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Research Article

Effect of Salinity Stress on Yield and Its Components as Affected by some Antioxidants Foliar Application of Two Wheat Cultivars

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Abstract:

Salt affected soil is one of the limiting factors of cereal crop production all over the world. There are various ways to improve salt-tolerant of crops. One of these methods is the plant breeders and used spray foliar application of antioxidants and growth regulators. The aim of this work was to study the effect of some antioxidants on mitigating salinity stress and improving plant parameters and production of two wheat (*Triticum aestivum* L.) cultivars grown under salinity stress in the north Delta of Egypt. In a split–split plot design with three replicates. Two wheat cultivars (cv. Sakha 95 and Misr 3) were used with antioxidants foliar spray treatments: control, silicate potassium (300 mg L^{-1}), ascorbic acid (200 mg L^{-1}) and salicylic acid (200 mg L^{-1}) under two types of soil (normal and saline). The results showed that Sakha 95 cultivars exceeded the Misr 3 cultivars in biological and grain yield in both seasons, which the both yields increased an average of both seasons by 10% and 13%, respectively. An average increase in plant height, spike length, number of kernels/spike and 1000-kernel weight were reached 20.4%, 15.4%, 28.8% and 8.7%, respectively, after the application of ascorbic acid compared to untreated plant (control). The foliar spray by ascorbic acid (ASA) with Sakha 95 cultivars significantly surpassed plant height, spike length, number of kernels/spike, 1000-kernel weight, grain and biological yield under normal and saline soils. It can be concluded that using c.v Sakha 95 and a foliar spray by the ASA is most effective ways for increasing wheat productivity under salinity stress condition.

1. Introduction

Wheat (*Triticum aestivum*) is considered one of the world's major cereals, especially in Egypt (FAO, 2020). The national production represents about 8.9 million Mg (2020-2021), and the total consumption increased to 20.6 million Mg due to the annual population growth, which is considered a high country in wheat imports (FAO, 2021 a).

Salt-affected soils are found in as many as 118 countries, comprising 13.1% of world soils (FAO, 2021 b). In the Egyptian Nile Delta 56% of irrigated soils is salt-affected (Aboelsoud et al., 2022). Salinity stresses lead to excessive production of ROS causing progressive oxidative damage and ultimately cell death. Furthermore, induces lipid peroxidation, disrupt nucleic acids that ultimately decreases the consistency and overall yield of the affected seed (Kumari and Kaur 2020). Nadeem et al., (2020) reported that salinity negatively influenced the yield, nutritional quality traits, and mineral nutrient content in wheat crop due to altering ion homeostasis, water status, and assimilate partitioning.

In 20th century, the major focus was on the management of salt-affected soils, improving salt-tolerant crops "biological fix" was realized as become a substitutional to soil reclamation. This triggered plant breeders to initiate breeding programs aimed at developing salt-tolerant crop cultivars (Ashraf and Munns 2022). El-Hawary et al., (2022) revealed that the cultivars Misr 3 and Sakha 95 manifested higher grain yield under the soil salinity conditions with the lowest reduction, which indicates a good ability to tolerate difficult growing conditions.

