.L^{-1}	
1.487 C	2,000 ced	1,500 de	0.700 e	0.733 e	2,500 be	6NaCl gm.L^{-1}	
	3.208 A	2.833 A	2.592 A	2.725 A	3.083 A	Average	

Averages with similar letters within columns of single factors or overlapping averages do not They differ from each other morally at the probability level.0.05According to Duncan's multiple range test.

The table shows (2) No significant differences For soaking transactions In the averages of the length of the frond of yellow corn, while significant differences were observed in the averages of the salinity concentrations of irrigation water, as the concentration gave6NaCl g.L $^{-1}$ The lowest average for this characteristic was 1.487 cm3 compared to the control treatment with distilled water, which was 4.400 cm3.The researcher's opinion is attributed to the difference in environmental conditions and the difference in salt concentration, in addition to the difference in soaking coefficients in plant growth characteristics.

The results in the same table also show differences in the averages of the interaction between the soaking materials and the salinity concentrations of the irrigation water, as the highest average interaction was with the soaking materials in distilled water.5.500 cm and irrigation with distilled water, and the lowest average interference with salicylic acid soaking materials was 0.700 cm at a concentration of 6NaCl g.L^{-1}.

4.3 Fresh weight for the root and the rod (gm)

The results in the table (3) The superiority of the soaking treatment with proline acid for the fresh weight of wheat, which gave the highest average for this trait, which reached 0.2300 gm, with an increase rate of 30.1% compared to the comparison treatment, while the soaking treatment with vitamin E gave the lowest average for this trait, which reached 0.1767 gm, with a decrease rate of 23.1% compared to the comparison treatment, and the irrigation water concentration of 4NaCl gm.L $^{-1}$ gave the lowest average of 0.1880 gm compared to the control treatment, and this is attributed to the role of vitamin E in protecting the plant from salt stress and protecting the cell membrane[23]. The results of the same table indicate that there are differences in the averages of interaction between the soaking materials and the salinity concentrations of irrigation water, as the highest average of interaction was with the soaking materials with ascorbic acid, which reached0.2700 g at a concentration of 2 NaCl g.L $^{-1}$, and the lowest average interference with proline acid soaking materials was 0.1567 g and irrigation with distilled water.

The table indicates (3) No significant differences For soaking transactions In average fresh weight trait For yellow corn It is noted that there is a gap and Moral And In irrigation water salinity concentrations, as it gave focus 6NaCl g/L $^{-1}$Minimum average 0.2733Sadly, the percentage decreased by 30.6% compared to the control treatment with distilled water and irrigation with distilled water, which amounted to 0.3940 Sadly, and with an increase of44.1%, and the researcher's opinion is attributed to the difference in environmental conditions and the difference in salt concentration in addition to the difference in soaking coefficients in plant growth characteristics.The results of the same table indicate that there are differences in the averages of interaction between the soaking materials and the salinity concentrations of irrigation water, as the highest average of interaction was with the soaking materials in distilled water .Irrigation with distilled water reached 0.4633 g, while the lowest average interference was achieved by soaking treatment .With salicylic acid 0.1967 Sadness And the concentration of salinity of irrigation water 6NaCl g/L^{-1}.

Table (3) The effect of soaking with some acids and irrigation with increasing concentrations of table salt on the average fresh weight (root and rod) For wheat seedlings and yellow corn

Soaking materials						Irrigation water salinity concentrations	Plant
Average	Proline acid 150 mg/L-1	Vitamin E 150 mg/L-1	Salicylic acid 150 mg/L-1	Ascorbic acid 150 mg/L-1	Distilled water		
0.2180 AB	0.2367 abc	0.1567 c	0.2200 abc	0.2267 abc	0.250 ab	Distilled water	Wheat
0.2300 A	0.2600 ab	0.1900 abc	0.2100 abc	0.2700 a	0.2200 abc	2NaClgm.l-1	
0.1880 B	0.1867 abc	0.1700 bc	0.1933 abc	0.2200 abc	0.1700aa	4NaClgm.l-1	
0.1947AB	0.2367 abc	0.1900 abc	0.1733 bc	0.2000 abc	0.1733 bc	6NaClgm.l-1	
	0.2300 A	0.1767 B	0.1992 AB	0.2292 A	0.2033 AB	Average	
0.3940 A	0.3500 abc	0.4067 ab	0.4000 ab	0.3500 abc	0.4633 a	Distilled water	Yellow corn
0.3560 AB	0.3233 abc	0.3933 ab	0.3500 abc	0.4867 a	0.2267 bc	2NaClgm.l-1	
0.3153 BC	0.3733 abc	0.2467 bc	0.2600 bc	0.3300 abc	0.3667 abc	4NaClgm.l-1	
0.2733 C	0.3500 abc	0.2633 bc	0.1967 cab	0.2500 bc	0.3067 abc	6NaClgm.l-1	
	0.3492 A	0.3275 A	.3017 A	0.3542 A	0.3408 A	Average	

Averages with similar letters within columns of single factors or overlapping averages do not They differ from each other morally at the probability level.0.05According to Duncan's multiple range test.