The integrated and sustainable strategy to enhance salt tolerance in wheat by using the spray foliar application of antioxidants and growth regulators to mitigate the harmful effect of salinity on wheat yield and grain quality (El-Sabagh et al., 2021). Under salt stress conditions, the foliar application of potassium silicate increases the enzymatic activities of antioxidants, thereby reducing the permeability of the plasma membrane and increasing the activity of the roots. This, in turn, enhances nutrient uptake (Ibrahim et al., 2016), and improves plant growth (Ahmad et al., 2013). Salem et al., (2017) obtained that the foliar application of potassium silicate increased growth parameters and yield components of wheat plants grown salinity stress. As same as the salicylic acid exogenously applied can maintain cellular detoxification through the regulation of antioxidant defense systems (El-Hawary et al., 2023), regulation of plant physiological processes (Talaat and Shawky 2022). Furthermore, it not only led to a higher grain yield of wheat, but also significantly improved their salt tolerance (Pirasteh-Anosheh et al., 2022). Iqbal et al. (2022) showed that the exogenous application of 1.0 mM of salicylic acid (SA) positively influenced the 90% germination percentage, growth, biomass of plants, gas exchange attributes, photosynthetic rate, glycine betaine, MDA, carbohydrates, protein, and electrolyte leakage, antioxidant activities of enzymes and yield parameters of wheat under salinity stress. Also, ascorbic acid is one of the most important antioxidants in plants that alleviate different environmental stresses, furthermore, it has been found to enhance markedly the capacity of antioxidants and to improve protein metabolism to moderate oxidative stress (Akram et al., 2017), which plays an important role in plant growth and development, cell division, cell wall metabolism, cell expansion, shoot apical meristem formation, root development, photosynthesis, regulation of fluorescence, and regulation of leaf senescence (Ortiz-Espín et al., 2017). The foliar application of ascorbic acid increased the yield of the wheat crop (Osman and Nour Eldein 2017 and Ishaq et al., 2021).

The main objective of the present study is to use foliar antioxidants spray to alleviate hazards on wheat (*Triticum aestivum L.*) grown under normal and salt stress condition.

2. Materials and Methods

2.1. Experimental design and Treatments

In a split split–plot design with three replicates, a lysimeters experiment was carried out on two wheat cultivars (*Triticum aestivum* L., c.v Sakha 95 and Misr 3) during two successive seasons 2020/21 and 2021/22 at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate, Egypt (31° 5'38.70" latitude N and 30°56'54.00" longitude E with an elevation 6 m above mean sea level). This study aimed to study the effect of foliar spraying with antioxidants on the productivity of wheat crop (*Triticum aestivum* L.) and reduce the harmful effect of salinity on two cultivars of wheat (Sakha 95 and Misr 3) under salt stress condition. The main plots included two types of soil (normal and saline), the sub-plots were randomly assigned to two wheat cultivars (Sakha 95 and Misr 3), and the sub-sub plots were to various foliar treatments: control, silicate potassium (300 mg K_2SiO_3 L^{-1}), ascorbic acid (200 mg ASA L^{-1}) and salicylic acid (200 mg SA L^{-1}). Some soil properties as shown in Table 1.

Table 1. Soil test of the lysimeter experiment before two growing seasons.

Soil types	Lysimeters	pH	EC (dS m^{-1})	ESP	OM (%)	BD (Mg m^{-3})	Soil mechanical analysis (%)		
							Sand	Silt	Clay
Normal	Group 1	8	3.5	9.33	1.3	1.32	19.1	29.8	51.2
	Group 2	8	3.3	8.93	1.2	1.31	19.2	29.9	50.9
	Group 3	7.9	3.4	9.16	1.2	1.33	19.1	29.9	51.1
	Group 4	8.1	3.7	10.2	1.2	1.31	19.2	30	50.9
	Average	8	3.5	9.41	1.2	1.32	19.1	29.9	51.0
Saline	Group 1	8.3	8	15.4	1.2	1.36	18.6	29.1	52.2
	Group 2	8.3	8.2	15.6	1.2	1.34	18.9	29.5	51.6
	Group 3	8.3	8.1	15.9	1.2	1.33	18.8	29.4	51.8
	Group 4	8.3	7.9	15.4	1.2	1.36	18.7	29.2	52.1
	Average	8.3	8.1	15.6	1.2	1.35	18.8	29.3	51.9

* pH = Power Of Hydrogen, EC = Electrical Conductivity, ESP= Exchangeable Sodium Percentage, OM%= Organic matter content, BD= Bulk density

The total lysimeters used were 48 plots (lysimeter area was 0.78 m^2), which had divided into 4 groups; each group includes 12 lysimeters. Two wheat cultivars (Sakha 95 and Misr 3) were graciously supplied by the Sakha Wheat Research Department, Field Crops Research Institute, Agricultural Research Center, Egypt; Names, pedigrees and Selection history are shown in Table 2. Plants were irrigated every 30 days and all cultural practices were followed according to the recommendations of the Egyptian Ministry of Agriculture. All foliar application treatments were applied twice at 35 and 50 days after sowing.

2.2. Measurements and analysis

2.2.1. Soil analysis

Soil samples representing the surface of 30 cm were collected for analysis according to methods cited by Richards (1954), Vomocil (1957), Dewis and Fertias (1970), Hesse (1971), Cottenie et al., (1982) and Page et al., (1982).

Table 2. Pedigrees and Selection history of the studied wheat cultivars

Cultivar	Pedigree&Selection history
Sakha 95	PASTOR//SITE/MO/3/CHEN/AEGILOPS SQUARROSA (TAUS)//BCN/4/WBLL1(CMSA01Y00158S-040P0Y-040M-030ZTM- 040SY-26M-0Y-0SY-0S).
Misr 3	ATTILA*2/PBW65*2/KACHU (CMSS06Y00582T-099TOPM-099Y-099ZTM-099Y-099M-10WGY-0B-0EGY).

2.2.2. Wheat yield and its attributes

At harvest plant height (cm), spike length (cm), number of kernels/spike, 1000 – kernel weight (g), biological yield (ton fed^{-1}) and grain yield (ton fed^{-1}).

2.3. Statistical analysis

All statistical analysis was performed using analysis of variance technique by “MSTAT-C” (1990) computer software package and treatment means was compared with Duncan Multiple Range Test the treatments were compared at 0.01% level of significance Duncan (1955).

3. Results

3.1. Wheat yield and its attributes:

3.1.1. Wheat attributes:

Data presented in Table (3) show the effect of soil salinity, wheat cultivars, foliar spray and their interaction on what attributes (plant height, spike length, number of kernels/spike and 1000-kernel weight). The results proved that wheat attributes were reduced high significant compared to unstressed condition (normal soil).

A significant difference among wheat cultivars attributes across both seasons. Sakha 95 cultivars significantly surpassed plant height (94.29 and 95.00 cm), spike length (9.50 and 9.98 cm), and 1000-kernel weight (52.54 and 53.20 g). Whereas, Misr 3 showed better performance in number of kernels $spike^{-1}$ (10.13 and 10.21). Insignificant differences in spike length value in the first season. Foliar spraying was accompanied by a significant increase in selected wheat attributes than that control treatment.

The result cleared that, the application of ascorbic acid (ASA), was high significantly affecting the wheat attributes. An average increase in plant height, spike length, number of kernels/spike and 1000-kernel weight were reached 20.4%, 15.4%, 28.8% and 8.7%, respectively, after the application of ascorbic acid compared to untreated plant (control).

Table (3) demonstrates the interaction between soil salinity and wheat cultivars on wheat attributes. Both cultivars grown under normal or/and saline conditions showed insignificant or slight reduction in plant height, spike length, number of kernels/spike and 1000-kernel weight.

Concerning the interaction of soil salinity and foliar spraying, the results in Table (3) showed that there was a highly significant difference for all traits in both seasons. Application of (ASA) recorded the best treatment for counteracting salinity stress in terms of the wheat yield attributes. Furthermore, a foliar spray by silicate potassium (K_2SiO_3) is no differences of significance with the application of (ASA) for spike length in both seasons.

Regarding the combinations between cultivars and foliar spray, the data illustrated in Table (3) clearly indicate that antioxidants foliar application, especially ascorbic acid with Sakha 95 gave a highest mean values of plant height (101.67 and107.83 cm) and 1000-kernel weight (54.66 and 55.40 g). While, the maximum number of kernels/spike was obtained with ascorbic acid + Misr 3 (11.50 and 11.50) or with Sakha 95 (11.33 and 11.17). Insignificant differences in spike length in both seasons.