4.4 Relative Salinity Tolerance Index

The table indicates (4) There are significant differences For soaking transactions In the averages of the relative salinity tolerance index For wheat seedlings ,The soaking treatment with distilled water gave the lowest average for this characteristic, which was0.100And a decrease of 28.5% compared to other soaking treatments ,It is noted that there is no significant difference in the salinity concentrations of irrigation water .This is due to the difference between wheat varieties in terms of their tolerance to salinity, as wheat is a plant with moderate tolerance to salinity [3]. The results of the same table indicate that there are differences in the averages of interaction between the soaking materials and the salinity concentrations of irrigation water, as the highest average of interaction was with the soaking materials in distilled water. Irrigation with distilled water reached 0.4633 g, while the lowest average interference was achieved by soaking treatment. With salicylic acid 0.1967 Sadness And the concentration of salinity of irrigation water 6NaCl g/L^{-1}.
Shows Same table non There is an overlap between the soaking materials. And irrigation water salinity concentrations.

The results in the table (4) To the superiority of soaking treatment with acid. Ascorbic in Averages of the Relative Salinity Tolerance Index Yellow corn seedlings, which gave the highest average for this trait, which was 0.1600 With an increase rate of 201.8%Compared to the distilled water soaking treatment, which gave the lowest average for this characteristic. 0.053And a decrease of 66%, Significant differences were observed in the average salinity of irrigation water, as: Give focus Salinity irrigation water 6NaCl g $^{-1}$. L. The lowest average was 0.138 compared to control treatment Which gave the highest average of 0.198 Focus6NaCl g/L $^{-1}$ This is attributed to the fact that soaking the grains in ascorbic acid had some positive effects on plant growth, which resists the inhibitory effects of salinity stress [35].

The results of the same table indicate that there are differences in the averages of the interaction between the soaking materials and the salinity concentrations of irrigation water, as the highest average interaction with the soaking materials was With vitamin-E 0.280 Focus 2NaCl g.L^{-1} , and the lowest average interference with soaking materials was With distilled water 0.000 Focus 4NaCl g/L^{-1} and Focus 6NaCl g/L-1.

Table (4) The effect of soaking with some acids and irrigation with increasing concentrations of table salt on Average relative tolerance index of wheat and maize seedlings

Soaking materials						Irrigation water salinity concentrations	Plant
Average	Proline acid 150 mg/L^{-1}	Vitamin E 150 mg/L^{-1}	Salicylic acid 150 mg/L^{-1}	Ascorbic acid 150mg.L^{-1}	Distilled water		
0.132	0.140	0.140	0.140	0.140	0.100	2NaCl gm.L^{-1}	Wheat
0.132	0.140	0.140	0.140	0.140	0.100	4NaC gm.L^{-1}	
0.132	0.140	0.140	0.140	0.140	0.100	6NaCl gm.L^{-1}	
	0.140	0.140	0.140	0.100	0.140	Average	
0.138	0.170	0.170	0.080	0.170	0.100	2NaCl gm.L^{-1}	Yellow corn
0.142	0.170	0.170	0.100	0.170	0.100	4NaCl gm.L^{-1}	
0.142	0.170	0.170	0.100	0.170	0.100	6NaCl gm.L^{-1}	
	0.170	0.170	0.093	0.170	0.100	Average	

Averages with similar letters within columns of single factors or overlapping averages do not They differ from each other morally at the probability level.0.05 According to Duncan's multiple range test.

5. CONCLUSION

1- plant species of wheat and yellow corn have taken a different behavior towards the non-enzymatic antioxidants soaking materials.
2- The soaking and irrigation treatment with a concentration of 2 g of NaCl liter. -1, gave the highest averages for plant characteristics and was the best for the growth of wheat and yellow corn seedling.