For the interaction of soil salinity, cultivars and foliar spray, data shown in Table (4) indicate highly significant differences for plant height in the 1st season, number of kernels spike^{-1} in the 2nd season and 1000-kernel weight in both seasons. The greatest values were obtained from foliar spray by ascorbic acid (ASA) + Sakha 95 under the unstressed condition.

3.1.2. Wheat yield

Biological and grain yield of the two wheat cultivars as affected by soil salinity and foliar spray, and their interaction in the 2020/21 and 2021/22

Table 3. The plant height, spike length, number of kernels/spike and 1000-kernel weight of the two wheat cultivars as affected by soil salinity and foliar spraying with some antioxidants in 2020/21 and 2021/22 seasons.

	Factors	**Plant height (cm)**		**Spike length (cm)**		**Number of kernels/spike**		**1000 – kernel weight (g)**	
		2020/21	2021/22	2020/21	2021/22	2020/21	2021/22	2020/21	2021/22
Soil salinity(A)									
Normal		94.88a	95.65a	9.63a	10.04a	55.15a	55.36a	52.75a	53.40a
Saline		91.75b	92.15b	9.23b	9.71b	52.89b	52.89b	51.74b	52.43b
F-test		**	**	**	**	**	**	**	**
Cultivars (B)									
Sakha 95		94.29a	95.00a	9.5	9.98a	53.58b	53.37b	52.54a	53.20a
Misr 3		92.33b	92.79b	9.35	9.77b	54.50a	54.93a	51.96b	52.63b
F-test		**	**	ns	*	**	*	**	**
Foliar spray (C)									
Control		85.00d	85.71d	8.33c	9.25c	47.08c	47.99c	50.03d	50.67d
ASA		100.21a	105.38a	10.00a	10.25a	61.44a	60.96a	54.38a	55.13a
SA		92.83c	89.04c	9.38b	10.00b	53.80b	53.80b	51.75c	52.21c
K_2SiO_3		95.21b	95.46b	10.00a	10.00b	53.80b	53.80b	52.83b	53.65b
F-test		**	**	**	**	**	**	**	**
				Bilateral interaction					
Soil salinity (A)	**Cultivars (B)**								
Normal	Sakha 95	95.96	96.75	9.71	10.21a	55.15a	54.7	52.96a	53.67
	Misr 3	93.79	94.54	9.54	9.88b	55.15a	56.04	52.54b	53.13
Saline	Sakha 95	92.63	93.25	9.29	9.75cd	52.01b	52.01	52.11c	52.73
	Misr 3	90.88	91.04	9.17	9.67d	53.80c	53.8	51.37d	52.12
F-test		ns	ns	ns	**	**	ns	*	ns
Soil salinity(A)	**Foliar spray (C)**								
Normal	Control	88.33f	87.00g	8.83e	9.67c	48.42d	50.21d	50.90g	51.42e
	ASA	101.92a	108.50a	10.00a	10.50a	64.56a	63.66a	54.97a	55.85a
	SA	93.83d	89.92e	9.67b	10.00b	53.80c	53.80c	51.92e	52.27d
	K_2SiO_3	95.42c	97.17c	10.00a	10.00b	53.80c	53.80c	53.23c	54.07b
Saline	Control	81.67g	84.42h	7.83f	8.83d	45.73e	45.73e	49.15h	49.92f
	ASA	98.50b	102.25b	10.00a	10.00b	58.28b	58.28b	53.78b	54.40b
	SA	91.83e	88.17f	9.08c	10.00b	53.80c	53.80c	51.59f	52.15d
	K_2SiO_3	95.00c	93.75d	10.00a	10.00b	53.80c	53.80c	52.44d	53.23c
F-test		**	**	**	**	**	**	**	**
Cultivars (B)	**Foliar spray (C)**								
Sakha 95	Control	86.58g	86.50f	8.5	9.5	45.73d	45.73d	50.63f	51.37e
	ASA	101.67a	107.83a	10	10.42	60.97a	60.08a	54.66a	55.40a
	SA	93.50e	89.25e	9.5	10	53.80b	53.80b	51.86e	52.27d
	K_2SiO_3	95.42c	96.42c	10	10	53.80b	53.80b	53.01c	53.77c
Misr 3	Control	83.42h	84.92g	8.17	9	48.42c	50.21c	49.43g	49.97f
	ASA	98.75b	102.92b	10	10.08	61.87a	61.87a	54.09b	54.85b
	SA	92.17f	88.83e	9.25	10	53.80b	53.80b	51.65e	52.15d
	K_2SiO_3	95.00d	94.50d	10	10	53.80b	53.80b	52.66d	53.53c
F-test		**	**	ns	ns	**	*	**	**

Note*: ***and**** indicate a significant difference and **NS** indicates an insignificant difference at *P<0.01*. Different lowercase letters in the column indicate a significant difference between the treatments, while the same letters show no statistical difference at *P<0.01* (Duncan's multiple range test). ASA = Ascorbic acid, SA = Salicylic acid, K_2SiO_3 = Silicate potassium.

seasons are presented in Table (5). Data showed that the soil salinity resulted in a highly negative effect on biological, grain yield in both seasons. Soil salinity caused a marked reduction in biological yield by (14.84 and 20.15 %) and grain yield (17.86 and 18.34%) compared with normal soil in the two easons, respectively.

The results indicated that, Sakha 95 cultivars exceeded the Misr 3 cultivars in biological and grain yield in both seasons, which the both yields increased an average of both seasons by 10% and 13%, respectively.

Foliar spraying treatments caused an observed increase in biological and grain yield compared to untreated plants (control). Ascorbic acid recorded the highest increases in the biological and grain yield, followed by potassium silicate, while, the lowest increase was obtained with salicylic acid Table (5).

The soil salinity × cultivars interaction is positive affect the biological yield of wheat only in the 1st season (Table 7). However, insignificant effects on the grain yield of wheat in both seasons and in the 2nd season with biological yield.

Table (5) refers that the interaction between soil salinity and foliar spray on the biological and grain yield. Ascorbic acid more effective foliar spray treatment under normal and saline soil conditions than that other foliar spray treatments (SA and K_2SiO_3).

Table 4. Interaction effect of soil salinity, wheat cultivars and foliar spray on the plant height, spike length, number of kernels/spike and 1000-kernel weight in the 2020/21 and 2021/22 seasons.

Factors			**Plant height (cm)**		**Spike length (cm)**		**Number of kernels/spike**		**1000 – kernel weight (g)**	
	Seasons		2020/21	2021/22	2020/21	2021/22	2020/21	2021/22	2020/21	2021/22
Soil salinity(A)	**Cultivars (B)**	**Foliar spray (C)**								
Normal	Sakha 95	Control	90	87.00k	9	10.00b	48.42e	48.42	51.13j	51.77g
		ASA	103.33	111.50a	10	10.83a	64.56a	62.77	55.33a	56.30a
		SA	94.67	90.00i	9.83	10.00b	53.80d	53.8	52.00gh	52.33f
		K_2SiO_3	95.83	98.50e	10	10.00b	53.80d	53.8	53.38de	54.27cd
	Misr 3	Control	86.67	87.00k	8.67	9.33c	48.42e	52.01	50.67k	51.07h
		ASA	100.5	105.50b	10	10.17b	64.56a	64.56	54.60b	55.40b
		SA	93	89.83i	9.5	10.00b	53.8	53.8	51.83h	52.20fg
		K_2SiO_3	95	95.83f	10	10.00b	53.8	53.8	53.07e	53.87d
Saline	Sakha 95	Control	83.17	86	8	9.00d	43.04f	43.04	50.12l	50.97h
		ASA	100	104.17c	10	10.00b	57.39c	57.39	53.98c	54.50c
		SA	92.33	88.50j	9.17	10.00b	53.80d	53.8	51.71hi	52.20fg
		K_2SiO_3	95	94.33g	10	10.00b	53.80d	53.8	52.63f	53.27e
	Misr 3	Control	80.17	82.83m	7.67	8.67e	48.42e	48.42	48.18m	48.87i
		ASA	97	100.33d	10	10.00b	59.18b	59.18	53.58d	54.30cd
		SA	91.33	87.83jk	9	10.00b	53.80d	53.8	51.47ij	52.10fg
		K_2SiO_3	95	93.17h	10	10.00b	53.80d	53.8	52.25g	53.20e
F-test			ns	**	ns	*	**	ns	**	**