6. Suggestions

1. Conducting this study in the field and with larger areas in the soil instead of dishes.
2. Treating the seeds of other plants before planting with non- enzymatic antioxidants to improve their ability to withstand soil salinity and irrigation water.

REFERENCES

[1] M. M. El-Fouly, Z. M. Mobarak, and Z. A. Salama, "Micronutrients (Fe, Mn, Zn) foliar spray for increasing salinity tolerance in wheat Triticum aestivum L.," Afr. J. Plant Sci., vol. 5, no. 5, pp. 314–322, 2011.
[2] M. F. Al-Hassan, Understanding the emptying mechanism in several varieties of bread wheat (Triticum aestivum L.) on the effect of seeding rate and nitrogen level and its relationship to grain yield and its components, Ph.D. thesis, Coll. Agric., Univ. Baghdad, 2011.
[3] R. Costa et al., "Effect of sowing date and seeding rate on bread wheat yield and test weight under Mediterranean conditions," Emir. J. Food Agric., pp. 951–961, 2013.
[4] X. Rao et al., "Comparative cell-specific transcriptomics reveals differentiation of C4 photosynthesis pathways in switchgrass and other C4 lineages," J. Exp. Bot., pp. 1–14, 2015.
[5] S. M. J. Al-Abbasi, Estimation of some genetic parameters of yield and its components for genotypes introduced from maize (Zea mays L.), M.Sc. thesis, Univ. Mosul, Coll. Agric. Forestry, 2009.
[6] M. A. Solihah, W. I. Wan Rosli, and N. A. R. Nurhanan, "Phytochemicals screening and total phenolic content of Malaysian Zea mays hair extracts," Int. Food Res. J., vol. 19, no. 4, pp. 1533–1538, 2012.
[7] Y. Wang, J. Zhang, H. Liu, and X. Huang, "Physiological and ecological responses of alfalfa and milkvetch seed to PEG priming," Acta Ecol. Sin., vol. 24, no. 3, pp. 402–408, 2004.
[8] G. Duthie et al., "Plant-derived phenolic antioxidants," Curr. Opin. Clin. Nutr. Metab. Care, vol. 3, no. 6, pp. 451–447, 2000.
[9] P. Rahdari and S. M. Hoseini, "Evaluation of germination percentage and some physiologic factors under salinity stress and GA3 treatments in wheat (Triticum aestivum L.)," Int. Adv. Res. Biol. Sci., vol. 2, no. 2, pp. 122–131, 2015.
[10] J. Miquel, "Can antioxidant diet supplementation protect against age-related mitochondrial damage," Ann. N. Y. Acad. Sci., vol. 959, pp. 508–516, 2002.
[11] M. C. Yin and K. C. Chan, "Nonenzymatic antioxidative and antiglycative effects of oleanolic acid and ursolic acid," J. Agric. Food Chem., vol. 55, pp. 7177–7181, 2007.
[12] E. F. Al-Douri, "Effect of foliar spraying with ascorbic acid on the vegetable growth of apricot seedlings, Labib cultivar," Diyala J. Agric. Sci., 2014.