Note*: *and indicate a significant difference and **NS** indicates an insignificant difference at $P<0.01$. Different lowercase letters in the column indicate a significant difference between the treatments, while the same letters show no statistical difference at $P<0.01$ (Duncan's multiple range test).

Table 5. Biological and grain yields of the two wheat cultivars as affected by soil salinity and foliar spraying with some antioxidants in 2020/21 and 2021/22 seasons.

Factors		Biological yield (ton fed^{-1})		Grain yield (ton fed^{-1})	
Seasons		2020/21	2021/22	2020/21	2021/22
Soil salinity(A)					
Normal		4.72a	4.89a	1.98a	2.00a
Saline		4.11b	4.07b	1.68b	1.69b
F-test		**	**	**	**
Cultivars (B)					
Sakha 95		4.59a	4.76a	1.94a	1.96a
Misr 3		4.25b	4.20b	1.72b	1.73b
F-test		**	**	**	**
Foliar spray (C)					
Control		3.21d	2.96d	1.16d	1.19d
ASA		6.21a	6.16a	2.53a	2.54a
SA		3.76c	4.00c	1.67c	1.69c
K_2SiO_3		4.49b	4.79b	1.95b	1.98b
F-test		**	**	**	**
Bilateral interactions					
Soil salinity (A)	**Cultivars (B)**				
Normal	Sakha 95	4.96a	5.09	2.08	2.12
	Misr 3	4.48	4.69	1.88	1.89
Saline	Sakha 95	4.22c	4.42	1.8	1.8
	Misr 3	4.01d	3.71	1.57	1.58
F-test		*	ns	ns	ns
Soil salinity(A)	**Foliar spray (C)**				
Normal	Control	3.29f	3.58c	1.39g	1.42f
	ASA	6.97a	6.76a	2.77a	2.80a
	SA	3.87e	4.16bc	1.70e	1.74e
	K_2SiO_3	4.76c	5.06b	2.04c	2.06c
Saline	Control	3.12f	2.35d	0.94h	0.96g
	ASA	5.44b	5.55b	2.29b	2.27b
	SA	3.66e	3.84c	1.64f	1.64e
	K_2SiO_3	4.23d	4.52b	1.86d	1.89d
F-test		**	*	**	**
Cultivars (B)	**Foliar spray (C)**				
Sakha 95	Control	3.27g	3.51	1.32f	1.35e
	ASA	6.61a	6.51	2.73a	2.73a
	SA	3.83e	4.06	1.69e	1.71d
	K_2SiO_3	4.64c	4.95	2.01c	2.05c
Misr 3	Control	3.15g	2.42	1.01g	1.03f
	ASA	5.80b	5.8	2.34b	2.34b
	SA	3.70f	3.94	1.65e	1.66d
	K_2SiO_3	4.34d	4.63	1.89d	1.91c
F-test		**	ns	**	*

Note*: *****and**** indicate a significant difference and **NS** indicates an insignificant difference at $P<0.01$. Different lowercase letters in the column indicate a significant difference between the treatments, while the same letters show no statistical difference at $P<0.01$ (Duncan's multiple range test).

Concerning the interaction of cultivars and foliar spray, the results in Table (5) show that there is a difference in the biological, grain yield of both cultivars. The highest biological and grain yield was observed with Sakha 95 cv. + foliar spray by ascorbic acid (ASA). While, Misr 3 without spraying by control gives the lowest values. Insignificant differences in biological yield in the 2nd season.

For the interaction of soil salinity, cultivars and foliar spray, data shown in Table (6) indicate highly significant differences for grain yield in both seasons and a significant difference in biological yield in 2nd season. Insignificant differences in biological yield in 1st season. The greatest values were obtained from foliar spray by ascorbic acid (ASA) + Sakha 95 under the saline condition.

4. Discussion

Wheat attributes

The results in this study cleared; there the wheat attributes showed adverse effects under salt stress. This decrease might be attributed to salinity stress negatively affects the metabolism, particularly the nitrogen or carbon assimilatory pathway, which in turn reflects a reduced growth and yield (Ashraf and Harris 2013; Gadallah et al., 2017 and Din et al., 2020).

Table 6. Interactions between soil salinity, cultivars and foliar spray on biological yield and grain yield during 2020/21 and 2021/22 seasons.

Factors			Biological yield (ton fed^{-1})		Grain yield (ton fed^{-1})	
	Seasons		2020/21	2021/22	2020/21	2021/22
Soil salinity(A)	**Cultivars (B)**	**Foliar spray (C)**				
Normal	Sakha 95	Control	3.37	3.65ghi	1.44h	1.47hi
		ASA	7.61	7.31a	3.05a	3.09a
		SA	3.94	4.21efgh	1.72fg	1.77fg
		K_2SiO_3	4.92	5.21cd	2.09cd	2.13cd
	Misr 3	Control	3.21	3.51hi	1.35hi	1.36ij
		ASA	6.34	6.21b	2.50b	2.52b
		SA	3.8	4.11fghi	1.68fg	1.70fg
		K_2SiO_3	4.59	4.91de	1.99d	2.00cde
Saline	Sakha 95	Control	3.16	3.37i	1.20i	1.23j
		ASA	5.62	5.71bc	2.41b	2.37b
		SA	3.72	3.91ghi	1.66fg	1.65fgh
		K_2SiO_3	4.36	4.69def	1.92de	1.96de
	Misr 3	Control	3.08	1.34j	0.67j	0.70k
		ASA	5.26	5.39cd	2.18c	2.17c
		SA	3.6	3.77ghi	1.62g	1.62gh
		K_2SiO_3	4.09	4.36efg	1.80ef	1.82ef
F-test			ns	*	**	**

Note*: ***and** indicate a significant difference and **NS** indicates an insignificant difference at *P<0.01*. Different lowercase letters in the column indicate a significant difference between the treatments, while the same letters show no statistical difference at *P<0.01* (Duncan's multiple range test).

A significant difference among wheat cultivars attributes across both seasons. Sakha 95 cultivar significantly surpassed plant height, spike length, and 1000-kernel weight. Whereas, Misr 3 showed better performance in number of kernels spike^{-1}. These results agreed with Ibrahim et al., (2022) found that cultivar Misr 3 surpassed in 1000 kernel weight.

The positive effect of ascorbic acids on yield components could be attributed to its role as a cofactor for enzymes involved in photosynthesis, hormone biosynthesis, and the regeneration of antioxidants (Tuna et al., 2013; Ahmad et al., 2014; Yaghoubian et al., 2014; Chattha et al., 2015).