[13] M. S. Abdel Wahed, A. Hadi, and R. Hashem, "Effect of spraying with ascorbic and salicylic acid on some physicochemical properties of sweet orange seedlings (Citrus aurantium L.)," Thi-Qar Univ. J. Agric. Res., vol. 1, no. 2, 2012.
[14] M. Zarei, H. Abbaspour, J. S. Masood, and A. Rahbair, "Quality traits of corn salicylic acid and sowing date in late summer planting in Damghan region," Int. J. Agric. Sci., vol. 2, no. 7, pp. 635–641, 2012.
[15] S. Muthulakshimi and Lingakunar, "Role of salicylic acid (SA) in plants: A review," Int. J. Appl. Res., 2017.
[16] I. M. Radi, "Effect of spraying salicylic and ascorbic acid on the growth and yield of tomato (Lycopersicon esculentum Mill.)," Al-Furat J. Agric. Sci., vol. 8, no. 2, pp. 52–56, 2016.
[17] N. Smirnoff and G. L. Wheeler, "Ascorbic acid in plants: Biosynthesis and function," Biochem. Mol. Biol., vol. 35, no. 4, pp. 291–314, 2000.
[18] N. Smirnoff, "The function and metabolism of ascorbic acid in plants," Ann. Bot., vol. 78, pp. 661–668, 1996.
[19] I. Afzal et al., "Magnetic field treatments improve sunflower yield by inducing physiological and biochemical modulations in seeds," Molecules, vol. 26, p. 2022, 2021, doi: 10.3390/molecules26072022.
[20] M. H. Mojbel, "Effect of ascorbic acid and organic fertilizer Seamino on growth indicators and yield of tomato plant (Lycopersicon esculentum Mill.)," J. Coll. Basic Educ., vol. 25, no. 105, 2019.
[21] M. G. Traber, "Heart disease and single-vitamin supplementation," Am. J. Clin. Nutr., vol. 85, no. 11, pp. S293–S299, 2007.
[22] H. A. Faisal, M. F. Abbas, and O. N. Jaafar, "Effect of ascorbic acid, tocopheryl and silicon on some biochemical and molecular characteristics of date palm offshoots (Barhi variety) under saline conditions," Diyala J. Agric. Sci., vol. 12, 2020.
[23] W. A. Al-Qaisi, R. W. Mahmoud, and A. S. Hamid, "Effect of proline and aspirin on seed germination and seedling growth of tomato (Lycopersicon esculentum) and Fusarium oxysporum superficial growth," Baghdad J. Sci., vol. 11, no. 2, 2014.
[24] N. Lotfi, K. Vahdati, B. Kholdebarin, and A. Reza, "Soluble sugars and proline accumulation as indicators for drought tolerance in Persian walnut (Juglans regia L.)," Fruits, vol. 65, pp. 97–112, 2010.
[25] L. B. A. Shtereva, T. Karcheva, and V. Petkov, "Effect of water stress on growth rate, water content and proline accumulation in tomato calli and seedlings," Acta Hort., vol. 789, 2008.
[26] M. F. Al-Hassan, Understanding the emptying mechanism in several varieties of bread wheat (Triticum aestivum L.) on the effect of seeding rate and nitrogen level and its relationship to grain yield and its components, Ph.D. thesis, Coll. Agric., Univ. Baghdad, 2011.
[27] A. J. H. Al-Saadi, A. G. M. Al-Qazzaz, and S. S. Yahya, "Role of proline in growth and yield of wheat under sodium chloride stress," J. Coll. Basic Educ., no. 76, pp. 801–812, 2012.
[28] J. G. Mayer, "The common oat (Avena sativa) has been named medicinal plant of the year 2017," Forstchengrppe Klostermedizin, 2017.
[29] A. A. G. H. S. Al-Ani, Effect of foliar feeding with zinc and potassium fertilization on the growth, yield and quality of two cultivars of white corn, M.Sc. thesis, Coll. Agric., Anbar Univ., 2011.
[30] S. Kahrizi, M. Sedghi, and O. Sofalian, "Effect of salt stress on proline and antioxidant enzymes in ten durum wheat cultivars," Ann. Biol. Res., vol. 3, no. 8, pp. 3870–3874, 2012.
[31] J. K. Datta, S. Nag, A. Banerjee, and N. K. Mondal, "Impact of salt stress on five wheat (Triticum aestivum L.) cultivars under lab conditions," J. Appl. Sci. Environ. Manag., vol. 13, no. 3, pp. 93–97, 2009.
[32] A. M. A. Alhakimi and A. M. Desert, "Counteraction of salinity stress on wheat plants by grain soaking in ascorbic acid, thiamin or sodium salicylate," Biol. Plant., vol. 44, pp. 253–261, 2001.
[33] M. Z. Alam, T. Stuchbury, R. E. I. Naylor, and M. A. Rashid, "Effect of salinity on growth of some modern rice cultivars," J. Agron., vol. 3, no. 1, pp. 1–10, 2004.
[34] H. Farahbakhsh, "Germination and seedling growth in unprimed and primed fennel seeds under NaCl-induced water stress," Int. Res. J. Appl. Basic Sci., vol. 3, no. 4, pp. 737–744, 2012.
[35] C. Zorb et al., "Biochemical response of maize (Zea mays L.) to salt stress characterized by symptom mitigation not adaptation," Plant Sci., vol. 167, pp. 91–100, 2004.

BIOGRAPHIES OF AUTHORS

	Leqaa Taher Kamel at the College of Education for Pure Science, University of Diyala, Iraq. Master of Life Sciences. Email: Lekaa.taher@gmail.com Scopus
	Azhar Lateef Shwish at the College of Education for Pure Science, University of Diyala, Iraq. Master of Life Sciences. Email: azharsh652@gmail.com Scopus
	Dorees Taher Hasan higher Diploma College of Education for Pure Science, University of Diyala, Iraq. Email: lwy88941@gmail. com Scopus