The interaction between soil salinity and wheat cultivars on wheat attributes showed that the both cultivars grown under normal or/and saline conditions showed insignificant or slight reduction in plant height, spike length, number of kernels/spike and 1000-kernel weight. The results were aligned Hasan et al., (2015) noted that saline stress reduced significantly wheat attributes either tolerant or sensitive cultivars. These results agreed with Abd El-Hamid et al., (2020), Genedy and Eryan (2022), Elsawy et al., (2023) and Khedr et al., (2023).

Concerning the interaction of soil salinity and foliar spraying, the results showed that the application of ASA recorded the best treatment for counteracting salinity stress in terms of the wheat yield attributes. This result might be attributed to ascorbic acid regulates plant growth owing to its effects on cell division and differentiation (Desoky and Merwad 2015). These results agree with Bakry et al., (2013) and Ishaq et al., (2021) they reported that, the application of ascorbic acid greatly enhances the yield attributes of wheat under saline stress.

Regarding the combinations between cultivars and foliar spray, the data clearly indicate that ascorbic acid with Sakha 95 gave a higher mean value of wheat yield attributes. The results indicated that, the attitude of foliar spraying of wheat traits differed from cultivar to another.

For the interaction of soil salinity, cultivars and foliar spray, data indicated that the greatest values were obtained from foliar spray by ascorbic acid + Sakha 95 under the unstressed or/ and salinity stress conditions. The effect of these interactions on that trait was significant in both seasons, except, plant height and spike length in the first season and number of kernels/spike in the second season, indicated that these treatments are dependable on each other's in their influence on these traits.

Wheat yield

Data showed that the soil salinity resulted in a highly negative effect on biological, grain yield in both seasons, which caused a marked reduction in biological yield and grain yield compared with normal soil. The results agreed with Kumar et al., (2012), Hasan et al., (2015) and Nadeem et al., (2020) which indicated a negative effect of salinity on biological and grain yield. In addition, losses in grain weight due to saline stress are due to pollen sterility, reduced production of assimilates, and reduced partitioning to economical parts (grains) of plants (Dadshani et al., 2019).

The results indicated that, Sakha 95 cultivar exceeded the Misr 3 cultivar in biological and grain yield in both seasons. It seems that, wheat yields had affected by among cultivar to another.

Foliar spraying treatments caused an observed increase in biological and grain yield compared to untreated plants (control). Ascorbic acid recorded the highest increases in the biological and grain yield. This result agreed with El-Awadi et al., (2014) found that the treatment of wheat plants with foliar spraying of ascorbic acid resulted in an increase in the biological and grain yield.

The soil salinity × cultivars interaction is positive affect the biological yield of wheat. Those findings agree with Abd El-Hamid et al., (2020), Genedy and Eryan (2022), Elsawy et al., (2023) and Khedr et al., (2023).

Ascorbic acid more effective foliar spray treatment under normal and saline soil conditions than that other foliar spray treatments. These results agreement with Fawy and Attia (2013) and Bakry et al., (2013) and they mention that application of ascorbic acid spray led to increases in biological, grain yield under stress condition. It seems that, soil salinity affected by changing foliar spray treatments.

Concerning the interaction of cultivars and foliar spray, the results showed that the highest biological and grain yield were observed with Sakha 95 c.v + foliar spray by ascorbic acid (ASA). It seems that, wheat cultivars had affected by changing foliar spray treatments.

The interaction of soil salinity, cultivars and foliar spray, data indicated that the greatest values were obtained from foliar spray by ascorbic acid (ASA) + Sakha 95 under the saline condition. These significant interactions among these characters indicated that, these factors are dependable on each of the others in their in influences.

5. Conclusions

It can conclude that the foliar spraying using ascorbic acid at a rate of 200 mg L^{-1} led to a reduction in the harmful effects of salinity on the plants and led to an increase in the characteristics the wheat crop in favor of Sakha 95 cultivar. Therefore, it is recommended to plant Sakha 95 cultivars, due to its superiority over Misr 3 cultivars, tolerance to salinity as well as foliar spraying using ascorbic acid.

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